June 4, 1940. A. I. ABRAHAMS 2,202,886

MICROPHONE

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Fig. 1

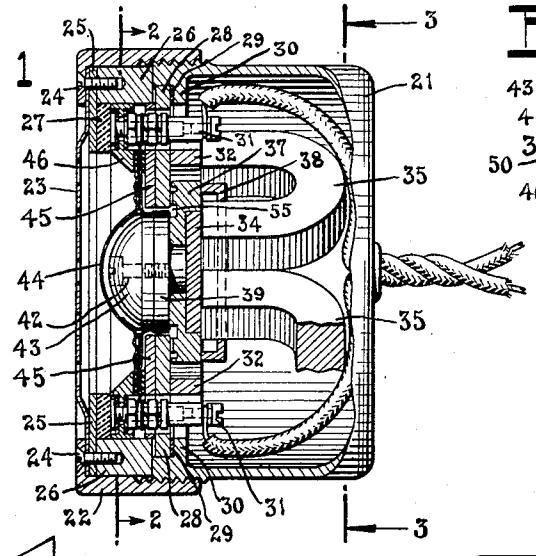


Fig. 9

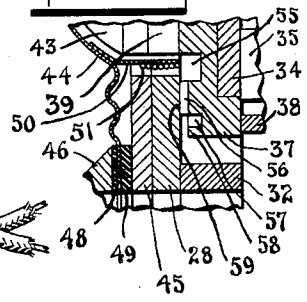


Fig. 4

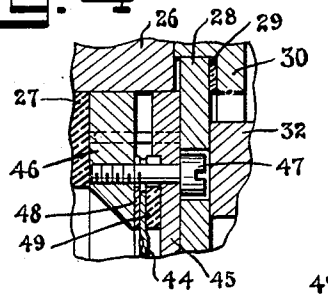


Fig. 3

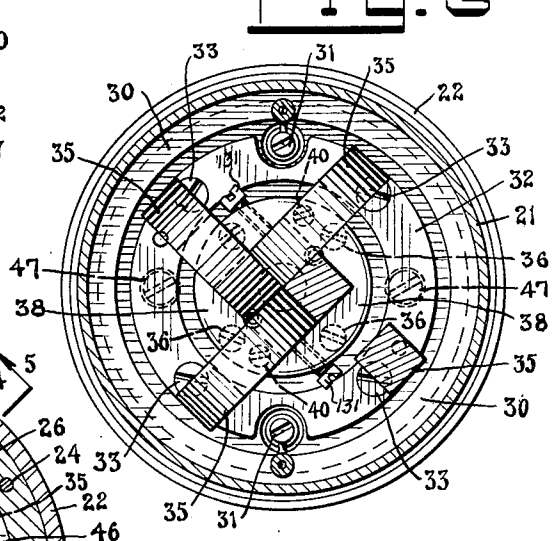


Fig. 2

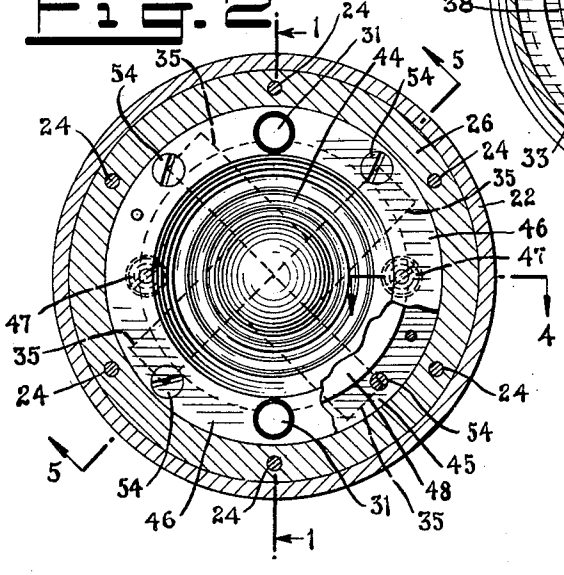
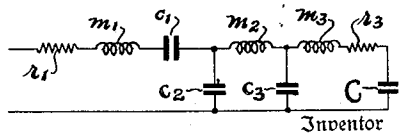


Fig. 8



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Fig. 5

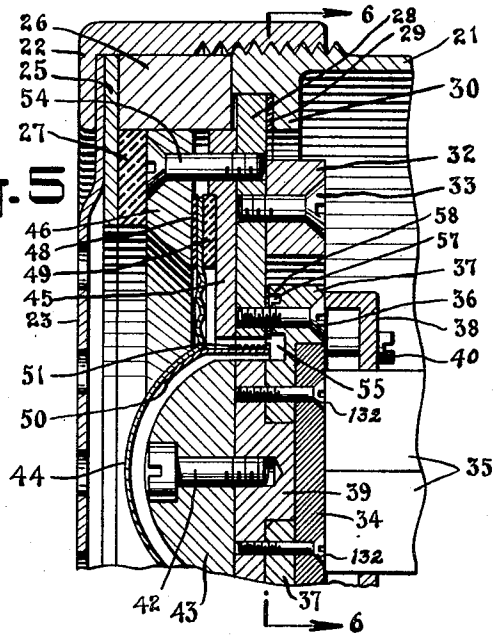


Fig. 7

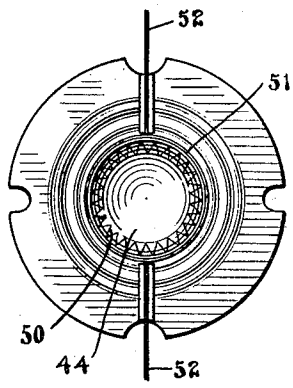
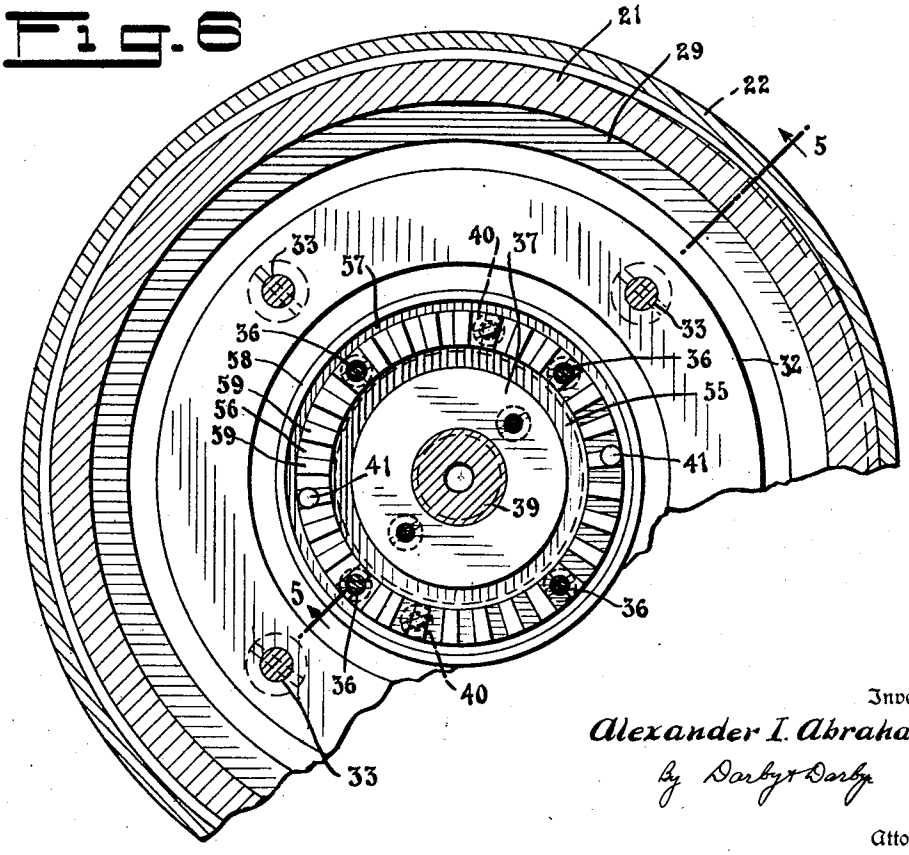


Fig. 6



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Patented June 4, 1940

2,202,886

UNITED STATES PATENT OFFICE

2,202,886

MICROPHONE

Alexander Isador Abrahams, New York, N. Y.

Application June 15, 1937, Serial No. 148,291

1 Claim. (Cl. 179—180)

This application is a continuation in part of my application Serial No. 730,390, filed June 13, 1934, for Electro-acoustic translator.

This invention relates to devices for translating acoustical vibrations into electrical impulses, which devices may be used as microphones in a public address system or radio transmission system or the like.

More particularly it relates to a microphone in which a moving diaphragm is used, and in which the motion of this diaphragm is damped by means of suitable chambers, tubes and passages. In the operation of such a device it is necessary for faithful reproduction that the damping shall have the desired effect at all frequencies within any given range.

An object of this invention is to produce a microphone having an air damped diaphragm which will respond faithfully to all signals in any given range.

Other objects of the invention are to provide devices which are cheap to manufacture, have no delicate parts requiring attention, require little skill in assembly, are not affected by weather, temperature, or climate, will stand abuse without getting out of order, and in which the operating parts are protected from injury.

In approaching the problem of suitable damping for a diaphragm used in a microphone it is possible to make use of electrical equivalents for the air chambers, tubes and passages provided. This is possible because, as is well known, the characteristics of wave motion are the same for acoustical, mechanical, or electrical systems, and the equations for the propagation, transmission, and dissipation of energy are identical except for the symbols employed. The theory underlying my invention may be explained therefore by electrical equivalents.

When a device embodying my invention has its characteristics translated into electrical equivalents it may be seen that these translated characteristics are similar to those of a band pass filter.

In the drawings,

Figure 1 is a side elevation partly in section of my microphone;

Fig. 2 is a view along the lines 2—2 of Fig. 1 in the direction of the arrows;

Fig. 3 is a view along the lines 3—3 of Fig. 1 in the direction of the arrows;

Fig. 4 is a view along the lines 4—4 of Fig. 2 in the direction of the arrows;

Fig. 5 is a view along the lines 5—5 of Fig. 2 in the direction of the arrows;

Fig. 6 is an enlarged view along the lines 6—6 of Fig. 5 in the direction of the arrows;

Fig. 7 is a view of my diaphragm and the leads connected to the moving coil thereof looking at it from the bottom, or from right to left in Fig. 5;

Fig. 8 is an approximate equivalent electrical circuit diagram of my acoustical damping arrangement; and

Fig. 9 is an enlarged view of a portion of Fig. 1.

In my device illustrated in the drawings a casing 21 having threads on its outer surface at one end is adapted to be engaged by a threaded securing member 22. A cover 23, having suitable openings therein to permit acoustical vibrations to reach the diaphragm, is secured to the member 22 by means of screws 24. A pair of spacing rings 25 and 26 are also secured to the member 22 by said screws 24. Another spacing ring 27, which may be of resilient material, engages the spacing ring 25 on its upper surface and the spacing ring 26 at its periphery. A ring of magnetic material 28, which serves as the outer pole piece for the moving coil, is engaged by another spacing ring 29 which may also be of resilient material, and which rests on a flange 30 of the casing 21. The structure comprising the working parts of my microphone is thus securely held in position between the resilient spacing members 27 and 29 for the purpose of separating acoustically the front of the diaphragm from the rear. The ring 28 has apertures therein for the passage therethrough of binding posts 31 which pass therethrough without touching. A second metallic ring 32 of magnetic material is secured to the ring 28 by screws 33 (Figs. 3, 5).

The electrical field for the moving coil may be provided by means of four permanent magnets 35 which each have one foot resting on the ring 32 and the other foot resting on magnetic plate 34 yet to be described. The arrangement of these magnets 35 is best shown in Fig. 3. The field may, of course, be provided by any other suitable means, such as electro-dynamic type magnetic structure.

Secured to the outer pole piece 28 by means of screws 36 (Figs. 3 and 5) is a damping member 37. The damping member is of non-magnetic material such as aluminum and will be described in detail hereafter. Secured to the damping member by means of screws 40 is a magnet locking member 38 which also is of non-magnetic material and is in the form of a hollow cylinder having a cover at one end, which cover is cut out at its center in the form of a square. The feet of the four magnets which rest on the plate 34 fit tightly

inside this square, and may be secured by screws 131 (Fig. 3). The magnets established a magnetic circuit from the plate 34 to the ring 32. The damping member 37 is secured between a T-plate 39 and the plate 34, both of magnetic material, which are held together by screws 132. The plate 39 is the inner pole piece. As shown in Fig. 6, pins 41 align the outer pole piece 28 with the damping member 37. Secured to the face of the pole piece 39 by means of a screw 42 is a non-magnetic face plate 43 having a dome shaped surface. A diaphragm 44, which may be of any suitable material such as aluminum or aluminum alloy, is secured between an annular spacer 45 and an annular face member 46 having a tapered edge, by means of screws 47 (Figs. 2, 3, 4). The diaphragm is provided with corrugations around its rim as shown to permit it to vibrate, and is held by the members 45 and 46 between washers 48 and 49 (better shown in Figs. 4 and 5) which allow sufficient space to permit it to vibrate. Secured to the diaphragm in any suitable manner, as by gluing, and forming an integral part thereof, is an extension 50 to which is fastened a coil of wire 51 having leads 52 connected to the binding posts 31. The members 45 and 46 are further secured together, and to the outer pole piece 28 by means of additional screws 54 (Fig. 5).

The damping member 37 may be seen in face view in Fig. 6. From Figs. 1, 5, 6 and 9 it will be seen that there is an annular groove 55 in the damping member just below the coil 51. This groove provides clearance for the movement of the coil. Extending radially from this groove are radial cuts or slots 56 (Fig. 6). The grooves 56 open into annular air chamber 57, the outer edge of which is formed by the section 58 of the damping member. As the damping member 37 rests squarely against the outer pole piece 28 outside of the coil 51, and against the inner pole piece 39 inside the moving coil, and as the washer 49 makes an air tight fit with the rim of the diaphragm, the air which is displaced beneath the diaphragm may not escape except through the chambers and passages in the face of the damping member 37. The surfaces 59 of the damping member between the grooves 56 rest flatly against the outer pole piece 28, thus providing closed passages for the air along the grooves. The outer section 58 of the damping member 37, however, is spaced from the face of the outer pole piece 28 a suitable distance to permit air to escape between the two faces. By so proportioning this space it may be caused to act practically as an equivalent electrical resistance and inductance. The slots 56 must be so proportioned as to act substantially as an equivalent electrical inductance and capacity without resistance, and chamber 57 as an equivalent electrical capacity. The air which is released through the space between the outer pole piece 28 and the face of section 58 of damping member 37 escapes inside the casing 21 to the rear of the diaphragm.

It will be noted that the entire inner structure of my microphone, including the diaphragm assembly, the damping member which provides the chambers and passages, and the inner pole piece are all supported by the outer pole piece.

The electrical circuit equivalent of the diaphragm and damping arrangement of my microphone is shown in Fig. 8. In this figure $r1$ represents the resistance of the diaphragm, $m1$ represents the inductance due to the mass of the diaphragm, and $c1$ represents the reciprocal of the stiffness of the diaphragm. $c2$ represents the reciprocal of the stiffness of the air chamber under the diaphragm plus one-half the reciprocal of the stiffness of the slots. $m2$ represents the inductance due to the mass of air in the passage or slots 56 connecting the chamber under the diaphragm with the chamber 57. $c3$ represents the reciprocal of the stiffness of the chamber 57, plus one-half the reciprocal of the stiffness of the slots. $m3$ represents the inductance due to the mass of air between the outer pole piece 28 and the face 58 of the damping member, and $r3$ represents the resistance due to the passage of air between these members. C represents the reciprocal of the stiffness of the air chamber in the casing 21 at the rear of the diaphragm.

The reason air spaces have the equivalent effect of inductance, capacity and resistance in different cases is well known, and is due to the relative configuration of the space through which the air is being transmitted. Thus the chamber under the diaphragm, chamber 57 and the chamber within the casing act as capacities because of their relatively large dimensions transverse to the direction of motion as compared to their dimensions in the direction of motion. The passages or slots 56 act as inductances and capacities without resistance because of their relatively large dimension in the direction of motion as compared to their dimension in the direction transverse to the motion, and the appreciable depth of the slots, and the passage between pole piece 28 and surface 58 acts as a combined resistance and inductance because of the relatively small, but appreciable, depth transverse to the direction of motion and relatively short length in the direction of motion.

In the construction of my microphone in the manner described it is possible to attain extreme accuracy. No washers are used to provide the spacing for the air chambers and the passages, and these may be properly made by accurate machine work. The assembly is simple and all centering may be taken care of by pins. It is thus possible for my microphone to be properly assembled by unskilled workmen, as no precise adjustments of any kind are required, these being taken care of in the machinery.

It will be noted that the space within the casing at the back in my device is an equivalent acoustical capacity. Such a capacity tends to introduce distortion. Such a capacity effect may be avoided by making this space of relatively very large size. For example, in Wente Patent No. 1,766,473, the casing is provided with openings which release into a large box which closes the rear of his device. As shown in the patents to Thuras Nos. 1,847,402, 1,869,178 and 1,964,606 this capacity effect is eliminated by providing a tube connecting the space in the rear of his diaphragm with the atmosphere outside of the device. Instead of thus avoiding a capacity effect as in these patents, I take advantage of this capacity effect in order to improve the characteristics of my device. This is done by making the space between pole piece 28 and the surface 58 of the damping member small enough to provide a resistive effect, and large enough to provide an equivalent inductive effect which, combined with the capacity effect of the casing, provides a resonant circuit which may be adjusted to any resonance desired. I thus not only provide a smaller and more compact device, but one having fewer parts and less complicated structure and, in addition, one having more degrees of

freedom so that it may be accurately designed to have a particular characteristic which may be desired in any particular case. For example, the cut-off may be made sharp at a desired frequency, or the device may be given a rising or falling characteristic with frequency, in any case where such characteristic should be desired.

What is claimed is:

A microphone comprising a diaphragm, a coil secured to said diaphragm, inner and outer pole pieces for said coil, a damping member secured directly to the inner and outer pole pieces, said damping member having therein a plurality of circumferential grooves and a plurality of radial grooves forming air chambers and passages between its surface and the surfaces of said pole pieces when attached thereto.

ALEXANDER ISADOR ABRAHAMS.