An electrostatic electroacoustic transducer having two or more vibrating films. A treated signal is mechanically divided into two or more frequency ranges.

4 Claims, 3 Drawing Figures
This is a continuation of application Ser. No. 162,381, filed July 14, 1971 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electrostatic electroacoustic transducer, and more particularly to a multi-way electrostatic electroacoustic transducer.

2. Description of the Prior Art

Heretofore, there has been generally proposed a two way electroacoustic transducer, for example, a two way speaker system wherein two dynamic speakers are employed, one for a high frequency range and the other for a low frequency range. Such a transducer must be provided with an electrical frequency divider so as to divide an input signal into high and low frequency signals. Consequently, the speaker system is complex in construction, heavy in weight and expensive to produce. The problem of the heavy weight is especially inconvenient for a headphone.

On the other hand, there has been proposed another two way speaker system wherein a divider is not used, but only one dynamic speaker is used. In this case, the dynamic speaker has a construction wherein a sub-diaphragm light in weight and small in size is mounted within a main diaphragm, and both diaphragms are driven by a single voice coil. Thereby, the low frequency range is reproduced by the main diaphragm, and the frequency range higher than the reproducible frequency of the main diaphragm is reproduced by the sub-diaphragm. Such speakers, for example as disclosed in Japanese Pat. No. 256,903, are called mechanical two way speakers, and they are easy to use as they do not need dividers, but they are restricted in a dynamic type and cannot be realized in an electrostatic type.

In an electrostatic type speaker, if a vibrating film is tight, the frequency characteristics are good in the high frequency range but not good in the low frequency range; on the other hand, if the vibrating film is slightly loose, the frequency characteristics are good in the low range but not good in the high range.

SUMMARY OF THE INVENTION

It is, therefore, the main object of this invention to provide an electrostatic electroacoustic transducer wherein excellent frequency characteristics are obtained by dividing a vibrating film into two portions, one of a high frequency range and the other for a low frequency range.

It is another object of this invention to provide an electrostatic electroacoustic transducer which is simple in construction, does not require a frequency divider, and uses only one driving unit for vibrating the film portions.

It is a further object of this invention to provide an electrostatic electroacoustic transducer which is excellent for mass production and is inexpensive to manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of one embodiment of the present invention.

FIG. 2 is a sectional view taken along the line II—II of FIG. 1, wherein the parts shown in FIG. 1 are joined together.

FIG. 3 is a schematic diagram of the embodiment of the present invention wherein the back electrode and vibrating film shown in FIG. 2 are connected to an alternating signal source.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, one embodiment of the present invention, which is an electrostatic type speaker, will be explained in detail referring to drawings.

In FIG. 1, a back electrode 11 is a plate made of aluminum, electroconductive plastics or the like and having many holes for passing acoustic radiation. A gasket 12 is made of an elastic material, for example, polyethylene, polyurethane or the like, which has many independent foams therein. An electret 13 comprises a mixture of 70 parts by weight of a polyvinylidenfluoride resin and 30 parts by weight of a polyethylene metacrylate resin, and has many holes for passing acoustic radiation which holes correspond respectively with the holes of the back electrode 11. A vibrating film 141 of about from 5 to 15 microns in thickness is spread comparatively loosely onto the upper face of an outer portion of a frame 14. On the other hand, a vibrating film 151 of about from 1 to 10 microns in thickness is spread comparatively tightly onto the lower face of an inner portion of a frame 15. The vibrating film 141 responds mainly to signals in a low frequency range and is composed of, for example, copolymer of vinylidenchloride and vinyl-chloride (bearing the trademark of Klewrap) or polyethylene-terephthalate (bearing the trademark of Mylar), and one face or both faces of the film are made electroconductive.

The vibrating film 151 responds mainly to signals in a higher frequency range and is composed of, for example, polyethylene-terephthalate (bearing the trademark of Mylar), polypropylene, metallic foil of aluminum, titanium or the like, and one face or both faces of the film are made electroconductive like the film 141. An electret 16, a gasket 17 and a back electrode 18 correspond to the electret 13, the gasket 12 and the back electrode 11, respectively, in construction, and corresponding parts are composed of the same material.

FIG. 2 is a sectional view taken along the diametric line II—II of FIG. 1 and shows all the parts joined together. The space between the vibrating film 141 and both electrets 13 and 16 is about two or three hundred microns. The thickness of both vibrating films 141 and 151 is very small compared to these spaces; therefore, both vibrating films may be regarded as existing in one plane surface at the center of both electrets 13 and 16, as shown in FIG. 2.

When an alternating signal is fed to both electrets 13 and 16 and both vibrating films 141 and 151 in a known way, an acoustic output is obtained from the speaker.

In FIG. 3, there is shown one embodiment of the manner in which the alternating signal is applied to the speaker. The electrets 13 and 16 are charged beforehand to the polarities shown in FIG. 3; therefore, the vibrating films 141 and 151 are charged, in the absence of an input signal, to the polarities also as shown in FIG. 3. The vibrating films 141 and 151 are electrically connected to each other. The back electrodes 11 and 18
are connected to one terminal of the secondary winding of a step-up transformer 19, and the vibrating films 141 and 151 are connected to the other terminal of the secondary winding of the step-up transformer 19. When an alternating signal is fed to the step-up transformer 19 from the signal source 20, the back electrodes 11 and 18 are simultaneously charged with the same charge, thereby decreasing the surface charge of one electret, which was previously charged, and increasing the surface charge of the other electret. This process is alternately repeated, whereby the films 141 and 151 are vibrated.

The vibrating film 141 is comparatively thick and is spread slightly loosely; therefore, this film vibrates well in the low frequency range but not well in the high frequency range. On the other hand, the vibrating film 151 is comparatively thin and is spread slightly tightly, therefore, this film vibrates well in the high frequency range but not well in the low frequency range.

The present invention, as described hereinabove, provides many improvements over prior art devices. That is, first, a vibrating film is divided into two portions, one for the low frequency range and the other for the high frequency range; therefore, good frequency characteristics can be obtained easily in each frequency range, and frequency characteristics are excellent in all frequency ranges. Second, in case this transducer is used as a speaker, it is not necessary to provide a dividing network to divide an input signal into high and low frequency ranges, and the transformer may be simple in construction, light in weight and inexpensive to produce. Third, the frames 14 and 15 may be identical to each other, and only the vibrating films are spread differently, one loosely and one tightly; therefore, a two way transducer may be easily obtained with increasing the number of parts. Fourth, only one pair of electrets, as the fixed electrodes, is required in spite of using two vibrating films. Fifth, the vibrating films 141 and 151 can be spread in the same plane surface, whereby a two way transducer can be constructed with almost the same thickness as a one way transducer.

While the invention has been particularly shown and described with reference to the preferred embodiment thereof, it will be understood by those skilled in the art that a three way, a four way or more transducer may be made without departing from the spirit and scope of the invention. The structure of this invention may be applied in a general electrostatic electroacoustic transducer which does not use any electrets. Further, the structure of this invention may be applied not only in a push-pull type but also in a single type transducer.

We claim:

1. An electrostatic electroacoustic transducer comprising in a sandwich the following elements in a vertical stack:
   a. first fixed electrode means;
   b. a first, relatively highly tensioned film for vibrating in a high frequency range;
   c. a second, relatively low tensioned film for vibrating in a low frequency range; and
   d. second fixed electrode means, said films being non-overlapping and located in substantially the same horizontal plane.

2. An electrostatic electroacoustic transducer as defined in claim 1 wherein both of the films have a circular shape, said first film having a smaller diameter than said second film, said second film being in the form of an annulus having a central circular aperture with a diameter at least as great as the diameter of said first film, the first film being in the form of a disc and vertically aligned with the central aperture in the second film, whereby said films are non-overlapping.

3. An electrostatic electroacoustic transducer as defined in claim 2, further comprising first and second substantially identical frame members disposed in the sandwich respectively between said first electrode means and said first film and between said second electrode means and said second film, each of said frame members being in the form of an annulus having an inner central circular aperture, the inner and outer diameters of the annulus of each frame member being substantially identical to the inner and outer diameters of the annulus formed by said second film, the inner diameter of the annulus of each frame member being substantially equal to the diameter of said first film, said first film being spread over only the inner central circular aperture of said first frame member on the lower face thereof, and said second film being spread over only the annulus of said second frame member on the upper face thereof.

4. An electrostatic electroacoustic transducer as defined in claim 3 wherein each of said first and second fixed electrode means comprises a charged electret and a back electrode fixed to the electret surface opposite the electret surface facing the electret’s associated film.