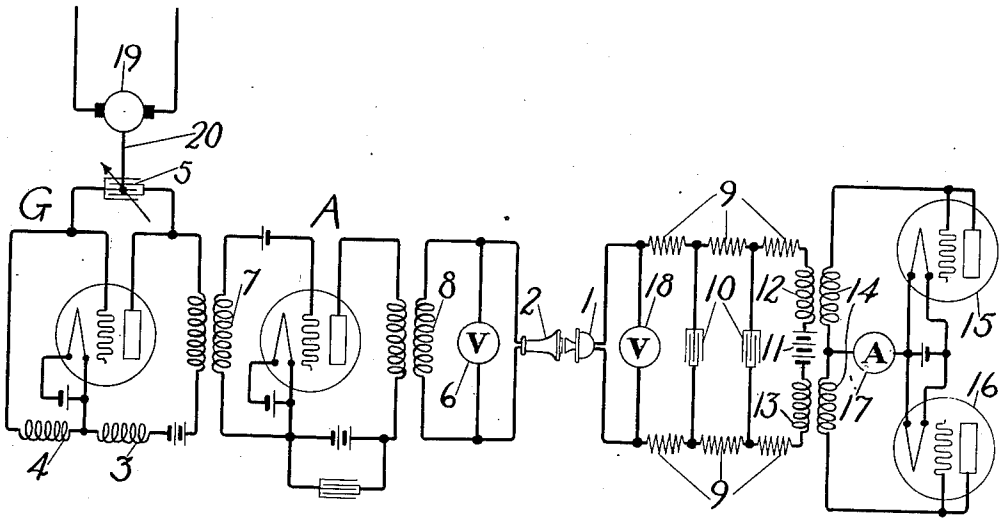
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METHOD OF GENERATING AN ALTERNATING CURRENT OF VARIABLE FREQUENCY

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UNITED STATES PATENT OFFICE.

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METHOD OF GENERATING AN ALTERNATING CURRENT OF VARIABLE FREQUENCY.

Original application filed November 12, 1917, Serial No. 201,565, now Patent No. 1,426,807, dated August 22, 1922. Divided and this application filed September 8, 1920. Serial No. 408,843.

To all whom it may concern:

Be it known that we, HAROLD DE FOREST ARNOLD and JOHN PRESTON MINTON, citizens of the United States, residing at Maplewood, in the county of Essex, State of New Jersey, and White Plains, in the county of Westchester, State of New York, respectively, have invented certain new and useful Improvements in Methods of Generating an Alternating Current of Variable Frequency, of which the following is a full, clear, concise, and exact description.

This invention relates to oscillation generators of a type in which the frequency can be caused to vary cyclically and continuously over a selected range, and is a division of U. S. patent to Arnold and Minton 1,426,807, August 22, 1922.

The above-mentioned patent discloses an application of this invention in a system in which it is particularly adapted to be used. The invention there disclosed is a method of and a system for testing the comparative efficiency of telephone transmitters or receivers. In this "machine" method of testing transmitters, as distinguished from what may be designated the "voice" method, the vibrating element of the transmitter, or receiver, is acoustically actuated by a mechanical means which embodies the present invention. The invention disclosed in the prior patent makes use of a source, for example, a telephone receiver, the sound emitted from which is conducted into the transmitter in such a manner as to exclude, as far as possible, resonant or interference effects of the outside air, to the end that the sound energy may be transmitted from the source to the instrument under test in an efficient manner, and in such a manner as to simulate, as closely as possible, the characteristic modes of speech transmission.

The source, in this case a telephone receiving instrument, should correspondingly be made to simulate in its function and mode of operation, the human agency of speech or voice. It is well known that telephone currents produced by speaking into a transmitter are very complex and may be considered as made up of currents of various frequencies extending over the acoustic range. In order to duplicate actual working conditions, even approximately, by combinations of mechanical elements, there are obviously presented formidable difficulties. A special form of generator is required for energizing the receiver which actuates the element under test.

In the invention of the prior patent this generator is caused to supply current which continuously and cyclically varies in frequency over the important part of the voice frequency range, thereby casting apparatus at all frequencies which are most important in speech.

Ordinary diaphragms, as is well known, are not equally responsive to forces of all frequencies. Hence, if in the above testing system a current having a variable frequency is supplied to the receiver, its diaphragm, having a non-uniform frequency response, would give rise to more intense sounds at some frequencies than at others. This is not important in case comparative tests are being made, since all of the elements under investigation are tested under like conditions, although if it is desired to investigate the frequency response characteristic of the element under test, or if it seems desirable for any other reason, the receiver diaphragm may be actuated by well-known means so as to give rise to equally intense sounds at all frequencies.

The present invention resides in an oscillation generator adapted to be used in a testing system similar to that disclosed in the said prior patent, and in the method of causing the frequency of the generator to vary cyclically and continuously over a selected range, although the invention is considered as having a much broader application than is indicated by this use.

The primary object of the invention is to provide an oscillation generator for producing a continuously and cyclically varying frequency. Secondary objects of the invention are, to provide an oscillation generator capable of producing oscillating currents of a continuously and cyclically varying frequency over the range of audible frequencies, and especially over that range of audible frequencies which is necessary for telephone apparatus to transmit efficiently in order to produce speech, and to vary the oscillation frequency of a generator having an oscillation circuit comprising capacity, over a selected range, by means of cyclically varying said capacity. Further objects of the in-

vention will appear hereinafter in connection with the detailed description of the invention.

For an illustration of one of the forms embodying the invention and suitable for carrying out the method, reference is made to the accompanying drawing, in the single figure of which is shown the application of the invention to the system briefly described above.

In the drawing is shown a machine testing system for testing element 1, which is illustrated as a telephone transmitter. The diaphragm of transmitter 1 is acoustically actuated by source 2, here shown as a telephone receiver, and which may be of the usual magnetic type, and in the circuit of which is a means, embodying the invention, for producing in the diaphragm of the receiver vibrations having a continuously and cyclically varying frequency. In this circuit the generator G supplies current to the receiver 2. This generator is shown as one form of the audion type in which the grid and plate circuits are inductively coupled by means of inductances 3 and 4, the oscillation circuit including inductances 3, 4, the primary winding of transformer 7 and the capacity 5. An audion type of oscillation generator is shown, although any other type, in which the frequency of oscillations depends on the inductance and capacity constants of an oscillation circuit, may be used. In the type here shown, the frequency of the oscillation depends upon the values of the inductances 3, 4 and the transformer primary and the capacity 5. It is the essence of the invention to vary the frequency of the generator continuously and cyclically between selected limits in contradistinction to a step-by-step variation which would, in this case, be undesirable. This may be done by varying cyclically either one of the constants, inductance and capacity, which enter into the frequency equation of the oscillation circuit. For the purpose of this invention it is proposed to vary the capacity 5. This may be accomplished by continuously rotating the movable element of a variable condenser by means of a constant speed motor 19 connected to the movable element of the condenser by means of shaft 20. Condensers capable of being operated in the manner described are well known to those versed in the art and it is not considered necessary to disclose a specific embodiment in this specification.

The currents delivered by the generator may be amplified by the amplifier A before they are sent to the repeating element comprising receiver 2 and transmitter 1, which have been described. The average voltage of the current supplied to the receiver 2, observed by means of voltmeter 6, is maintained constant.

The input circuit of amplifier A is shown as deriving its electromotive force from the output circuit of the oscillator G by means of the transformer 7, and the receiver circuit is similarly coupled with the output circuit of amplifier A, although in either case direct coupling may be used.

A voltmeter 18 may be provided across the terminals of the transmitter 1. In circuit with the transmitter 1 is provided a suitable electrical load which may be made up, as shown, of series resistance or inductances 9 and shunt condensers 10 having suitable values to simulate the impedance of any desired length of telephone cable.

Direct current for the transmitter 1 is supplied by the battery 11 through the coils 12 and 13 inductively related to the coils 14. In circuit with the coil 14 are two rectifiers 15 and 16 connected in opposition, so as to rectify the alternating current. The ammeter 17 measures the rectified current. By means of voltmeter 18 and ammeter 17 the energy used in the transmitter circuit may be calculated in accordance with well known principles.

From the above description it will be apparent that the oscillator G supplies to the receiver 2, currents which uniformly, cyclically, rapidly and continuously vary in frequency. It should be noted that the term "cyclically" when used alone and given its broader significance, is descriptive merely of a recurring variation, the primary conception being that of position or physical relation rather than that of time, and accordingly a current may conceivably be caused to cyclically vary even though there is no orderly sequence in the consecutive periods. The word "uniformly" here limits the term to the case in which there is a definite and constant period. Further, the term "cyclically" alone as used herein does not imply any particular mode of variation but concerns merely the end products of the periodic variation. In the present case, the word "continuously" limits the conception to a cyclical change in which there is a change in frequency from each instant of time to every other instant of time, however slight the interval of time may be. The alternating current delivered by the transmitter 1 to its load circuit 9 and 10 may be observed by means of the measuring instrument 17. On account of its mass the natural period of the needle of this instrument is great as compared with the period of impressed current impulses. Accordingly, it is unable to follow the minute variations of the current and is given a substantially steady deflection which is a measure of the average effect of the variable currents. For the purpose of comparison, other transmitters or receivers, or component parts thereof, may be substituted, the alternating out-

put in each case being compared with an arbitrarily chosen standard. It is thus possible to determine whether or not the devices under test meet the necessary requirements as to efficiency throughout the acoustic range.

The features of the invention which are believed to be novel have been pointed out above as applied in a specific system for which it is particularly well adapted. It should be understood, however, that the invention is equally well adapted to be used in other systems, in which it is desired to make use of a source of alternations, the frequency of which continuously and cyclically varies, and further that the invention is not necessarily limited to generators adapted to produce variations in frequency of the order used in telephone circuits since it is well known that oscillators of the audion type have been built capable of oscillating with frequencies much below audio frequency and with a frequency of many millions, nor to a generator of the audion type, as has been pointed out.

What is claimed is:

1. The method of operating an oscillator which is adapted to generate a continuous wave of a single frequency and which includes a frequency determining oscillation circuit, which comprises cyclically and continuously varying the tuning of said oscillation circuit.

2. The method which comprises generating an alternating current, and simultaneously continuously and cyclically varying the frequency of the current as generated within the acoustic range.

3. An oscillation generator comprising an audion tube, an oscillation circuit for determining the frequency of said generator, and means for varying the resonance of said circuit whereby said generator is adapted to supply current uniformly and recurrently varying in frequency.

4. In combination, means for continuously producing a substantially pure sine wave, comprising a frequency determining oscillation circuit including a variable condenser which has a rotatable electrode for varying its capacity, and means for continuously and cyclically varying the capacity of said condenser by uniformly and continuously rotating said element.

5. An oscillation generator of variable frequency, comprising in combination an electron discharge device which includes a cathode, an anode, and an impedance controlling element, a source of continuous space current connected to said anode, coupled input and output circuits related to said discharge device, reactive circuit means associated with said circuits and constituting therewith a resonant circuit, and means for continuously and cyclically varying the constants of said reactive circuit.

6. In combination, an oscillation generator comprising a highly evacuated containing vessel, an electron-emitting cathode, an anode, and an impedance-controlling element, coupled circuits related to said last-mentioned element, a frequency-controlling condenser of variation, to constitute, with said coupled circuits, a resonant circuit, and means for continuously and cyclically varying the capacity of said condenser.

In witness whereof, I hereunto subscribe my name this 17th day of August A. D., 1920.

HAROLD DE FOREST ARNOLD.

In witness whereof, I hereunto subscribe my name this 21st day of August A. D., 1920.

JOHN P. MINTON.