

June 9, 1931.

J. J. STEEDLE

1,809,754

ELECTROSTATIC REPRODUCER

Filed May 13, 1929

2 Sheets-Sheet 1

Fig. 1.

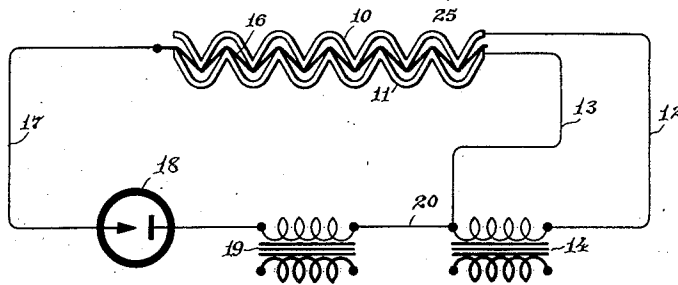


Fig. 2.

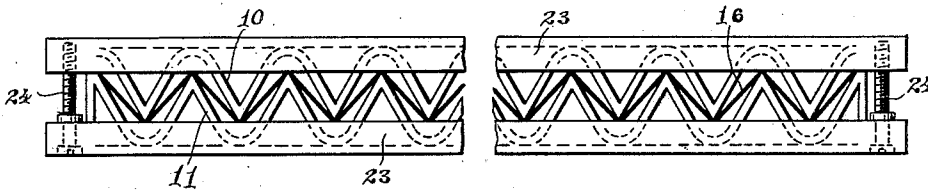
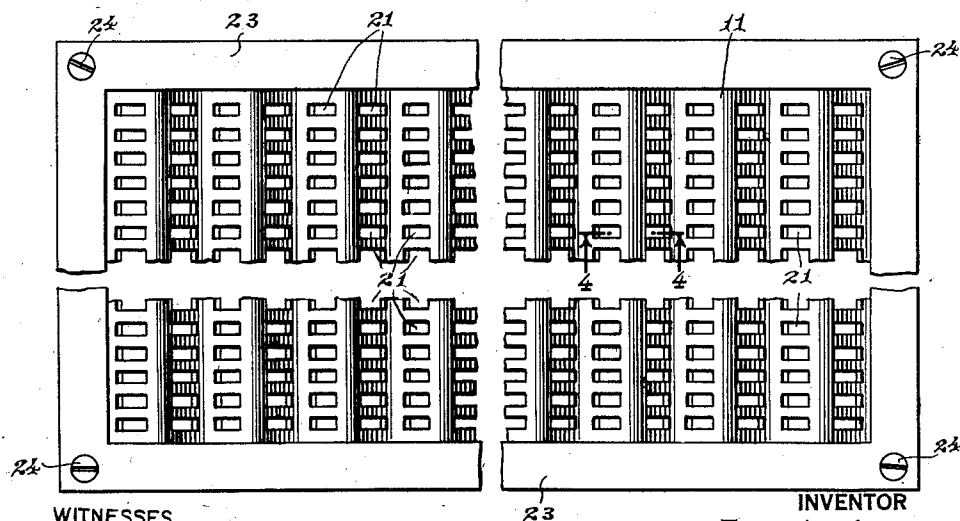


Fig. 3.



WITNESSES
Joe. R. Lavin
A. L. Sperry

INVENTOR
Joseph J. Steedle
BY *Munroe*
ATTORNEYS

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Fig. 4.

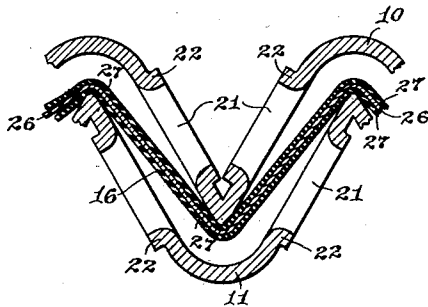


Fig. 5.

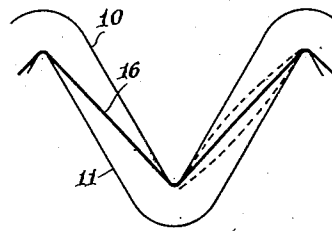


Fig. 6.

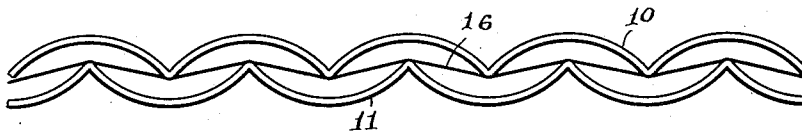


Fig. 7.

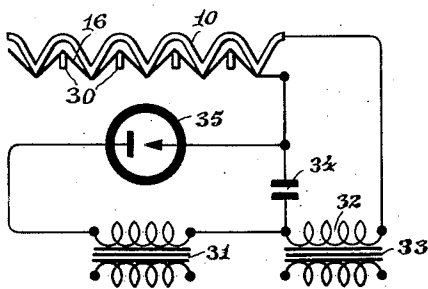


Fig. 8.

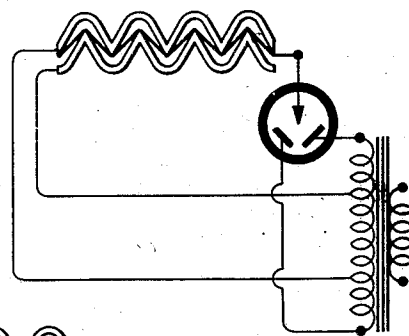
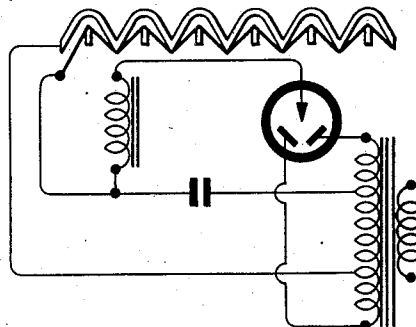


Fig. 9.



WITNESSES

Joe. L. Kania
A. T. Perry

INVENTOR

Joseph J. Steedle
BY Mumuksho
ATTORNEYS

UNITED STATES PATENT OFFICE

JOSEPH J. STEEDLE, OF SCRANTON, PENNSYLVANIA

ELECTROSTATIC REPRODUCER

Application filed May 13, 1929. Serial No. 362,681.

This invention relates to electrostatic reproducers.

It is among the objects of the present invention to provide a novel and improved electrostatic speaker which is simple in construction and operation and which is designed to faithfully reproduce sound waves and to operate at a maximum efficiency.

It is a further object of the present invention to provide an electrostatic speaker, the diaphragm surface of which is of greater area than the area of the device, whereby increased volume may be obtained.

A further object of the present invention is to provide an electrostatic speaker which will propagate sound waves over a wider horizontal angle, thus avoiding the beam propagation of sound waves usually accompanying such devices.

A further object of the present invention is to provide an electrostatic speaker within which a plurality of small area propagating surfaces are provided, thus reducing the normal self-resonance tendency of such devices.

A further object of the present invention is to provide an electrostatic speaker which is of improved sturdy construction whereby lighter and less expensive material may be employed in its construction.

Other objects of the present invention are to provide an electrostatic speaker concentrating a greater area of conducting electrostatic field within a given space and to provide a speaker with means for adjusting the electrostatic capacity of the reproducer to conform with variable attendant apparatus.

Another object of the invention is to provide an electrostatic reproducer having means for varying the tension of the vibrating element whereby the same may be adjusted for all audible frequencies.

Numerous other objects and features of the present invention will be apparent from a consideration of the following specification taken in conjunction with the accompanying drawings, in which

Figure 1 is a cross sectional view of one form of my invention illustrating the associated circuit therefor;

Fig. 2 is a plan view of one embodiment of reproducer speaker;

Fig. 3 is a front elevation of the device as shown in Fig. 2;

Fig. 4 is a sectional view taken on lines 4—4 of Fig. 3;

Fig. 5 is a diagrammatic illustration showing the vibration of the propagating areas;

Fig. 6 is a sectional view of a modified form of the reproducer;

Figs. 7, 8 and 9 are views similar to Fig. 1, showing various modifications of the invention and its associated circuit.

As shown in Fig. 1, the electrostatic reproducer consists essentially in a pair of conducting plates 10 and 11, associated with opposite sides of the output circuit including the conductors 12 and 13 of a transformer 14, the primary coil of the transformer being arranged in the receiving circuit, whereby alternating electrical current of speech frequency will be impressed upon the plates 10 and 11 to charge them in response thereto. Between the plates 10 and 11, a sound propagating diaphragm 16 is mounted, which is arranged for high potential polarization through the conductor 17, rectifier 18, and step-up transformer 19, the circuit being completed through the conductor 20 which is associated with one side of the transformer 14.

The present invention relates specifically to the structure of the reproducer. By referring to Figs. 2, 3 and 4, it will be seen that the plates 10 and 11 are angularly formed, the angles being here shown as 60 degrees, and are positioned so that their alternate peaks and depressions fit within one another, whereby the adjacent surfaces of the sides of the angles are parallel. The plates 10 and 11 are also provided with punched apertures 21 to permit the free passage of the sound waves set up by the diaphragm; thus each aperture is provided with a peripheral extruded portion 22 which materially strengthens the structure, thus permitting the use of thin inexpensive material.

The plates 10 and 11 are mounted within suitable frames 23, which are retained in spaced adjustable relation through screws 24, which permit a variable spacing of the gap

between the plates to allow a latitude of adjustment in the electrostatic capacity and in the tension on the diaphragm.

The diaphragm 16 preferably consists of metal foil 26 carried between flexible dielectric sheets 27, thus insulating the diaphragm from the plates 10 and 11. It will be understood that the diaphragm is stretched between the plates, thus providing a plurality of angled longitudinal independent propagating areas. By referring to Fig. 5, it will be seen that with a high potential applied to the diaphragm, the undulating polarity of the side members 10 and 11 will attract and repel the diaphragm 16 to cause its vibration, as indicated by the dotted lines in Fig. 5, which vibrations will be seen to be at speech frequency and which will thus propagate sound waves. Each area will be seen to propagate sound waves at an angle from its adjacent area and thus the usual beam effect of sound will be avoided.

By referring more particularly to Fig. 6, it will be seen that the invention may undergo numerous modifications without departure from the spirit or scope thereof. In the modification shown in Fig. 6, the upper and lower plates 10 and 11 are formed in a curved manner, the crest of one plate being received in the trough of the adjacent plate, and the diaphragm 16 being tensioned and contacting with the various crests.

Referring again to the circuit shown in Fig. 1, it will be understood that the step-up transformer 19 will have its primary coil connected to the alternating current light circuit and one side of its secondary is connected with the secondary of the transformer 14, while the other side of the secondary is connected through the rectifier 18 to the diaphragm 16. It will be seen that the polarizing current applies a positive potential on the diaphragm with respect to the plates 10 and 11, so that the fluctuating signal current making the plates alternately positive and negative, will cause the diaphragm to be attracted first by one and then by the other plate and thus set up the desired sound vibrations which will correspond in frequency and amplitude to the signal current.

Referring more particularly to Fig. 7 of the drawings, it will be seen that in this form of the device, the lower plate 11 is not used and in place thereof a plurality of transversely extending bars 30 are provided which provide the tension for the diaphragm. Referring to the electrical circuit disclosed in this figure of the drawings, it will be seen that a step-up transformer 31 is associated with one side of the output of the secondary coil 32 of the signal transformer 33 and that the upper plate 10 is directly associated with one side of the secondary 32 while the diaphragm 16 is associated through a blocking condenser 34, rectifier 35 and the secondary of the step-

up transformer with the opposite side of the secondary of the input transformer. Thus the diaphragm will be polarized and will, at the same time, be influenced by the sound modulated current from the transformer 33, and thus the vibrations of the angularly related areas of the diaphragm will be in accordance with the impressed voice currents as in the manner of the device shown in Fig. 1.

Referring more particularly to Figs. 8 and 9 of the drawings, two forms of self-polarizing circuits for use with the electrostatic reproducer, are here shown, in which cases tri-element full-wave rectifiers are utilized, the cathode of which is associated with the diaphragm while the signal current is directed from center taps on the transformer to the plate or plates of the reproducer. These figures are presented to show the wide variety of electrical circuits which may be utilized in connection with the reproducer. Thus the invention is subject to various modifications and changes both in the structural details presented and in the electrical circuits shown in association therewith, and the invention is thus not confined to the specific embodiments herein presented, but numerous changes and modifications and the full use of equivalents may be resorted to without departure from the spirit or scope of the invention as outlined in the appended claims.

What is claimed is:

1. An electrostatic speaker, including a plurality of angular plates, and a diaphragm angularly disposed therebetween, whereby a plurality of angularly related propagating areas are formed by said diaphragm.

2. An electrostatic speaker, including a plurality of angular plates, a diaphragm angularly disposed therebetween, whereby a plurality of angularly related propagating areas are formed by said diaphragm, and means for variously polarizing said plates and diaphragm.

3. An electrostatic speaker, including a plurality of angular plates, a diaphragm angularly disposed therebetween, whereby a plurality of angularly related propagating areas are formed by said diaphragm, means for variously polarizing said plates and diaphragm, and means for undulating the polarization of one of said members by voice currents.

4. In an electrostatic reproducer, a corrugated plate forming angularly-related sections, and a movable diaphragm disposed across said plate having portions angularly related to the angular portions of said plate.

5. In an electrostatic reproducer, a corrugated plate forming angularly-related sections, a movable diaphragm disposed across said plate having portions angularly related to the angular portions of said plate, and

means for holding the diaphragm in normal position.

6. In an electrostatic reproducer having two plates, each with a plurality of angles and a propagating diaphragm positioned between the plates and in close proximity thereto.

7. An electrostatic reproducer having two angular plates, and a propagating diaphragm disposed between the said plates and supported thereby.

8. An electrostatic reproducer, including two plates, each with a plurality of angles, and a propagating diaphragm disposed between the said two plates and in contact therewith.

9. An electrostatic reproducer having two angular plates, a propagating diaphragm disposed between the said two plates and in contact therewith, and means to move one of the plates relatively to the other plate to adjust the tension of the propagating diaphragm.

10. An electrostatic reproducer having two plates, each with a plurality of angles, and a propagating diaphragm disposed between the said plates and engaged by the angular portions of the latter to hold the propagating diaphragm at a plurality of angles.

11. An electrostatic reproducer, including a plurality of apertured angular plates, a propagating diaphragm positioned between the plates and in contact therewith, and means for positively polarizing said diaphragm.

12. An electrostatic reproducer having two plates, each with a plurality of angles, a propagating diaphragm positioned between the plates and in contact therewith, means for positively polarizing said diaphragm, and means for impressing voice currents upon said plates.

13. An electrostatic reproducer having two plates, each with a plurality of angles, a propagating diaphragm positioned between the plates and in contact therewith, means for positively polarizing said diaphragm, and means for impressing voice currents upon said plates, said first mentioned means including a step-up transformer and rectifier.

14. An electrostatic reproducer, including two plates, each with a plurality of angles, a propagating diaphragm positioned between the plates and in contact therewith, means for positively polarizing said diaphragm, and means for impressing voice currents upon said plates, said first mentioned means including a step-up transformer and rectifier and said second mentioned means including the output circuit of a voice-transmitting device.

15. In an electrostatic reproducer, a corrugated plate forming angularly-related sections, a movable diaphragm disposed across said plate and having portions angularly related to the said angular portions of said plate, and means for holding the diaphragm

with portions disposed against portions of the corrugated plate.

16. In an electrostatic reproducer, a corrugated plate forming angularly-related sections, a movable diaphragm disposed across said plate, and means for holding the diaphragm in contact with the said corrugated plate.

17. An electrostatic reproducer, comprising a corrugated apertured plate forming angularly related apertured sections, and a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate.

18. An electrostatic reproducer, comprising a corrugated apertured plate forming angularly related apertured sections, a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate, and a second corrugated apertured plate having its crests in staggered relation with respect to the crests of the first-mentioned plate.

19. An electrostatic reproducer, comprising a corrugated apertured plate forming angularly related apertured sections, a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate, and a second corrugated apertured plate having its crests in staggered relation with respect to the crests of the first-mentioned plate, said plates co-operating to tension said diaphragm therebetween.

20. An electrostatic reproducer comprising a corrugated apertured plate forming angularly related apertured sections, a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate, and a second corrugated apertured plate having its crests in staggered relation with respect to the crests of the first-mentioned plate, said plates co-operating to tension said diaphragm therebetween, whereby said diaphragm is corrugated in conformity with the corrugations of said plates.

21. An electrostatic reproducer, comprising a corrugated apertured plate forming angularly related apertured sections, a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate, and a second corrugated apertured plate having its crests in staggered relation with respect to the crests of the first-mentioned plate, said plates co-operating to tension said diaphragm therebetween, whereby said diaphragm is corrugated in conformity with the corrugations of said plates, said diaphragm thus providing individual sound propagating portions angularly related to each other.

22. An electrostatic reproducer, comprising a corrugated apertured plate forming angularly related apertured sections, a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate, and a second corrugated apertured plate having its crests in staggered relation with respect to the crests of the first-mentioned plate, said plates co-operating to tension said diaphragm therebetween, whereby said diaphragm is corrugated in conformity with the corrugations of said plates, said diaphragm thus providing individual sound propagating portions angularly related to each other, every other angular portion of said diaphragm being parallel.

23. An electrostatic reproducer, comprising a corrugated apertured plate forming angularly related apertured sections, a movable diaphragm stretched across said plate having portions angularly related in similar manner to the angular relation of the portions of said plate, a second corrugated apertured plate having its crests in staggered relation with respect to the crests of the first-mentioned plate, said plates co-operating to tension said diaphragm therebetween, whereby said diaphragm is corrugated in conformity with the corrugations of said plates, said diaphragm thus providing individual sound propagating portions angularly related to each other, every other angular portion of said diaphragm being parallel, and adjustable connecting members between said plates whereby their spaced relation may be varied to adjust the tension applied to said diaphragm.

JOSEPH J. STEEDLE.