

Feb. 9, 1932.

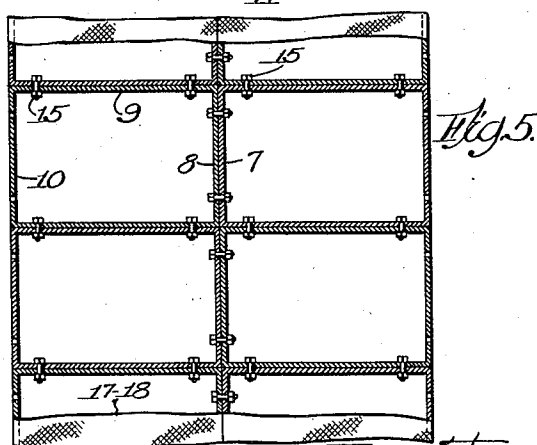
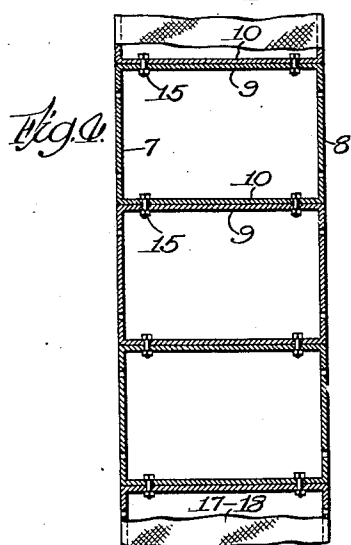
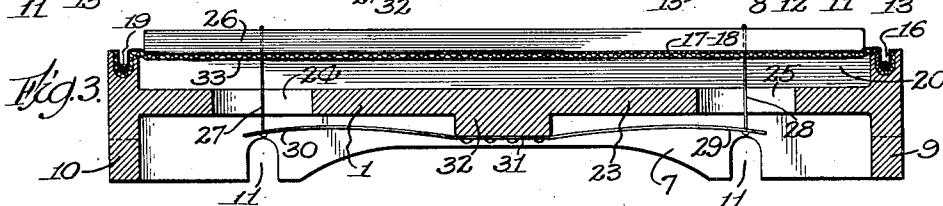
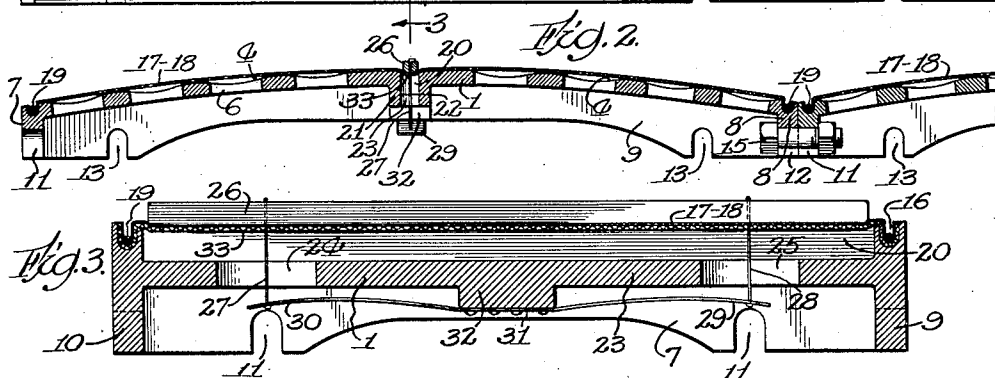
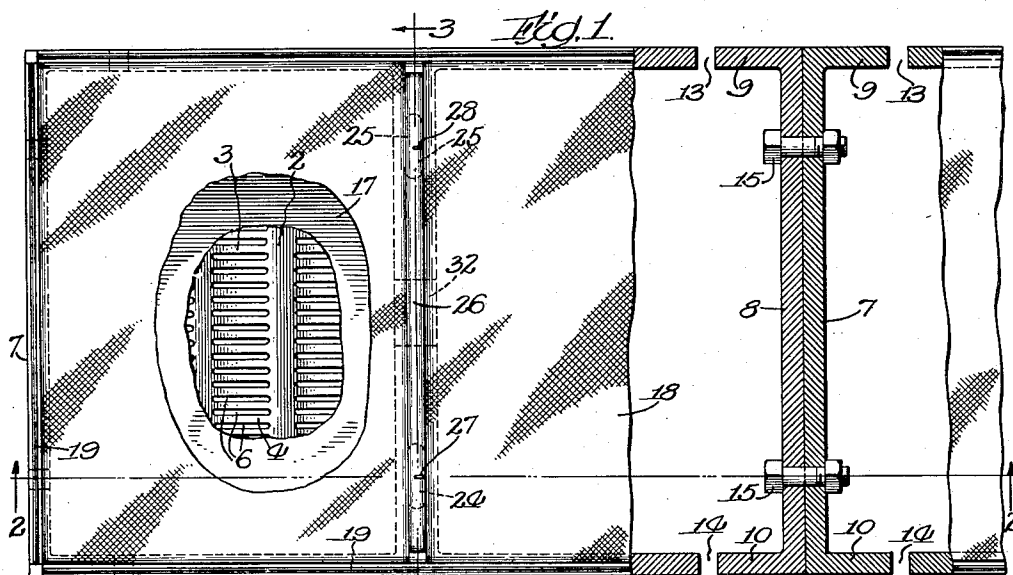
V. F. GREAVES

1,844,219

SECTIONAL ELECTROSTATIC SOUND PRODUCER

Filed Jan. 14, 1929

2 Sheets-Sheet 1



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SECTIONAL ELECTROSTATIC SOUND PRODUCER

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2 Sheets-Sheet 2

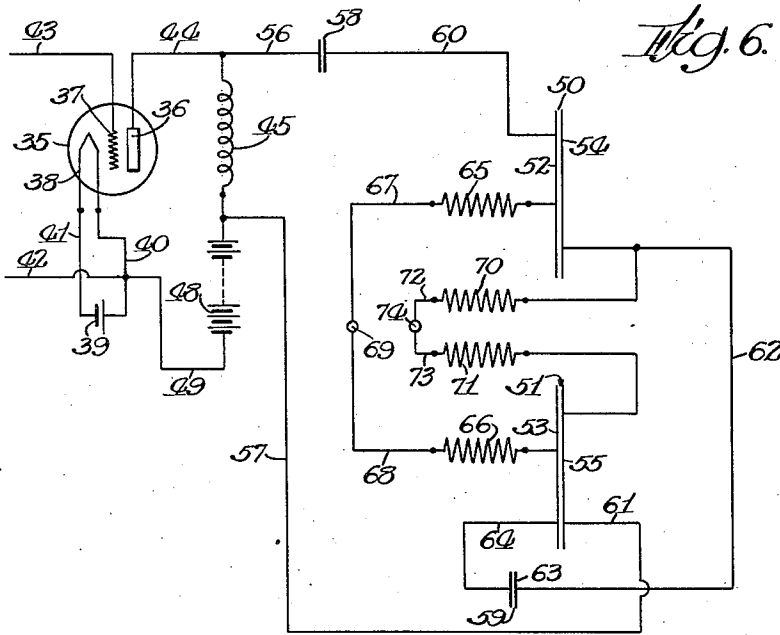


Fig. 6.

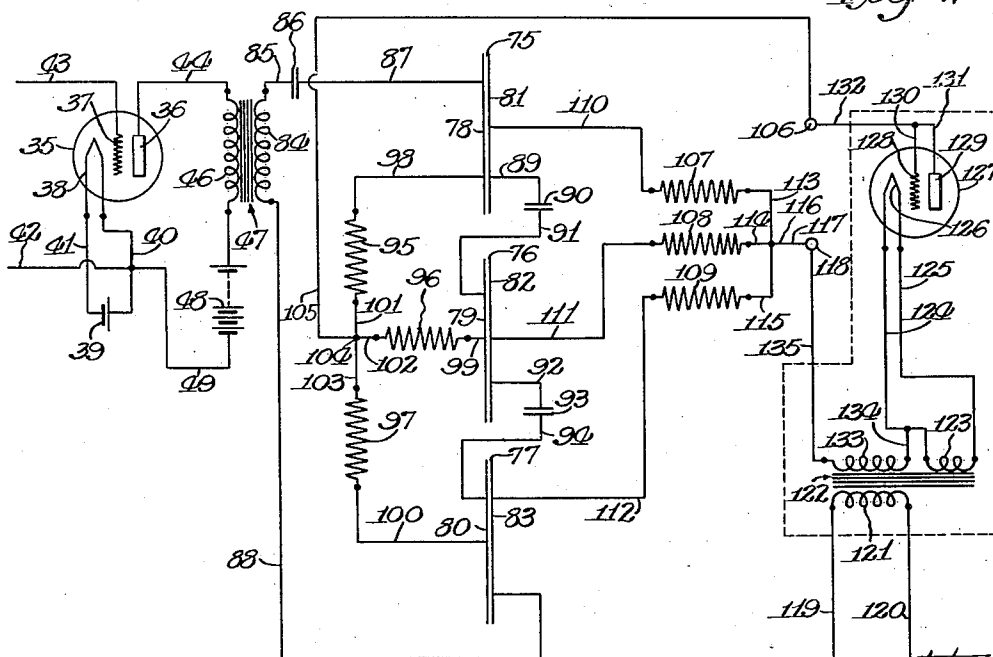


Fig. 7.

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UNITED STATES PATENT OFFICE

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SECTIONAL ELECTROSTATIC SOUND PRODUCER

Application filed January 14, 1929. Serial No. 332,464.

The present invention relates to the electrostatic or condenser type of sound producer or reproducer or loud speaker.

Among the objects of the invention is to provide a novel speaker of any desired size and strength and composed of sections or units of such capacities, reactances and impedances as to produce large volumes of sound without distortions and other defects peculiar to single large condenser structures.

Merely increasing the size or area of a condenser or electrostatic type of sound reproducer for the purpose of obtaining a greater or larger volume of sound, introduces unfavorable tone quality results. The present invention comprehends the provision of a large volume condenser or electrostatic type of speaker in which the desirable tone qualities of a small area electrostatic or condenser type of speaker are retained as well as improved, and the unfavorable characteristics of a single equally large device are eliminated.

If a single very large condenser speaker be connected to a vacuum tube of usual type, the impedance relations are such as to produce the unfavorable tone qualities mentioned above. The reactance of a condenser varies inversely with the frequency of the electromotive force applied and the capacity of the condenser. It is equal to the reciprocal of the product of 2π times the frequency of the electromotive force and the capacity of the condenser. It may be represented by the formula

$$\frac{1}{\omega c}$$

where ω is $2\pi \times$ the frequency of the electromotive force and c is the capacity of the condenser, the capacity being directly proportional to the area of the condenser. From this it will become apparent that this reactance diminishes with increasing frequency so that at high frequencies the reactance becomes small in comparison with the plate impedance of the vacuum tube. This results in unfavorable and undesirable frequency characteristics for the reproduction of audible sounds. The higher frequencies will be lacking in loudness or volume, and the result is a

booming effect of reproduction with poor or no articulation of speech. My invention avoids such disadvantages by the building up of a large area electrostatic or condenser speaker from a number of small units and connecting them electrically in either parallel or series relations, or both, or in any combination thereof with or without resistances and reactances both inductive and capacitive to form an electrical network affording in any case the optimum reproduction quality under any conditions and with any type of amplifier.

If, for example, a large area speaker be made or composed of two or more smaller condensers, and they be connected electrically in series, the effective capacity is smaller than that of a single condenser of the total area, and a more favorable frequency characteristic is produced. To illustrate, in a speaker divided into two parts or sections which are connected electrically in series, the capacity would be one fourth that of the large single condenser speaker, as also of a large condenser speaker with the sections electrically connected in parallel. Another object of the invention is to so connect the units or sections as to secure the desired large volume of sound with proper and favorable tone qualities and characteristics.

A further object is to maintain a constant large direct electromotive force or polarizing voltage between the plates of the condenser, so as to secure proper operation effects. The units are so arranged that they may be effectively in series with respect to the alternating signal voltage and effectively in parallel with respect to the direct polarizing voltage.

Other advantages, objects, capabilities and features are comprehended by the invention as will later appear and as are inherently possessed thereby.

Referring to the drawings, Fig. 1 is a view partly in elevation and partly broken away to show a mode of forming a speaker from units or sections.

Fig. 2 is a sectional view taken in a plane represented by line 2—2 in Fig. 1 of the drawings.

Fig. 3 is a transverse sectional view taken

in a plane shown by line 3—3 in Fig. 1 of the drawings.

Fig. 4 shows a series of units connected in line.

Fig. 5 shows a number of units connected both longitudinally and laterally.

Fig. 6 is a diagrammatic showing of the circuits used when connecting two units in series, and

Fig. 7 is a similar diagrammatic showing of the circuits for connecting three units in series.

Referring now more in detail to the drawings, each unit or section comprises a metal plate portion 1 which is preferably, but not necessarily, curved or convex and having undulations on the convex or outer surface thereof. These undulations comprise crests 2, troughs 3 and slopes 4 between the crests and troughs. Slots 6 may be provided in the troughs and adjacent portions of the slopes as clearly shown in Figs. 1 and 2.

At the edges or margins of the plate are provided inwardly extending flanges 7, 8, 9 and 10, provided with one or more apertures or slots 11, 12, 13 and 14 through which suitable securing elements, such as rivets or bolts 15 may extend when securing together the flanges of adjacent sections or units.

At the margins of the plate and in the inner surface thereof are provided recesses or grooves 16 into which extend marginal portions of a dielectric sheet 17 carrying on its outer surface a flexible conducting medium 18. The dielectric may be a sheet of rubber, or silk, or rubberized silk or any other like and similar material which may be specially treated as desired. The flexible conducting medium may be a metal or metallized film or coating, or foil such as gold, silver, copper, aluminum or similar metal foil, suitably made to adhere to the outer surface of the dielectric 17. In the slots or grooves 16 are forced or pressed binding or anchoring elements 19 which may be in the form of wire, rods, or the like, and if desired may be of conducting material. These elements permanently hold or anchor the marginal portions of the flexible dielectric. In the case of the coating thereon extending into the grooves 16, and the rods being of conducting material, these rods contacting with the conducting medium will afford a convenient means for the connecting of circuit conductors thereto. When a woven fabric is used as a dielectric or as a part of a dielectric, such as rubberized silk, it is preferable to dispose the threads of the fabric on a bias or diagonally to the sides and ends of the unit and to a tensioning member later described, whereby the sheet will be properly stretched and without wrinkles.

At an intermediate part of the unit, the plate is provided with a transverse slot 20 located between inwardly extending flanges 21 and 22 connected with a web 23 in which

are provided apertures or slots 24 and 25 as clearly shown in Fig. 3. Over the slot 20 and upon the outer face of the flexible dielectric and adhering conducting medium 17—18, is disposed a tensioning bar 26 which may be of insulating material. To this bar are secured connecting elements 27 and 28 such as wires with outer bent ends or hooks, these elements extending inwardly through the slot 20 and the respective apertures or slots 24 and 25, the inner ends of these elements being suitably connected to the free end portions 29 and 30 of a leaf spring 31 secured at its intermediate portion to a boss 32 forming an integral part of the web 23, as clearly shown in Figs. 2 and 3. The spring portions 29 and 30 impress tension on elements 27 and 28 which in turn press the bar 26 inwardly to deflect a part 33 of the dielectric and conductor film 17—18 into the groove 20 as clearly shown in Fig. 2. This tensioning is effective thereon throughout the length of the bar 26 and stresses the fabric in a direction on a bias or diagonally to the threads of the fabric thus producing a tensioning in at least two directions from a single line of tension stress application. This maintains the dielectric properly stretched whereby all chance of any wrinkle is eliminated.

Under the electrostatic stresses imposed upon the dielectric, the portions thereof between crests, are flexed to and from the slopes and troughs of the plate, thus setting up sound waves in the air.

The units are so constructed that they may be connected together in any desired number and into any desired form and final size of the speaker. As for example, in Fig. 4 the units are shown as connected in a line with the flange 9 of one unit bolted to the flange 10 of another. Fig. 5 shows the connecting of the units also laterally, as by bolting the flange 7 of one unit to the flange 8 of another. In this way a large volume speaker may be built-up without the defects and disadvantages that would be present in a speaker of similar size but being a single condenser.

Referring to Figs. 6 and 7, the speaker may be connected to a vacuum tube 35 having the usual electrodes, such as plate 36, grid 37 and filament 38. The filament has a heating source such as an A battery 39, connected to the filament by conductors 40 and 41. Input leads or conductors 42 and 43 are connected respectively to conductor 40 and grid 37. From the plate 36 runs a conductor 44 to a resistance 45 or primary 46 (Fig. 7) of an audio transformer 47, and thence to a potential source, such as a B battery 48, the negative side of which connects by a conductor 49 to the conductor 40.

In Fig. 6 are shown two speaker units 50 and 51 connected electrically capacitively in series, and having back plates 52 and 53 and front plates 54 and 55. The opposite ends

of the resistance 45 are connected by conductors 56 and 57 by way of condensers 58 and 59 and conductors 60 and 61 to the back plate 52 of unit 50 and the front plate 55 of the unit 51, respectively. The front plate 54 of unit 50 and the back plate 53 of unit 51 are connected by way of a conductor 62, condenser 63 and conductor 64. The capacities of the condensers 58 and 59 are preferably considerably greater than those of the speaker units. Plates 52 and 53 are connected in parallel with resistances 65 and 66, and by way of conductors 67 and 68 to a polarizing voltage pole 69. Likewise plates 54 and 55 are connected in parallel with resistances 70 and 71, and by way of conductors 72 and 73 to a polarizing voltage pole 74. The resistances 65, 66, 70, and 71 may be of the order of one half megohm. The polarizing voltage or potential is applied between the poles 69 and 74, and may be supplied from any suitable source, as a battery or high voltage rectifier, as desired.

In Fig. 7 the circuit is shown as extended to a speaker having three units 75, 76 and 77 respectively having back plates 78, 79, and 80, and front plates 81, 82, and 83. An end of a secondary 84 of the transformer 47 is connected by way of conductor 85, condenser 86 and conductor 87 to the back plate 78 of the unit 75. The other end of the secondary 84 is connected by way of a conductor 88 to front plate 84 of unit 77. Front plate 81 of unit 75 is connected by way of conductor 89, condenser 90 and conductor 91 to back plate 79 of unit 76, and front plate 82 of unit 76 is connected by way of conductor 92, condenser 93 and conductor 94 to back plate 80 of unit 77.

Back plates 78, 79 and 80 are connected in parallel with resistances 95, 96 and 97, by conductors 98, 99 and 100. These resistances are connected by conductors 101, 102 and 103 to a common point 104 connected by a conductor 105 to a polarizing voltage pole 106. Front plates 81, 82 and 83 are connected in parallel with resistances 107, 108 and 109 and by way of conductors 110, 111 and 112, the resistances being connected by way of conductors 113, 114 and 115 to a common point 116 which is connected by a conductor 117 to another polarizing voltage pole 118. The values of the resistances and the condensers in these circuits are preferably of the same order as those shown in the diagram of Fig. 6.

Between the poles 106 and 118 is connected a potential or voltage source, which in the case shown is a high voltage rectifier, shown in the dotted line area. This rectifier has an input line 119—120 having an A. C. supply, which may be of 60 cycles or the like, and connected to a primary 121 of a step-up transformer 122. The transformer may have a heating secondary 123 connected by conduc-

tors 124 and 125 to a filament 126 of a triode vacuum tube 127. The grid 128 and plate 129 may be connected together by conductors 130 and 131, so that the tube will function as a diode rectifier. The conductors 130 and 131 are connected by a conductor 132 to the pole 106.

The transformer has a high potential secondary 133 connected at one end by way of conductor 134 to conductor 124, and at the other end by way of conductor 135 to pole 118.

While I have herein described and upon the drawings shown illustrative embodiments of the invention, it is to be understood that the invention is not limited thereto but comprehends other constructions, arrangements of parts, details and features without departing from the spirit of my invention.

Having thus disclosed the invention, I claim:

1. An electrostatic sound producer comprising units each having a rigid conductor, a flexible conductor, a dielectric therebetween, and means for connecting the units together to form a large area producer assembly, the rigid conductor of one unit being capacitively connected to the flexible conductor of another unit.

2. An electrostatic sound producer comprising units each having a rigid conductor, a flexible conductor, a dielectric therebetween, each unit having projections, and means for connecting a projection of one unit to an adjacent projection of another unit, the rigid conductor of one unit being capacitively connected to the flexible conductor of another unit.

3. An electrostatic sound producer comprising units each having a rigid conductor, a flexible conductor, a dielectric therebetween, the rigid conductor of one unit being capacitively connected to the flexible conductor of another unit, polarizing potential poles connected in parallel to said conductors.

4. An electrostatic sound producer comprising units each having a rigid conductor, a flexible conductor, a dielectric therebetween, the rigid conductor of one unit being capacitively connected to the flexible conductor of another unit, polarizing potential poles, one of said poles being resistantly connected to the rigid conductors of said units, and the other of said poles being resistantly connected to the flexible conductors of said units.

5. An electrostatic sound producer comprising units each having a rigid conductor, a flexible conductor, a dielectric therebetween, the rigid conductor of one unit being capacitively connected to the flexible conductor of another unit, polarizing potential poles, a resistance connected to each flexible conductor of said units and to one of said poles, and a

resistance connected to each rigid conductor of said units and to the other of said poles.

6. An electrostatic sound producer comprising units each having a rigid conductor, a flexible conductor, a dielectric therebetween, the conductors of said units being connected capacitively in series, polarizing potential poles, and resistances connected in parallel with said conductors and said poles.

7. An electrostatic sound producer comprising a series of units each having back and front conductors of which one is movable under electrostatic stresses, and a dielectric between the conductors, the front conductor of each unit being connected capacitively to the back conductor of the next unit of the series, polarizing potential poles, the front conductors of the series being connected to one of said poles, and the back conductors of the series being connected to the other of said poles.

8. An electrostatic sound producer comprising a series of units each having back and front conductors of which one is movable under electrostatic stresses, and a dielectric between the conductors, the front conductor of each unit being connected capacitively to the back conductor of the next unit of the series, polarizing potential poles, said poles respectively connected to said front and said back conductors of said series, and resistances in the connections from said poles to said conductors.

In witness whereof, I hereunto subscribe my name to this specification.

VALENTINE F. GREAVES.

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