Sept. 20, 1938. W. A. BRUNO 2,130,946

MICROPHONE

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Fig. 1.

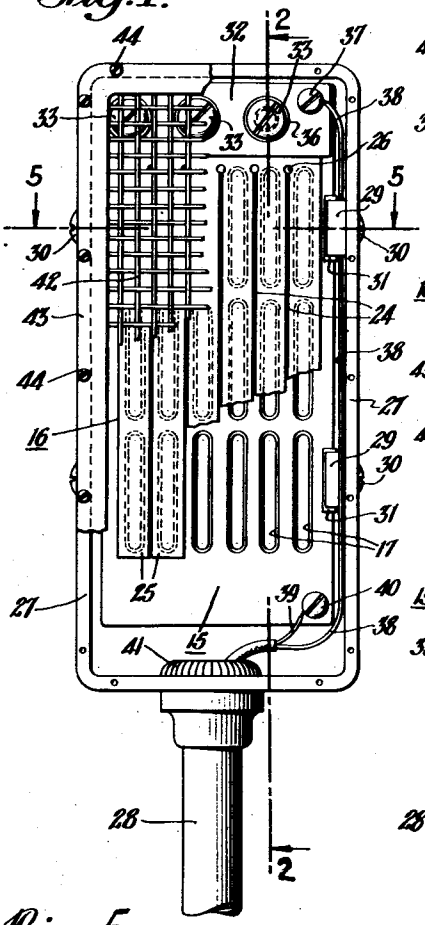


Fig. 2.

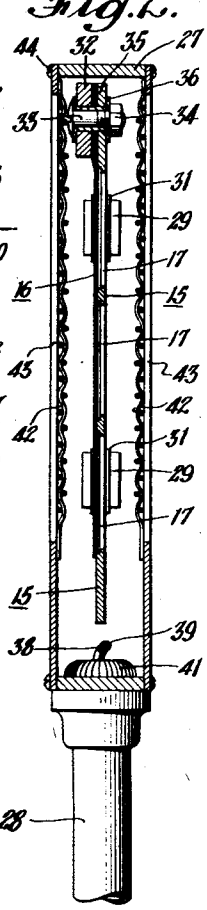


Fig. 3.

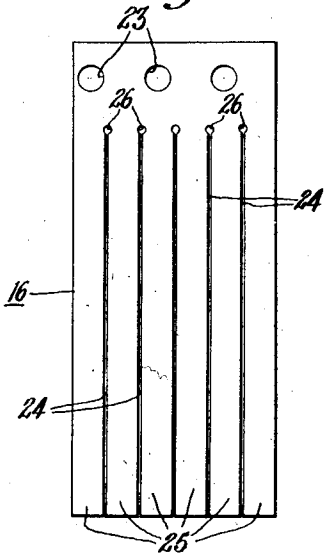


Fig. 4.

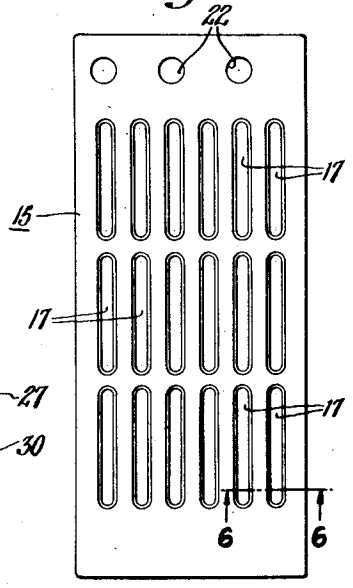


Fig. 5.

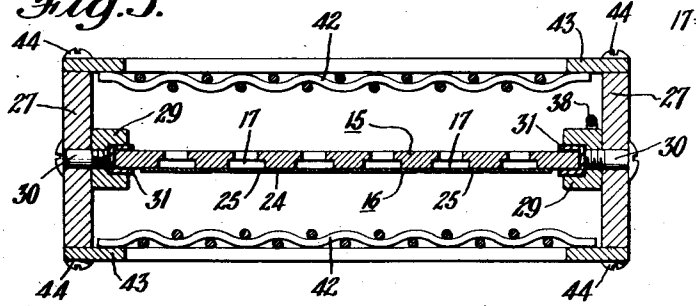
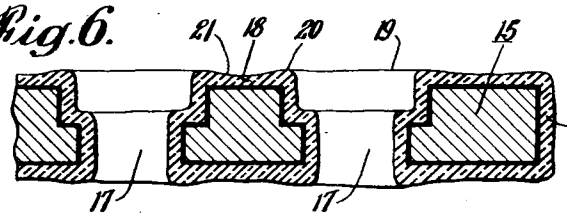


Fig. 6.



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Fig. 7.

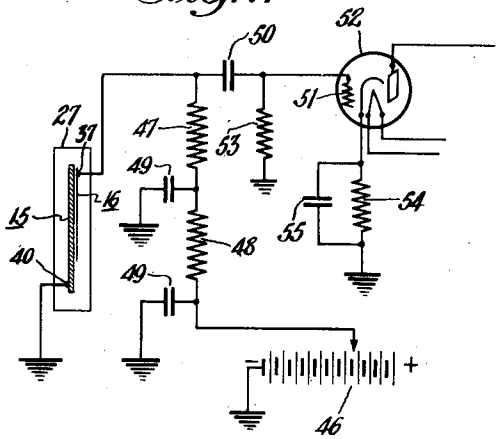


Fig. 8.

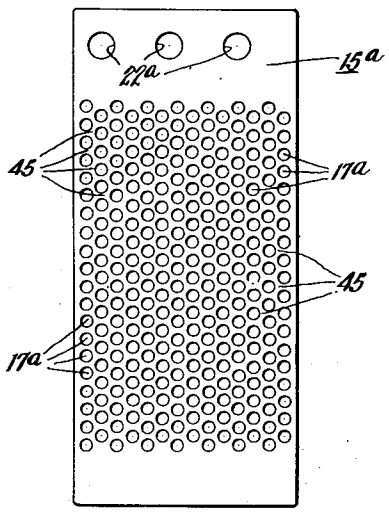


Fig. 9.

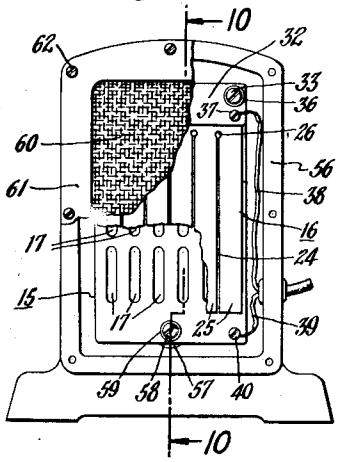
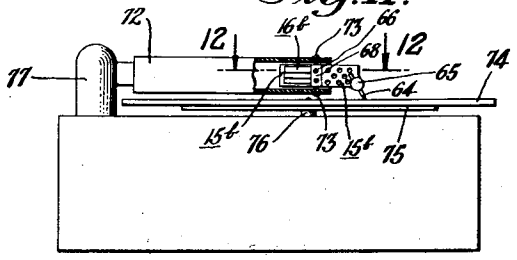


Fig. 11.



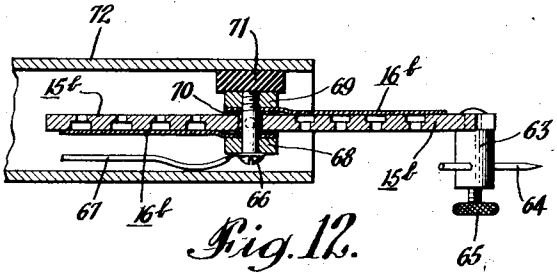


Fig. 12.

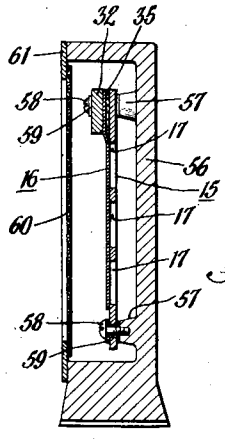


Fig. 10.

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2,130,946

UNITED STATES PATENT OFFICE

2,130,946

MICROPHONE

William A. Bruno, New York, N. Y.

Application December 29, 1936, Serial No. 118,134

13 Claims. (Cl. 179—111)

The present invention relates to improvements in microphones, it being understood that this term is used in its broad significance and that the invention may be equally well applied to loud speakers, vibration recorders, such as cardiographs and the like and phonograph pickups.

The invention is concerned with the condenser type of microphone in which the condenser couple consists generally of a rigid or stationary back plate and a conducting membrane electrically insulated from said back plate, but mechanically vibrating with respect thereto in order to vary the capacity of the condenser which will affect the circuit in which the microphone is included. In other words, the condenser will translate small variations in pressure into related variations in electrical capacity.

It is well known that in microphones of the condenser type, variations in sound pressure upon the diaphragm displace it in its relation to the back plate, the diaphragm being insulated from the back plate and the diaphragm being usually separated from the back plate by the interposed air; the relative movement of the diaphragm causing changes in the capacity existing between the diaphragm and back plate. Such variations are, by means of well known electrical circuits and devices, converted into sound waves, similar to the original.

Devices of this type are, however, subject to several inherent defects, some of which are low electrical output, sensitivity to humidity and rapid changes in temperature and barometric pressure. It is an object of the present invention to improve the construction so as to eliminate, or greatly reduce, these defects, chiefly by slitting the diaphragm to convert same into a series of ribbons having independent and local vibratory movement of high responsiveness to both mechanical and electrical forces.

Another object of the invention consists in the method of support or mounting for the ribbon diaphragm, which support has for its chief purpose to maintain the diaphragm in its proper relative position to the back plate, yet supporting the diaphragm in an unstretched condition.

A further object of the invention is to produce a condenser couple in which the back plate is slotted and either covered or enveloped with a dielectric coating having a roughened, uneven, or non-uniform external surface against which the ribbon diaphragm mechanically abuts, whereby the ribbons of the diaphragm will be held against a great number of high points of the dielectric coating rather than against any flat surface which might tend to cause clinging of the ribbons against the dielectric surface with the result that its movement and resilient action might be minimized.

The invention also contemplates the use of the device for phonographic reproductions, and to this end aims to produce a novel form of phonographic arm in which the improved condenser couple is included in a novel arrangement.

With the foregoing and other objects in view, the invention will be more fully described hereinafter, and will be more particularly pointed out in the claims appended hereto.

In the drawings, wherein like symbols refer to like or corresponding parts throughout the several views,

Figure 1 is a front elevation, with parts broken away, of an improved microphone and its support, as constructed in accordance with the present invention.

Figure 2 is a vertical cross-section taken on the line 2—2 in Figure 1.

Figure 3 is a plan view of the ribbon diaphragm.

Figure 4 is a similar view of the back plate or fixed element.

Figure 5 is a horizontal section taken on the line 5—5 in Figure 1.

Figure 6 is a fragmentary section, taken on an enlarged or magnified scale, through a portion of the back plate along the line 6—6 in Figure 4 and showing the dielectric insulating coating.

Figure 7 is a circuit diagram showing one method of connecting the improved microphone in an electronic amplifying circuit.

Figure 8 is a plan view of a modified form of back plate.

Figure 9 is a front elevation, with parts broken away, showing a modified form of microphone intended for translation of mechanical vibration.

Figure 10 is a vertical section taken on the line 10—10 in Figure 9.

Figure 11 is a side elevation, with parts broken away and parts shown in section, of the improved condenser shown as applied to a phonograph arm, and

Figure 12 is a horizontal section, taken on an enlarged or magnified scale, through a portion of the phonograph arm and improved condenser along the line 12—12 in Figure 11.

Referring more particularly to the drawings, and for the present to Figures 1 to 6 inclusive, there is shown one embodiment of the improved microphone involving a condenser couple com-

posed generally of a back plate 15 and a diaphragm 16.

As shown in Figure 4, the metallic back plate 15 is preferably formed with a series of elongated slots 17 passing completely through the plate for the free movement of the air resulting from the act of vibration in the metallic resilient diaphragm 16.

As shown in Figure 6, the back plate 15 is covered by a coating 18 of a dielectric insulating material. This material will be molded or otherwise formed about the back plate without interference to the slots or openings 17 therethrough; such material naturally forming a roughened, uneven or non-uniform surface 19 against which the diaphragm 16 will mechanically bear, whereby such diaphragm will be supported by high points 20 of the dielectric, which high points are adjacent low points 21, which will prevent the diaphragm from cleaving or clinging to the back plate or its coating.

Referring to Figures 3 and 4, it will be seen that along the upper portions thereof the back plate 15 and the diaphragm 16 are provided with perforations 22 and 23 respectively, which register with one another whereby to receive appropriate fastening means for binding the two electrodes together.

Referring to Figure 3 the diaphragm 16 is slitted as indicated at 24, along a number of parallel longitudinally extending lines which may or may not be equi-distant from one another, thereby producing a plurality of ribobns 25. The slits 24 extend over the major portion of the diaphragm 16 and substantially convert this diaphragm from a plate into a series of independently vibrating ribbons 25. The independence of these ribbons is assured by the fact that the slits 24 extend completely through one edge of the diaphragm 16 so that the only connection the ribbons have with the diaphragm 16 is at their upper edges. This support is narrow, and due to the thinness of the diaphragm 16, such ribbons will be very sensitive to mechanical and electrical forces tending to set up vibrations therein. The local vibratory quality of the elongated ribobns 25 will be greatly increased. The independence of the ribbons one from another and from the former construction of a solid plate, is further enhanced by the provision of cut-away portions 26 in the diaphragm 16 at the inner ends of the slits 24. These cut away portions 26 are for the purpose of allowing freedom of pivotal or hinging movement of the ribbons 25 with the blank head portion of the diaphragm 16 which serves as a suspending support for the various ribbons as well as an attaching means for the diaphragm to the plate and to the electrical circuit. The diaphragm is wholly unstretched and is supported only by the head-piece 16 so that the ribbons 25 have a new freedom of movement over anything heretofore known in the art.

Where slots, such as 17, are produced in the back plate 15, such slots will be of such a width as to be spanned by the ribbons 25, and the slots 17 will preferably be arranged in vertical rows, each ribbon being sufficiently long to extend over all of the slots of a vertical row, and the major areas of the ribbons being exposed over the slots 17 while the edge portions of the ribbons 25 rest against the uneven surfaces of the dielectric coating 18 at opposite sides of such slots.

From a comparison of Figures 3 and 4 it will be noted that the diaphragm 16 is narrower than the back plate 15. This is for the purpose of enabling free edge portions of the plate 15 to be received in the side clamps which support the condenser in a casing 27, which is a usual form of microphone casing supported upon the hollow standard 28.

The clamps are indicated at 29 and the same are held by the screws 30 or other fastenings to the side walls of the casing 27. In the clamps are channel-shaped insulating bushings 31 which are in immediate contact with the back plate 15. These clamps are shown to be four in number, two at each side of the case. These clamps support the back plate 15 directly from the casing 27. The diaphragm 16 is supported by the back plate 15 in insulated relation therefrom but bearing mechanically against the dielectric coating as heretofore described.

While the support may be of any suitable character, I prefer to employ a metallic bar 32 having openings therethrough in registry with the openings 22 and 23 of the back plate 15 and diaphragm 16, whereby screws or other fastenings 33 may be passed through the aligning openings in these three members and secured in place by means of nuts 34 or the like. Preferably an insulating strip 35 will be interposed between the head-piece of the diaphragm 16 and the upper portion of the back plate 15 to insure that the insulation does not break down at this point where the pressure of the fastening means is being tightened up is apt to squeeze through the dielectric coating. Also insulating sleeves 36 surround the screws 33, their heads and the nuts 34. The metallic bar 32 is of course in direct electrical contact with the head-piece of the diaphragm 16 against which it directly bears. A screw or binding post 37 may be carried directly on this metallic bar 32 in order to connect the microphone at the diaphragm side in the electrical circuit, and a lead 38 is shown as connected to this binding post 37. Another lead 39 is shown as connecting with a screw or binding post 40 mounted in direct metallic contact with the metal body of the back plate 15. The leads 38 and 39 pass down through a bushing 41, which serves to mount the casing 27 upon the hollow standard 28, and through this hollow standard to the external circuit.

The wire guards are shown at 42 the same being affixed to, or carried by, the frames 43, these frames being mounted upon the open ends of the case 27 as by use of the screws or other fastenings 44. These guards 42 will protect the interior parts in a well understood manner.

Referring more particularly to Figure 8, a modified form of back plate 15^a is shown in which perforations 17^a replace the slots 17 of Figure 4. The upper portion of this plate is provided with perforations 22^a similar to the perforations 22 of Figure 4 and have a like purpose. The ribbons 25 of the diaphragm are laid across the perforations 17^a of this modified form of back plate. Of course insulating material, similar to the insulating material 18 of Figure 6, will surround the perforations 17^a and create raised points between the perforations 17^a, such raised points occurring as indicated at 45.

Referring more particularly to Figure 7, the improved microphone is designated generally by its case 27. The terminal 40 of back plate 15 is connected to the negative side of the direct current power supply 46. The terminal 37 of the diaphragm 16 is connected through resistances 47 and 48 to a positive terminal of said power supply 46. The condensers 49 are filter units which,

working in conjunction with filtering resistor 48, tend to prevent voltage fluctuations from power supply 46 affecting the polarizing potential, which it supplies to microphone 27, and alternating current fluctuations caused by movement of the diaphragm 16 going through power supply 46 and other parts of the circuit. A coupling condenser 50 allows the voltage variations, produced by movement of the microphone diaphragm 16, appearing across resistor 47, to be impressed upon the grid 51 of vacuum tube 52. A resistor 53 furnishes the return path for the grid circuit. A resistor 54 is used to furnish bias for tube 52 and the condenser 55 to smooth out any possible variations in this bias. The circuits following from the plate in the hollow arm or tube 52 are well known in the electronic art and need not be described.

Movement of the diaphagm 16 of the microphone causes charging and discharging current to flow through resistor 47 due to polarizing potentials supplied by the power supply 46 and the change in capacity of the condenser formed between the back plate 15 and the ribbon diaphragm 16. This voltage, appearing across the resistor 47, is then impressed upon the grid 51 of the tube 52, and amplified accordingly.

Referring more particularly to Figures 9 and 10, there is shown a form of device which is of use in translating mechanical vibrations into equivalent electrical variations.

The casing 56 is placed in mechanical contact with the vibrating object and these vibrations are in turn transmitted to the ribbon diaphragm and back plate through the mounting studs 57. Thus the mechanical vibrations set up similar vibrations in the ribbons of the diaphragm and in the back plate assembly, causing corresponding variations in capacity between the two electrodes. These variations may be translated by means of a circuit, such for instance as that illustrated in Figure 7, into corresponding electrical vibrations.

In this case the condenser unit is the same as heretofore described in connection with Figures 1 to 6 of the drawings and involves the back plate 15, the ribbon diaphragm 16, the bar 32 and the insulating strip 35 together with the means for holding these parts together as a unit. In this instance, instead of the condenser unit being supported to the casing by means of side clamps, the unit is attached directly to the stud 57 as by the use of screws or other fastenings 58 passing through insulating sleeves 59. The condenser unit is connected to the external circuit by leads connecting with the two electrodes as shown in Figure 9, and as previously explained.

The front portion of the casing 56 is covered by a metallic screening 60 held in place by a front frame 61 which is removably secured to the casing as by means of the screws or other fastenings 62. This screening forms a protection for the condenser unit and other interior parts of the device.

Referring more particularly to Figures 11 and 12, I here show a modification of the condenser unit for use as a phonograph pickup. In this case the back plate 15b, which is similar to the back plate already described, is insulated in the manner previously explained and attached mechanically to a holder 63. The holder is perforated for the passage of the phonograph needle 64 held adjustably and rigidly in place by means of a knurled screw 65. In this form of the invention, two diaphragms 16b are employed, such ribbons or diaphragms being disposed upon opposite sides of the back plate 15b. Each diaphragm only covers substantially one-half of the back plate 15b. These diaphragms are both connected together at the center portion of the back plate by means of a screw 66. Such screw forms one terminal of the device, the wire or lead 67 being connected thereto. This screw 66 passes through the two clamp bars or blocks 68 and 69. The clamp bar or block 69 will be threaded to receive the threads of the screw 66. The other clamp bar 68 may have a plain or unthreaded bore for the free passage of the bolt or screw 66 therethrough. An insulating grommet 70 surrounds the shank of the bolt 66 and extends up on the opposite faces of the back plate 15b between such plate and the adjacent end portions of the two diaphragms thus effectively insulating the diaphragms from the back plate. The clamp blocks or bars 68 and 69 are in electrical connection both with the two diaphragms and with the bolt 66.

Bearing against the device, and preferably against one of the clamp blocks or bars 69, is a resilient damping block 71 inserted at this point to dampen out undesired oscillations in the mechanical system. The resilient damping block 71 engages at its outer side against a fixed part, for instance the swinging arm 72 of a phonograph mechanism.

As shown in Figure 11 the condenser assembly is pivoted within the hollow phonograph arm 72 on the pivots 73. This enables the entire assembly to move on a vertical axis such as is necessary for the needle 64 in following the variations in the groove of the record disc 74. The record is carried upon a revolving turn-table 75 driven through a shaft 76 in a manner well known to the mechanical art. The phonograph arm 72 is in the usual manner pivotally carried by a support 77, whereby the needle may traverse the groove in the record 74 from the outer edge of the disc to a central portion as required by the volute form of the groove.

As the needle 64 is moved from side to side from its static position in following the variations in the groove of the recorded disc, such variations are transmitted as vibrations to the assembly, including the back plate and the two ribbon diaphragms, causing proportional changes in capacity between them. These changes in capacity are again translated into similar electrical variations, for instance by the circuit arrangement shown in Figure 7.

The use of the device as a microphone is believed to be clear. The circuit arrangement, such as shown in Figure 7, impresses the output of the microphone upon the grid of the amplifying tube. Variations in capacity between the ribbon diaphragm and the back plate, caused by acoustic inputs to the device, draw charging current through the series resistance 47 due to polarizing potential applied through this resistance. Such variations in voltage are impressed upon the grid 51 of the tube 52 in a conventional manner.

While the components of the new device and the recognized condenser microphone are similar, these components have been altered in a manner to produce a superior effect. The invention eliminates the necessity for the use of a massive and accurately-machine back plate. It also eliminates the necessity for a stretched diaphragm. The back plate 15 may consist of a relatively thin metallic plate. The movable element, namely, the ribbon diaphragm 16, may consist of an extremely thin aluminium sheet, for

instance thinner than one-thousandth of an inch. This ribbon diaphragm is not restricted in its movement in that it is held physically in position only at the point of contact with its external connection.

It is preferable to entirely insulate the back plate, and by means of a high dielectric constant material which surrounds the plate in its entirety with the exception of the point of external electrical contact to the plate, which in this case is at ground potential.

As previously stated the insulating material is raised at a variety of points to offer support for the movable element and to prevent the diaphragm ribbons from adhering to the insulation of the back plate due to electrostatic attraction when a potential difference is applied between the electrodes. Those portions of the back plate and diaphragm, which are separated by the high dielectric constant insulating material covering the back plate, and air constitute the working or changeable portion of the capacity thus formed between the conducting elements. The slots 17 or perforations 17ª of the back plate are so arranged that small and rapid variations in atmospheric pressure, such as constitute sound waves, are free to move the ribbbons of the diaphragm toward and away from the back plate.

As the capacity of a condenser increases inversely as the square of the distance between its plates, and as in the present improved device the average distance between the active portions of the ribbons and the areas involved can be made so much larger than in any stretched diaphragm type of condenser microphone, the improved device can be made to have a much greater output than is possible through any other means. Thus, the resultant capacity changes will be relatively large due to the disposition of the ribbons, the large areas involved (by comparison to the stretched diaphragm type unit) and the ease with which the movable portions of the ribbons are free to move.

It will be noted that in the improved device the diaphragm is unstretched and that it is held in position preferably at one point or along one edge. The diaphragm is slitted so as to operate on both the pressure and the velocity gradient. The back plate is perforated or slotted so that the device operates on the velocity gradient of the sound waves.

Whenever the term "microphone" is used in this description or in the following claims, it will be understood to be applicable not only to a sending instrument but also to receiving instruments and to loud speakers, as well as to the other instruments illustrated and described herein.

It is obvious that various changes and modifications may be made in the details of construction and design of the above specifically described embodiment of this invention without departing from the spirit thereof, such changes and modifications being restricted only by the scope of the following claims.

What is claimed is:—

1. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric of uneven surface, a diaphragm freely supported and contacting only the high points of said dielectric for preventing said diaphragm from clinging to said back plate, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, said upper edge being narrow and said diaphragm being relatively thin, said diaphragm being further cutaway at the inner ends of said slits for providing freedom of pivotal movement of said ribbons, and slots in said back plate arranged to completely be spanned by said ribbons, said diaphragm being narrower than said back plate, said diaphragm being secured to said plate solely at its upper end.

2. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric of uneven surface, a diaphragm freely supported and contacting only the high points of said dielectric for preventing said diaphragm from clinging to said back plate, said diaphragm being in the form of a series of ribbons, each ribbon being supported at one end and free for vibration at the other end, said upper edge being narrow and said diaphragm being relatively thin, said diaphragm being further cut away at the inner ends of said slits for providing freedom of pivotal movement of said ribbons, and slots in said back plate arranged to be completely spanned by said ribbons, said diaphragm being narrower than said back plate, said diaphragm being secured to said plate solely at its upper end.

3. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric of uneven surface, a diaphragm freely supported and contacting only the high points of said dielectric for preventing said diaphragm from clinging to said back plate, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, and slots in said back plate arranged to be completely spanned by said ribbons, said diaphragm being narrower than said back plate, said diaphragm being secured to said plate solely at its upper end.

4. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric of uneven surface, a diaphragm freely supported and contacting only the high points of said dielectric for preventing said diaphragm from clinging to said back plate, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, said diaphragm being secured to said plate solely at its upper end.

5. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric of uneven surface, and a diaphragm freely supported and contacting only the high points of said dielectric for preventing said diaphragm from clinging to said back plate, said diaphragm being in the form of a series of ribbons, each ribbon being supported at one end and free for vibration at the other end.

6. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric of uneven surface, a diaphragm freely supported and contacting only the high points of said dielectric for preventing said diaphragm from clinging to said back plate, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, slots in said

back plate, said diaphragm being secured to said plate solely at its upper end.

7. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric, a wholly unstretched diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, said diaphragm being secured to said plate solely at its upper end.

8. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric, a wholly unstretched diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, said diaphragm being further cut away at the inner ends of said slits for providing freedom of pivotal movement of said ribbons, said diaphragm being secured to said plate solely at its upper end.

9. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric, a wholly unstretched diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at the upper edge, said diaphragm being further cut away at the inner ends of said slits for providing freedom of pivotal movement of said ribbons, and slots in said back plate, said diaphragm being secured to said plate solely at its upper end.

10. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric molded about said back plate, a wholly unstretched diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at the upper edge, said diaphragm being further cut away at the inner ends of said slits for providing freedom of pivotal movement of said ribbons, and slots in said back plate, said diaphragm being secured to said plate solely at its upper end.

11. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric, a diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, and slots in said back plate arranged to be completely spanned by said ribbons, said diaphragm being narrower than said back plate, said diaphragm being secured to said plate solely at its upper end.

12. In a translating device, a condenser couple, having a back plate, said plate being coated with a dielectric, a diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, and slots in said back plate, said diaphragm being secured to said plate solely at its upper end.

13. In a miscrophone, a condenser couple, having a back plate, said plate being coated with a dielectric, a diaphragm freely supported, said diaphragm being slitted along a number of parallel longitudinally extending lines forming ribbons, said slits extending through one edge of the diaphragm so that the only connection the ribbons have with the diaphragm is at their upper edge, said diaphragm being secured to said plate solely at its upper end.

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