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PRELIMINARY

PATENT APPLICATION

"PLASMA DYNAMIC MICROPHONES"

Docket No. 8310

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San Francisco, California
June 12, 1967

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"MICROPHONE"

COMMENTS:

This invention is based on a well-known but virtually unused principle in physics whereby the electrical energy required to maintain a plasma envelope around a highly-charged electrode varies with the ambient gas pressure upon the envelope. In other words, changing the ambient pressure upon the corona around a discharging point changes the current necessary to maintain that corona. Several factors are responsible for this inter-relation.

1) Change in ambient pressure affects the capacitance of the coronal envelope by altering its electric permittivity (dielectric constant).

2) Change in ambient pressure affects the plasma density and its electrical conductivity.

The net result is that any corona-emitting point acts as a sensor for the ambient gas pressure.

Sound waves, of course, are pressure variations. Hence, if sound is concentrated, as by a parabolic reflector, upon a sensor located at the focus, proportionate changes are produced in the charging current. If suitable means are provided for amplifying these charging currents, the structure serves as a microphone.

Such a pressure-sensing electrode structure has the advantage over all conventional microphones in that no moving diaphragm or other moving mechanical part is required. The freedom from inertia permits a frequency response presently estimated to extend from a few cycles per second to well over 250 KC per second smoothly thruout the entire frequency range and without resonance peaks.

The microphone system referred to herein takes the form of a parabolic reflector or the like, a highly-charged probe at the focus of said reflector and means whereby variations in an otherwise steady charging current are amplified and utilized as the output signal.

It has been found that positive corona is to be preferred in most cases over negative corona, but this depends upon the temperature of the probe and the nature of the emissive coatings thereon. In certain cases, it is desirable to operate the highly-charged probe at high temperature, the heat being supplied by an internal resistance unit or by making the probe in the form of an incandescent filament.

In certain cases, emission is facilitated by fabricating the probe of radioactive material or by coating the probe with cesium or barium chloride or thorium oxide in order to increase its emissivity.

SUGGESTED SPECIFICATIONS:

1) This invention relates to microphones, transducers or the like, for converting sound energy into electrical signals.

2) This invention relates to pressure-sensing devices, especially for rapid changes in gas pressure.

1) This invention features a microphone without diaphragm or other moving mechanical part.

2) This invention features a microphone which can be made highly directional so that it is telescopic in pick-up capability and resolution.

3) This invention features a high-fidelity microphone, free from inertial and Doppler distortion.

4) This invention features an ultra-sonic microphone with pick-up capability believed to extend beyond 250 KC per second.

Referring to the attached drawings:

Fig. 1 is a circuit diagram of the simplest aspect of the invention (wherein the probe is not electrically-heated) and illustrating a transformer coupling for the generation of the output signal.

Fig. 2 is an alternative arrangement showing the pressure-sensing probe heated by electrical resistance by a separate circuit.

Fig. 2a is a detail of a probe heated by an internal electric resistance unit.

Fig. 2b is a detail of a hot-filament probe.

Fig. 3 is a diagram illustrating an electrically-heated probe in combination with a suitable vacuum tube circuit for detecting variations in the probe current to provide a signal output.

Referring in more detail to the attached drawings:

Fig. 1 illustrates a parabolic reflector 1 used to concentrate incoming sound (as shown by the arrows) into a focal spot where pressure variations are most intense. Probe 2 is an electrode positioned in said focal spot and is insulated from reflector 1 by bushing 3 thru which insulated lead 4 passes. High potential DC is applied to lead 4 from high voltage power supply 5. Transformer 6 is placed in the circuit between said power supply and reflector 1, said reflector may be electrically grounded for safety in handling.

The secondary of transformer 6 provides the signal output which may then be suitably amplified.

Fig. 2 illustrates a similar circuit to that shown in Fig. 1, except that probe 8 is electrically-heated, heating current being provided by step-down transformer 9 from an AC voltage source. The balance of the circuit is similar to that set forth in Fig. 1. The secondary of step-down transformer 9 must be insulated from the primary to the limit of the high potential supplied to probe 8.

Fig. 2a is a detail of probe 8 provided with internal resistance heating. In this figure, probe 8 is spherical to provide optimum conditions for sound-pressure convergence. Resistance-heating element 10 is contained within spherical container 8 and conducts heat thereto.

For convenience and safety in handling, insulated leads 4 and 4' (now 2-conductor) are contained within flexible shielded cable 11 which also provides a ground to reflector 1, thereby eliminating the need for an insulating bushing and a separate ground to reflector 1.

Fig. 2b is an alternate form of probe consisting of an exposed platinum or tungsten filament 12, heated (only) to a dull red (non-oxidizing) temperature.

Fig. 3 is a more complete diagram showing reflecting surface 1, heated-filament probe 12, high potential insulated leads 4 and 4' with flexible shield 11. Step-down transformer 9 supplies current to heat probe 12. Capacitor 15 couples the changing voltage of lead 4 to the grid of triode 14. The circuit which is illustrated is a conventional amplifying circuit, consisting of grid bias resistor 16, bias supply 17, plate supply 18, plate resistor 19 and output coupling capacitor 20.

It must be pointed out that power supply 5 must produce an output which is thoroughly filtered, i.e., with minimum ripple. The voltage output should be sufficient to maintain intense ionization and coronal emission around electrode-probe 2. For this purpose 10-15 KV has been found to be satisfactory if probe 2 is of small dimensions.

When probe 2 is cold or not coated with specific materials to improve emission, polarity is not important. Either positive or negative corona is effective. If probe 2 is heated, the negative polarity is preferred. Various coatings may be applied to probe 2 so as to improve either positive or negative emission.

It is obvious that there may be many variations in the shape of the sound reflecting surface or in the electrodes and circuit making up the system without departing from the spirit of the invention as set forth in the following claims.

I claim:

1) Method of converting sound waves into electrical signals consisting in directing said waves into a focal spot by means of a reflecting surface, fixing an insulated electrode at said spot, electrically charging said electrode to a high direct current potential relative to said reflecting surface and utilizing the resulting variations in the charging current to produce electrical signals.

2) A microphone consisting of a parabolic reflector, an electrode positioned at the focus of said reflector, means for charging said electrode relative to said reflector and means for utilizing the variations in charging current as an output signal.

3) Apparatus for converting sound into electrical signals, consisting of an arcuate sound-concentrating surface, an electrically-conducting probe at the focus of said surface, means for providing a charging current of high potential to said probe and means for sensing the variations in said charging current.

4) Apparatus according to claim 3, including means for electrically-heating said probe to increase the emissivity thereof.

5) Apparatus according to claim 3, including the coating of said probe with materials to increase the emissivity thereof.

6) Apparatus according to claim 3, including a probe composed of radioactive material to increase the emissivity thereof.

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Additional Claims: Docket No. 8310

Add:

7) Method of converting sound waves into electrical signals consisting in concentrating sound pressure variations upon the coronal envelope of a high potential electrode, maintaining said electrode at high potential and utilizing the resulting variations in the charging current to produce electrical signals.

8) A microphone comprising a corona-emitting electrode charged to high potential, means to concentrate incoming sound pressure upon the coronal envelope of said electrode and means to utilize the resulting variations of corona current to produce output signals.

9) Electrokinetic apparatus for converting sound into electrical signals comprising an electrode maintained at high potential so as to produce corona, means to concentrate sound upon said corona and means to utilize the variations in corona current to produce output signals.

10) Apparatus according to claim 9 including a horn to collect sound pressure and concentrate the same upon said corona.

11) Apparatus according to claim 9 including means for electrically heating said electrode to increase the corona therefrom.

12) Apparatus according to claim 9 including the coating of said electrode with materials to increase the corona therefrom.

13) Apparatus according to claim 9 including an electrode composed of radioactive material to increase the corona therefrom.

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ADDENDUM

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P1 Par. 5 After "output signal" add another sentence:

An alternative form of the invention makes use of an exponential horn or the like for concentrating and intensifying the incoming sound waves in the region of the highly-charged probe.

The horn method for concentrating sound waves in the region of the sensing probe is superior to the parabolic reflection method, especially at high frequencies, because of the reduction of phase distortion. In this form, especially when the horn is rectangular in transverse cross-section, the probe may be a fine wire of considerable length. This permits increased sensitivity.

P2 add:

Fig. 1a is a circuit diagram similar to Fig. 1 except that a horn (preferably an exponential horn) is used to concentrate the sound waves.

Fig. 4 is a circuit diagram similar to Fig. 1a, partly in perspective, showing a rectangular exponential horn with elongated sensing probe.

P3 add:

Fig. 1a shows an alternative form of the invention whereby the incoming sound waves are concentrated and intensified by an exponential horn 1a or the like.

Fig. 4 is an extension of the form of the invention illustrated in Fig. 1a. When horn 1a is made rectangular in cross-section, probe 2a is filiform and of considerable length. This adds surface area to the probe and improves sensitivity. Probe 2a may be heated (where necessary to improve emission) by current supplied by step-down transformer 21. High voltage is supplied from power supply 22 and variations in probe current are sensed in transformer 23 to produce an output signal as indicated. It is to be understood that vacuum tube circuitry can be employed as an alternative arrangement to detect variations in probe current as illustrated in Fig. 3.

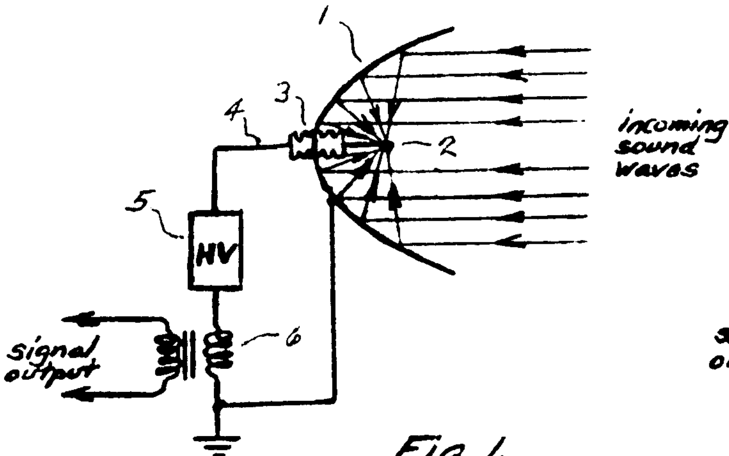

Fig 1.

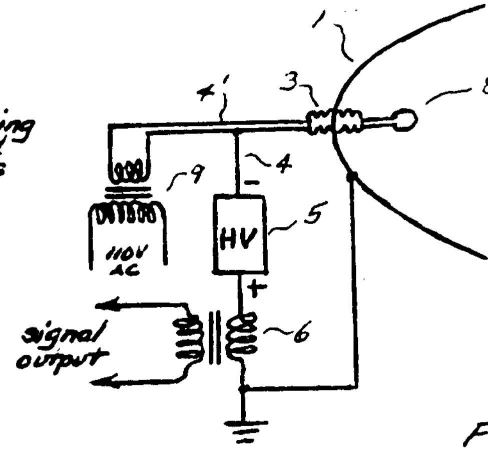

Fig. 2

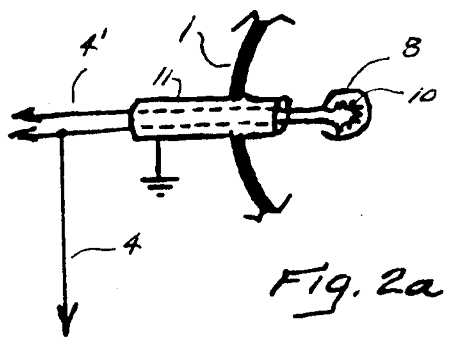

Fig. 2a

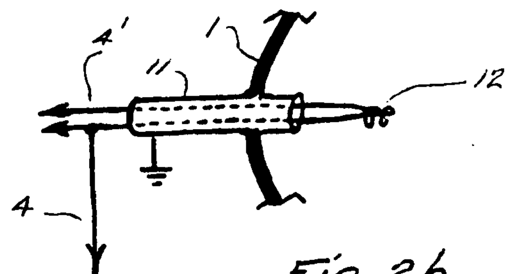

Fig. 2b.

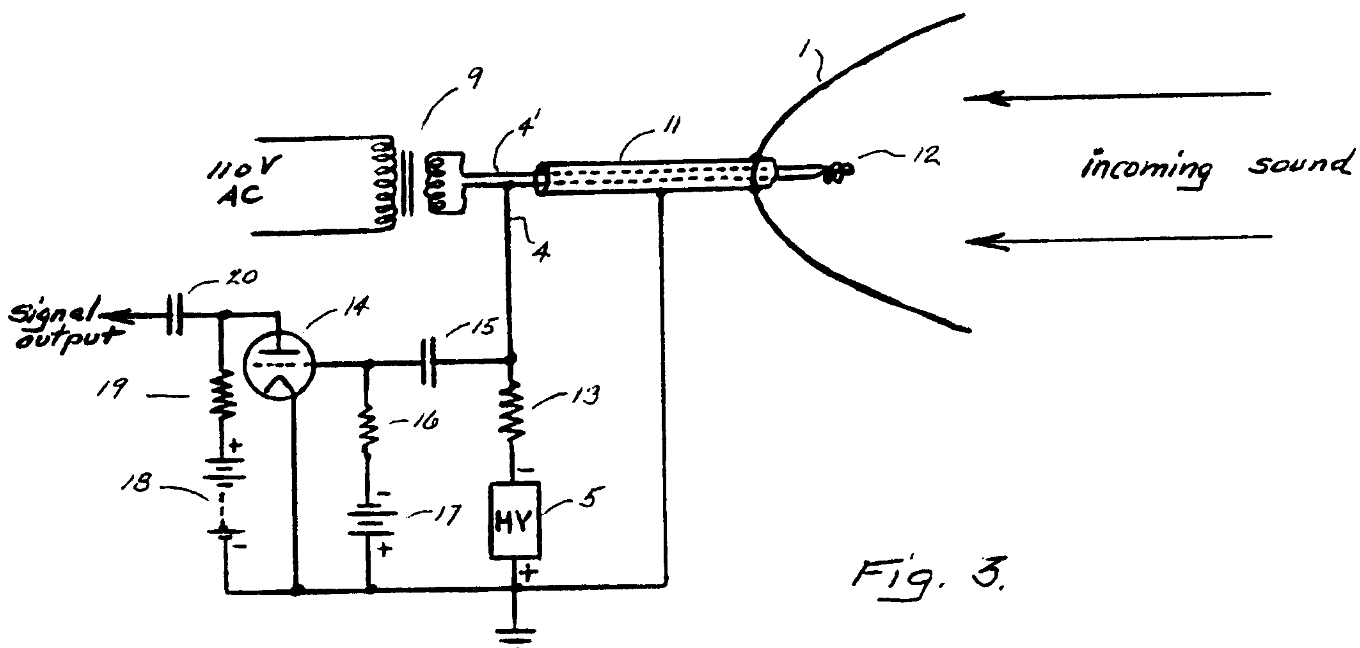

Fig. 3.

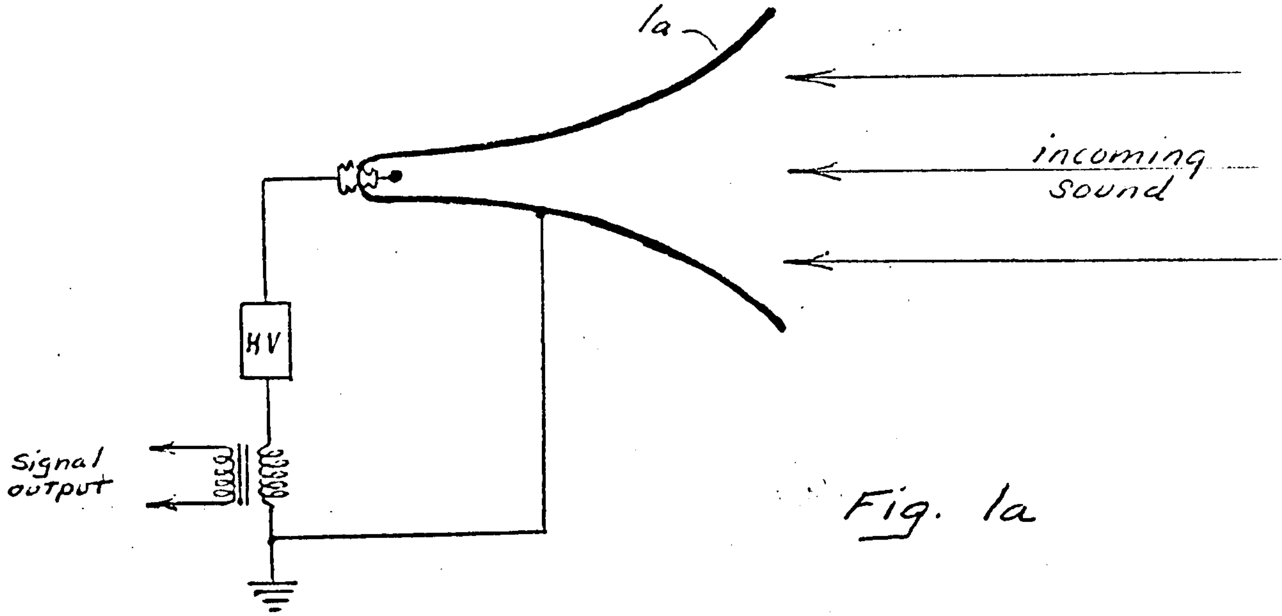

Fig. 1a

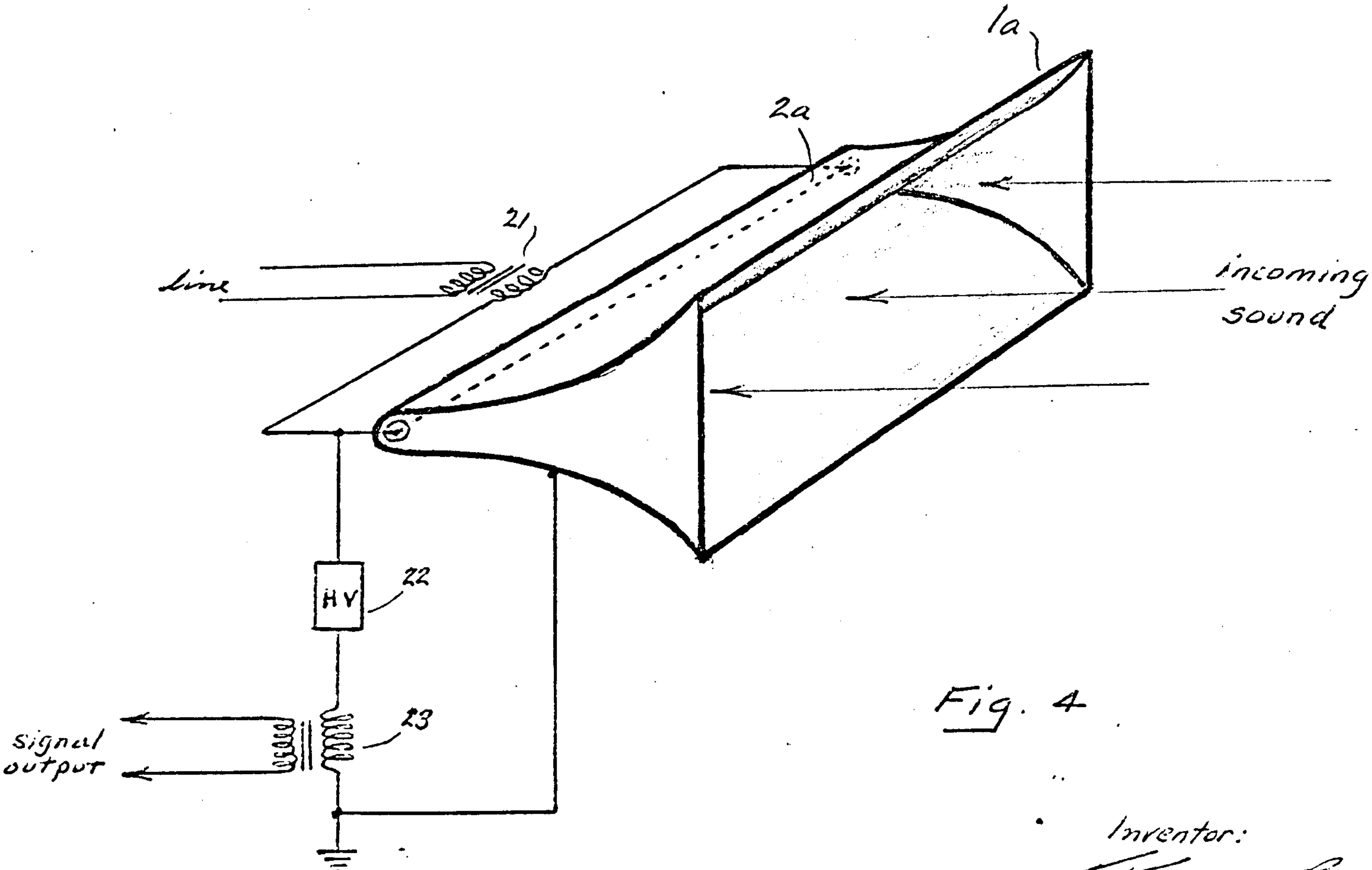

Fig. 4

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