Jan. 10, 1961 H. C. PYE 2,967,914

TELEPHONE TRANSMITTER

Filed June 2, 1955 2 Sheets-Sheet 1

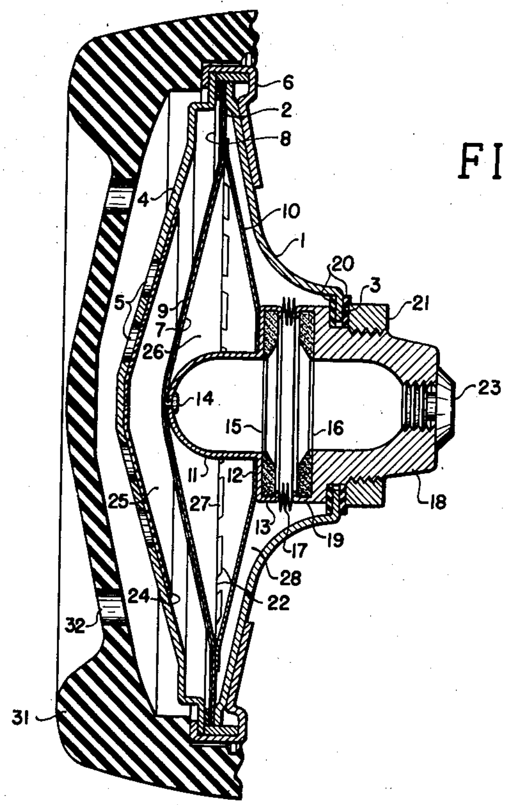

FIG. 1

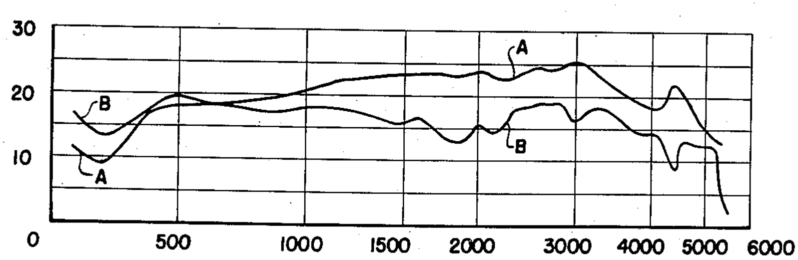

FIG. 4

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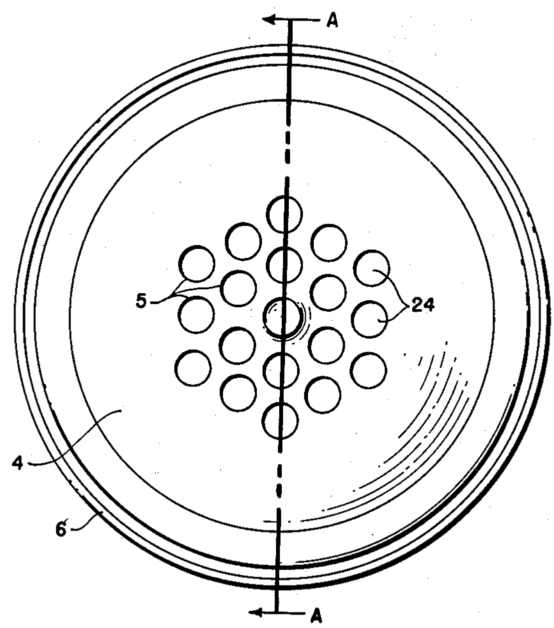

FIG. 2

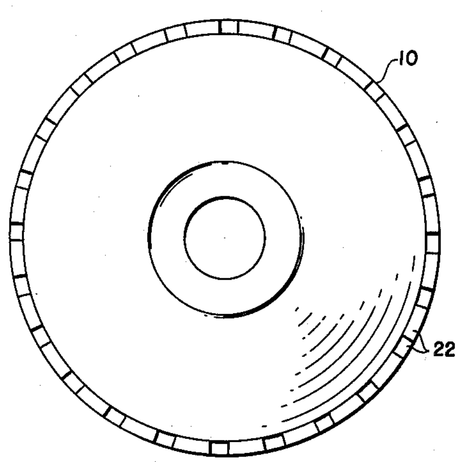

FIG. 3

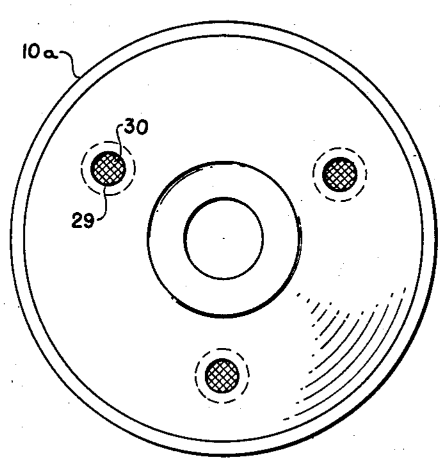

FIG. 3A

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United States Patent Office

2,967,914

Patented Jan. 10, 1961

2,967,914

TELEPHONE TRANSMITTER

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Filed June 2, 1955, Ser. No. 512,672

15 Claims. (Cl. 179—123)

This invention relates to telephone transmitters and particularly to improvements in such transmitters of the carbon granule type for use in the handset of cradle type telephone sets.

One of the main objects of this invention is to provide a transmitter which will provide a more faithful reproduction of the voice.

Another object of the present invention is to provide a telephone transmitter embodying features for reducing the interference of high ambient noises with signal transmission.

A further object is to provide a transmitter with a relatively flat frequency output characteristic.

Still another object is to provide a transmitter which is of extremely simple and rugged construction, which is compact and economical to manufacture and which is efficient in operation.

These objects are realized through the cooperative functioning of some or all of the following features incorporated in this invention.

The first of these features is an air chamber enclosed within the diaphragm, which chamber through suitable openings in the diaphragm wall cooperates with a rear air chamber to produce a more uniform output and an increase in the high frequency limit.

Another feature is the inclusion of a front screen which attenuates high intensity sound, thereby protecting the carbon cell, and preventing transmitter overloading.

Generally speaking, the transmitter disclosed herein is a direct improvement on the transmitter disclosed in Patent No. 2,149,628, issued March 7, 1939, to Harold C. Pye.

As is well known a flat diaphragm can vibrate in sections or modes at various frequencies without transmitting this vibration to an attached carbon cell. To overcome this and to cause the diaphragm structure to approximate the action of a piston, variously shaped diaphragms have been utilized. Some diaphragms have been corrugated in various ways to stiffen them, others have been shaped as conical sections or both. In the transmitter of the Pye patent the diaphragm is constructed to two conical members reinforced at the center to form a very stiff central section, with a circumferential flange to permit vibration of the central section as a unit. This construction eliminated sectional vibration and permitted the diaphragm to be mechanically resonant at some single frequency and has been retained in the present invention. To restrict this resonance and to reinforce the response at other frequencies, resonant or damping chambers located on both sides and next to the diaphragm are utilized, such as the resonant chambers **25** and **28**. These chambers are tuned to frequencies other than the natural frequency of the diaphragm normally higher than the diaphragms natural frequency. Such design gives a transmitter that has a rapidly rising output toward the natural frequency of the diaphragm, and then a somewhat less steep rise in the output curve to the upper limit of frequency response.

To improve the low frequency response by the use of resonating chambers would require a chamber of greater volume than is here utilized. This larger chamber would also, while increasing the lower frequency response, contribute nothing to the higher frequencies output. In this invention two chambers with an acoustically resistive opening between them are utilized. This combination permits the one chamber adjacent the diaphragm to still improve the higher frequency output, while at the lower frequencies, where the acoustic resistance of the openings between the two chambers becomes negligible, it develops in conjunction with this other chamber a new point of resonance, thus boosting the low frequency response also. The use of an auxiliary resonating chamber would increase the overall size of the transmitter were it not for the ingenious utilization of the air chamber defined by the two conical diaphragm members. The acoustically resistive passages in one embodiment are formed by corrugating the periphereal edge of one of the conical members, and in another option by piercing the conical member in a number of places and then covering these openings with cloth to obtain the proper resistance to the passage of air.

A conventional telephone transmitter is responsive to a band of frequencies in the audible range, and when used in conventional telephones under normal conditions of low ambient noise provides satisfactory articulation. However if the noise is sufficiently great, in the range of 100 db, the signals become inarticulate. This is because the conventional carbon transmitters are designed to be most efficient at sound pressures in the range of from 50 to 90 db (above .0002 microbar). When the sound pressure is raised to 110 db the transmitter has reached its maximum response at the regions of greatest output. Increasing the sound pressure 6 db above 110 db results in only a 1 db increase in transmitter output and further increases of sound input result in no further increases of transmitter output. It is for this reason that talking loudly into the conventional transmitter results in only greater distortion of the speech transmitted and makes it impossible to use the range of audibility above the 110 db masked level.

A desirable feature of telephone transmitters is a faithful reproduction of the voice. A measure of this fidelity is the response of a transmitter with frequency variations. The range of frequencies transmitted by conventional telephone circuits extends from 300 to 3500 cycles. The frequency response of conventional transmitters gives an output that rises with frequency from 300 cycles to 2000 cycles. This rising characteristic is intended to compensate for the attenuation of telephone cable which increases with frequency. The receiver is made to respond rather uniformly from 200 up to 3000 cycles. These combined characteristics are advantageous in a regular telephone system with long lines where transmission is often limited to a frequency band between 300 cycles and 3000 cycles and attenuation is relatively high and increases with frequency. However with shorter lines with negligible attenuation such as would be encountered in a ship's service telephone system, the frequency band is not restricted.

It is possible to make the response frequency characteristic of a transmitter more uniform and to extend the response to at least 4000 cycles by sacrificing the amplitude of response somewhat. This will also give improved intelligibility in loud noise fields and is accomplished in the present device.

These and other features of this invention will become apparent as the description progresses.

The accompanying drawings comprise Figs. 1 to 4 and show two embodiments of the novel transmitter unit according to the invention.

Fig. 1 is an enlarged side cross-sectional view through the center of the transmitter unit, and mouthpiece of the telephone handset;

Fig. 2 is a front view of the transmitter unit;

Figs. 3 and 3*a* consist of views of two optional rear diaphragm member constructions;

Fig. 4 is a graph illustrating the performance characteristics of the transmitter units made according to this invention.

Referring now to Fig. 1 of the drawings, the rear housing member of the transmitter unit is indicated by the reference character **1**. It is provided with a rim **2** on the surface of which is mounted the diaphragm assembly, another rim **3** provides a mounting for a portion of the carbon cell. A front housing member or face plate **4** having a number of openings **5** arranged in a circular pattern (see Fig. 2) to permit the speech waves to reach the diaphragm, is held in place by a retaining ring **6**.

The entire transmitter assembly is then positioned and clamped in place in the telephone handset by the mouthpiece **31**, the voice passing through the openings such as **32** in the face of the mouthpiece to reach the transmitter.

The moving system comprising the diaphragm assembly is made of a light material such as thin duralumin sheet metal. Three separate parts are assembled together to form the diaphragm. The front part or main diaphragm member **7** is conical in shape and has a relatively wide flange around its outer edge. A thin cushioning ring **8**, a moisture proof protective element **9** completely covering the front of the diaphragm member **7**, and the diaphragm member **7** are clamped between the face plate **4** and the inside of the housing member **1**. Behind the front diaphragm member **7** lies a rear diaphragm member **10** in the shape of a frustum of a cone. This rear diaphragm member is also flanged along its outer edge and this flange is radially fluted or corrugated in the preferred embodiment of this invention (see Fig. 3). Twenty-four equally spaced flutes 0.060 inch wide and 0.0026 inch deep were found to be satisfactory.

Another construction providing equally good acoustic qualities is shown in Fig. 3A by reference character **10*a***. In this construction the conical section has three holes such as **29** which are covered with cloth **30** to obtain the proper acoustic resistance. A dome shaped cup **11** (Fig. 1) is inserted through the opening in the rear diaphragm member **10** and a flanged portion **12** of the diaphragm member **10** engages a flange **13** of the dome shaped cup **11**. The complete diaphragm assembly comprising the front diaphragm member **7**, the rear diaphragm member **10**, and the dome shaped cup **11** is then drawn together under tension to the position indicated in Fig. 1, and the top of the dome **11** and the center of the front diaphragm member **7** are secured together by means of the rivet **14**, thus forming a diaphragm assembly which is very stiff over the center conical portion and flexible around the flanged portion of the diaphragm member **7**. This construction insures that the diaphragm moves as a whole similar to a piston and will not vibrate in sections as a flat plate does when driven by sound waves of various frequencies.

Enclosed by this construction is an annular chamber **26** whose boundaries are defined by the diaphragm members **7** and **10**, and the cup member **11**. This chamber is completely confined by the members of and is within the moving system. It cooperates acoustically with the exterior chamber **28** through the air passageways of the diaphragm assembly.

A ring shaped electrode **15** constructed of solid carbon is fastened to the flange **13** of the dome shaped cup **11** by the flange **13**. Opposite the moving electrode **15** is a fixed ring shaped carbon electrode **16** of the same shape as the moving electrode. This is mounted in the edge of

the flange **19** of another dome shaped cup **18**, which cup is rigidly fastened to the transmitter housing member **1** by means of the nut or threaded ring **21**. The cup **18** is electrically insulated from the housing member **1** by means of the ring shaped insulating washers **20** on the shank of the dome shaped cup **18**. Between the outer edges of the carbon ring electrodes **15** and **16** there is cemented a flexible paper bellows **17** of circular shape. This paper bellows **17** confines the granular carbon in the cell which is formed between the two cups **11** and **18** and the electrodes **15** and **16**. The inner surfaces of the dome shaped cups **11** and **18** in contact with the carbon granules are covered with a suitable insulating enamel so that the current flow in the microphone cell is confined to the path between the carbon electrodes **15** and **16**. For the purpose of illustrating the individual parts of the microphone cell more clearly the granular carbon material which almost completely fills up the space between the electrodes and the dome shaped cups **11** and **18**, has not been shown in the drawings.

At the rear end of the dome shaped member **18** there is provided an opening whereby the microphone cell may be filled with the carbon granule material. After the filling is completed the plug **23** is threaded into the opening and then the head of the plug is sheared or twisted off.

In this embodiment of the transmitter for use in very high ambient noise locations and with comparatively short lines there is mounted on the inside of the face plate **4** a disc **24** of closely woven cloth. One such cloth found to be satisfactory is double filled duck, weight 12.4 oz. per square yard and a count of 89 x 31 threads per inch. The purpose of disc **24** is to attenuate the sound input to the transmitter and thus prevent the transmitter from reaching its maximum response at sound pressures of 110 db and unless the transmitter is to be used in such high ambient noise it is not included. This screen in cooperation with the other improvements also causes the output of the transmitter to be relatively uniform for all frequencies between 500 cycles and 3500 cycles and provides a useable band between 200 and 5000 cycles per second as shown by curve B of the graph of Fig. 4. Because of the disc **24** the transmitter will not be saturated or operated to its maximum response by the noise level and if the user will shout into the transmitter at a higher level than the noise level, this speech will be transmitted intelligibly. In addition the uniform output of the transmitter at all frequencies between 500 cycles and 3500 cycles prevents the transmitter from saturating at some of these frequencies while still able to transmit all of the other frequencies.

The peculiar characteristic for a telephone transmitter of a relatively flat response over its useful range is necessary because of the comparatively short telephone lines and greater noise found on ship board for which this version of the transmitter is intended. The lines found on land are usually much longer and have a greater reactance causing the higher frequencies to be attenuated more than the lower frequencies. To compensate for this increasing attenuation with increasing frequency, telephone transmitters usually have an output that increases with frequency up to the highest practical limit of usable frequency. The increasing output thus compensates for the increasing line losses with increasing frequency to give a natural response at the receiving end. Frequently this design was carried to the limit for the longest lines encountered in an exchange area, and its use with the shorter lines caused the voice to sound unnatural and loud. The output of the transmitter of this invention (without disc **24**) at the various frequencies is therefore designed for use with the length of line most frequently found in an exchange area, and is shown by curve A of the graph of Fig. 4.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is contemplated to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A transmitter for use in a telephone set including, a diaphragm unit comprising two conical shaped members having their peripheries in contact defining an air chamber therebetween, passage ways in one of said conical members for permitting the movement of air to and from said chamber, and means comprising said chamber and said perforations for controlling the resonant frequency of said diaphragm.

2. In a transmitter for use in a telephone set, a diaphragm unit comprising two conical shaped members having their peripheries in contact, a cup member having its bottom end secured to the apex of one of said conical members and its edges in contact with the other of said conical members, an annular air chamber defined around said cup member and between said two conical members, air passages in the other of said conical members for permitting the controlled movement of air to and from said chamber, means comprising said annular air chamber in cooperation with said perforations to control the resonant frequency of said diaphragm.

3. A telephone transmitter as set forth in claim 2 in which said air passages comprise a plurality of equally spaced flutes radially positioned along the periphery of said other of said conical members, approximately 0.060 inch wide and 0.0026 inch deep.

4. In a telephone transmitter, a diaphragm unit comprising members defining an acoustic resonant air chamber within said diaphragm, means defining another air chamber adjacent said diaphragm, means for controlling movement of air between said chambers, said means and said chambers cooperating to control the response of said diaphragm to sounds.

5. In a telephone transmitter, a diaphragm comprising a conical member and a frusto-conical member and a portion of a cylindrical microphone cell with a semi-spherical end, said conical and frusto-conical members having their concave faces and basal peripheries abutting each other, said semi-spherical end of said microphone cell projecting through the center of said frusto-conical member into the chamber formed by the abutting concave faces of said conical and frusto-conical members and attached to the apex of said conical member, a flange on the cylindrical end of said microphone cell portion clamping said frusto-conical member against said conical member, an exterior chamber adjacent said frusto-conical member, the basal periphery of said frusto-conical member fluted, the hollows of said flutes facing the conical member thus define a plurality of restricted passages between said chamber in said diaphragm and said exterior chamber, said restricted passages and said chamber in said diaphragm in cooperation with said exterior chamber alter the low frequency output of said diaphragm in relation to the high frequency output of said diaphragm.

6. In a telephone transmitter, a diaphragm comprising two conical shaped members having their peripheries in contact, a cup member having its bottom end secured to the apex of one of said conical members and its edges in contact with the other of said conical members, an annular air chamber defined around said cup member and between said two conical members, perforations in the other of said conical members for permitting the movement of air to and from said annular chamber, cloth screens over said perforations for controlling the rate of said movement, said annular air chamber in cooperation with said perforations and cloth screens effective to control the resonant frequency of said diaphragm.

7. A telephone transmitter as set forth in claim 6 in which said perforations are approximately 0.125 inch in diameter, and said cloth screens are discs of duck cloth of 3.9 oz. weight per square yard and approximately 0.25 inch in diameter.

8. In a telephone transmitter, a casing, a diaphragm comprising two conical shaped members having their peripheries in contact, a cup member having its bottom end secured to the apex of one of said conical members and its edges in contact with the other one of said conical members, an annular air chamber defined around said cup member and between said two conical members, perforations in the other one of said conical members for permitting the controlled passage of air to and from said chamber, means for mounting said diaphragm in said casing to form another closed annular air chamber between said other conical member and said casing, said two chambers interacting through said perforations to facilitate movement of the diaphragm at the lower voice frequencies.

9. In a telephone transmitter, a casing, a waterproof protective membrane, a diaphragm comprising two conical shaped members having their peripheries in contact, a cup member having its bottom end secured to the apex of one of said conical members and its edges in contact with the other one of said conical members, a first annular air chamber defined around said cup member and between said two conical members, perforations in the other one of said conical members for permitting the controlled entry of air to and escape of air from said chamber, means for mounting said diaphragm in said casing so that another annular air chamber is formed between said other conical member and said casing, said other annular air chamber connected with said first chamber by means of said perforations in the other one of said conical members, and means for mounting said protective membrane in said casing to thereby protectively seal said diaphragm and said chambers from the entrance of moisture.

10. In a telephone transmitter, a casing comprising a perforated face plate and a back shell, a diaphragm clamped between the face plate and the back shell, said diaphragm comprising two conical shaped members having their peripheries in contact, a cup member, the bottom end of said cup member secured to the apex of the front one of said conical members and its edge in contact with the rear one of said conical members, a diaphragm air chamber defined around said cup member and between said two conical diaphragm members, perforations in the rear one of said conical members for permitting the controlled entry of air to and escape of air from said diaphragm chamber, said diaphragm dividing the casing cavity into two chambers, a front air chamber and an annular rear air chamber, said annular rear air chamber connected with said diaphragm chamber by means of said perforations in the rear one of said conical members, said rear chamber and said diaphragm chamber interacting through said perforations to cause resonance of said diaphragm at a low voice frequency thereby increasing the diaphragm movement at the lower voice frequencies without materially affecting its movement at the higher frequencies, said front air chamber so dimensioned that it increases movement of the diaphragm at the higher frequencies while tending to damp the natural resonant peaks of the diaphragm, said three air chambers cooperating with the diaphragm to give an output gradually rising between 400 and 3000 cycles.

11. In a telephone transmitter for use in high ambient noise, a casing comprising a perforated face plate and a rear housing member, a diaphragm clamped between said face plate and said rear housing member, said diaphragm comprising two conical shaped members having their conical peripheries in contact, a cup member, the bottom end of said cup member secured to the apex of the front one of said conical members and its edge in contact with the rear one of said conical members, an annular air chamber defined around said cup member and between said two conical diaphragm mem-

bers, perforations in the rear one of said conical members for permitting the passage of air to and from said chamber, cloth screens covering said perforations for controlling the rate of said air passage, said diaphragm dividing the casing cavity into a front air chamber and a rear air chamber, said rear air chamber connected with said annular chamber by means of said cloth covered perforations in the rear one of said conical members, the two chambers interacting through said perforations to attain resonance at a frequency below that of the natural frequency of either chamber to reinforce the diaphragm movement at the lower sound frequencies, while not materially altering the resonance of the rear air chamber at the higher sound frequencies, said front air chamber so dimensioned that it reinforces the higher sound frequencies while tending to damp resonant peaks of the diaphragm, a cloth disc in said front air chamber, said cloth disc mounted on the interior surface of the perforated face plate and covering said perforations to limit the energy input to the diaphragm and prevent saturation of the microphone cell by high ambient noises.

12. In a telephone transmitter, a casing, a water-proof protective membrane, a microphone cell and a diaphragm comprising two conical shaped members having their peripheries in contact, a cup member having its bottom end secured to the apex of the front one of said conical members and its edges in contact with the rear one of said conical members, an annular air chamber defined around said cup member and between said two conical members, radially positioned corrugations along the periphery of said rear conical member, the concave flutes of said corrugations facing the front conical member thus define a series of minute air passages for the entry and escape of air to said chamber, the rear portion of said casing with said diaphragm thus define another closed annular air chamber therebetween, said chambers connected by means of said air passages formed by the flutes in the rear one of said conical diaphragm members, said protective membrane located between said diaphragm and the front of said casing thereby protectively sealing said diaphragm, microphone cell and air chambers from the entrance of moisture.

13. For use in a telephone set, a transmitter cap, a transmitter comprising a casing including a face plate, a microphone cell, a diaphragm comprising two conical shaped members having their peripheries in contact, a cup member having its bottom end secured to the apex of the front one of said conical members and its edges in contact with the rear one of said conical members, an annular diaphragm air chamber defined around said cup member and between said two conical members, radially positioned corrugations along the periphery of said rear conical member, concave flutes in said corrugations facing the front conical member thus define a series of minute air passages for the entry and escape of air to said chamber, said diaphragm dividing the casing cavity into a front air chamber and an annular rear air chamber, said annular rear chamber connected with said diaphragm chamber by means of said air passages, said rear chamber and said diaphragm chamber interacting through said air passages to cause resonance of said diaphragm at a low voice frequency thereby increasing the diaphragm movement at the lower voice frequencies without materially affecting its movement at the higher frequencies, said front air chamber so dimensioned that it increases movement of the diaphragm at the higher frequencies while tending to damp any resonant output peaks of the diaphragm, a fourth chamber formed between said transmitter cap and said transmitter face plate, said fourth chamber reinforcing the action of said front chamber to give an increased overall output from the transmitter, said four air chambers cooperating with the diaphragm to produce an output gradually rising between 400 and 3000 cycles.

14. In a transmitter in which movement of a diaphragm responsive to sound pressures causes an electrical output, a diaphragm comprising at least two elements that enclose, an air chamber between said elements, vents for controlling the movement of air to and from said chamber, a damping element for controlling the effect of sound pressures on said diaphragm, said vents and said damping element cooperating to control the movement of said diaphragm so that the electrical output of said transmitter is substantially proportional to the intensity of the sound pressure for all sound frequencies from 500 cycles to 3500 cycles.

15. In a transmitter in which a diaphragm responds to sound waves and operates a granular carbon microphonic element to cause electrical output, a diaphragm including two members that include a chamber therebetween, a screen for altering the effect of sound waves on said diaphragm, a plurality of air vents in said diaphragm, said screen and said vents controlling the response of said diaphragm to sound waves of predetermined frequencies so that the electrical output of the transmitter is substantially proportional to the sound intensity at all of said predetermined frequencies.

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