

Oct. 27, 1959

W. L. HARTSFIELD

2,910,539

MICROPHONES

Filed July 27, 1956

3 Sheets-Sheet 1

Fig. 1

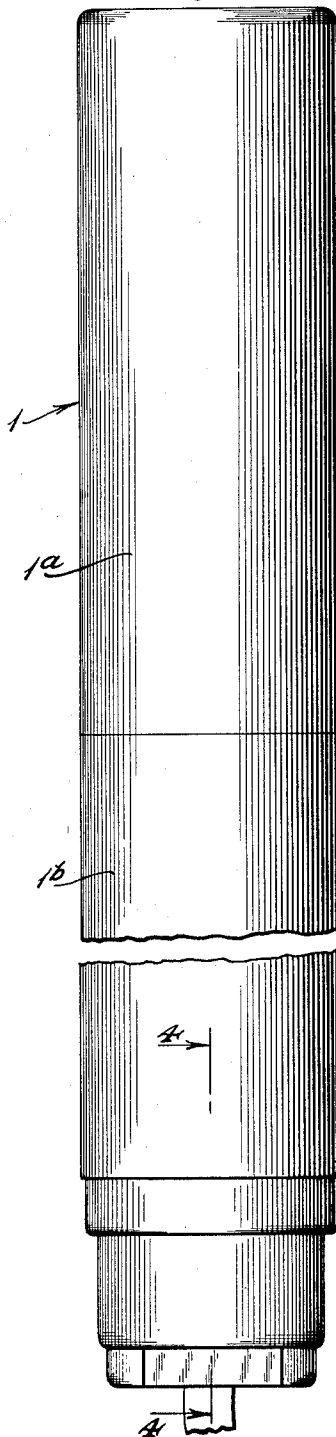


Fig. 2

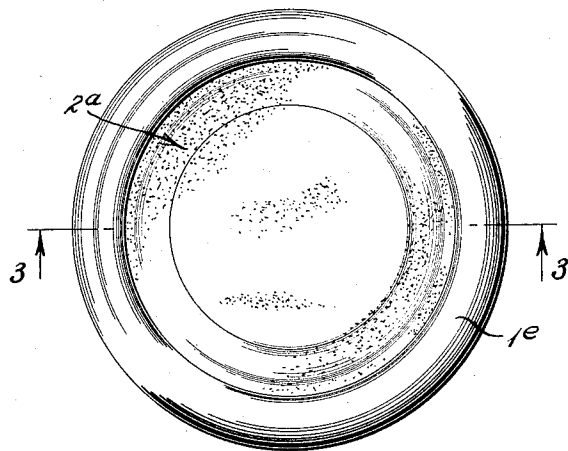
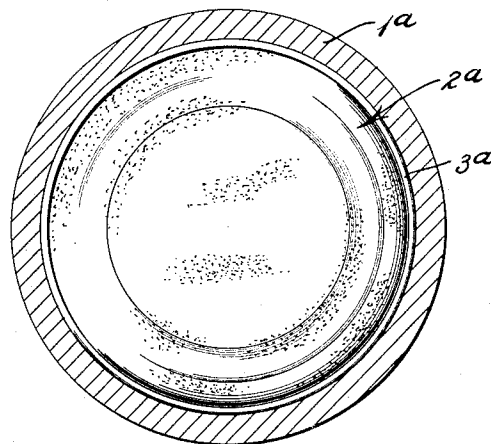


Fig. 5



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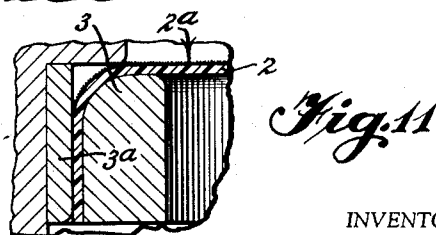
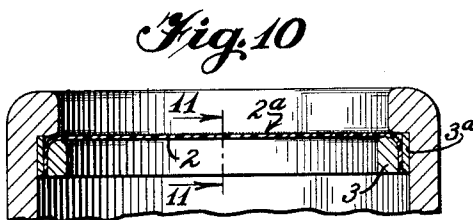
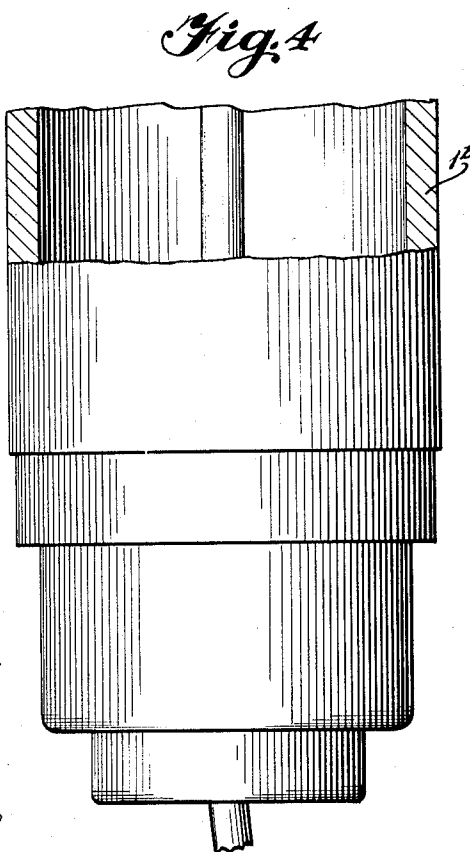
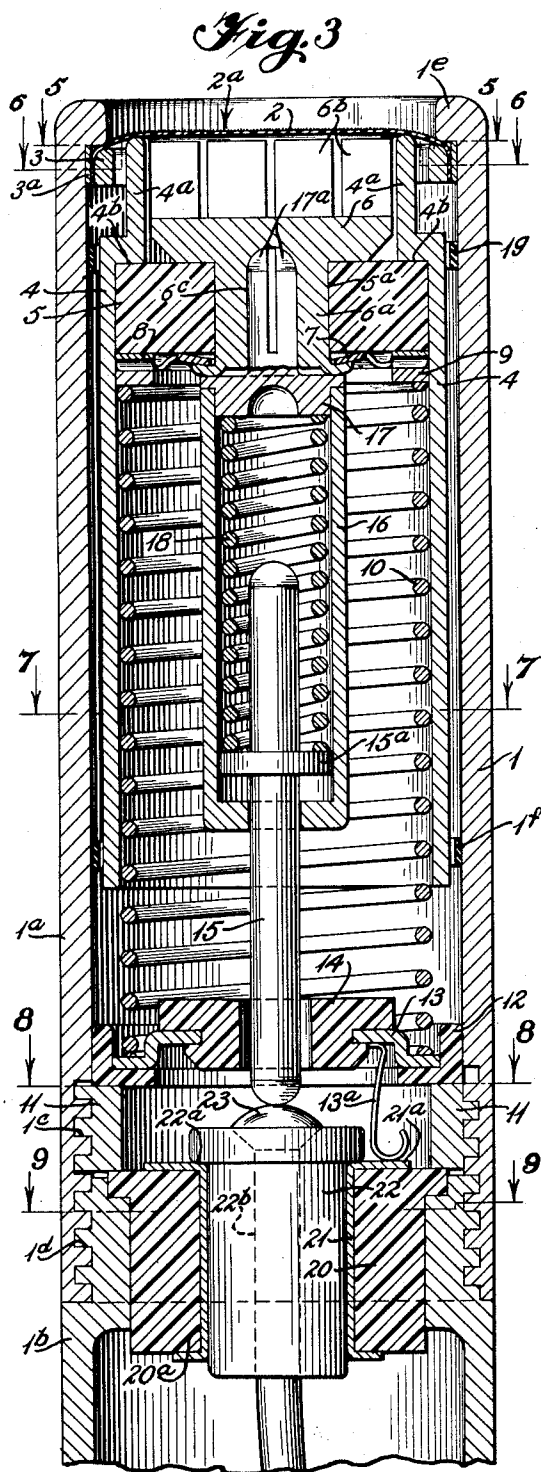
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Fig. 6

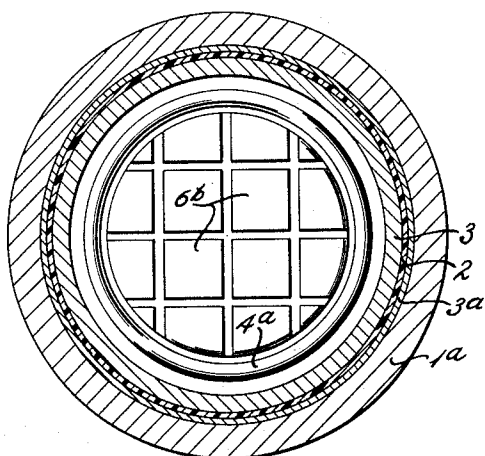


Fig. 7

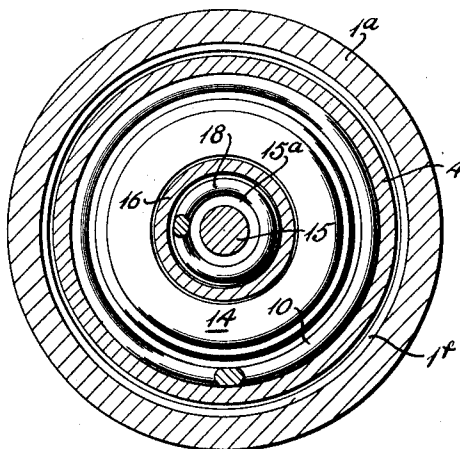


Fig. 8

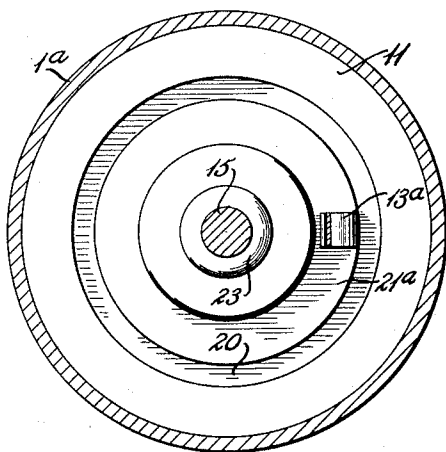
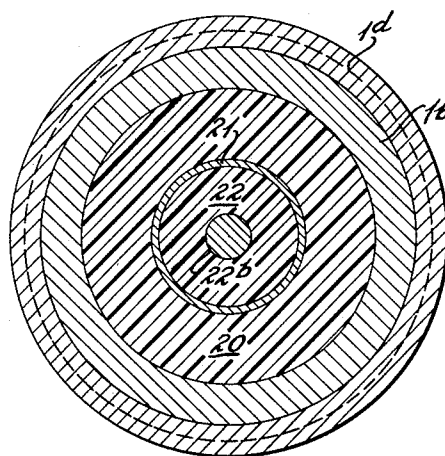


Fig. 9



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MICROPHONES

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Application July 27, 1956, Serial No. 600,556

22 Claims. (Cl. 179—111)

My invention relates to condenser-type microphones, and more particularly relates to improvements in the diaphragm, the mounting therefor, and the means for maintaining a constant tension on the diaphragm.

The principal object of my invention is to provide a microphone having a flexible coated plastic diaphragm which is supported under a predetermined tension by its mounting means and then is further tensioned by an assembly which is resiliently urged against it and which carries the back-plate of the condenser, the coated diaphragm constituting the movable plate of the condenser.

Another principal object of this invention is to provide a condenser microphone structure wherein, as the plastic material of the diaphragm cold-flows and thereby stretches, the assembly carrying the fixed back-plate automatically moves in such a direction as to compensate the stretch and retain a constant diaphragm tension.

Another major object of my invention is to provide a microphone structure wherein, even though said assembly moves to retain said constant diaphragm tension, the gap between the diaphragm and the back-plate will remain constant in width regardless of changes in position of said assembly.

Another object is to provide in a condenser microphone a diaphragm mounted in a holder and constituting an easily replaceable sub-assembly.

Still another object is to provide a microphone structure wherein the diaphragm may be changed quickly and easily, and, after reassembly of the microphone, the gap between the new diaphragm and the back-plate will be exactly the same as the gap when the old diaphragm was in place, whereby the quiescent value of the capacity between the diaphragm and the back-plate will be unchanged.

A further object of my invention is to provide a microphone wherein the back-plate and diaphragm-tensioning assembly are so designed as to minimize the amount of change in the gap between the back-plate and the diaphragm resulting from temperature variations, and thereby minimize variations in output characteristics of the microphone due to changes in ambient temperature.

Still a further object is to provide in a microphone a diaphragm made of a flexible plastic which is homogeneous in internal structure and has high tensile strength and a high dielectric constant. It is especially advantageous to employ in the diaphragm a plastic material having low density and therefore low mass so that the diaphragm is able to absorb more of the sound energy and reflect less of it, thus permitting the microphone to follow sharp transients more faithfully than a microphone having a diaphragm of greater mass.

Another object of my invention is to provide a condenser microphone head which is readily adaptable for use either in a floating-grid circuit or in an R.F. bridge circuit.

Other objects and advantages of my invention will become apparent during the following discussion of the drawings, wherein:

Figure 1 is an elevational view of my microphone including upper and lower portions thereof.

Fig. 2 is an enlarged plan view looking down on the upper end of the microphone.

5 Fig. 3 is a cross sectional along line 3—3 of Fig. 2.

Fig. 4 is a side elevation of the outside of the casing which forms the lower portion of the microphone.

Fig. 5 is a cross sectional view along line 4—4 of Fig. 3.

10 Fig. 6 is a cross sectional view along line 6—6 of Fig. 3.

Fig. 7 is a cross sectional view along line 7—7 of Fig. 3.

Fig. 8 is a cross sectional view along line 8—8 of Fig. 3.

15 Fig. 9 is a cross sectional view along line 9—9 of Fig. 3.

Fig. 10 is a cross sectional view of the uppermost end of the microphone, showing the means whereby the diaphragm is retained within the outer microphone housing.

20 Fig. 11 is a partial enlarged cross sectional view along line 11—11 of Fig. 10.

Referring now to the drawings and particularly to Figs. 1, 2 and 3, the microphone has an outer housing 1 which includes upper and lower portions 1a and 1b. The present invention is particularly concerned with the structure found within the upper housing 1a, the lower housing 1b being provided mainly as a handle and also being provided for the purpose of containing electrical connections between the cable coming into the lower housing and the condenser microphone head contained within the upper housing 1a. It should also be added that in the event it is desirable to provide a miniature pre-amplifier tube in the housing of the microphone, the tube would be located within the lower housing 1b, although no such tube is illustrated in the present drawings since it forms no part of the present invention.

As can best be seen in Fig. 3, the upper housing 1a is joined to the lower housing 1b at the screw threads 1c and 1d, respectively. By this means the upper and lower housings may easily be separated for the purpose of gaining access to the parts assembled therewithin. At the top of the upper housing there is a flange 1e for the purpose of retaining within the upper housing 1a the diaphragm assembly. The internal structure of the lower housing 1b is illustrated only at the lower end of Fig. 3, the continuation of the lower housing shown in Fig. 4 being shown solid since the internal structure thereof constitutes no part of the present invention. The upper end of the upper housing 1a has an annular opening within the flange 1e. Across this opening, as best illustrated in Figs. 3, 10 and 11, is stretched a plastic diaphragm 2, which diaphragm is coated with a conductive material 2a such as gold.

The diaphragm may be constructed of various types of plastic material, but in particular the Du Pont product commercially known as "Mylar," or the Dow Chemical product known as "Saran," have been found suitable. "Mylar" is a polyethylene terephthalate, and "Saran" is a vinyl vinylidene chloride co-polymer. Both of these plastics have very considerable tensile strength, and in addition both have high dielectric constants. The gold coating can be applied to the outer surface of the diaphragm comparatively easily by well-known methods, but since the thickness of the diaphragm is only about half a mil, and since the dielectric constant of the diaphragm of the plastic material is high, the externally located gold coating serves as satisfactorily as if it were internally located.

The plastic diaphragm is stretched tightly and is retained in stretched condition by the rings 3 and 3a, as best illustrated in Figs. 10 and 11. It will be noted that the edges of these rings have been rounded somewhat so as to obviate any tendency that the rings might have to cut the plastic material. The rings are made of metal such

as brass and are snugly sized one to the other so that the plastic material is retained therebetween merely by friction. As stated in the objects of the invention, the tension applied to the plastic diaphragm by the rings 3 and 3a constitutes only part of the tension which will be applied to the diaphragm when it is in use. The remaining part of the tension is applied to the diaphragm as shown in Fig. 3.

In this figure will be seen a sleeve 4 with a smaller cylindrical upper portion 4a the upper periphery of which is rounded. The change in diameter of the upper and lower portions of this cylinder provides a shoulder 4b and against this shoulder is abutted an insulator 5 having a bore 5a therethrough. A back-plate assembly 6 is provided with a downwardly extending hollow portion 6a which passes through the bore 5a in the insulator 5 and is spun over at its lower end about a corrugated ring washer 7. The washer 7 is made of spring material and serves the purpose of tightly retaining the back-plate 6 against the upper surface of the insulator 5. The upper end of the back-plate 6 comprises a slotted condenser plate 6b, as best seen in Figs. 3 and 6. The purpose of slotting the condenser plates 6b is to provide the proper amount of diaphragm damping, as is well known in the prior art.

The insulator 5 is in turn tightly pressed against the shoulder 4b by another corrugated spring washer 8 disposed between the bottom surface of the insulator 5 and the upper surface of a ring 9 which is a press fit within the internal surface of the sleeve 4. Below the ring 9 and pressing against the lower surface thereof is a coil spring 10 which presses the entire sleeve 4 and associated parts upwardly against the lower surface of the diaphragm 2. This spring is relatively longer so that its compression may be thought of as remaining constant through relatively small changes in its length as the sleeve 4 moves up and down so as to retain the relatively constant tension of the plastic diaphragm.

Within the lower end of the upper housing 1a is secured a threaded ring 11 which is held in place within the lower end of the housing by engaging the threads 1c. The ring 11 in turn supports an insulator 12 upon which is seated an annular metal ring 13. The lower end of the spring 10 abuts the upper surface of the ring 13, as shown in Fig. 3. In addition, the ring 13 has a bore through its center, within which is located an insulator 14 constituting a spacer. This spacer 14 has a bore through its center through which passes a contact 15 having a T-shaped abutment 15a near its upper end. The contact 15 extends upwardly into a metal tube 16 which has at its upper end a metal plug 17 carrying a slotted finger contact 17a which extends upwardly into a bore 6c in the extension 6a of the back-plate 6. Within the tube 16 is located a compression spring 18 which presses downwardly against the abutment 15a so as to yieldably urge the contact 15 downwardly. Thus it will be seen that the contact 15 is electrically connected with the back-plate 6 which constitutes one of the condenser plates of the microphone.

The other condenser plate of the microphone is represented by the diaphragm which is electrically connected to the upper housing 1a of the microphone. Depending on the type of circuit in which the microphone is being used, the outer casing is either insulated from or electrically connected with the sleeve 4. The electrical contact from the sleeve 4 is carried through the spring 10 to the ring 13 and finally through a small spring finger 13a so that it along with the housing 1a and the contact 15 constitute the three possible connections to the condenser microphone head.

In order to prevent the sleeve 4 from touching the inner periphery of the housing 1a, a pair of spacers 1f and 1g may be employed. These spacers would be pressed into the inner periphery of the outer housing 1a but would be a sliding fit with the outer periphery of the sleeve 4 so as to permit the spring 10 to longitudinally move the sleeve

4 against the lower surface of the diaphragm 2 in order to provide proper tension of the latter.

As shown at the lower end of Fig. 3, the lower housing 1b has at its upper end an insulator 20 pressed thereto. This insulator 20 has an annular metal sleeve 21 spun over so as to retain it in the bore 20a of the insulator 20. Within the coil spring 21 is another insulator 22 which may be frictionally retained therein and which has an annular shoulder 22a at the top thereof to prevent the insulator 22 from being pressed downwardly through the sleeve beyond the position shown in Fig. 3. The insulator 22 also has a bore 22b therethrough and through this bore may be passed a wire having an enlargement, such as a lump of solder 23 at its upper end to provide a conductive surface against which the contact 15 may be pressed. The sleeve 21 has at its upper end an annular flange 21a to provide a contact against which the spring finger 13a may press. At the lower end of this connector assembly including the parts 20—21—22, suitable wires may be attached which lead either to an external amplifier, or else to the terminals of a miniature tube which may be contained within the lower housing 1b, and which is not shown in the present drawings.

When it becomes necessary to change the diaphragm 2 or to change any of the other parts located inside of the microphone head, it is merely necessary to unscrew the upper housing 1a from the lower housing 1b at the screw threads 1c—1d. When the upper and lower portions of the microphone are separated, removal of the threaded ring 11 will permit the insulator 12 and the sleeve 4, which contains most of the parts of the assembly, to drop out of the upper housing 1a. The diaphragm and supporting rings 3 and 3a can then easily be removed from the upper end of the housing 1a and replaced by new parts. Once the new diaphragm has been inserted in the housing 1a and has been moved up to abut the flange 1e, the sleeve 4 and associated parts of the insulator 12 may then be replaced within the housing 1a and the threaded ring 11 can then be screwed back in place to cooperate with the threads 1c to retain the microphone headparts in place.

As stated above, one of the most important features of the present invention is the construction located in the vicinity of the upper end of the sleeve 4. The insulator 5 is made of a dimensionally stable insulating material having a very high resistance so as to reduce the likelihood of the microphone being noisy. It will be noted that the upper surface of the insulator 5 supports the lower surface of the back-plate 6, and in turn is itself supported against the shoulder 4b. Because of the fact that corrugated spring retaining washers 7 and 8 are employed, the thermal expansion and contraction characteristics of the microphone are considerably improved, from the viewpoint that the upper surface of the condenser plate 6b is separated from the lower surface of the diaphragm tube by a gap the width of which depends upon the relative position of the upper surface of the condenser plate 6b and upper rounded periphery of the upper end of the sleeve 4, marked 4a. The upper periphery 4a of the sleeve 4 is somewhat higher than the upper surface of the condenser plate 6b, and the diaphragm is stretched tightly across the upper rounded periphery of the sleeve 4. Therefore the width of the gap between the upper surface of the condenser plate 6b and the lower surface of the diaphragm is determined by the amount that the upper surface of the condenser plate 6b is recessed below the upper periphery 4a of the sleeve 4. Thus it should be apparent that the only change in the width of the gap resulting from thermal expansion and contraction of the various parts would occur as a result of expansion or contraction in the axial direction of the portion of the cylinder marked 4a and the portion of the condenser plate 6b which is co-extensive with that portion of the sleeve marked 4a. This would be a very short length to be affected by temperature changes, and

therefore unequal expansion of the parts 6b and 4a could produce only an extremely small change in the width of the gap. Moreover, the back-plate 6 and the sleeve 4 may be made of the same metal to reduce unequal expansion. Thus this structure for determining the gap is very important since it provides the microphone with substantially constant quiescent capacity characteristics. The use of a plastic material in the diaphragm and in particular the use of "Mylar" or "Saran" has proved to be particularly advantageous, apparently for the reason that these particular plastic materials accurately follow the compressional vibrations reaching the diaphragm and apparently have very little tendency to set up their own spurious modes of vibration. Undoubtedly there are other plastics which would serve the purpose provided their characteristics are similar to the characteristics exhibited by "Mylar" and "Saran." Most of the remaining insulators used throughout this microphone may advantageously be made of "Teflon" which material exhibits satisfactory characteristics with respect to mechanical stability and with respect to electric leakage.

I do not limit my invention to the exact form shown in the drawings, for obviously changes may be made within the scope of the claims.

I claim:

1. A capacity-type microphone comprising an outer housing having a bore in its upper end; an elastic conductive diaphragm across said upper end and closing the bore; diaphragm mounting means engaging said housing and retaining the diaphragm tightly gripped around its periphery; a sleeve in said bore below said diaphragm and having an upper peripheral edge resting against the lower surface of the diaphragm; spring means in said bore pressing said sleeve upwardly to distend said diaphragm and tension the latter; and a back-plate having an upper face disposed parallel with the diaphragm, the back-plate being rigidly secured within the sleeve and recessed just below said upper peripheral edge and being electrically insulated from other conductive members comprising the microphone.

2. In a microphone as set forth in claim 1, said diaphragm mounting means comprising two concentric rings of conductive material, the inner ring being a snug fit within the outer ring, and the diaphragm being gripped between the two rings and partially tensioned thereby.

3. In a microphone as set forth in claim 1, said sleeve being hollow and having an internal abutment, and said spring means comprising a helical spring in said bore extending into said sleeve and seating on said abutment, the spring being long in comparison with its diameter to provide a pressure which remains substantially constant for small axial motions of the sleeve within the housing.

4. In a microphone as set forth in claim 1, said sleeve being made of conductive material; an insulator secured in said sleeve, and said back-plate being mounted on said insulator.

5. In a microphone as set forth in claim 4, said diaphragm being made of a non-conductive material and having a conductive coating on its upper surface; insulator means within said bore between the housing and the sleeve; and insulator means between said spring means and the housing.

6. A capacity-type microphone comprising a housing having a bore therein; an elastic conductive diaphragm closing the bore; a sleeve in said bore behind said diaphragm and having a peripheral edge resting against the inner surface of the diaphragm; spring means in said bore pressing said sleeve outwardly to distend said diaphragm and tension the latter; and a back-plate secured in the sleeve and recessed just below said upper peripheral edge.

7. In a microphone as set forth in claim 6, said sleeve being made of conductive material; an insulator secured in said sleeve, and said back-plate being mounted on said insulator.

8. In a microphone as set forth in claim 7, said diaphragm being made of a non-conductive material and having a conductive coating on its upper surface; insulator means within said bore between the housing and the sleeve; and insulator means between said spring means and the housing.

9. A capacity-type microphone comprising an outer housing having a bore therethrough and having an internally disposed flange restricting the bore near the upper end thereof; an elastic conductive diaphragm; annular diaphragm mounting means gripping the diaphragm tightly at all points around its periphery, said mounting means being conductive and being a sliding fit in said bore below said flange; a sleeve of diameter smaller than said bore and axially slidable therein, the sleeve having an upper peripheral edge contacting the diaphragm from inside the bore; a back-plate secured in said sleeve and recessed just below said peripheral edge; and spring means acting between the housing and the sleeve for pressing the sleeve against the diaphragm.

10. In a microphone as set forth in claim 9, said diaphragm mounting means comprising two concentric rings of conductive material, the inner ring being a snug fit within the outer ring, and the diaphragm being gripped between the two rings and partially tensioned thereby.

11. In a microphone as set forth in claim 9, said sleeve being made of conductive material; an insulator secured in said sleeve, and said back-plate being mounted on said insulator.

12. In a microphone as set forth in claim 11, said diaphragm being made of a non-conductive material and having a conductive coating on its upper surface; insulator means within said bore between the housing and the sleeve; and insulator means between said spring means and the housing.

13. In a microphone as set forth in claim 9, a removable plug for closing the lower end of said bore and serving as a seat for the lower end of said spring means, the upper end of said spring means pressing against said sleeve, whereby the diaphragm and mounting means may be changed by removing said plug and dropping the mounting means, sleeve, and spring means out of said bore.

14. A capacity-type microphone comprising an outer housing having a bore in its upper end; an elastic conductive diaphragm across said upper end and closing the bore; a sleeve in said bore below said diaphragm said sleeve being axially slidable in said bore and having an upper peripheral edge, the sleeve being hollow and having an internal shoulder below said upper peripheral edge, and said edge contacting said diaphragm along a closed line disposed in a plane normal to the axis of the bore; spring means in said bore pressing said sleeve upwardly to distend said diaphragm and tension the latter; an insulator in said sleeve below the shoulder; retaining means in the sleeve and urging said insulator upwardly against said shoulder; and a back-plate secured to the upper face of the insulator and having a face disposed parallel with the plane of said upper peripheral edge and recessed therebelow, and the distance from the said upper peripheral edge to the shoulder being small in comparison with the diameter of the bore.

15. In a microphone as set forth in claim 14, said retaining means comprising an abutment secured in said sleeve below the insulator; and a corrugated spring washer compressed between the lower surface of the insulator and the abutment.

16. In a microphone as set forth in claim 15, said spring means comprising a helical spring in said bore extending into said sleeve and seating on said abutment, the spring being long in comparison with its diameter.

17. In a microphone as set forth in claim 15, said insulator having a hole therethrough disposed axially of the sleeve, and said back-plate having a downwardly disposed extension passing through the hole and having an enlarge-

ment at its lower end, and a second corrugated spring washer compressed between said enlargement and the lower surface of the insulator.

18. In a microphone as set forth in claim 14, said sleeve being made of conductive material, and said diaphragm being made of a non-conductive material and having a conductive coating on its upper surface; insulator means within the bore between the housing and the sleeve; and insulator means between said spring means and the housing.

19. A diaphragm assembly for use in a microphone, comprising an outer ring; an inner ring insertable coaxially within said outer ring; and a plastic sheet homogeneous in internal structure and stretched over the inner ring and secured thereon by the outer ring, the plastic being coated on at least one side to render it conductive of electricity.

20. In an assembly as set forth in claim 19, said plastic being coated with a thin layer of metallic particles.

21. In an assembly as set forth in claim 19, said plastic being polyethylene terephthalate.

22. In an assembly as set forth in claim 19, said plastic being vinyl vinylidene chloride co-polymer.

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