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Victoreen

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[54] **CONDENSER MICROPHONE HAVING A PLURALITY OF DISCRETE VIBRATORY SURFACES**

[76] Inventor: **John A. Victoreen,** 350 N. Maitland Ave., Maitland, Fla. 32751

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[52] **U.S. Cl.** .... **179/111 R**
[51] **Int. Cl.** **H04r 19/00**
[58] **Field of Search** .... 179/181 R, 111 R

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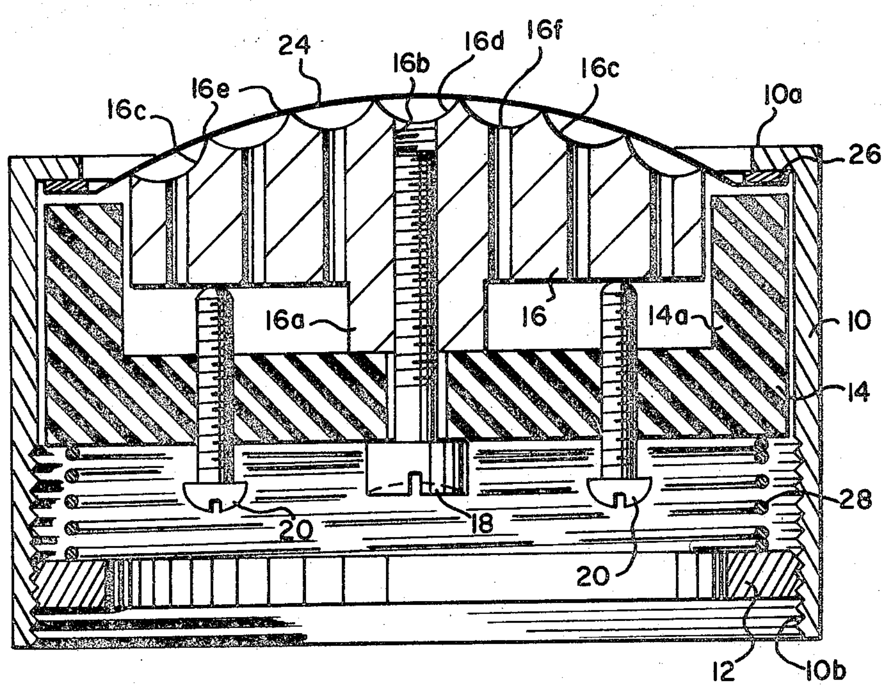
Primary Examiner—Thomas W. Brown
Attorney, Agent, or Firm—J. Darrell Douglass

[57] ABSTRACT

The diaphragm of a condenser microphone is broken up into many small pieces so that each attains a natural high frequency resonance above the range of sounds to be picked up with the sum total of the pieces providing an output as great as a single diaphragm with a lower impedance by providing a series of concentric ring contacts wih a diaphragm stretched over the rings, the highest points or ridges of which lie on a convex surface, to break up the diaphragm into annular sections.

12 Claims, 4 Drawing Figures



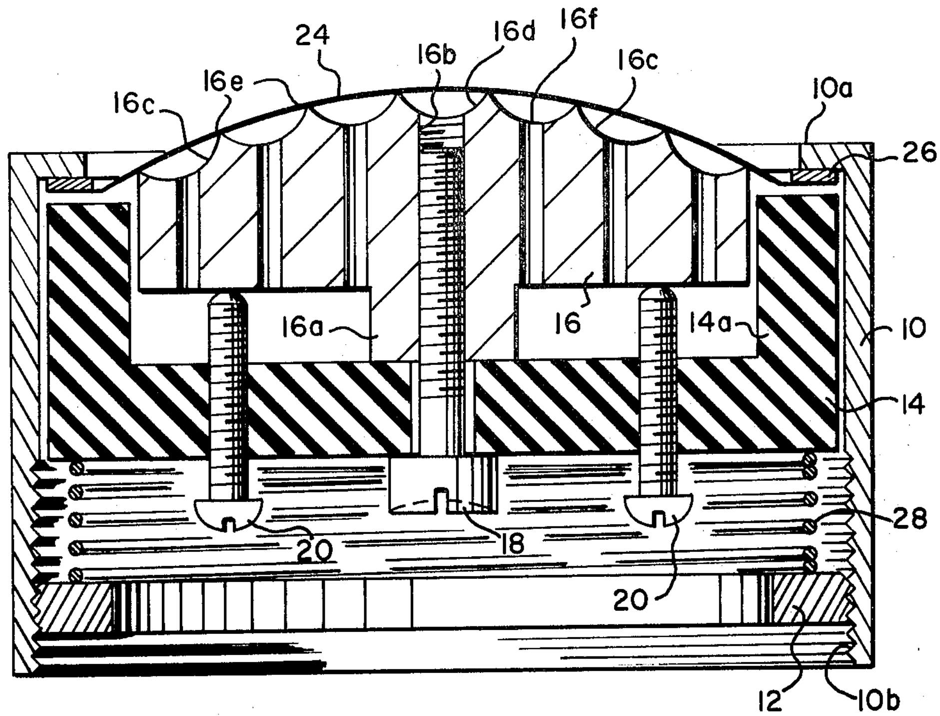

24
16b
16d
16f
16c
16e
16c
10a
26
16a
16
14a
10
14
28
20
18
20
12
10b

Fig. 1

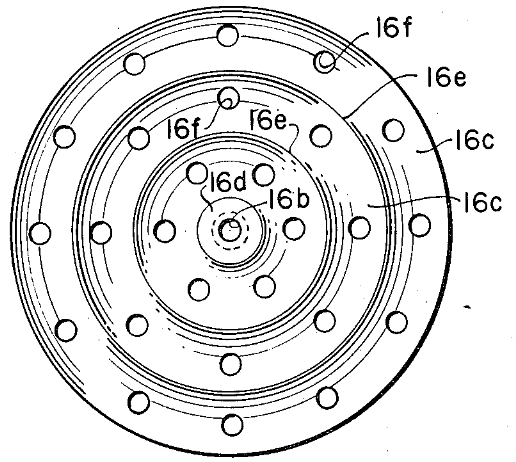


Fig. 2

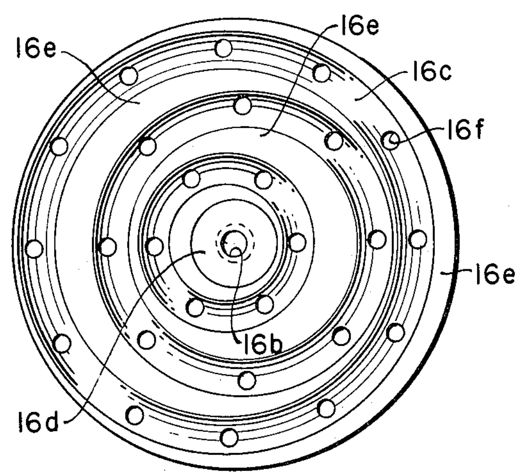


Fig. 3

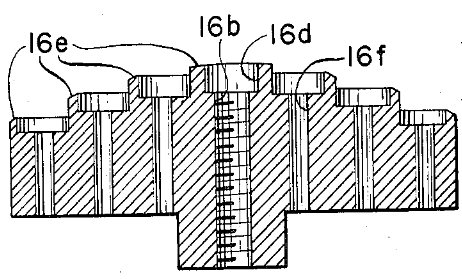


Fig. 4

CONDENSER MICROPHONE HAVING A PLURALITY OF DISCRETE VIBRATORY SURFACES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The construction of prior microphones consist essentially of a back plate, which is one plate of a condenser and a diaphragm which is spaced closely to the back plate that is the other plate of the condenser. A polarizing voltage is applied between the two plates, and the capacitance change provides the output from the device.

2. Description of the Prior Art

In the prior art, the front plate or diaphragm must be under tension, when in final position, to bring its natural resonant frequency out of the range (higher) than the sounds to be picked up. It is highly desirable to keep the spacing between the plates as close as possible to keep the incremental dynamic capacitance change as high as possible to provide maximum output. There are limitations on the closeness of the two plates due to the applied polarizing voltage which tends to pull the plates together, and there must be space for the amplitude swings of the diaphragm due to impingement of sound thereon so that the diaphragm will not touch the back plate during these swings. Both or either one of the above could cause the one to touch the other which would interfere with the operation. The present construction and the simplicity of the currently existing consenser microphones would make it appear that improvements thereon would consist largly of refinements in design.

SUMMARY OF THE INVENTION

By the present invention a microphone of the capacitance type can be made, using the usual polarizing potential, which is materially less expensive than the prior microphones but has substantially as good a frequency response.

I have found that by a different approach, limitations on previous designs that were imposed by the diameter of the diaphragm and tension thereof, which determines the upper level of natural resonant frequency, may be largely eliminated. One may reduce the natural period by reducing the operational size of the unit which ordinarily results in bad signal to noise ratio. By using a design where the diaphragm is broken up into many small pieces, each one attains such a natural high frequency that the tension of the diaphragm becomes relatively unimportant and the size of the pieces becomes insignificant, with a sum total output which is as great as a single diaphragm and a signal to noise ratio which may be as good or better than a diaphragm of the same size.

My design makes it possible to manufacture parts for the microphone in such a way that dependence on critical manufacturing tolerances is eliminated and these parts may be made by production methods which greatly decrease the overall expense by as much as a factor of 10.

Basically my invention contemplates making the diaphragm effectively into a series of effective areas by using a series of concentric ring contacts which provide a series of concentric ring areas capable of independent vibration, each ring area being so narrow that the diaphragm tension does not have to be great to raise the natural period above the resonance point in the desired range. One way to do this is to provide a generally convex surface or crown having annular grooves concentric with the axis leaving a series of concentric raised portions. A flexible diaphragm is stretched over that surface in contact with the high points on the convex surface to thus break the diaphragm up into annular sections. Instead of the high points being continuous annular rings they could be in a series of annularly arranged high points providing different shaped apices. The spacing of the rings could also be changed so that each annular ring would be of a different width thus causing the natural resonance points for each ring to be at a different frequency. The arrangement of the points could also be arranged to have different spacing to further break the resonance.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a highly enlarged sectional view of a microphone;

FIG. 2 is a top plan view of the conductive back plate on a reduced scale to that of FIG. 1.

FIG. 3 is view similar to FIG. 2 of a modification thereof;

FIG. 4 is a view similar to FIG. 1 of a modification thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing, which is greatly enlarged, there is shown a casing **10** of generally cylindrical form having an inwardly extending flange **10*a*** at one end and the other end interiorly threaded at **10*b***. Interiorly a ring **12** is threaded in the end **10*b***. A body of stiff insulating material comprising a circular base **14** having a circular flange **14*a*** extending upwardly from the base, has secured thereto the conductive back plate, or disc **16**, which constitutes one electrode of the condenser. The back plate is of generally circular disc form having a stem **16*a*** which may bear against the base and serves as a spacer and forms a back space between the back plate and the base. The stem **16*a*** has an axially threaded opening **16*b*** whereby the electrode may be secured to the base **14** by a threaded fastener **18**, the head of which engages the bottom of the base. It is pointed out that the structure illustrated is for the purpose of explanation and a better understanding of the invention; certain of the dimensions as well as the forms are exaggerated for that purpose. A single screw **18** could be used to secure the electrode or back plate **16** and the base **14** together, but it is desirable to be able to adjust the relative positions of the parts **14** – **16** and therefor screws **20** are threaded through the base **14** to engage with the bottom of rear of the disc **16** which together with the screw **18** enable the position of the disc **16** relative to the base **14** to be accuratly adjusted. As will later appear this also enables an adjustment of the diaphragm tension. Although it is contemplated that the positional relationship between the back plate or electrode disc **16** and the base **14** may be fixed as stated, it could be and is shown in this drawing as being adjustable to enable a degree of adjustment of the diaphragm electrode tension by the screws **18** and **20**. The adjustment of the screw **20** would normally be coordinated with the adjustment of the screw **18**.

The shape of the outer face of the electrode **16** can best be understood by an explanation of the manner in which it is made. The outer face of the back plate **16** is convex. It may be of parti-spherical form. For instance for a disc of ½ inch dia., the face would be formed on such a radius that a crown or center 0.005 inch higher than the edge is provided. Then a series of concentric grooves **16***c*, which may vary in number but are shown as three in the drawing, are cut into surface to such a depth that they almost touch at their edges leaving a plurality of circular concentric ridges **16***e* the highest portions of which are disposed along and follow the contour of the original surface and are sharp or of minimum area. At the center a depression **16***d* of the same contour as the grooves is provided. The grooves preferably vary in depth from the ridges **16***e* to their centers by approximately 0.001 inch or less. Air holes or ducts **16***f* extend from the bottom of the grooves preferably to the bottom of the back plate **16** opening into the space between the disc **16** and the support **14.**

It has been found that superior results are obtained by providing grooves that have a parti-circular cross section. The objective of the groove shape is to provide, together with the other electrode, maximum incremental capacitance change with impinging sound pressure while providing sufficient space for motional amplitude to occure and at the same time providing a damping means for prevention of the generation of resonance effects. It will be apparent that zones of decreasing cross section of the grooves are provided, adjacent the ridges or points of contact of the diaphragm, which provide increased damping toward the points of contact with the diaphragm. The entraped air in these zones serves to increase the diaphragm stiffness and therefor the natural resonant frequency. This points up the fact that the cross section contour of the grooves **16***c*, as well as the size of the ducts **16***f*, may be varied from that shown and described to vary the damping, the main criterion apparently being that the grooves preferably do not provide ridges with side walls normal to the surface, although such may also be useful. The grooves are preferebly concentric to each other, but there could be some eccentricity of the grooves to each other to provide ridges of varying width. FIGS. **3** and **4** show an electrode **16,** where the walls **16***d* of the grooves are normal to the surface, as can best be seen from FIG. **4.** In addition, the grooves, as best seen from FIG. **3** are eccentric to each other, thus providing ridges of varying width. It is apparent that the shape of the grooves as shown in FIG. **4,** could be used in the electrode of FIG. **1,** where the grooves are concentric.

It is pointed out that ideally the high portions of the ridges **16***e* are disposed on such a line that the pressure of the diaphragm against the points is the same but that there could be some variation, due to manufacturing tolerances, where this condition might not be exactly obtained. This would still have no material effect on its operation due to the small vibrational areas.

The other or vibrating electrode, or membrane **24,** is comprised of a thin non-conducting flexible base material on the side toward the disc **16,** having a flexible conducting surface on the outer side thereof. One such material can be one of the fluorocarbon, polyester or polycarbonate foils such as Teflon with aluminum placed thereon by evaporation although the conducting material could be placed thereon by other means. The flexible material **24** is secured in a zone at its periphery to a ring **26.** The ring and the material or membrane are ordinarily formed separately with the membrane stretched and secured to the ring in a stretched condition. The assembly is then placed over the electrode **16** and then the base and electrode as an assembly **14** inserted into the housing or shell **10.** It is contemplated that the adjustment ring **12** msy be of such a size that it easily threaded into the shell to directly engage the base **14** and hold the base toward the flanged end of the shell to thus clamp the ring **26** between the flange **10***a* of the shell and the ring **14***a* on the base **14.** Under these conditions, the tension on the diaphragm **24** may be determined by the relative position of the electrode **16** and the base **14.**

As shown in the drawing, a spring **28** is disposed between the ring **12** and the base **14** which urges the base **14** and electrode **16** with the diaphragm **24** toward the flange **10***a*. The ring **26** eventually engages the flange **10***a*. Under this condition shown, a constant tension is exerted on the diaphragm by virtue of the spring **28.** In the drawing the ring **12** engages the spring **28** or other compressible material which in turn engages the base **14** and as the ring **12** is threaded inward the base **14,** the ring **26,** with its membrane, moved into contact with the flange **10***a* at which time the membrane has been stretched into the multiple point engagement with the base electrode. Since the relative position of the electrode **16** and the base **14** can be fixed by the screws **18** and **20** this allows a fixed but resilent tension to be placed on the membrane **24.** The arrangement shown also permits of further tightning the membrane by moving the base electrode **16** upward relative to the base **14.** Thus the diaphragm tension may be fairly fixed when a ring such as **12** is used with a spring and the base and disc are secured together in the position shown.

Thus, to summarize, the structure shown enables the tension on the diaphragm to be obtained by screwing in the ring **12** in so far that the spring **28** is fully compressed to cause the ring **14***a* to clamp the diaphragm ring **26** to the flange **10***a*. This pressure may be further varied by adjusting the plate **16** relative to the base **14** by means of the screws **18 – 20.** Obviously in this case the spring could be eliminated and the ring **12** have direct contact with the base **14.** Constant tension of the diaphragm may be obtained by positioning the parts as shown in the drawing where the ring **14***a* on the base is out of contact with the ring **26** and the pressure is through the spring **28** and this tension may be varied by changing the position of the ring **12** and base **14** to the diaphragm by the back plate **16** or the relative position of the back plate and base by means of the screws **18 – 20.**

It is pointed out that the adjustment discussed such as the ability to use a spring to keep constant tension on the diaphragm, the screws connecting the back electrode to the base for relative positional variations are all in the nature of refinements and do not detract from the base electrode and the diaphragm stretched across it are such that a simplified structure may be realized and none of the adjustments needed.

It is contemplated that there may be occasions where the plastic and aluminum diaphragm are not suitable because of ambient conditions, of which temperature may be an example. In this instance and possibly for other reasons it may be desirable to use a simple metallic diaphragm which would not be inherently insulated from the base electrode. In this instance the ridges at their peaks could be of insulating material provided by anodizing or otherwise coating of the back electrode in its convex form and then forming the grooves after anodization to leave anodized ridges. With the use of a plain metallic diaphragm the adjustments shown for tension would be useful.

Although it has been stated that the device is to be used in the conventional way of condenser microphones by the application of a polarization voltage it is contemplated that the diaphragm may be permanently polarized to provide a self contained electric field by heating and cooling the dielectric material comprising the active microphone surface in the presence of a suitable electric field as is well known in the art or electrons may be directly implanted therein.

I claim:

1. An electro-acoustic transducer having a vibratile conducting electrode and a fixed conducting electrode, the improvement in which comprises a surface on the fixed electrode having a plurality of projections which decrease in height from the midpoint outwardly toward the edge with the vibratile electrode stretched over the fixed electrode with said projections having ridges which are on a line having a convex curvature and whereby each point of contact provides substantially the same amount of tension on the diaphragm as the other points and wherein said points are provided by annular grooves in a convex surface.

2. An apparatus as described in claim 1 wherein said grooves are concentric to each other.

3. An apparatus as described in claim 1 where said grooves are eccentric to each other.

4. An apparatus as described in claim 1 wherein said grooves are concave in cross section.

5. An apparatus as described in claim 1 wherein said grooves are square in cross section.

6. An apparatus as described in claim 4 wherein said concave grooves decrease in depth crosswise to their edges to the point of contact with the vibratile electrode to provide a decreasing acoustical friction from the edges toward the center and to provide mechanical damping and wherein the vibratile electrode is stretched over the fixed electrode.

7. An apparatus as described in claim 4 wherein a space is provided back of the fixed electrode and ducts communicate with the grooves and said space.

8. An apparatus as described in claim 1 wherein means is provided to adjust the position of the fixed electrode relative to the periphery of the vibratile electrode and wherein the vibratile electrode has a holding means at its periphery and wherein a housing is provided and the holding means of the vibratile electrode is engaged with the housing.

9. An apparatus as described in claim 8 wherein said housing has a cylindrical inner wall with an inwardly extending flange at one end and a ring is in threaded engagement with the other end.

10. An apparatus as described in claim 8 wherein said adjustment means includes a spring means between the fixed electrode and a support having a base is adjustably mounted in the housing.

11. An apparatus as descriped in claim 10 wherein said adjustment means is arranged to adjust the position of the fixed electrode relative to the base.

12. An apparatus as described in claim 9 wherein said holding means for the vibratile electrode is engaged with said flange and a base is provided for the fixed electrode and the fixed electrode is axially adjustable relative to the base and means is provided to hold said base in clamping engagement with the said holding means and said flange.

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