May 26, 1942. W. A. BRUNO 2,284,039

REPRODUCTION OF SOUND

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Fig. 1

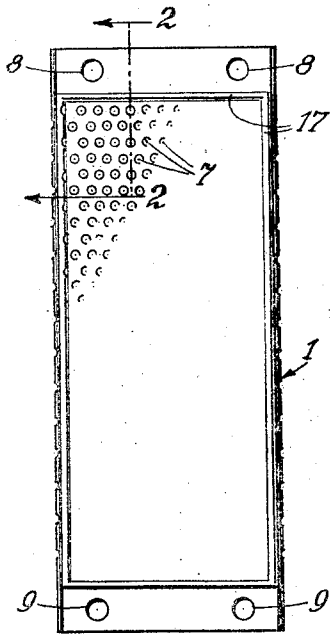


Fig. 2

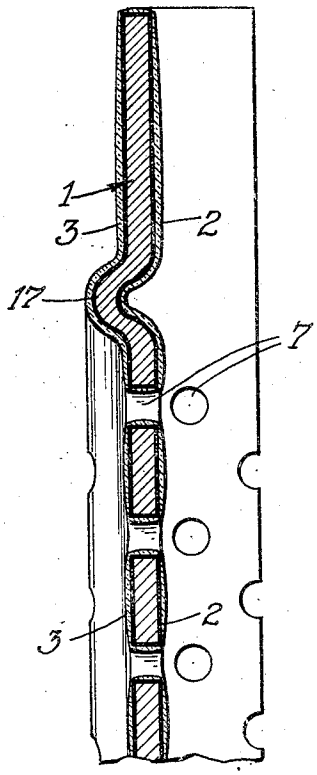


Fig. 4

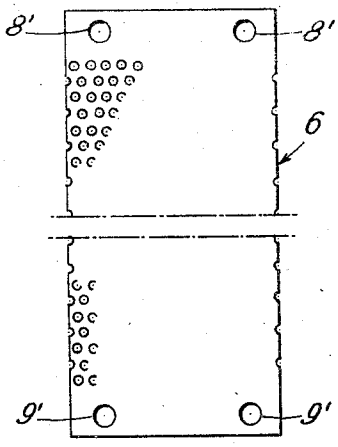
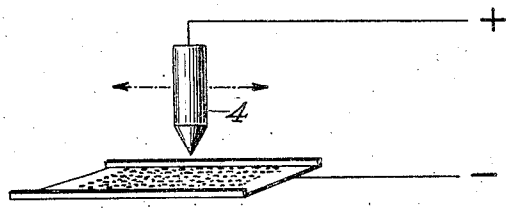


Fig. 3



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Fig. 5

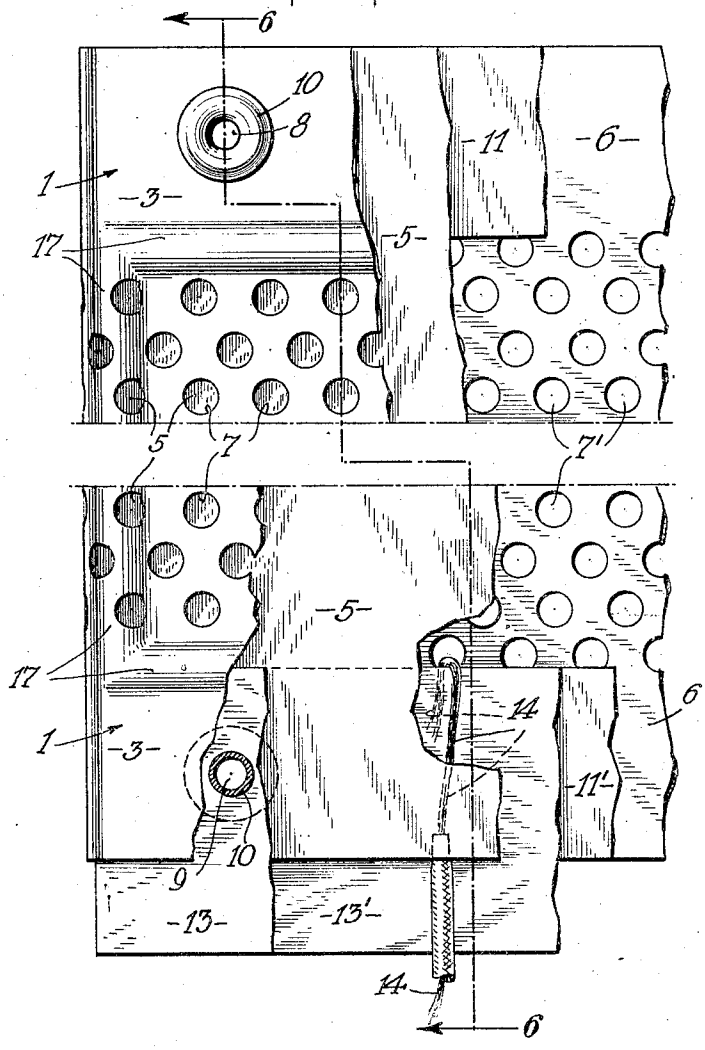


Fig. 6

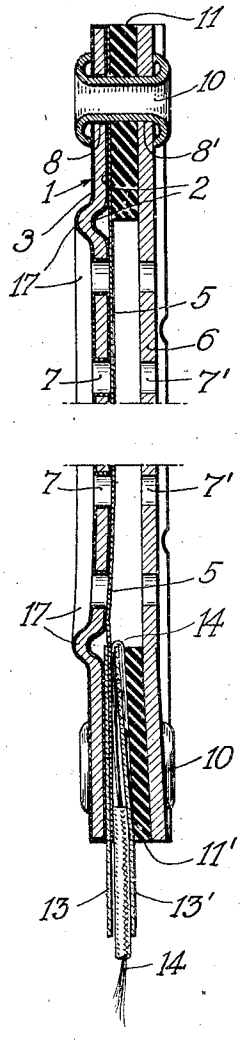
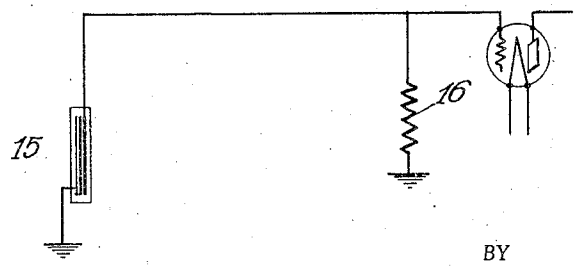


Fig. 7



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UNITED STATES PATENT OFFICE

2,284,039

REPRODUCTION OF SOUND

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Application July 16, 1940, Serial No. 345,714

4 Claims. (Cl. 179—111)

This invention relates to a device for converting sound energy into electrical energy or electrical energy into sound energy. More particularly this invention relates to a device of the type, in which translation of sound energy into electrical energy takes place without the simultaneous supply of electrical energy to said device by outside sources.

The known types of sound translating devices, such as for example carbon microphones, or those of the electrostatic, electrodynamic or photoelectric type, show various disadvantages. The carbon microphone provides a high current output, but produces a relatively large amount of hiss, while microphones of the other types hitherto used, in addition to other disadvantages, provide a low current output.

The main object of my invention is to provide a device, in which incident sound oscillations are transformed into electrical oscillations without the simultaneous supply of electrical energy to said device by outside sources, such as batteries, by making use of a permanent static field.

Another object of my invention is to provide a microphone which is simple to construct, does not introduce undesired noises, and has a high sensitivity and accurate response. Further objects will appear from the following specification, the novel features being particularly pointed out in the claims.

According to the preferred embodiment of my invention, I provide a perforated metallic plate which is coated with a well adhering thin wax layer. A diaphragm which consists of a thin metallic foil, preferably aluminum, is placed on the wax-coated, perforated metallic plate. In assembling my microphone, the wax coated metallic plate is exposed to a static electrical charge, and is then covered with said thin metallic foil diaphragm. I have found that the unit thus obtained is capable of transforming incident sound oscillations into electrical oscillations which can be amplified and used for the reproduction of the original sound oscillations.

The accompanying drawings, in which like reference characters denote like parts throughout, illustrate by way of example, a preferred embodiment of my present invention.

Fig. 1 is a front elevational view of a perforated metallic stationary plate of a microphone according to my invention;

Fig. 2 shows said perforated metallic plate in fragmentary view in section along the line 2—2 of Fig. 1, in an enlarged scale.

Fig. 3 is a diagrammatic illustration of the charging of a microphone made in accordance with my invention;

Fig. 4 shows a perforated protecting plate;

Fig. 5 is a fragmentary face view of the assembled microphone, layer by layer broken away.

Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Fig. 7 shows, by way of example, one method of connecting a microphone according to my present invention, in an amplifying circuit.

The stationary plate 1 which is shown in Fig. 1 in natural size, and is provided with perforations 7 extending from side to side, may consist of any suitable metal. It is to be understood that size, number and shape of the perforations are not limited to the embodiment shown, and other sizes, numbers and shapes may be used. I prefer to use an aluminum plate which has been subjected to a pre-treatment resulting in a rough surface on which a well-adhering coating can be easily obtained. I have found that an electrolytic oxidizing treatment, for example anodic oxidation in diluted, aqueous sulfuric acid, is particularly suitable for producing such surface. The pretreated surface of the perforated aluminum plate is then coated with a thin layer 2 of carnauba wax by dipping said metal plate in the molten wax, and shaking off the surplus wax from the perforations of the plate. Instead of carnauba wax, compositions of carnauba wax can be used, i. e. compositions which consist mainly of carnauba wax and contain an admixture of a vegetable rosin or rosins and/or other suitable admixtures. Other waxes may also be used instead of carnauba wax or its compositions. I have found, however, that the use of coatings consisting of carnauba wax or carnauba wax compositions is necessary for obtaining a more permanent, high-quality microphone. A suitable wax composition consists, for example, of 60% of carnauba wax and 40% rosin.

During dipping, the back side of the metallic plate also obtains a wax coating 3. This coating can be replaced by any other insulating coating or can be omitted, if desired.

Fig. 2 shows the wax coated, perforated metallic plate 1 in section along line 2—2 of Fig. 1, in an enlarged scale. The pretreated surface of the aluminum plate 1 is coated with the carnauba wax layer 2, and the unit thus formed is then exposed to a static electrical charge, as shown in Fig. 3. Plate 1 is provided with reinforcing ridges 17.

In Fig. 3, the wax coated, perforated plate 1, is

connected with one pole of a high potential direct current source, while an electrode which may consist of a metallic bar 3, and is connected with the other pole of said electrical source, is moved preferably all over and above the wax coated surface of plate 1, at a suitable distance which is determined by the length of the spark available and should be somewhat more than said length. I prefer the use of a current, the voltage of which is suitable to produce a spark of at least two inches. After this treatment, an aluminum foil 5 is placed over and in contact with the wax coating 2. Under the action of the charge, the aluminum foil 5 will strongly adhere to the wax coating.

The size and distance of the perforations in plate 1 affect the frequency response of the device, but in no other way affect the operation of my invention. The thickness of the metallic plate 1 may be, for example, $\frac{1}{32}$'', the thickness of the wax coating may preferably amount to $\frac{1}{64}$'', and the thickness of the aluminum foil to .0025'', for example.

Fig. 4 shows a perforated protecting plate 6 which may consist of any suitable electrically conducting or insulating material. I prefer however the use of a metallic protecting plate in order to shield the diaphragm from outside electrical influences. The perforations of protecting plate 6 need not register with the perforations of the stationary plate 1. Figs. 5 and 6 show a microphone according to my invention provided with such protecting plate. As shown in Figs. 5 and 6 the metallic back plate 1 is provided with perforations 7 passing completely through the plate. The surface of said plate 1 is covered with a wax coating 2 to which the diaphragm 5 will adhere. The end portions of plate 1 are provided with holes 8 and 9 to receive appropriate fastening means for connecting the back plate 1 with the protecting plate 6. This protecting plate is also provided with holes 8' and 9' which register with the corresponding holes of the back plate 1. Metallic fastenings 10 may be passed through the aligning holes 8, 8' and 9, 9' of the back plate and protecting plate and secured in place in any suitable manner. Strips of insulating material 11 and 11' are interposed between the end portions of the back plate 1 and protecting plate 6. In addition, insulating strips 13 and 13' are interposed between insulating strip 11' and the end portion of plate 1; an end portion of the aluminum foil diaphragm is interposed between said strips 13 and 13', and is in electrical contact with lead 14.

Fig. 7 shows, by way of example, one method of connecting my microphone in an amplifying circuit. The stationary plate is connected to ground and the diaphragm of the microphone 15 is connected with resistor 16 and grid of the amplifying circuit in the conventional manner.

Sound oscillations impinging on the diaphragm cause it to oscillate at those points which are free and not restricted in motion by the electrostatic adhesion between diaphragm and wax coating. These diaphragm oscillations occurring within a field of the electrostatic charge of the wax layer, generate a flow of E. M. F. of acoustic significance, which, in turn, affects the grid circuit of an electronic amplifier in the usual manner.

I have found that the electrostatic charge in the wax coating does not dissipate for an undetermined period of time, once the device is constructed as described above, and is bound to remain operative for a number of years. The device is not affected by normal or abnormal atmospheric changes of temperature, humidity and altitude.

It is to be understood that while the device herein described is constructed to resemble a microphone of the condenser type, and more specifically of the type described in my U. S. Patent No. 2,130,946, it is not to be confused with a condenser type microphone, because it does not depend on its operation by an external source of electrical potential. The device according to my present invention, instead of being influenced by an external E. M. F. in accordance with the change of capacity of the device itself, due to the variation of spacing between the electrodes of the device caused by the sound wave, generates currents of acoustic significance, once the diaphragm is disturbed by any incoming sound wave.

It is to be understood that my present invention may also be applied to other translating devices, such as phonograph pick-ups, vibration recorders, and loud speakers.

As will be evident from the above description, the invention is not limited to the specific embodiments presented herein for illustration and is susceptible of numerous modifications within the broad scope and spirit of the invention as defined in the appended claims.

I claim:

1. In a translator of sound energy into electrical energy and electrical energy into sound energy, an electro-statically charged system adapted to translate sound energy into electrical energy without the simultaneous supply of electrical energy to said system by outside sources, said system comprising a metallic back plate having transverse perforations extending from side to side, and consisting of aluminum having an electrolytically oxidized surface, a thin coating of carnauba wax composition on said electrolytically oxidized surface, and a diaphragm consisting of a thin aluminum foil.

2. In a translator of sound energy into electrical energy and electrical energy into sound energy, an electro-statically charged system adapted to translate sound energy into electrical energy without the simultaneous supply of electrical energy to said system by outside sources, said system comprising a metallic back plate having transverse perforations extending from side to side, and consisting of aluminum having an electrolytically oxidized surface, a coating of carnauba wax composition of a thickness of about $\frac{1}{64}$'', on said electrolytically oxidized surface, a diaphragm consisting of a thin aluminum foil, a metallic protecting plate provided with transverse perforations extending from side to side, the end portions of said back plate and said protecting plate being provided with registering holes for receiving fastening means, fastening means passed through said holes, strips of insulating material interposed between the end portions of said back plate and said protecting plate, sheets of insulating material interposed between one of said strips of insulating material and an end portion of said back plate, the aluminum foil being in electrical contact with one of the electric leads between said sheets of insulating material.

3. In a translator of sound energy into electrical energy and electrical energy into sound energy a permanent electret consisting of a metallic plate having transverse perforations ex-

tending from side to side and being provided with an electrically charged thin coating of a carnauba wax composition on its surface.

4. In a translator of sound energy into electrical energy and electrical energy into sound energy an electrostatically charged system adapted to translate sound energy into electrical energy without the simultaneous supply of electrical energy to said system by outside sources, said system comprising a metallic plate having transverse perforations extending from side to side, a thin wax coating on said metallic plate, and a metallic foil diaphragm adhering to said wax coating.

WILLIAM A. BRUNO.