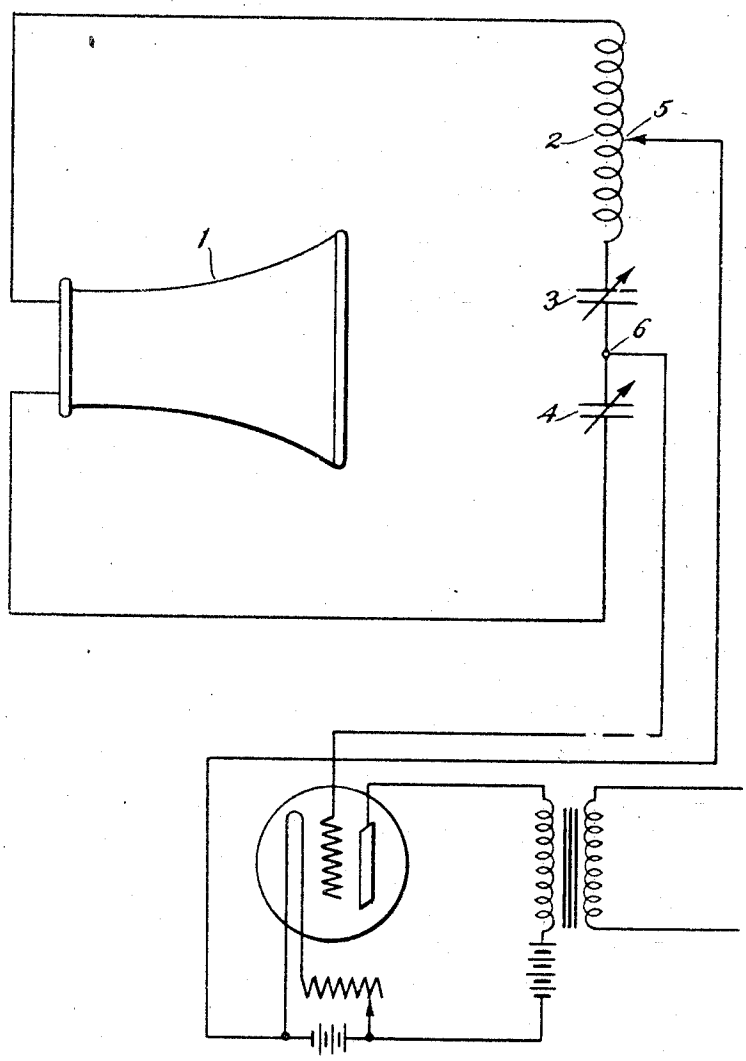
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C. R. HANNA

MICROPHONE CIRCUIT

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WITNESSES:

Carl J. Loesch

H. A. Whittaker Jr.

INVENTOR

Clinton R. Hanna

BY

Wesley G. Carr

ATTORNEY

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# UNITED STATES PATENT OFFICE.

CLINTON R. HANNA, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## MICROPHONE CIRCUIT.

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This invention relates to devices for responding to sound and delivering electric currents corresponding to the sound.

It is an object of this invention to provide a device of this class in which the voltage produced shall be proportional to the pressure exerted by the sound received, at substantially all frequencies.

It is a further object of this invention to so correlate the electrical constants of the circuit to which a microphone is connected, with the characteristics of the microphone, that the electrical effect obtained shall be the same, for the same amount of sound energy received, over a very considerable range of frequency.

By properly designing the correlations just mentioned, it is possible to give any desired character to the variation of the voltage produced with the frequency. The invention, therefore, is not limited to keeping this variation as small as possible, although that is usually the desired result.

Other objects of the invention and details of the construction will be clear from the following description and the accompanying drawing in which the single figure is a diagram illustrating the circuits and apparatus which embody my invention.

The microphone 1 is part of a local circuit including an inductor 2, a condenser 3 and a second condenser 4, all arranged in series. As will be pointed out below, a portion of the inductance or one of the condensers or both the inductance and a condenser may be inside of the casing of the microphone 1 or may even constitute parts of the microphone itself.

A second or operating circuit, of which the energization is controlled by the conditions in the local circuit including the microphone, includes a terminal 5, which adjustably divides the inductor 2, and a terminal 6 between the two condensers 3 and 4.

I have shown the condensers as adjustable but, in the actual use of the device, these condensers, having once been adjusted, would remain undisturbed.

The inductor 2 and the condensers 3 and 4 are chosen of such values, or are adjusted to such values, that the circuit including them in series is resonant at that frequency at which the microphone 1 delivers the greatest electromotive force in response to a given sound energy.

Most microphones respond in a resonant manner to a particular frequency, delivering at that frequency a greater electromotive force than at other frequencies. With a microphone of this character, the current flowing in the series circuit will be a maximum at that frequency at which the microphone is resonant.

The terminal 5 is adjusted along the inductor 2 and the condensers 3 and 4 are adjusted until the portion of the series circuit between the terminals 5 and 6 is also resonant to the frequency for which the microphone is resonant. In performing this adjustment, the equivalent capacity of the two condensers 3 and 4 in series should be left unchanged, but if it is changed, the adjustment must be repeated until both the series circuit and the portion thereof between the terminals 5 and 6 are resonant at the resonance frequency of the microphone.

Because the portion of the series circuit between the points 5 and 6 is resonant, its impedance will be a minimum at this particular frequency. Because the series circuit as a whole is resonant, the current flowing therein will be a maximum at this particular frequency. The variation of the impedance between the terminals 5 and 6 with the frequency is, therefore, in a direction opposite to that of the corresponding variation in the current through said impedance. Consequently, the alternating difference of potential between the points 5 and 6 remains substantially unchanged with changing frequency. The difference of potential impressed upon the operating circuit, is, therefore, a constant regardless of the changes in frequency in the sound energy, varying only with the amplitude of sound.

The operating circuit may be connected to another potential-responsive device. For the purpose of illustration I have shown it connected to the grid and filament of a vacuum tube. The output of this tube may be connected to any of the usual radio or other transmitting systems.

It will be obvious that the sharpness of the tuning of the circuit and the sharpness of the tuning of the portion between the terminals 5 and 6 may be varied by distribut-

ing the resistance throughout the series circuit in accordance with the desired sharpness of the two tuned connections. By thus varying the relation between the sharpness of each of the two tunings, the curve representing the relation of the frequency to the electromotive force impressed upon the operating circuit may be made concave in either direction. It is, therefore, evident that, if the resistance be properly distributed, this curve may be made concave in either direction, that is, it may be a straight line.

Because the series circuit through the inductor 5 and the condensers 3 and 4 is resonant, at the resonance frequency of the microphone, the current therein at frequencies below this, will be leading the electromotive forces while, at frequencies above resonance, it will be lagging behind the electromotive force. The leading current at frequencies below that of resonance of the diaphragm assists in overcoming the stiffness. A lagging current at frequencies above the resonance of the diaphragm assists in overcoming the inertia. For these reasons the resonant character of the series circuit assists in increasing the current delivered by the microphone at non-resonant frequencies.

At resonance, the current is in phase with the voltage and thus acts as an additional load upon the diaphragm. The resonant character of the series circuit, therefore, diminishes somewhat the peak of the electromotive force at resonance. These two effects of the resonant character of the series circuit assist in giving a straight line form to the curve, representing the relation of the electromotive force impressed upon the operating circuit to the sound frequency. They may even cause it to be concave, so that a smaller electromotive force is impressed upon the operating circuit at resonance than at other frequencies.

Any portion of the inductor 2, which it is desired to include in the microphone instrument itself or to house within the casing of the microphone, may be thus located. Likewise, any portion of the capacity represented by the two condensers 3 and 4, which the designer wishes may be included in the microphone structure or housed within the microphone case. It is, therefore, entirely possible to have the terminals 5 and 6 be the terminals of the microphone. The diagram is not to be taken as indicating that the parts 2 to 6 must be outside of the microphone case.

Other variations of the construction will be apparent to those skilled in the art and the specific form illustrated and described is not to be construed as a limitation. No limitation is intended except that required by the prior art and indicated in the accompanying claims.

I claim as my invention:

1. In a sound-translating device, a microphone having a resonance period, a circuit including said microphone and having the same resonance period, connections to said circuit at separated points, the portion of said circuit between said points also having the same resonance period.

2. In a sound-translating device, a microphone having a resonance period, a circuit including an inductive reactance and a capacitative reactance so proportioned that the circuit is resonant at the same period as the microphone, connection points in said circuit separating each of said reactances into two parts such that the part of the inductance and the part of the capacity included between said connections points render the portion of the circuit between said points resonant at the said period.

3. In combination, a microphone, a series resonant circuit upon which the microphone impresses electromotive force and a circuit connected at two separate points to said series resonant circuit, the electrical dimensions of the portion of the series circuit between said terminals being so correlated to the electrical dimensions of the remainder of said series resonant circuit that the dependence of the electromotive force impressed upon the second-named circuit upon the frequency shall be of any predetermined character.

4. In a sound translating system, a microphone having a predominant resonant frequency, a circuit including said microphone and being electrically tuned to said resonant frequency, a voltage responsive device, and connections between said device and said circuit, that portion of said circuit included between the points of connection of said voltage responsive device thereto being series-resonant to said predominant frequency, whereby when said microphone is energized by sound the potentials across said series resonant portion are substantially independent of the frequency of the sound input to said microphone.

In testimony whereof, I have hereunto subscribed my name this 22nd day of May, 1924.

CLINTON R. HANNA.