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P. THOMAS

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METHOD OF AND MEANS FOR TRANSLATING PRESSURE VARIATIONS

Filed Nov. 14, 1922

Fig. 1.

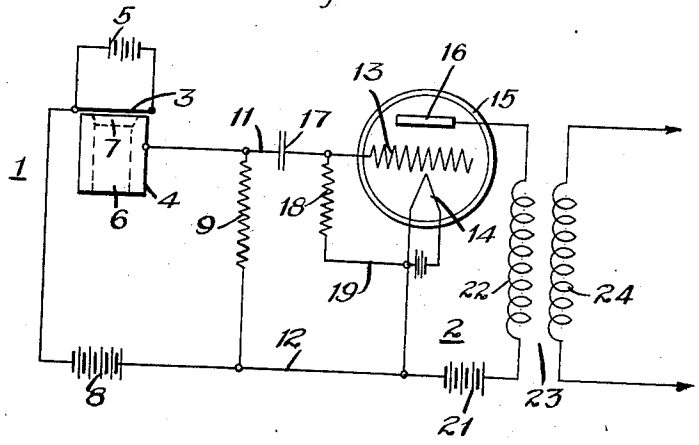
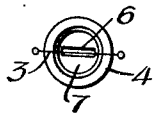


Fig. 2.



WITNESSES:

A. L. Jeffrey

H. L. Godfrey

INVENTOR

Phillips. Thomas

BY

Wesley G. Carr

ATTORNEY

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UNITED STATES PATENT OFFICE.

PHILLIPS THOMAS, OF EDGEWOOD, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

METHOD OF AND MEANS FOR TRANSLATING PRESSURE VARIATIONS.

Application filed November 14, 1922. Serial No. 600,821.

To all whom it may concern:

Be it known that I, PHILLIPS THOMAS, a citizen of the United States, and a resident of Edgewood, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Methods of and Means for Translating Pressure Variations, of which the following is a specification.

My invention relates to telephone circuits and apparatus having particular relation to an improved sound-wave translating system.

One object of my invention is to provide a pressure-translating device, wherein pressure variations may be faithfully translated into correspondingly modulated electrical variations without introducing distortion.

Another object of my invention is to provide apparatus of the class described, which embodies no moving parts, and, more particularly, one wherein the usual vibratory diaphragm is dispensed with.

A further object of my invention is to provide a translating device which is characterized by its simplicity of designs, efficiency of operation and lack of complicated adjustments and which lends itself to inexpensive quantity-production methods of manufacture, the several parts of which are suitable for manufacture in existing automatic machinery and adapted for assembly with a minimum expenditure of time and money.

In the ordinary microphone of the carbon-capsule type certain undesirable operating characteristics are present by reason of the peculiar design thereof as, for instance, the employment of a vibratory element which tends not only to introduce distortion but also to complicate the construction of such transmitters. Other disadvantages inherent in telephone systems employing such transmitters are well known to those skilled in the art.

According to my invention, I provide an improved method of, and means for, translating pressure variations as, for instance, sound waves, into amplified current variations having a wave form corresponding to that of the impressed pressure variations. The desired result is accomplished by varying the pressure in order to vary the mobility or average velocity of the electrons constituting an electron stream and then detecting the electrical changes in said electron stream incident to the variations in the mobility thereof.

Other objects and applications of my invention, as well as details of construction and operation, whereby my invention may be practised, will be apparent from the following description of my invention when taken in connection with the accompanying drawing, wherein

Fig. 1 is a view, partially diagrammatic and partially structural, of circuits and apparatus illustrating one embodiment of my invention.

Fig. 2 is a top plan view of the anode-cathode structure shown in Fig. 1.

By way of illustration, I shall describe in the drawing a particular arrangement of circuits and apparatus which has proved satisfactory in practice, although it is to be expressly understood that my invention is not limited thereto. In general, the system comprises a sound-wave translating device 1 and means 2 for translating and for amplifying a variable electrical quantity in the sound wave translating device 1 in the presence of pressure, all as explained more fully hereinafter.

The device 1, which translates the pressure variations into corresponding electrical variations, comprises a hot cathode 3, such, for instance, as a Nernst filament, and an anode 4, all of which are disposed in spaced relation in a gaseous atmosphere, as air. The hot cathode 3 may be energized from a source 5 of direct-current energy having a voltage of, say, 120 volts.

The anode 4, which is of special design adapted to increase the effects of pressure variations on the mobility of an electron stream, comprises a block having a slit-like opening 6 extending longitudinally from one end thereof to the other. One end of the block is also hollowed out to form a depression 7. With the hot cathode 3 disposed in the plane of the slit 6 and immediately adjacent to the depression 7, it is seen that pressure variations in the vicinity thereof cause air movements through the slit 6, thereby accentuating the effect of such pressure variations on the electron current established between the anode 4 and the cathode 3.

A plate-filament circuit for the translating device 1 includes a source 8 of direct-current

energy for establishing electrostatic forces in the space between the hot cathode 1 and the plate or anode 4, tending to draw the electrons emitted from the cathode 1 to the anode 4, and a resistor-coupling device 9.

The variable electrical voltage, which is established across the resistor 9 when sound waves are directed at the translating device 1, as more fully hereinafter explained, may be further amplified by impressing the same through conductors 11 and 12 upon the grid and filament elements 13 and 14, respectively, of a three-electrode vacuum tube 15, which includes, in addition, a plate element 16.

A condenser 17 having a negligible impedance to currents of the frequency of the pressure variations being translated, is included in the grid conductor 11 and serves to prevent the so-called "quiet" voltage drop across the hot cathode 3 and the anode 4 from operating to effect a blocking of the tube 15. A grid-leak resistor 18 may be included in a circuit 19, which is connected in shunt relation to the filament 14 and to the grid 13 of the tube 15 in order to control the intensity of the negative charges which are accumulated on the grid 13.

A plate-filament circuit for the amplifier tube 15 includes a source 21 of direct-current energy and a primary winding 22 of a coupling transformer 23, the secondary winding 24 of which is connected to the input elements of a second amplifying device (not shown) or other circuit arrangement designed for employing such modulated electrical energy.

In order to complete the description of my invention, I shall now state the general theory of operation of my invention.

The intensity of an electron stream between a pair of spaced electrodes is materially limited by the space-charge effect of the electrons constituting the stream. I preferably employ such plate potentials that little or no ionization is produced in the space between the electrodes, and, under such circumstances, the space-charge effect is dependent solely upon the density of the electrons in the stream, which, in turn, is a function of the velocity of the electrons.

Furthermore, the average velocity of the electrons is dependent upon the gas pressure. This will be clear when it is considered that the average distance through which an electron can freely move without colliding with a gas molecule, in other words the mean free path of the electron, varies inversely with the pressure of the medium enveloping the same. When the pressure increases, the number of collisions increases, thereby materially retarding the passage of the electrons and decreasing their mobility or average velocity. When the pressure decreases, the converse is true.

In view of the foregoing, it can be seen that there is a definite relation between the pressure of the gas and the intensity of the electron stream, since an increase in pressure causes a decrease in the average velocity of the electron stream, and the decrease in velocity operates to increase the space-charge effect and hence, to decrease the intensity of the electron stream.

Thus, it is seen that, when a space current is established between the electrodes 3 and 4, the effect of pressure variations is to correspondingly vary the length of the mean free path of the electrons constituting the stream, and hence, the intensity of the electron stream. The resulting current variations are translated into potential variations across the resistor 9, and the potential variations are, in turn, impressed upon the input electrodes 13 and 14 of the repeater device 15. The resulting amplified modulated current traversing the plate-filament circuit of the tube 15 may be further impressed upon other circuits (not shown) through the coupling transformer 23.

In operation, my apparatus thus provides an electron-discharge path having a variable intensity of flow resulting from differences in pressure at successive instants at any point in a propagated sound wave traversing the space between the two electrodes. It will be obvious, therefore, that the dimensions of the space included between the electrodes should preferably be small, in the direction of propagation of the sound, as compared with the shortest wavelength of the sound.

While I have described one particular embodiment of my invention employing specific values of the constants, for the purpose of describing the invention and illustrating its principles of operation, it is apparent that various changes and modifications may be made therein without departing from the spirit of my invention and I desire, therefore, that only such limitations shall be imposed thereon as are demanded by the prior art or as are indicated in the appended claims.

I claim as my invention:

1. In a device for translating sound into electrical changes, a cathode, an anode and means for producing a potential difference between said electrodes, the space between said electrodes being open to the atmosphere whereby it is subjected to pressure variations due to sound, and said potential difference being at all times too small to produce substantial ionization of the atmosphere in said space.

2. In a device for translating sound into electrical changes, a cathode, an anode and means for producing a potential difference between said electrodes, the space between said electrodes being open to the atmos-

phere whereby it is subjected to pressure variations due to sound, said cathode having an emissivity sufficient to cause saturation by space charge at said potential difference and said potential difference being less than that required to produce substantial ionization, whereby the changes in density of the atmosphere upon the reception of sound are accompanied by corresponding changes in space charge.

In testimony whereof, I have hereunto subscribed my name this 10th day of November 1922.

PHILLIPS THOMAS.