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W. D. CROZIER

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PUSH PULL ELECTROSTATIC SOUND REPRODUCER

Filed Oct. 24, 1928

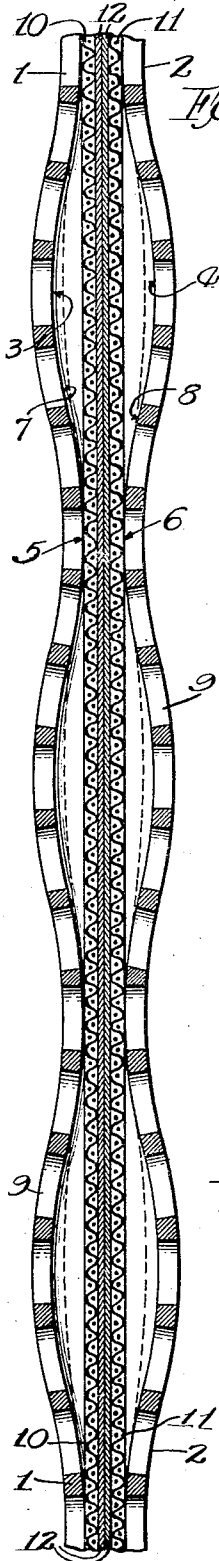


Fig. 1

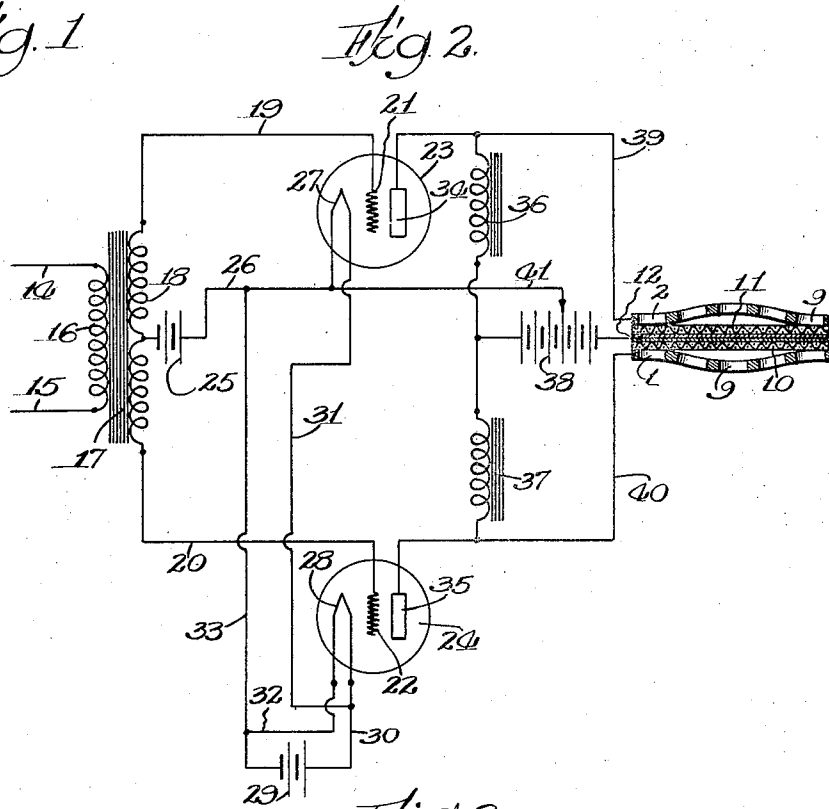


Fig. 2

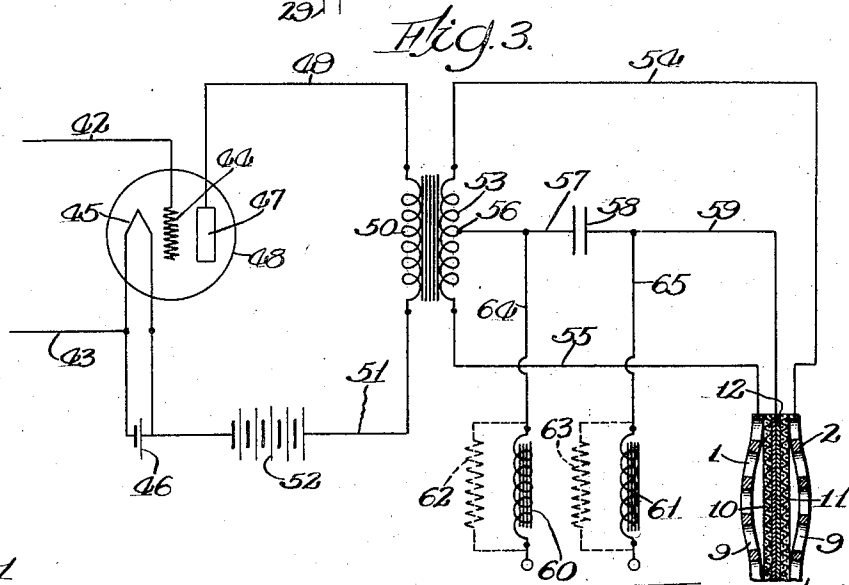


Fig. 3

Inventor:
William D. Crozier
By: Wallace R. Lane Atty.

UNITED STATES PATENT OFFICE

WILLIAM D. CROZIER, OF GENEVA, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
UNITED REPRODUCERS PATENTS CORPORATION, OF ST. CHARLES, ILLINOIS, A
CORPORATION OF NEVADA

PUSH-PULL ELECTROSTATIC SOUND REPRODUCER

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The present invention relates to sound producers and reproducers, such as those of the electro-static type, and the electrical circuit therefor, such as of the push-pull type.

Among the objects of the invention is to provide a novel sound producer and reproducer of the electrostatic type, which will produce sound faithfully with ample volume, and without distortion, when operating as a reproducer, and effect a faithful conversion of sound vibrations into electrical energies, when operating as a recorder or producer.

Another object of the invention is to provide a condenser type of sound reproducer or speaker with undulated rigid conductors and a flexible conductor so related to the rigid and undulated conductors, as to produce sound in both motions of the flexible conductor, under the attractive and repelling forces acting in the electro-static field of the conductors, and also to provide such a speaker adapted for use with a push-pull type of audio amplifying circuit.

In a specific form of device illustrating the invention, a pair of corrugated or undulated and apertured metal plates are juxtaposed with the crests and troughs of one opposed to the crests and troughs of the other plate, and with an interposed flexible conductor or conducting surface, as gold leaf, or other metal foil, or metal coating on a surface, such flexible conductor being out of contact with and separated from the plates by thin dielectrics, such as thin sheets of rubber, silk, or the like, or rubberized silk. The dielectric layers and the flexible conducting layers are preferably cemented or otherwise joined together to form a single sheet and to move together as a whole or as a single unit. When using a woven fabric, such as silk or rubberized silk, it is preferable to arrange the weft and woof threads to permit facile flexing of the dielectric and associated flexible conductor, in the opposed troughs of the plates.

Other objects, capabilities, advantages 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 sec-

tional view through a part of an electrostatic speaker constructed in accordance with the invention, with the parts shown on an enlarged scale for clarity.

Fig. 2 is a diagrammatic view of a push-pull system connected to such speaker; and

Fig. 3 is a diagrammatic view of an alternate circuit which may be used with the device.

Referring more in detail to the drawings, the embodiment selected to illustrate the invention is shown as comprising a pair of undulated plates 1 and 2 having troughs 3 and 4 and crests 5 and 6 with intermediate slope portions 7 and 8. These undulations may be of the cavity or concaved type, or may extend from one side to the other of the plates so that the crests and troughs are substantially parallel. Each plate has a number of suitable apertures or slots 9 acting as relief means for any compressed or rarefied air that might be included between the slopes and other parts of the plates and the flexed dielectric, later explained.

Between the plates 1 and 2 are interposed dielectrics 10 and 11, which may be of any suitable material, and in the specific embodiment selected to illustrate the invention, are of rubberized silk. On the outer surfaces of these dielectric elements may be coated or otherwise provided one or more flexible metallic conductors 12, such as gold leaf, aluminum foil, and other thin metallic material which may be in any suitable way attached to the surface of the dielectrics. These dielectrics and flexible conductors are preferably united together, as by cementing, to provide a single unit or sheet capable of moving as a whole. The plates 1 and 2 may be suitably secured together as desired so as to hold the dielectrics 10 and 11 with their flexible metallic surfaces, normally in a plane between the plates 1 and 2, such dielectrics being normally in contact with the plates 1 and 2 at the crests thereof.

In operation, the plates 1 and 2 are connected to the output side of an audio amplifying device, and the conductor 12 connected at a different potential or having a different polarity with that of the plates 1 and 2. As

the electro-static field is varied or changed in accordance with the modulated electrical energy passing through the amplifier, the dielectrics 10 and 11 and the flexible conductor 12 will be made to flex in one direction or the other and to alternate in such flexures more or less as indicated by the dotted lines in the troughs between the plates 1 and 2. In this way, movement of the air may be effected to produce sound vibrations and both motions of the dielectric and flexible member 12. As the dielectric and flexible member are made to flex toward the slopes of the plates, there is a progressive increase in proximity between the plates and the dielectric, thus aiding and progressively increasing the attraction or other stress being effected between the plates and the dielectric. The apertures 9 will aid in relieving compression when the flexure is toward the plate and to relieve rarefaction when the flexure is away from the plate, as also to serve for transmission of sound energy to the external air.

Fig. 2 shows in diagram a push-pull circuit adapted for use with the device. The electrical energy from a radio receiving set or the like passes through leads 14 and 15 to the primary 16 of a push-pull input transformer 17 of the audio type. This transformer may have a split secondary 18, with connections by way of conductors 19 and 20 to the grids 21 and 22 of audio amplifying tubes 23 and 24. The center point of the secondary may be connected to a biasing battery 25 having a connection 26 to the negative side of the filaments 27 and 28, these filaments being heated by a battery source 29 connected by leads 30, 31, 32, and 33 to the filaments. The plates 34 and 35 of the tubes are connected to transformers or choke coils 36 and 37 through a common point connected to a battery 38, the negative side of which is connected to the flexible conductor 12. From the plates 34 and 35 also are conductors 39 and 40 connected to the plates 2 and 1 of the electro-static sound reproducer. From a variable point of the battery 38 may be connected a conductor 41 to the negative side of the filaments.

Fig. 3 shows another circuit diagrammatically, which may be used. The input passes by way of conductors 42 and 43 to the grid 44 and negative side of the filament 45. The filament may be heated by a battery source 46. From the plate 47 of the audio tube 48 leads a conductor 49 to a primary 50 of an audio transformer, the primary 50 being connected by a conductor 51 to a battery 52, the negative side of the battery 52 being connected to the filament circuit. The audio transformer has a split secondary 53, one end of which is connected by a conductor 54 to the plate 2 of the electro-static sound reproducer. The other end of this primary is connected by conductor 55 to plate 1 of the electro-static sound reproducer. A center point 56 of the

secondary 52 is connected by way of a conductor 57, condenser 58 and conductor 59 to the flexible conductor 12 of the electro-static sound reproducer.

From each side of condenser 58 extend leads 64 and 65 which may be connected to the terminals of a battery or other source of electromotive force for maintaining the flexible conductor 12 at a different potential than that of the plates 1 and 2. In leads 64 and 65 may be included choke coils 60 and 61 or resistances 62 and 63 to prevent the transmission of audible frequency electric currents along these leads. They will also serve to prevent transmission of disturbances, such as A. C. hum from the polarizer.

While I have herein described and upon the drawings shown an illustrative embodiment of the invention and a circuit adapted to be used therewith, it is to be understood that the invention may comprehend other constructions, features, arrangements of parts, details and other electrical circuits without departing from the spirit thereof.

Having thus disclosed the invention, I claim:

1. A sound producing device comprising electrically conducting members having undulated portions providing juxtaposed troughs and crests, a dielectric between said members and contacting the same at said crests, the portions of said dielectric opposite the troughs being movable therein, and a flexible electrically conducting element in said dielectric.

2. A sound producing device comprising electrically conducting members having raised portions in juxtaposed relation to provide a space between the members beside said raised portions, a thin flexible dielectric extending between said members and said raised portions, and a flexible conducting element in said dielectric adapted to flex with said dielectric in said space under the varying electrostatic stresses in said device.

3. An electrostatic type of sound producer comprising a pair of metal plates, said plates having raised and receding portions and provided with apertures, said plates being arranged with the raised and receding portions of one juxtaposed with the raised and receding portions of the other of said plates, a flexible dielectric between said plates, and a flexible conducting element in said dielectric.

4. An electrostatic type of sound producer comprising a pair of metal plates, said plates having raised and receding portions and provided with apertures, said plates being arranged with the raised and receding portions of one juxtaposed with the raised and receding portions of the other of said plates, a flexible dielectric extending between said plates and contacting said juxtaposed raised portions, the juxtaposed receding portions forming a space for the flexure therein of the di-

electric, and a conducting element in said dielectric.

5. An electrostatic type of sound producer comprising a pair of metal plates, said plates having raised and receding portions and provided with apertures, said plates being arranged with the raised and receding portions of one juxtaposed with the raised and receding portions of the other of said plates, a thin flexible dielectric sheet extending between said plates and engaged between said juxtaposed raised portions, the juxtaposed receding portions forming a space for the flexure therein of the dielectric, and a thin flexible conducting sheet within said dielectric sheet and out of contact with said plates.

6. An electrostatic type of sound producer comprising a pair of relatively stationary and vented juxtaposed electrodes having opposed gradually receding and gradually approaching surface portions, a flexible electrode between said juxtaposed electrodes, and a dielectric between said electrodes.

7. An electrostatic type of sound producer comprising a pair of relatively stationary and vented juxtaposed electrodes having opposed surface portions variably spaced throughout their areas, a flexible electrode between said juxtaposed electrodes, and a dielectric between said electrodes.

8. An electrostatic type of sound producer comprising a pair of relatively stationary and vented juxtaposed electrodes having opposed surface portions variably spaced throughout their areas and defining a multiplicity of space sections, a flexible electrode between said juxtaposed electrodes and flexible in said space portions, and a dielectric between said electrodes.

9. An electrostatic type of sound producer comprising a pair of relatively stationary and vented juxtaposed electrodes having variably spaced opposed surface portions defining a multiplicity of space sections, said space section variation progressing gradually from minimum to maximum, a flexible electrode between said juxtaposed electrodes and flexible in said space sections, and a dielectric between said electrodes.

10. An electrostatic type of sound producer comprising relatively stationary and vented juxtaposed electrodes having adjacently opposed crests and troughs distributed over their areas, a flexible electrode between said juxtaposed electrodes and maintained in position at said projections and spaced from the portions of said juxtaposed electrodes lying between said projections, and a dielectric between said electrodes.

11. An electrostatic type of sound producer comprising relatively stationary and vented juxtaposed electrodes having adjacently opposed projections distributed over their areas, a flexible electrode between said juxtaposed electrodes and maintained in po-

sition at said projections and spaced from the portions of said juxtaposed electrodes lying between said projections, said spacing between said electrodes varying gradually from minimum at said projections to maximum remote from said projections, and a dielectric between said electrodes.

12. A sound producer comprising a pair of rigid vented electrodes having surfaces formed with crests and troughs, an interposed flexible electrode contacting the rigid electrodes at spaced loci, and a dielectric between said electrodes.

13. A sound producer comprising a pair of rigid vented electrodes having surfaces formed with crests and troughs, an interposed flexible electrode contacting the rigid electrodes at spaced loci, said rigid electrodes having inter-loci spaces varying gradually from zero to maximum and in which said interposed electrode progressively flexes.

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

WILLIAM D. CROZIER.