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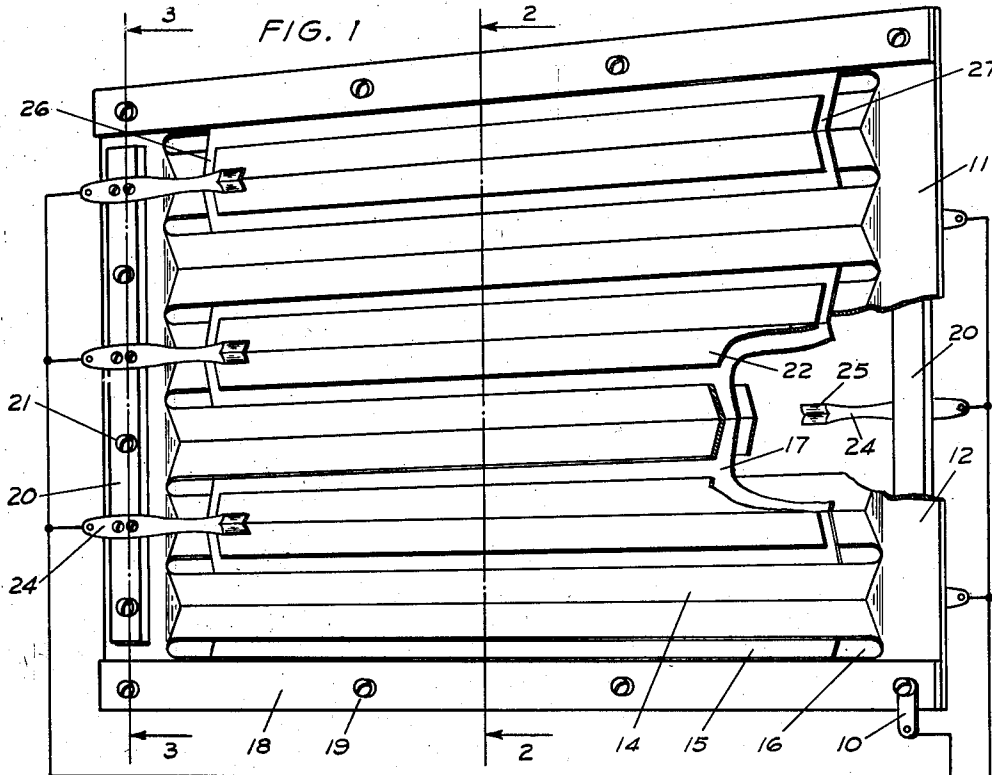
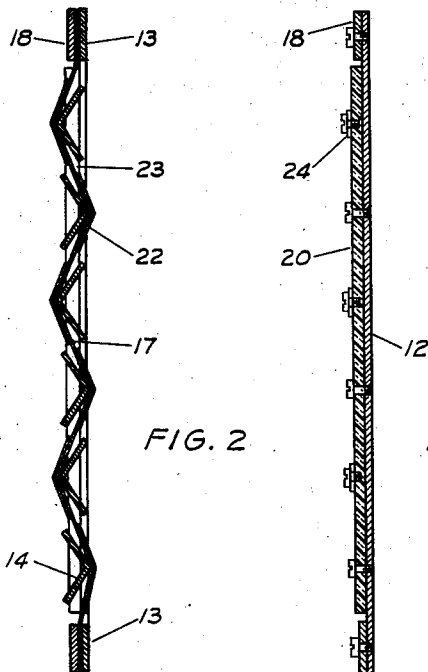
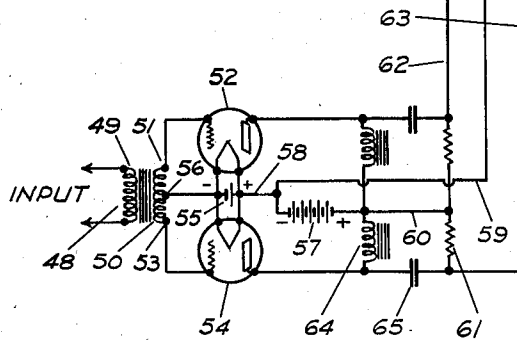
L. A. WOLFE

1,831,278

ELECTROSTATIC SOUND TRANSLATOR

Filed May 29, 1930

5 Sheets-Sheet 1



INVENTOR
Layton Allen Wolfe

Nov. 10, 1931.

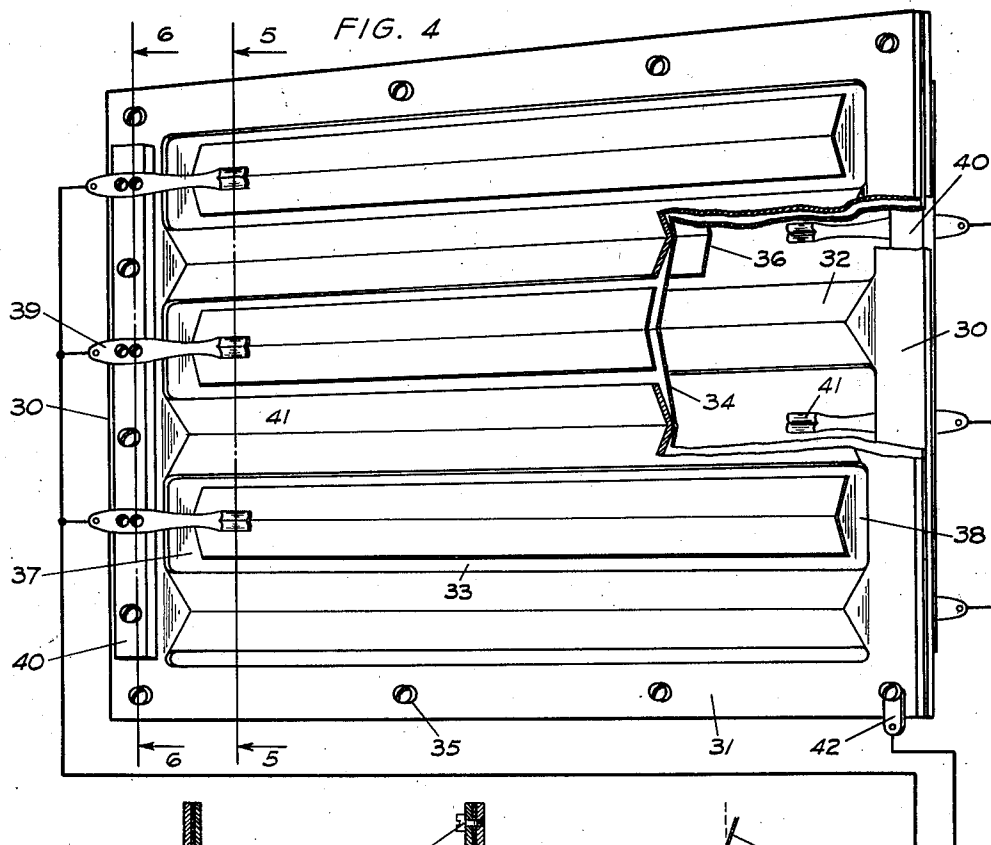
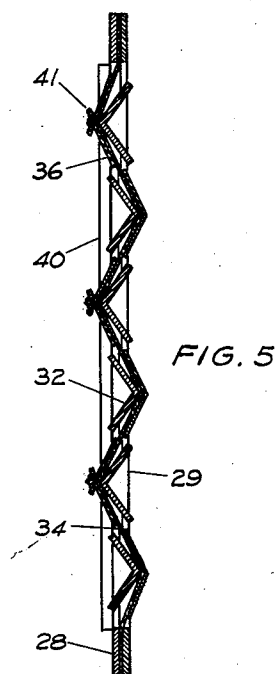
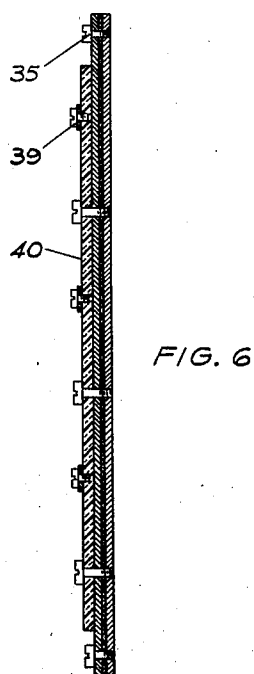
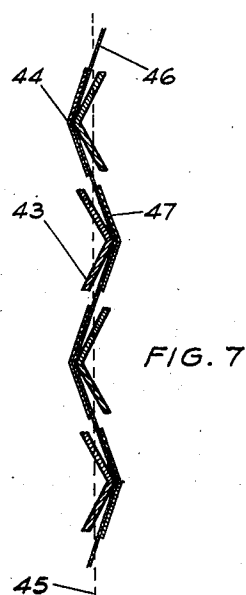
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5 Sheets-Sheet 2



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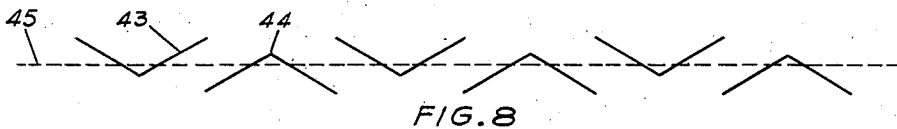
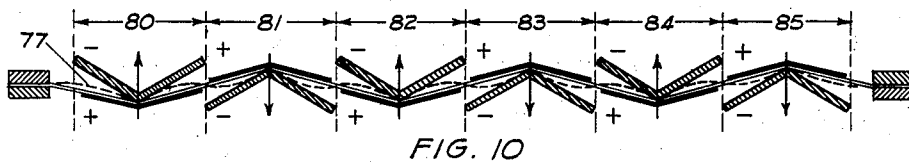
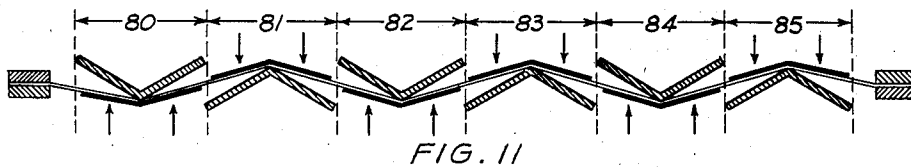
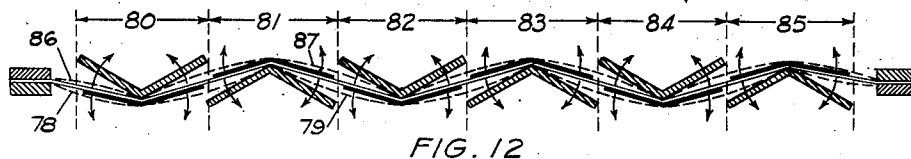
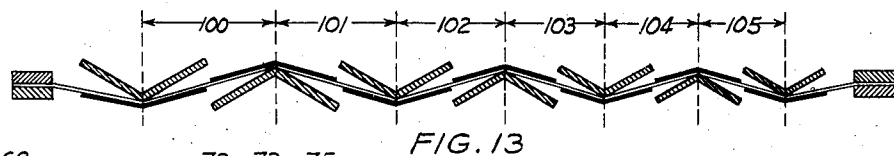
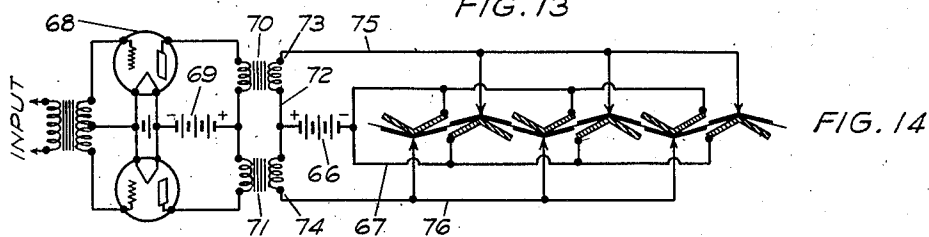
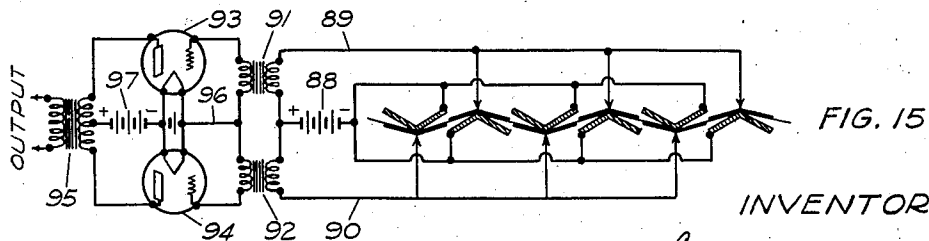
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ELECTROSTATIC SOUND TRANSLATOR

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5 Sheets-Sheet 3



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Nov. 10, 1931.

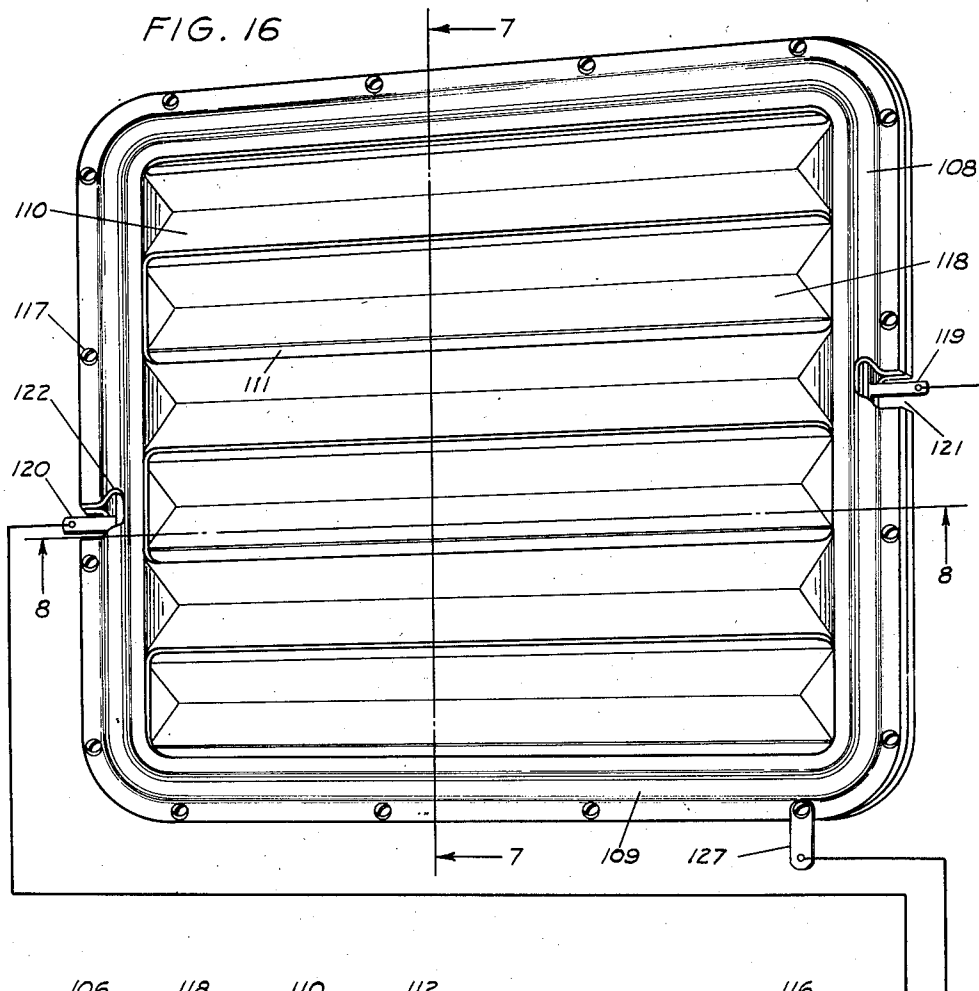
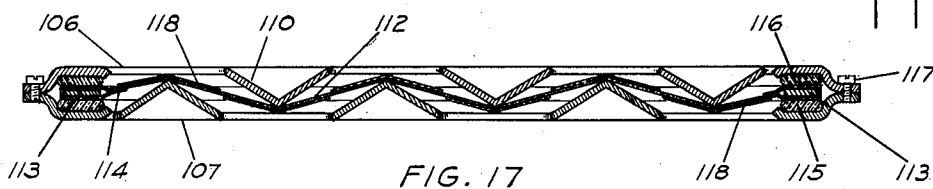
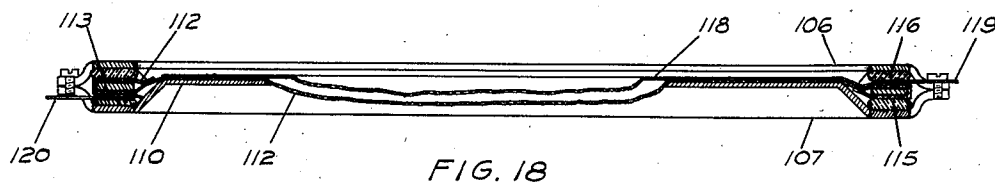
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ELECTROSTATIC SOUND TRANSLATOR

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5 Sheets-Sheet 4



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ELECTROSTATIC SOUND TRANSLATOR

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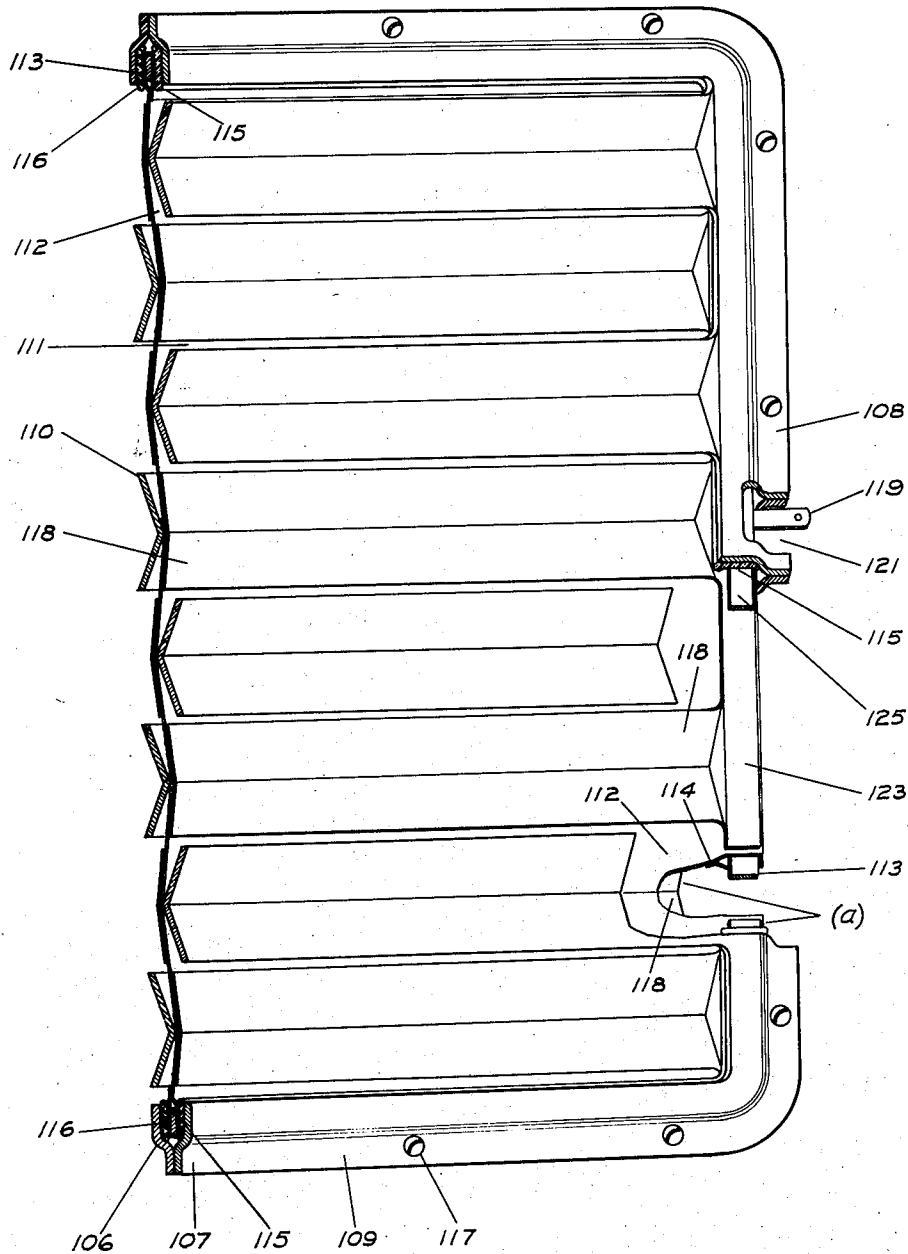


FIG. 19

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UNITED STATES PATENT OFFICE

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ELECTROSTATIC SOUND TRANSLATOR

Application filed May 29, 1930. Serial No. 457,063.

My invention hereinafter described is an electrostatic sound translator for transforming electrical vibration into audible sound vibration and vice versa.

5 In my invention, I employ what may be termed fixed grid members with a dielectric contacting with such members, the grid members being arranged alternately on opposite sides of the dielectric, and the dielectric opposite each grid member is provided with an electrically conductive coating or film; the substance of the coating or film being separated from the grid member by the body of the dielectric.

15 Another feature of my invention is in having the dielectric constituting a comparatively large diaphragm and the alternate grid members made in a somewhat V section, each successive member being inversely arranged, 20 permitting the diaphragm member to contact only with the apices of the V-shaped grid members and therefore allowing the dielectric diaphragm to vibrate between such apices. In the reproduction of sound, the 25 dielectric with its opposite and alternate conductive coatings or films vibrates in comparatively short sections, forming what may be considered elongated areas.

A characteristic feature, therefore, of my 30 invention is in having the dielectric diaphragm occupy as considered in a section, a zigzag location between V-shaped grid members alternately disposed and inversely positioned on opposite sides of the dielectric, and 35 opposed to each grid section the dielectric diaphragm has a conductive coating or film. The grid members are all electrically connected together to be simultaneously energized with the same polarity, and the coatings or films on one side of the dielectric are all electrically connected and those on the opposite side are electrically connected.

Another feature of my invention is the electrical connection whereby the grid members are given a constant negative bias in respect to the conductive coatings on the dielectric, which are positively biased by the same source of D. C. potential. Another feature of my invention is energizing the grid members and coatings additionally by elec-

tronic tubes arranged to operate on the push and pull principle. In the reproducing of sound, these tubes may be connected to a sound or voice controlled current. Therefore, by the electrical connection, when the coatings on one side of the dielectric are energized by the output of the corresponding electronic tube, with a positive current, those on the opposite side are non-energized by their corresponding electronic tube which is inactive at that period, and as the latter tube becomes active it energizes its corresponding dielectric coatings with a positive current and the first-mentioned tube becomes inactive; thus the tubes become active in periods of half-cycles and supply an uni-directional current of positive polarity to the dielectric coatings which they respectively control. This arrangement in effect causes the coatings on one side of the dielectric to be positively energized during one-half cycle of a current wave, and on the opposite side to be positively energized on the second half-cycle of the current wave, this action being repeated.

A characteristic feature of my invention is the permanent electrical bias between the fixed grid elements and their opposite conductive coatings on the dielectric to give a distortion to the shape of the dielectric so that it will not occupy exactly plane surfaces between the apices of the opposing grids. Then when the grid members and the conductive coatings on opposite sides of the dielectric are energized by a fluctuating voice or other sound controlled current, the sections of the coating between the apices of the grid are caused to vibrate between such apices and thereby reproduce sound. The construction and the manner of electrifying the grid elements and the coatings cause an action whereby when the coating opposite one grid element is being attracted thereto, the coating over the next adjacent grid element is being repelled from such latter element by virtue of the dielectric discharging, and necessarily the movings of the coatings cause a movement of the dielectric diaphragm. Therefore, there is a full vibration of the sections of the dielectric diaphragm be-

tween the apices of each of the adjacent grid elements. The amount of the permanent electrical bias charge on the grid elements and the coatings function with the charge developed on these elements through the voice current to give a resultant electrification vibrating the diaphragm.

My invention is illustrated in connection with the accompanying drawings, in which,
 Fig. 1 is a perspective elevation of one form of my invention, partly broken away to illustrate details and with a suitable electric hookup;

Fig. 2 is a transverse section on the line 2—2 of Fig. 1, in the direction of the arrows;

Fig. 3 is a transverse section on the line 3—3 of Fig. 1, in the direction of the arrows;

Fig. 4 is a perspective elevation of another form of my invention, partly broken away to illustrate details;

Fig. 5 is transverse section on the line 5—5 of Fig. 4 in the direction of the arrows;

Fig. 6 is a transverse section on the line 6—6 of Fig. 4, in the direction of the arrows;

Fig. 7 is an enlarged diagram illustrating the grid, the dielectric, and the coating elements;

Fig. 8 is a diagram showing the apices of the grid elements projecting over the neutral axis;

Fig. 9 is a diagram somewhat similar to Fig. 8, illustrating the grid elements with their apices on opposite sides of the neutral axis and the dielectric diaphragm in contact with such apices;

Fig. 10 is a cross-sectional diagram illustrating the electrical forces operating on the diaphragm due to the permanent electrical bias;

Fig. 11 is a diagram indicating the direction of diaphragm attraction in periods of half-cycles when excited by periodic potentials;

Fig. 12 is a diagram similar to Fig. 11, showing the electrical forces and direction of movement of the diaphragm when subjected to voice controlled periodic currents;

Fig. 13 is a diagram indicating a series of grid members of varying sizes and of different spacing;

Fig. 14 is a diagram of the electrostatic sound translator with a different electrical hookup;

Fig. 15 is a diagram illustrating the device as an electrical current producer acted upon by sound.

Fig. 16 is a perspective elevation of another form of my invention;

Fig. 17 is a transverse section on the line 7—7 of Fig. 16, in the direction of the arrows;

Fig. 18 is a longitudinal section on the line 8—8 of Fig. 16, in the direction of the arrows;

Fig. 19 is an enlarged perspective view of

my invention illustrated in Figs. 16, 17, and 18, and shown cut in two transversely and broken away at the edge to show the method employed in making positive electrical contact with the diaphragm conductive coatings by means of a contact plate along the marginal portion of the diaphragm.

In Figures 1, 2, and 3, I illustrate a grid designated generally by the numeral 11. This has end bars 12 and side bars 13. Between the end bars, there are V-shaped conductive grid elements 14. These elements have their apices pointing in opposite directions for alternate elements, each apex projecting beyond the neutral plane thru the elements; and there is a space or slot 15 between the marginal elements and the side bars 13, and a spacer slot 16 between adjacent grid elements. A diaphragm 17, formed of a sheet of material such as cloth, rubber, paper, or the like, or other material which will form a dielectric, is threaded between the grid elements to contact with the apices of such elements and a clamp at the two sides between the side bars 13 and a cover strip 18, there being screws 19 securing these elements together.

The dielectric has conductive coatings or films 22 deposited on the dielectric. These coatings are opposite each of the grid elements 14 and are on opposite sides of the dielectric. There is always, therefore, the dielectric sheet between each coating or film and its adjacent grid element, and the marginal edges of adjacent coatings are preferably slightly spaced apart as indicated at 23, considered in regard to the diaphragm so that no matter how severely this diaphragm vibrates, the coatings can never come in contact with the conductive grid elements. These coatings may be of metal foil or other suitable conductive material, or may be of metal deposited electrolytically or by hot or cold blowing thereon.

There are spring brushes 24 secured to the insulating strips 20, which are on opposite sides of the grid ends at the opposite ends of the construction. There are screws 21 or the like fastening these insulating strips to the bars 12 of the conducting grid. Each of the spring brushes 24 has a contacting end 25 to bear against its adjacent coating over the apex of the adjacent grid element. The coatings as illustrated do not run completely to the end of the grid elements and diaphragm dielectric, but are spaced from such ends as indicated by the numerals 26 and 27. Therefore, there is no manner in which the coatings come in direct contact with the end portions 12 of the grid or the side portions 13 thereof.

Referring next to the mechanical construction of Figs. 4, 5, and 6, embodying the fundamentals herein set forth, and where in this case I utilize two grid plates 28 and 29,

each of which has the end sections 30 and side sections 31, each grid plate also having V-shaped grid elements 32 spaced apart and adapted to be separated by spaces 33 extending longitudinally of the grid elements. In this construction, the dielectric diaphragm 34 in the form of a sheet is stretched between the two grid plates before these are brought together, and then when the plates are brought together, screws 35 or the like are secured through the marginal portions of the grid plates and thus clamp the dielectric sheet. This sheet thereby occupies a zigzag position in reference to the grid elements, being pressed to one side of the neutral axis by the apex of one grid on one plate and to the opposite side by the apex of the adjacent grid element on the opposite plate.

The diaphragm sheet is given conductive coatings 36, running longitudinally thereof and on opposite sides, these coatings being positioned over the adjacent grid elements. The coatings have a slight space apart considered transversely of the diaphragm, and being on opposite sides of the dielectric are maintained out of contact with the adjacent V-shaped grid element. The conductive coatings are spaced from the ends of the grid plates by spaces indicated at 37 and 38.

Conducting brushes 39 are secured to insulating strips 40 on one end of one of the conducting plates; that is, to the end portion 30 and on the insulating strip on the opposite end of the opposite plate. These brushes have contacting ends 41 engaging the surface of the metallic coating strips on opposite sides. There are also electrical terminal connections 42 secured to the two grid plates for attachment of conducting wires.

In the diagram of Fig. 8, I illustrate grid elements 43 approaching each other so that the apices 44 overlap the neutral plane or neutral axis 45.

In Fig. 9, the diaphragm is connected at 46, and it will be seen that this diaphragm crosses the neutral plane or axis and touches the apices of the grids. Therefore, when the diaphragm is stretched, it occupies a zigzag position considered in reference to the neutral plane 45, being supported, tensioned, and stabilized thereby over its surface.

Fig. 7 shows these various elements designating the grid elements 43, the apices 44, the neutral plane or axis 45, the dielectric diaphragm 46, and the conducting coatings are also illustrated, being designated by the numeral 47.

Referring to the electric hookup of Fig. 1, this illustrates an input transformer 48 which is presumed to derive its source of energy from a sound such as a voice controlled current of suitable amplification. This has a primary 49 and a secondary winding 50. One end 51 of the secondary 50 is connected to the grid of thermionic tube 52. The other

end 53 of the secondary is connected to the grid of the second thermionic tube 54. These tubes are, therefore, arranged to operate in a push and pull manner, there being illustrated a filament supply battery for energizing the filaments of both tubes, and this having a connection 56 to the center point of the secondary 50. A source of D. C. potential 57 is illustrated; this has a connection 58 to the filament supply and a lead 59 connecting to the grid terminal 10, and thus being connected to the grids forms a neutral connection. The sources of constant D. C. potential supply 57 also provide a permanent negative bias to the grids. The positive side of such battery or source of constant D. C. potential has a lead 60 connecting through resistances 61 to the leads 62 and 63, which are connected respectively to the brushes 24 on opposite sides of the grid, these brushes contacting with the conductive coating strips, and thus such strips are given a permanent positive bias. I find it satisfactory to have this bias of from 250 to 600 volts D. C. There are choke coils 64 inserted in the leads from the neutral line 60 to the plates of the tubes, and the plates of the tubes are connected through condensers 65 to the leads 62 and 63, as shown.

In Fig. 14, I show a modification of the electrical connections. In this case, there is a source of constant potential D. C. 66, which has leads 67 from its negative side to the grid elements. In this case, the push and pull type of thermionic connection designated generally by the numeral 68 has a source of constant D. C. potential 69, and has two transformers 70 and 71. The secondaries of these transformers have a connection 72 to the battery 66, which forms a neutral connection to the grid elements, and the ends 73 and 74 of the two transformers are connected respectively by leads 75 and 76 to the conductive coating or film on opposite sides of the dielectric diaphragm.

It will be seen by these electrical connections that there is at all times a biasing electrical influence between the grid elements and the opposite conductive coatings on the dielectric, and as the dielectric forms a non-conductor between these elements, there is no direct passage of current; there is, however, a condenser action.

In this construction it will be seen that there is a plurality of different fields, each field including a grid element and the complementary conductive coating on the dielectric. These fields may be designated as in units 80—81—82—83—84—85 (note Fig. 10). Therefore, considering one of the fields constitutes a fixed grid element and its adjacent conductive coating as having the coating positively charged and the grid element negatively charged, these elements will be attracted together. An action of the fields

80—82—84 will be similar and that of 81—83—85 will be similar when the grid elements are given a negative bias relative to the conductive coatings which are biased positive, the direction of diaphragm attraction of successive fields being indicated by the arrows. This, therefore, tends to cause the approach of the coatings on the dielectric to the fixed grid elements and which tend to cause the dielectric to occupy a sinuous position as indicated by the dotted line 77 in Fig. 10. However, on account of the stretch of the dielectric it cannot readily occupy this position, but occupies a position indicated more by the full lines of this figure, there being an electrical tension or attraction between the coatings on the dielectric and the fixed grid element, as one is always negatively energized by the biasing source of power. Therefore, the diaphragm as considered between the apices of any two adjoining grid members is held in a position of electro-mechanical counter-balance by the action of the two separate fields which inversely attract adjoining areas of the diaphragm.

Presuming the input transformer and hence the tubes are influenced by an incoming signal such as a controlled current, and as one tube gives a simplified audio frequency current during one-half of the cycle and the other tube during the other half of the cycle, it will be seen that the conductive coatings on opposite sides of the dielectric are alternately highly energized positively in periods of half cycles by this audio frequency which is superimposed upon the established constant bias potential and acts to disturb the counter-balanced equilibrium of the dielectric diaphragm, causing a movement of the diaphragm in a clockwise direction the first half of the audio frequency cycle and counter-clockwise the second half of the cycle. This action is shown in Fig. 11, wherein the conductive coatings of field sections 80—82—84 receive the superimposed positive audio charge the first half of the audio frequency cycle, causing them to move toward the grid members as indicated by the arrows, followed by a similar action of field sections 81—83—85 the second half of the audio frequency cycle, causing a movement of the diaphragm and conductive coatings toward corresponding grid elements but in an opposite direction as indicated by the arrows.

In addition to the action of the electrostatic charge on the bars and the adjacent conductive coating, there is the action of the electrical charge due to a condenser action in the diaphragm dielectric. In the first half of the wave cycle while the first tube is impressing a powerful positive charge, the dielectric absorbs such charge, and as the second tube comes into action with a positive charge, this positive charge on the dielectric seeks to dis-

charge and reverse its polarity, and in reversing becomes negative with respect to the grid members which are always negative, and therefore causes a repulsion of the coatings and the diaphragm from the adjacent grid member. This gives an additional force to those above described in causing the uniform vibration of diaphragm between the apices of the several grid members. This action is because the audio frequency potential which is higher than that of the bias potential overpowers it. Thus it will be seen that the dielectric will vibrate between the apices of the adjacent V-shaped grid elements, and that the action is influenced by the charging and discharging of the elements and that the vibrations of the dielectric diaphragm are in accordance with the electrostatic charge developed.

Referring to Fig. 12, there is indicated the vibratory action of the diaphragm as caused by the superimposed audio frequency potential. Lines 78 and 79 represent the position of the diaphragm the first half of the cycle, and lines 86 and 87 represent the position taken the second half of the cycle, this action repeating.

In Fig. 13, I illustrate in cross-section a variation in the structure formation of the grid unit, applicable to any adopted form of this instrument, wherein the distance between the apices 99 of succeeding grid members is substantially greater or less than that of adjacent members. This provides for the division of the diaphragm vibrating surfaces into sections of different widths and areas, each vibrating section being capable of responding more readily to a given band of frequencies. The several vibrating sections of different areas as created by the variously spaced grid members are indicated as sections 100—101—102—103—104—105. The larger areas responding to the lower frequencies and the smaller areas to the higher frequencies. By this arrangement, the effective range of frequency response of the instrument is increased.

In Fig. 15, I illustrate my invention electrically connected to function as a microphone in which the diaphragm is presumed to be vibrated by sound waves in the air. In this case, the fixed grid bars are negatively energized by a battery or other source of power designated 88; and the conductive coatings on the diaphragm have electrical connections 89 and 90 to the two transformers 91 and 92, the secondary of these transformers being connected to the grids respectively of the triode tubes 93 and 94. The plates of these tubes energize the primary of an output transformer 95. There is a neutral connection 96 between the secondary of the transformers 91 and 92 and through a biasing battery 97 to the mid-position of the primary of the output transformer 95. Therefore, by this connection,

when the diaphragm is vibrated by air sound waves, the current through the transformers 91 and 92 varies, thus causing a difference of potential of the grids and the plates of the two tubes; thereby giving a fluctuating electrical output wave corresponding to the air sound waves.

Referring next to the mechanical construction of Figures 16, 17, 18, and 19, embodying the fundamentals herein set forth, and where in this case I utilize two grid plates 106 and 107, each of which has the end sections 108 and the side sections 109, each grid plate also having V-shaped grid elements 110 spaced apart and adapted to being separated by spaces 111, extending longitudinally of the grid elements. In this construction, the dielectric diaphragm 112 in the form of a sheet is stretched tightly around the frame 113 and secured as shown at 114. This rigid frame entirely encircles the diaphragm and provides a reinforced rigid edge. The dielectric diaphragm is placed between the grid plates, being spaced therefrom at the edges by the insulating gaskets 115 and 116. The screws 117 or the like are secured thru the marginal portions of the grid plates, drawing them together and rigidly holding the diaphragm in place between them. This diaphragm sheet thereby occupies a zigzag position in reference to the grid elements, being pressed to one side of the neutral axis by the apex of one grid on one plate and to the opposite side by the apex of the adjacent grid element on the opposite plate. The diaphragm sheet is given conductive coatings 118, running longitudinally thereof and on opposite sides, these coatings being positioned over the adjacent grid elements. The coatings have a slight space apart considered transversely of the diaphragm, and being on opposite sides of the dielectric, are maintained out of contact with the adjacent V-shaped grid elements.

The longitudinal conductive coatings on opposite sides of the dielectric diaphragm are positioned in such a manner that on one side they start from a point which is recessed from one end (a) and extend across the surface of the diaphragm to the edge of the end (b) at the opposite end; while the coatings on the reverse side of the diaphragm start at the edge of the end (a) and extend across the surface of the diaphragm to a point recessed from the edge of the end (b). The coatings on each respective side are connected by a conductive strip (123 on end (a) and 124 on end (b)), extending along the respective marginal portions (a) and (b) of the dielectric diaphragm, over which a terminal plate 125 is placed and held in contact with the marginal conductive strip 123 on one side of the diaphragm (a), and similarly the terminal plate 126 on the reverse side and end of the diaphragm (b) contacts that marginal con-

ductive area 124, connecting the several longitudinal conductive coatings of the reverse side of the diaphragm. The insulating gaskets 115 and 116 serve to center the diaphragm between the grid plates 106 and 107 and also to securely hold the terminal plates 125 and 126 in contact with the marginal conductive strips 123 and 124 while insulating them from the grid plates 106 and 107. The contact plates 125 and 126 have terminal connections 119 and 120, extending thru cut away portions 121 and 122 of the grid plates 106 and 107 to permit electrical connections.

The electrical circuits previously described in Figures 1 and 14 can be used to operate this device, connections being made to the terminals 119, 120, and 127.

Various changes may be made in the principles of my invention without departing from the spirit thereof as set forth in the description, drawings, and claims.

I claim:

1. A sound translator, comprising in combination a plurality of fixed electrical conducting elements, a dielectric diaphragm positioned with portions thereof adjacent to the said elements, the dielectric having isolated conducting bodies thereon, each conducting body being adjacent to one of the elements, and means to electrically energize each element and its adjacent conducting body to different electrical potentials.

2. A sound translator, comprising in combination a plurality of fixed spaced electrical conducting elements, a dielectric diaphragm positioned between the said elements, the diaphragm having isolated conducting bodies thereon, said bodies being positioned and on opposite sides from a conducting element, whereby said conducting bodies and elements are out of contact, and means to electrically energize each element and its adjacent conducting body to different electrical potentials.

3. A sound translator, comprising in combination a plurality of fixed electrical conductor elements, each having a projecting portion, the projecting portions of adjacent elements facing in opposite directions, a dielectric diaphragm between the said elements and engaging the projecting portions, whereby the diaphragm occupies a position on opposite sides of a neutral plane through the said elements, the diaphragm having electrically conductive coatings isolated one from the other and positioned opposite each element, the dielectric spacing the coating from the adjacent element, and means to energize each element and its adjacent coating to different electrical potentials.

4. A sound translator, comprising in combination a dielectric diaphragm, spaced electrical conducting elements, adjacent elements being on opposite sides thereof and each having a projecting ridge engaging the dia-

phragm and bending the diaphragm on opposite sides of a neutral plane through the elements, the diaphragm having isolated conductive coatings opposite each element, each coating being spaced from the element by the diaphragm, and means to energize each element and its adjacent coating to different electrical potentials.

5. An electrostatic sound translator, comprising in combination a dielectric diaphragm with means to stretch such diaphragm, a plurality of electrical conducting elements, adjacent elements being on opposite sides of the diaphragm and each having a surface simulating a flattened V, the apex of each V being in contact with the diaphragm and forcing the diaphragm to occupy a position on opposite sides of a neutral plane through the said elements, the diaphragm having isolated conductive coatings thereon, there being a coating opposite each element and separated from such element by the diaphragm, and means to energize each element and its adjacent coating to different electrical potentials.

6. A sound translator, comprising in combination a dielectric diaphragm with means to stretch such diaphragms, a plurality of electrical conducting bar-like elements, adjacent elements being on opposite sides of the diaphragm, such elements being spaced apart and each having a ridge, the ridges of adjacent elements extending in opposite directions, the dielectric engaging each of the ridges and being forced to a position on opposite sides of a neutral plane through the said elements, the dielectric having isolated band-like conductive coatings, each coating being opposite the adjacent conducting element and separated therefrom by the diaphragm, and means to energize each element and its adjacent coating to different electrical potentials.

7. A sound translator as claimed in claim 6, there being an electrical connection for all of the conducting elements and an electrical connection for the coatings on one side of the diaphragm, and another connection for the coatings on the opposite side of the diaphragm, and means to energize the coatings on one side of the diaphragm and those on the opposite side to like electrical polarities.

8. A sound translator, comprising in combination a dielectric diaphragm with means to support and stretch such diaphragm, a plurality of electrical conducting elements, adjacent elements being on opposite sides of the diaphragm, the diaphragm having spaced conductive coatings thereon, each coating being opposite one of the elements and spaced therefrom by the diaphragm, means to energize the coatings on one side and the coatings on the opposite side to like electrical polarities, and means to energize the said conducting elements.

9. A sound translator, comprising in combination a dielectric diaphragm, means to support and stretch such diaphragm at its marginal portions, a plurality of electrical conducting elements, adjacent elements being on opposite sides of the diaphragm and each having a projection engaging the diaphragm and forcing the diaphragm at the engaged portion to opposite sides of a neutral plane through the said elements, the diaphragm having conductive coatings opposite each element isolated one from the other, and each spaced from its adjacent element by the diaphragm, and means to electrically energize the coatings on one side and those on the other side of the diaphragm to like electrical polarities, and means to energize each electrical conducting grid element to opposite polarity.

10. An electrostatic sound translator, comprising in combination a dielectric diaphragm, means to support and to stretch such diaphragm at its marginal portions, a plurality of bar-like conducting elements, adjacent elements being on opposite sides of the diaphragm, each element being spaced from the other, each having a projecting ridge extending longitudinally of the bar, the ridge of each element engaging the diaphragm and forcing the diaphragm into a position on opposite sides of a neutral plane through the said elements, the diaphragm having electrically conductive coatings isolated one from the other and on opposite sides of the diaphragm, each coating being in the form of a band and opposite a bar, being separated therefrom by the diaphragm, and means to electrically energize the coatings on one side and those on the opposite side to equal electrical potentials, and means to electrically energize the conducting elements to a lesser potential.

11. A sound translator, comprising in combination a diaphragm, a plurality of fixed electrically conducting structures, adjacent structures being on opposite sides of the diaphragm and engaging such diaphragm, the diaphragm being formed in separate areas by the said engagements with the said structures, each area being free to vibrate; means to create electrostatic charges on the fixed structures and the diaphragm, whereby the diaphragm vibrates between the engaging portions of the said structures, the portions engaged thereby being substantially free of vibration.

12. A sound translator, comprising in combination a dielectric diaphragm having conductive coatings on opposite sides, fixed conducting structures, adjacent structures engaging the diaphragm on opposite sides, the diaphragm being free to vibrate between the engaging portions of adjacent structures and being substantially prevented from vibration at the engaging portions, and means to create

electrostatic charges between each of the fixed elements and the portion of the coating adjacent thereto.

13. A sound translator, comprising in combination a diaphragm supported, tensioned and stabilized by adjacent fixed elements engaging said diaphragm on opposite sides and forcing it to occupy a position on opposite sides of a neutral plane through the said elements, and means to vibrate the areas of the diaphragm between the engaging points, the distance between the points of engagement of the diaphragm with the fixed elements regulating the range of frequency to which the diaphragm responds.

14. A sound translator, comprising in combination a dielectric diaphragm having conductive coatings thereon on opposite sides, the coatings on each side being spaced apart, a plurality of fixed conducting elements, adjacent elements being on opposite sides of the diaphragm, means to electrically energize the coatings and the fixed structures, comprising a pair of thermionic tubes, one tube having its plate connected to positively energize the coatings or one side of the diaphragm for the first half of a cycle while the other tube has its plate connected to positively energize the coatings on the opposite side of the diaphragm for a second half of a cycle, and vice versa, the fixed structures being connected to a neutral position of the said tubes.

15. A sound translator, comprising in combination a dielectric diaphragm, a plurality of fixed conducting elements, adjacent elements being on opposite sides of the diaphragm, coatings on opposite sides of the diaphragm, there being a coating opposite each element and separated therefrom by the diaphragm, means to produce a constant negative biasing charge on the said elements and a positive biasing charge on the said coatings, and means to additionally energize the coatings on one side and the coatings on the opposite sides of the dielectric to different potentials, whereby the electrostatic charges on the said elements and the coatings cause a vibration of the diaphragm.

16. A sound translator, comprising a vibratable dielectric diaphragm, a plurality of fixed conducting elements, adjacent elements being on opposite sides of the diaphragm, coatings on opposite sides of the diaphragm, there being a coating opposite each element and separated therefrom by the diaphragm, means to provide a constant negative bias to the said elements, and a positive biasing charge on the said coatings to cause an unbalanced field force between each element and its adjacent diaphragm coating, the said field forces from the position of the elements and the diaphragm being such that any two adjoining fields act to maintain the diaphragm

in a state of electro-mechanical counterbalance.

17. A sound translator, comprising in combination a diaphragm, adjacent fixed elements engaging the said diaphragm from opposite sides and forcing it at each point of engagement to a position on the opposite side of the neutral plane through the said elements, and means to vibrate the diaphragm between the engaging points, the diaphragm being practically non-vibrating at the positions of engagement, and electrical connections to the diaphragm and the fixed elements.

18. A sound translator, comprising in combination a diaphragm, supporting insulated structures engaging the diaphragm alternately on opposite sides and forcing it at the positions of engagement to points beyond the neutral plane through the said structures, means to form electrostatic charges between the diaphragm and the said structures, whereby separate areas of the diaphragm may vibrate, the diaphragm at the positions of engagement being substantially non-vibrating.

19. A sound translator comprising in combination a diaphragm, fixed adjacent structures alternately engaging the diaphragm from opposite sides and forcing it to positions beyond the neutral axis through the said structures, supporting, tensioning and stabilizing the diaphragm and dividing it into separate vibratable areas, the distance between the points of engagement of the diaphragm and the several fixed structures varying, thus dividing the diaphragm into sections of unequal area, the area of the section regulating the band of frequencies to which that portion of the diaphragm best responds.

20. A sound translator comprising in combination a diaphragm, and a plurality of supporting structures, engaging and disposing the diaphragm alternately on opposite sides to positions beyond the neutral axis thereof, establishing a constant electrical bias to provide an unbalanced field force between each of the several said structures and the portion of the diaphragm adjacent thereto, the forces of each separate, non-oppositely positioned, adjoining unbalanced field, being of inverse attraction and operating inversely to counterbalance the diaphragm electro-mechanically, and varying superimposed electrostatic charges between the diaphragm and the structures to cause vibrations of the portions of the diaphragm between any two supporting structures.

21. A sound translator comprising in combination a vibratable diaphragm, supported, tensioned and stabilized by a plurality of adjacent fixed conducting elements engaging said diaphragm on opposite sides and forcing it to occupy a position on opposite sides of a neutral plane through the said elements, each alternate element being on an opposite side of the diaphragm, there being a conducting

coating opposite each element and separated therefrom by the diaphragm, means to provide a constant negative bias to the said elements and a positive biasing charge to the said coatings to create a separate unbalanced field force between each element and its adjacent diaphragm conducting coating, the said forces from the position of the elements and the diaphragm being such that any two separate, non-oppositely positioned adjoining fields act to maintain the diaphragm in a state of electro-mechanical counterbalance by virtue of the inverse attraction of each alternate adjoining field, and further causing the counterbalance to be inversely disturbed in periods of half cycles by a periodic potential, whereby the vibrating element moves as it seeks to establish affinity with the fixed conducting elements.

22. A sound translator functioning by the employment of a multiplicity of separate electrostatic condenser units, each unit consisting of a fixed conducting plate and a second plate, the latter plates of all units being affixed to and constituting parts of a vibrating membrane, which upon the action of a common constant potential to all of the fixed plates and a similar but different valued potential to the complete set of moving membrane plates, create non-symmetrical electrostatic fields whereby the membrane is compelled to assume a sinuous position of equilibrium and that the further application of a varying superimposed electro-motive force to the system will cause a vibration or displacement, due to the tendency of the membrane to assume a position of equilibrium.

23. A sound translator functioning through the establishment of a series of separate adjoining, non-oppositely positioned, unbalanced electrostatic fields between a vibrating diaphragm and a plurality of supporting insulated structures disposed alternately on opposite sides thereof, each engaging and forcing the diaphragm in turn to opposite sides of the neutral axis, wherein succeeding field forces are of inverse attraction and non-neutralizing, and wherein the said field forces from the position of the supporting structures and the diaphragm are such that any two fields act to maintain that portion of the diaphragm which is between any two immediate supporting structures, in a state of electro-mechanical counterbalance, and further imparting electrostatic charges to the diaphragm and the fixed structures causes a vibration of the portion of the diaphragm between any two fixed structures.

In testimony whereof, I have hereunto set my hand at San Diego, California, this twenty fourth day of May, 1930.

LAYTON ALLEN WOLFE.