Feb. 1, 1938. F. F. ROMANOW 2,106,813

ACOUSTIC DEVICE

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FIG. 1

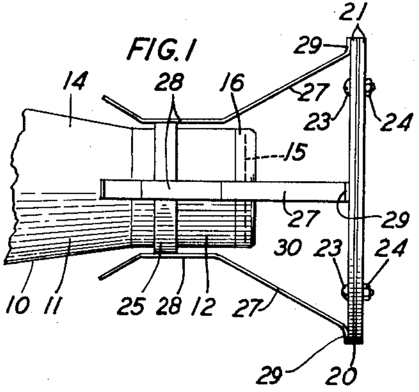

FIG. 2

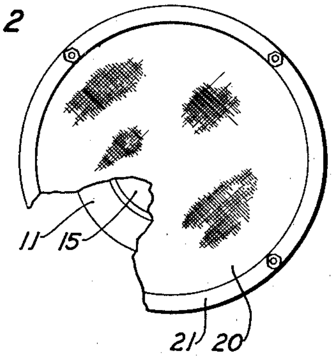

FIG. 3

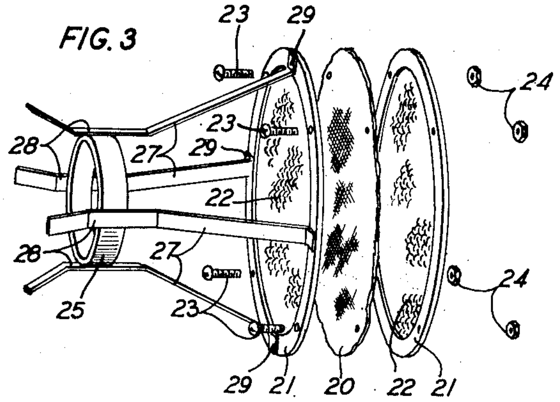

FIG. 4

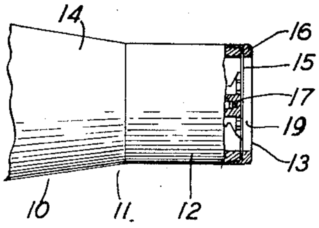

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FIG. 5

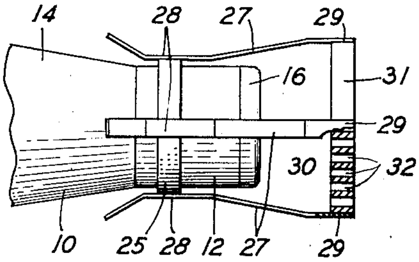

FIG. 6

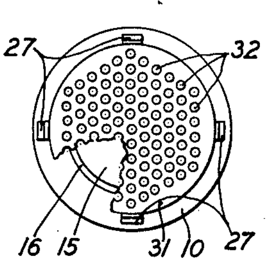

FIG. 7

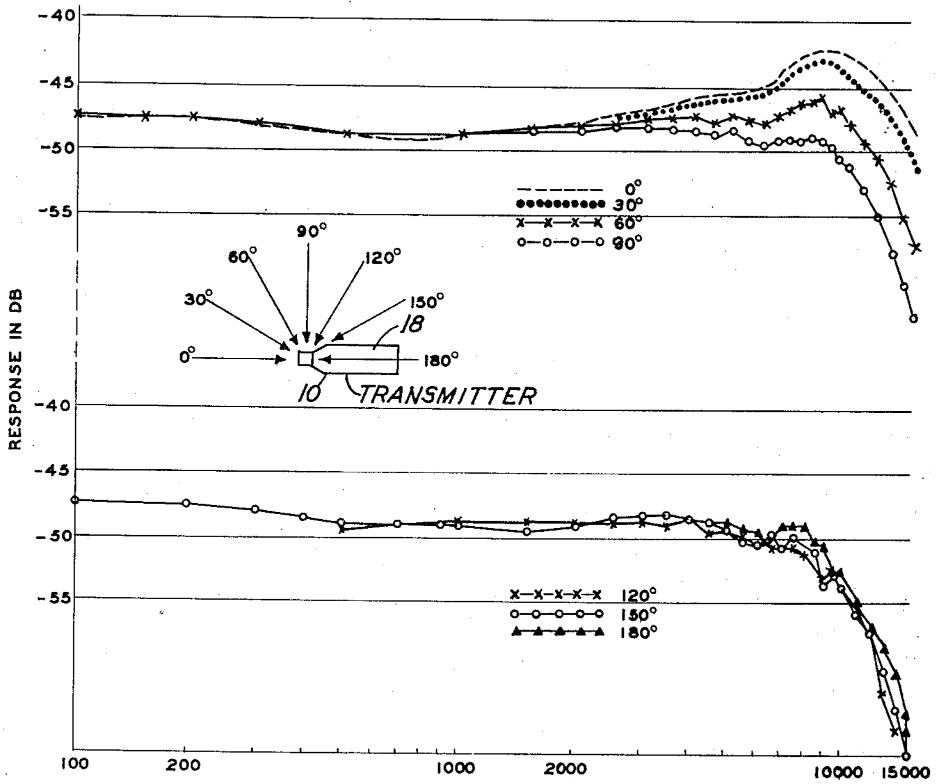

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FIG. 8

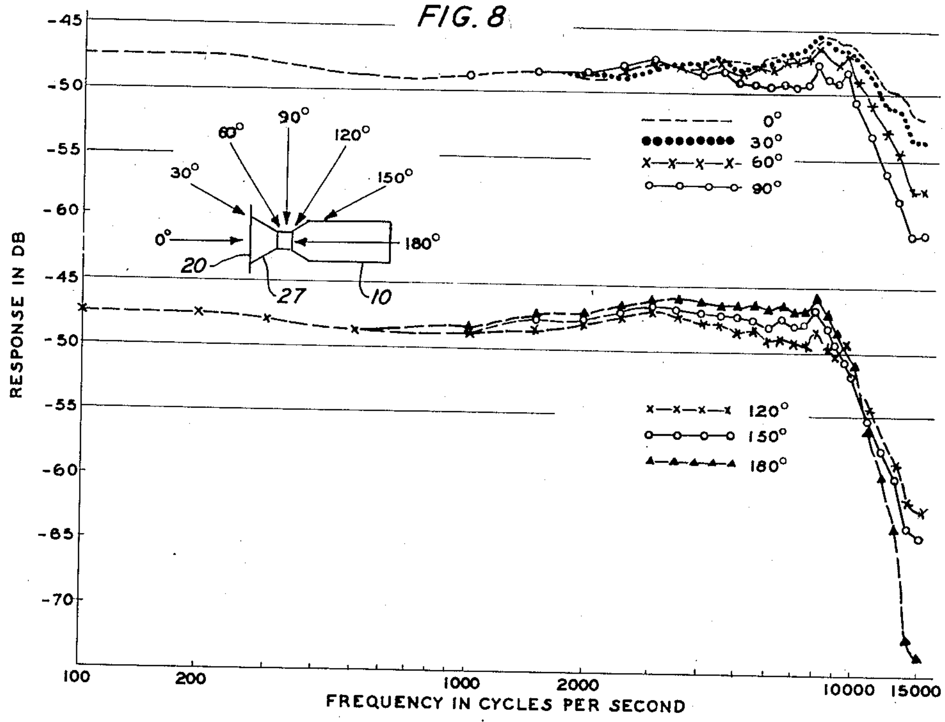
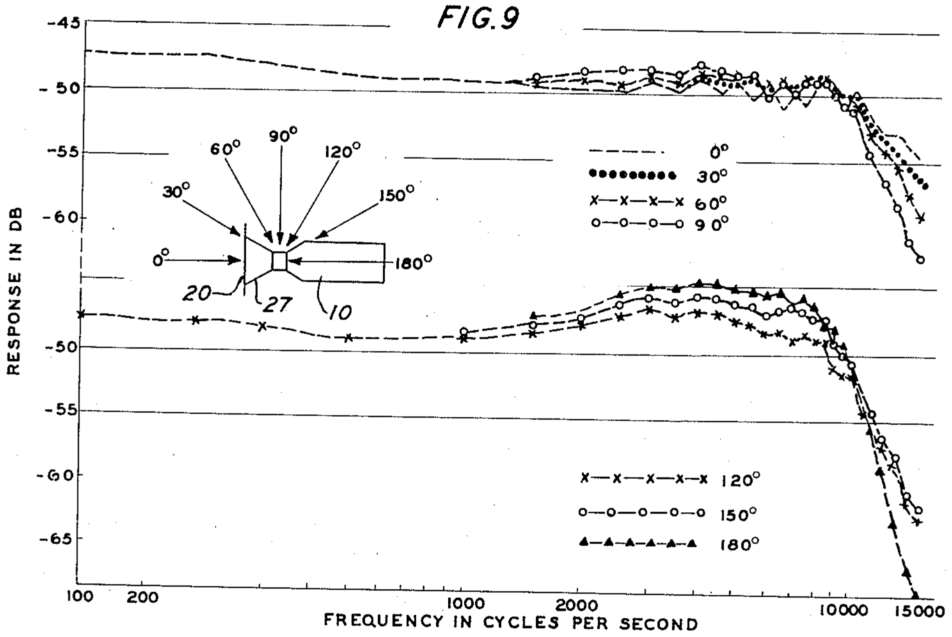


FIG. 9



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Patented Feb. 1, 1938 **2,106,813**

UNITED STATES PATENT OFFICE

2,106,813

ACOUSTIC DEVICE

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Application June 9, 1934, Serial No. 729,759

5 Claims. (Cl. 179—187)

This invention relates to acoustic devices, and, more particularly, to microphones or transmitters employed in open sound fields.

The open field characteristic of most pressure operated microphones shows a considerable increase at the high frequencies. This is caused by several factors which includes the diffraction around the microphone casing or housing, resonance in any cavity in front of the diaphragm of the microphone, and resonance in the holes of the diaphragm-protecting screen or guard, if one is used. The cavity in front of the diaphragm is formed by parts of the microphone necessary to hold the diaphragm in position, although effort is made to keep this cavity as shallow as possible. The resonant effects are independent of the angle of sound incidence, while diffraction decreases considerably as the microphone is rotated around an axis lying in the face of the instrument. For any position other than normal sound incidence, the pressure actuating the microphone is out of phase for different points of the diaphragm, thus causing an additional loss with the result, therefore, as the microphone is rotated, a rapid decrease in response. It would be of great advantage to have a microphone or transmitter which would be relatively free of these angle effects and show a uniform response regardless of the angle at which it is placed in the sound field with reference to the source of sound waves.

An object of this invention is to improve the open field response characteristic of a microphone.

A feature of this invention comprises a microphone that may be placed at any angle with reference to a sound source and have a substantially uniform response.

A further feature of this invention comprises a microphone including means in front of and spaced from the diaphragm thereof for impeding sound waves incident normally, but allowing free access of sound waves incident 90° to 180° removed from those incident normally.

Another feature comprises means for controlling the extent to which the high frequencies in the speech and music range have access to the diaphragm of a microphone.

Still another feature comprises means adjustably positioned in front of the diaphragm for controlling the high frequency response of a microphone.

Other and additional features will be evident from the general and detailed description which follows hereinafter.

This invention may be embodied in an acoustic device comprising a casing supporting a diaphragm and housing electrical means associated with the diaphragm for the translation of sound waves into electrical signals. Supported by, and adjustable to and from the casing, is a screen member, preferably of greater area than the diaphragm, and having its marginal edge outside of that of the diaphragm. The screen comprises, preferably, one or more thicknesses of silk cloth of predetermined acoustic resistance, preferably such as to impede the passage to the diaphragm of sound waves incident substantially normally. The screen is sufficiently spaced from the diaphragm to provide a substantially annular lateral passage permitting sound waves free access therethrough to the diaphragm.

A more complete understanding of this invention will be obtained from the detailed description which follows, read with reference to the appended drawings, wherein:

Fig. 1 is a side elevational view of an acoustic device embodying this invention;

Fig. 2 is a front elevational view of the device of Fig. 1, partially broken away;

Fig. 3 is an exploded perspective view of the diffraction-effect counteracting means embodied in the device of Fig. 1 in accordance with this invention;

Fig. 4 is a side elevational view of the microphone embodied in the device of Fig. 1, partly broken away and partly in section;

Fig. 5 is a side elevational view of another acoustic device embodying this invention, partly broken away;

Fig. 6 is a front elevational view of the device of Fig. 5, partly broken away;

Fig. 7 shows a series of frequency response curves for the microphone of the acoustic device of Fig. 1 for different angles of sound incidence;

Fig. 8 shows a series of frequency response curves for the acoustic device of Fig. 1 for the same angles of sound incidence; and

Fig. 9 shows a series of frequency response curves for a modification of the device of Fig. 1.

The acoustic device of Figs. 1–4 comprises a microphone or transmitter **10**, of the pressure operated type, specifically of the electrostatic type. The microphone comprises a casing **11** having a cylindrical front portion **12** having an open end **13** and a frusto-conical portion **14**. A diaphragm **15**, for instance, of a light weight, high strength material, such as aluminum or an aluminum alloy, such as duralumin, and preferably stretched, is mounted in the open end of the case, being secured thereto at its periphery by any suitable means, such as the clamping ring **16**, and has one or its outer surface exposed to sound waves. A stationary electrode **17** is supported within the case and closely spaced to the inner or rear and enclosed surface of the diaphragm.

The open field response of such an acoustic device provided with a cylindrical extension **18** for housing an amplifier for different angles of sound incidence, is shown by Fig. 7. It will be noted particularly that as the angle of incidence changes from 0° to 90°, the frequency response at the high audio frequencies, particularly between 2000 and 15,000 cycles per second, varies considerably and is greatly reduced from that of normal incidence. Between 90° and 180°, the variation is small and the reduction is only slightly greater than that for 90° incidence. These variations in response are ascribable to various factors. The cavity **19** in front of the diaphragm, although kept as shallow as possible, provides a resonance that tends to increase the response in the upper frequency range. The greater portion, however, of the increase in response at the high frequencies results from diffraction around the microphone casing. While the cavity resonance is independent of the angle of sound incidence, the diffraction effects decrease considerably as the microphone is rotated around an axis lying in the face of the instrument, assuming a substantially planar face. For any position other than that for normal sound incidence, however, the sound wave pressure is out of phase for different points on the diaphragm, causing an additional and rapid decrease in the high frequency response.

A microphone having a substantially uniform response regardless of the angle at which it is positioned in the sound field with reference to the sound source, may be attained in accordance with this invention by embodying in the microphone **10**, a sound wave impeding or sound wave frequency discriminating member or screen **20** spaced from and in front of the diaphragm **15** and of such size that its periphery or marginal portion is outside of that of the diaphragm and the open end of the casing. The screen **20** is preferably of one or more thickness of silk cloth. It is mounted at its periphery between a pair of rings **21**, the apertures in which contain metallic gauze screens **22**, providing a mechanical protection for the silk cloth, the rings **21** and the screen **20** being secured together by any suitable means, such as the screws **23** and nuts **24**. A sleeve or ring member **25**, encircles the casing portion **12**, and is slidable thereon. A plurality of spacers comprising thin, narrow, rigid, metallic strips **27** are fastened at one end **28** to the sleeve **23** and at their other ends **29** to one of the rings **21**, and are separated at regular intervals. By this arrangement, the screen **20** may be adjusted to and from the microphone until the position for optimum results is obtained. Of course, this optimum spacing could be predetermined and the screen and its support secured rigidly and immovably to the microphone, the support being constructed as a part of the microphone casing. In order to attain the optimum results, that is, a substantially uniform response regardless of the angle of sound incidence, the screen should be at least of such dimensions that if the front end of the microphone casing were placed against the screen, its peripheral or marginal portion would be within that of the screen, i. e., the screen should be at least as, but preferably more extensive in all directions laterally than the diaphragm or the front end of the microphone casing; its acoustic resistance should be such that the phase change in the sound waves passing through the screen to the microphone's diaphragm, results in a diminution in the pressure on the diaphragm to a value below that which would exist if the screen were not there; and its distance from the front end of the casing and, therefore, from the diaphragm, should be such that the equalizing of the response takes place particularly in the frequency region in which the greatest variations in response would take place with variation in angle of sound incidence without the use of the screen. Placing the screen nearer to the diaphragm than for optimum results, causes a greater decrease in the effect of diffraction at the upper end of the high frequency region of the audio frequency range, while placing it farther away causes a greater decrease in the effect of diffraction and angle effects at the lower end of the high frequency region of the audio frequency range.

Fig. 8 shows a series of frequency response curves for different angles of incidence for the device of Figs. 1 to 4. The portion **12** of the microphone casing was approximately one inch in diameter, and a single layer of silk cloth two and one-half inches in diameter and having an acoustic resistance of **44** mechanical ohms per square inch constituted the screen **20**, which was positioned at a distance of approximately three-eighths of an inch from the front end of the casing. It is to be noted that at least up to 10,000 cycles per second, the response for angles of incidence between 0° and 180° varies by not more than 5 decibels. An even more uniform response than that evidenced by Fig. 8, was obtained when the single layer of silk was replaced by two layers of silk. This is shown by Fig. 9. It is clear that sound waves incident normally, and at least a portion of the sound waves incident at an angle up to 90°, reach the diaphragm after passing through the screen **20**, while sound waves incident between at least 90° and 180° reach the diaphragm of the microphone either directly through the substantially annular passage **30** defined by the microphone casing and the screen **20** or by reflection from the screen **20**.

Figs. 5 and 6 show another acoustic device embodying this invention. It is similar in most respects to the device of Figs. 1 to 4, like parts being indicated by like reference characters. Instead of the screen **20**, a screen **31**, performing the same function, may be employed. This screen **31** comprises, preferably, a disc or plate of insulating material such as glass, hard rubber, or phenol condensation product, or corrosion resistant metal, such as aluminum or duralumin, containing a multiplicity of passages **32**, each preferably greater in length than in width or diameter and proportioned to resonate in the range where the maximum diffraction occurs. Sound energy is dissipated in the holes or passages and a fraction of the original pressure is transmitted.

Although this invention has been disclosed with reference to various specific embodiments thereof, it is to be understood that modifications may be made therein without departing from the invention, which is to be considered as limited, therefore, by the appended claims, only.

What is claimed is:

1. A transmitter comprising a casing having an opening therein, a diaphragm mounted in said casing and juxtaposed to said opening, an acoustic screen of uniform fabric in fixed axial alignment with and in front of said diaphragm and spaced from the wall of said casing to define an open lateral space between said screen and said casing, and means including a plurality of spacer members for supporting said screen.

2. A non-directional transmitter comprising a casing having an opening therein, a diaphragm mounted in said casing adjacent said opening, a fabric screen of uniform acoustic impedance characteristic over its entire area, mounted in front of said diaphragm and opening and in fixed axial relation thereto by a pair of clamping members between which the peripheral portion of said screen is secured, and a plurality of spacer members extending between the clamping members and the casing whereby the transmitter responds uniformly to sound waves from all directions.

3. A transmitter, comprising a casing having an opening therein, a diaphragm mounted in the casing adjacent said opening, a silk fabric screen of uniform acoustic impedance characteristic over its whole area, which is greater than that of the diaphragm, mounted in front of said diaphragm and opening in spaced relation thereto and in fixed axial alignment therewith by a pair of clamping members between which the peripheral portion of said screen is secured, and a plurality of spacer members extending between said clamping members and the casing, thereby defining a fixed, uniform, substantially annular opening between the screen and casing, whereby the transmitter responds substantially uniformly to sound waves arriving from all directions.

4. A transmitting device comprising a casing having an opening, a diaphragm mounted in the casing adjacent the opening, an acoustic impedance means and supports attached to said casing for mounting said means in spaced relation thereto and in fixed axial alignment with said diaphragm and opening, said impedance means comprising a screen of cloth having uniformly spaced weft and warp threads, whereby the acoustic impedance losses of sound waves coming through the screen are substantially equivalent to the diffraction losses of the sound waves coming from other directions.

5. A substantially non-directionally responsive transmitting device comprising a microphone having a diaphragm and an acoustic impedance screen of fabric, having uniformly spaced weft and warp threads, mounted in front of said diaphragm in spaced relation thereto and in fixed axial alignment therewith, whereby the acoustic impedance losses of sound waves from the front are substantially equivalent to the diffraction losses of sound waves from the sides and back of the device.

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