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GLOW DISCHARGE TRANSMITTER

Filed Oct. 28, 1922

Fig. 1.

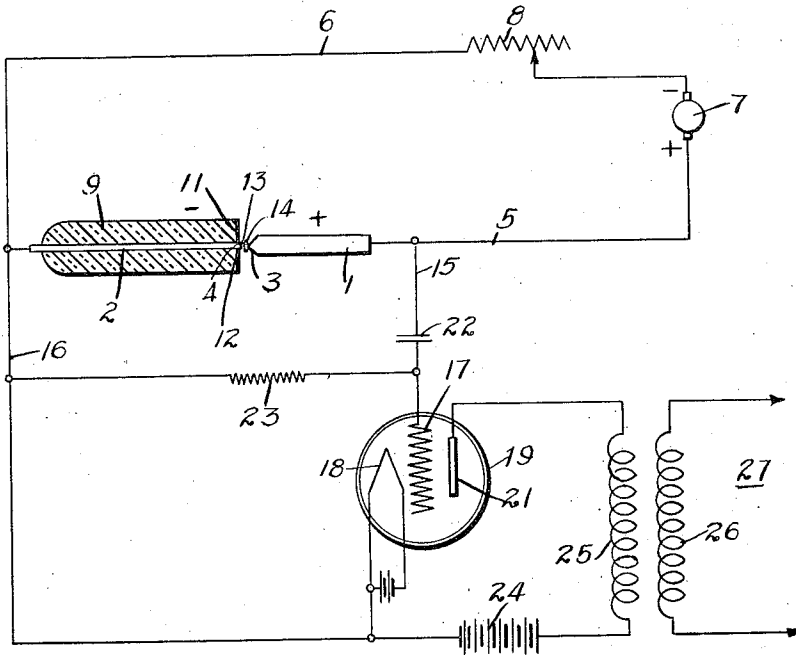


Fig. 3.

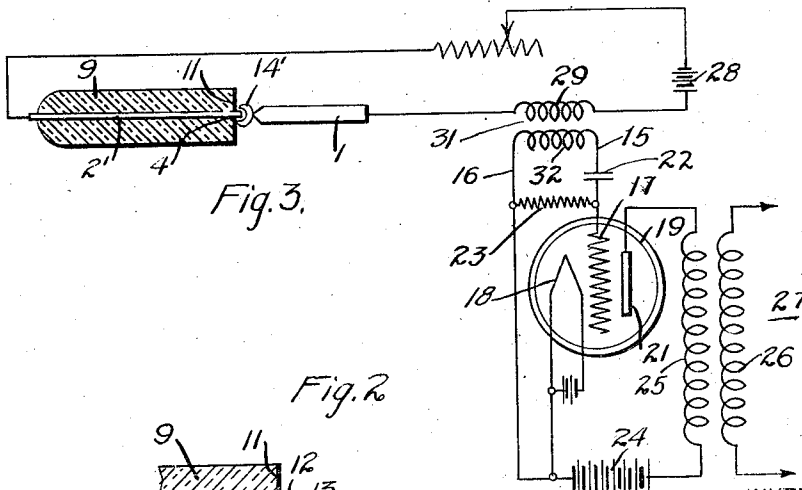
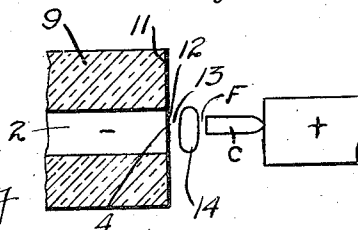


Fig. 2.



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UNITED STATES PATENT OFFICE.

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GLOW-DISCHARGE TRANSMITTER.

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My invention relates to telephone systems and apparatus and particularly to telephone transmitters.

One object of my invention is to provide a translating device, of the class described, wherein sound waves are faithfully translated into correspondingly modulated electrical energy without impairing the quality, tone and quantity of the translated energy.

Another object of my invention is to provide a sound-translating device and circuit connections therefor which insure the translation of sound waves into correspondingly modulated currents without the introduction of distorting harmonics.

Still another object of my invention is to provide telephone translating apparatus which embodies no moving parts and, more especially, one wherein the usual vibratory diaphragm may be dispensed with.

A still further object of my invention is to provide a translating device, of the class described, which is characterized by its simplicity of design and operation and which lends itself to inexpensive construction and manufacture, the several parts of which may be easily made on existing automatic machinery and may readily be assembled with a minimum expenditure of time and money.

According to my invention, I provide a sound-wave translating device employing a pair of spaced electrodes in the air or other medium subject to pressure variations from the sound waves to be translated, together with means for establishing, between said electrodes, a glow discharge of a particular character hereinafter described, and means for detecting or utilizing the changes in the characteristics of the discharge resulting from the atmospheric pressure variations.

In certain types of glow-discharge apparatus, among which may be mentioned those in which the anode is so close to the cathode that the positive column and the Faraday dark space is substantially absent from the glow-discharge, the discharge may be susceptible of covering not only the extreme end of the cathode but also a variable amount of the side surfaces, dependent upon pressure conditions. Under such circumstances, the voltage-drop across the discharge is ordinarily independent of small pressure variations in the surrounding medium. I have found, however, that when the available cathode surface is completely

covered by the discharge, so that the area of cathode surface covered by the discharge cannot change with varying pressure conditions, and when the current through the discharge is maintained substantially constant, the voltage drop varies directly with the pressure, for slight pressure variations.

While the discharge device just mentioned has been referred to as a translating device, it is, in reality, also an amplifying device, inasmuch as a source of energy, say, the sound waves, controls the constants of a circuit embodying a considerably larger source of energy.

Although the primary object of my invention is to provide a translating device for sound waves, it is apparent that my invention embodies certain distinctive features and characteristics which make it applicable to other uses, as will be apparent to those skilled in the art.

With these and other objects and applications in view, my invention further consists in the nature, the mode of operation and the constructional details hereinafter described and claimed and illustrated in the accompanying drawing, wherein:

Figure 1 is a view, partially diagrammatic and partially structural, of circuits and apparatus embodying a preferred form of my invention,

Fig. 2 is a greatly enlarged detail view of the discharge electrodes of Fig. 1, illustrating the maximum number of component parts of a glow discharge, and

Fig. 3 is a view similar to Fig. 1, showing a modification.

In the illustrated embodiment of my invention shown in Fig. 1, a pair of spaced electrodes 1 and 2 having discharge surfaces 3 and 4, respectively, are connected by conductors 5 and 6, to the plus and minus terminals of a source 7 of direct-current energy. A resistor 8, which serves to stabilize the current through the discharge and to hold the same substantially constant, may be connected in series-circuit relation with the conductor 6. In practice, it has been found that the energy source may have an electromotive force on the order of 6000 volts and the resistance of the resistor 8 may be on the order of a megohm.

For purpose of illustration, I have shown one arrangement for limiting the available discharge surface of the negative electrode

2, though my invention is not to be limited thereto. The arrangement comprises the conducting element 2, which is made of platinum or other suitable material and which is fused in the axis of a cylindrical mass of glass 9 having a substantially flat surface 11 at one end. The end of the mass of glass is ground flush with the end of said electrode 2, thus providing a construction wherein the exposed discharge surface 4 is limited to such portion of the conducting element 2 as is disposed in the flat-end surface 11 of the glass member 9.

When the electrodes are separated a certain amount, say, $\frac{1}{16}$ of an inch, for a system embodying the constants indicated, a glow discharge may be formed between the two electrodes 1 and 2 which comprises the following portions arranged in order between the negative electrode 2 and the positive electrode 1: a cathode glow 12, which is in immediate contact with the negative electrode 2, a cathode dark space 13, sometimes known as Crooke's dark space, a negative light 14, the Faraday dark space F, and a positive or anode column C, which terminates on the positive electrode 1, all as indicated on a much enlarged scale in Fig. 2.

In my invention, however, the electrodes 1 and 2 are preferably brought closer together than the distance which will produce all of the characteristic parts shown in Fig. 2, so that the positive column C and the Faraday dark space F disappear and the tip of the positive electrode 1 extends into the negative light 14. The dimensions of the cathode glow 12 and of the cathode dark space 13 are also much exaggerated in Fig. 2, as the negative light 14 appears to cover the end of the cathode 2. The dimensions of the discharge, however, as previously stated, should be such that the negative light 14 completely covers the available discharge surface 4 of the negative electrode 2.

As pointed out in the foregoing portions of this specification, it has been observed that, when the negative light 14 completely covers the available cathode surface 4, and when the current therethrough is maintained substantially constant, the potential drop across the electrodes 1 and 2, or, to be more specific, the so-called "cathode drop", or potential drop between the cathode and the free boundary of the cathode glow, varies inversely with the atmospheric pressure. Hence, when the pressure in the immediate vicinity of the discharge is varied, as by the presence of sound waves, the potential drop across the electrodes 1 and 2 is varied in accordance with the varying intensity thereof. The potential drop across the electrodes 1 and 2 is thus composed of a constant component, namely, the so-called "quiet voltage drop" and an alternating

component which, as just stated, corresponds in intensity with the varying intensity of the sound waves.

The alternating component of voltage just mentioned may be translated into amplified currents of similar wave form by impressing the same through conductors 15 and 16 upon the grid-filament elements 17 and 18, respectively, of a three-electrode vacuum tube 19, including, in addition, a plate element 21.

A condenser 22 having a negligible impedance to sound waves of the lowest frequency is included in the conductor 15 and serves to prevent the so-called "quiet voltage drop" across the electrodes 1 and 2 from operating to effect the blocking of the tube 19. A grid-leak resistor 23 may be connected in shunt relation to the grid-filament elements 17 and 18 of the tube 19 in order to control the intensity of the negative charges which are accumulated on the grid 17 during the operation of the tube 19.

A plate-filament circuit for the tube 19 includes a source 24 of direct-current energy and a coupling coil 25, the latter being operatively coupled to a second coupling coil 26 which is serially included in an outgoing or work circuit 27. The work circuit 27 may, in turn, be connected in any circuit arrangement designed to employ modulated currents.

In summary, the operation of my invention, as shown in Fig. 1, is, briefly, as follows: With the formation of a glow discharge between the electrodes 1 and 2 having such proportions that the cathode glow 14 completely covers the available cathode surface 4, the potential drop, or, to be more specific, the so-called "cathode drop", varies in accordance with the varying intensity of such sound waves as are caused to impinge thereon. The resulting alternating component of voltage is impressed upon the input electrodes 17 and 18 of the repeater device 19, causing the passage of relatively heavy currents having corresponding characteristics in the plate-circuit of the device 19. The amplified currents may, in turn, be further impressed upon the work circuit 27 which is associated with other circuits and apparatus not shown.

The arrangement shown in Fig. 3 is differentiated over that shown in Fig. 1 in the provision of a supply circuit for the discharge electrodes 1 and 2 having such low impedance that current variations are established therein, when the pressure in the vicinity of the discharge is varied, rather than potential variations, as in Fig. 1. The supply circuit for the discharge electrodes 1 and 2 now includes a low-voltage source 28 of direct-current energy and the primary winding 29 of a transformer 31 for translating the current variations in the supply

circuit to potential variations across the terminals of the secondary winding 32 of said transformer. The potential variations may be translated into amplified current variations in the same way as indicated in Fig. 1. The operation of this figure is otherwise as indicated for that of Fig. 1.

In Fig. 3, I have illustrated the cathode 2' as extending slightly beyond the end surface 11 of the glass, the cathode glow 14' being illustrated as apparently covering the entire exposed surface of the cathode, as hereinbefore explained.

While I have described my invention as embodied in circuit arrangements having certain specific values, it is to be understood that my invention is not to be limited thereby. Furthermore, it is apparent that various changes and modifications may be made in the nature, the mode of operation and the constructional details thereof without departing from the spirit of my invention. I desire, therefore, that only such limitations shall be imposed thereon as are indicated in the appended claims or demanded by the prior art.

I claim as my invention:

1. A sound-responsive device including a pair of spaced electrodes open to the atmosphere, means for causing a glow-discharge therebetween and means controlled by the electrical changes in said glow-discharge produced by sound for producing an output representative of said sound.

2. A sound-responsive device including a pair of spaced electrodes open to the atmosphere, means for causing a glow-discharge therebetween and means controlled by the electrical changes in said glow-discharge produced by sound for producing an output representative of said sound, and means associated with one of said electrodes for limiting the available discharge surface thereof.

3. A sound-responsive device including a pair of spaced electrodes open to the atmosphere, means for causing a glow-discharge therebetween and means controlled by the electrical changes in said glow-discharge produced by sound for producing an output representative of said sound, means associated with one of said electrodes for limiting the available discharge surface thereof, said discharge-causing means maintaining the discharge at sufficient dimensions to cover said available discharge surface.

4. In a sound-responsive device, a positive electrode and a negative electrode open to the atmosphere, means for limiting the available discharge surface of the negative electrode, means for establishing a glow-discharge between said electrodes, the distance between said electrodes having such a relation to the said discharge-establishing means that the glow-discharge comprises mainly a negative

light, a cathode dark space and a negative light, and said discharge-establishing means acting to keep the cathode glow of a size to completely cover the said available discharge surface of the negative electrode.

5. In a sound responsive device, a positive electrode and a negative electrode exposed to atmospheric pressure, said negative electrode comprising a conducting element and a non-conducting element, said elements being flush with each other, whereby an exposed discharge surface of limited area is provided, and means for establishing a glow-discharge between said electrodes, the distance between said electrodes being so short that the Faraday dark space and positive column if present together constitute less than a fourth of said distance, and said discharge-establishing means maintaining the glow-discharge of such magnitude that the said limited area is completely covered by the cathode glow.

6. In a sound responsive device, a positive electrode and a negative electrode exposed to atmospheric pressure, said negative electrode comprising a conducting element and a non-conducting element surrounding it, the end surfaces of said elements being flush with each other, whereby an exposed discharge surface of limited area is provided and means for establishing a glow-discharge between said electrodes, the distance between said electrodes being so short that the glow-discharge is substantially without a Faraday dark space or a positive column and said discharge-establishing means maintaining the glow-discharge of such magnitude that the said limited area is completely covered by the cathode glow.

7. In combination, an electrical circuit including a pair of spaced electrodes, means for establishing a glow discharge between said electrodes having such proportions as to cover the available discharge surface of one of said electrodes, means for causing the currents through said discharge to remain substantially constant with variations in the characteristics of said discharge caused by the presence of sound waves, and means for translating the effects resulting from variations in the characteristics of said discharge into amplified current variations.

8. A sound-wave translating device comprising a cathode and an anode in a medium subject to pressure variations in the presence of sound waves, means for establishing, between said cathode and said anode, a glow discharge including a cathode glow whereby the potential of said cathode glow relative to the cathode will vary with varying pressure, and a translating device responsive to said variations in said relative potential.

9. A sound-wave translating device comprising a pair of spaced electrodes in the air, means for establishing therebetween a glow

discharge including a negative light extending substantially from one electrode to the other, means for causing the discharge to cover, at all times, a substantially constant cathode area notwithstanding pressure variations due to sound waves impinging thereupon, and means responsive to the variations in an electrical quantity of said discharge in the presence of sound waves.

10 10. The method of converting sound waves into variations of electric current which consists in establishing a glow discharge including a cathode glow having a variable potential relative to the cathode dependent upon
15 pressure variations in the surrounding medium, and detecting the resultant variations in an electrical quantity of said discharge.

11. The method of detecting movements in a fluid non-conducting medium which consists in maintaining an electric glow-discharge therein and detecting the changes in a characteristic of the discharge resulting from said fluid movements. 20

12. A device for detecting movements in a fluid non-conducting medium comprising
25 means for maintaining an electric glow-discharge therein and means for detecting the changes in a characteristic of the discharge resulting from said fluid movements.

In testimony whereof, I have hereunto
30 subscribed my name this 25th day of October, 1922.

JOSEPH SLEPIAN.