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R. L. MILLER

2,254,852

OSCILLATION GENERATOR

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FIG. 1

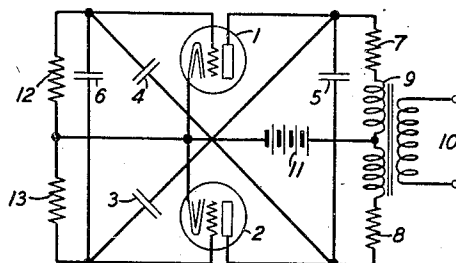


FIG. 2

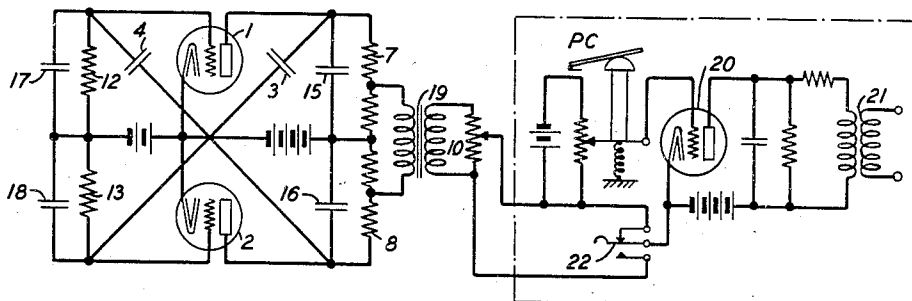


FIG. 3

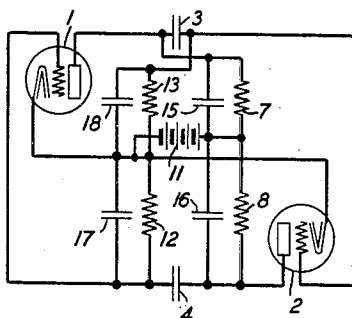
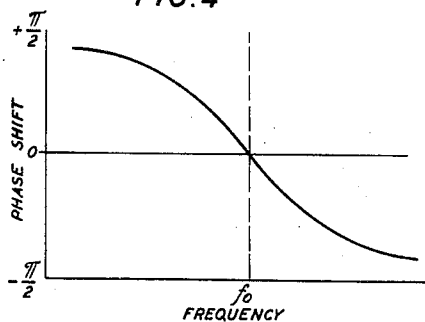


FIG. 4



INVENTOR  
R. L. MILLER  
BY *H. A. Burgess*  
ATTORNEY

## UNITED STATES PATENT OFFICE

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## OSCILLATION GENERATOR

Ralph L. Miller, Verona, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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10 Claims. (Cl. 250—36)

The present invention relates to the production of electrical waves for signaling or similar purposes, and more particularly to the production of low frequency waves.

A known type of oscillation generator is the so-called relaxation oscillator in which a condenser is alternately charged from a space discharge tube and discharged through a resistive circuit. This type of generator is frequently used where a non-sinusoidal wave is permissible or desired such as in the generation of a wave that is rich in harmonic content. Where a single frequency wave is desired, oscillators whose frequency is determined by a tuned circuit are commonly used.

In the production of waves of low frequency the tuned circuit type of oscillator requires tuning or filter reactances of large magnitude, while the relaxation type of circuit as heretofore used produces impure or non-sinusoidal waves.

It is an object of the present invention to secure substantially sinusoidal waves by means of an oscillation generator of the relaxation type, that is, one using resistance and capacity to determine the fundamental period.

This object is achieved in accordance with the present invention in its preferred form by use of two discharge tubes in tandem in the feedback loop for securing the necessary phase reversals and interstage circuits of substantially zero phase shift at the fundamental frequency. Also the interstage circuits have large shunt capacity which effectively suppresses harmonics and results in the production of relatively pure sinusoidal waves.

The invention will be more clearly understood from the following detailed description taken in conjunction with the drawing in which:

Figs. 1, 2 and 3 are schematic circuit diagrams of oscillation generator circuits according to the invention; and

Fig. 4 shows the phase-frequency characteristic of the interstage circuits.

Referring first to Fig. 1, the two space discharge devices 1 and 2 are connected in the general manner of the Abraham and Bloch relaxation oscillator with interstage coupling condensers 3 and 4 and plate and grid resistances 7, 8 and 12, 13. This circuit is, however, in accordance with the invention, provided with large condensers 5 and 6 connecting respectively the plates and the grids directly together. The load 10 may be coupled in any suitable manner and is indicated as coupled by transformer 9 to the

plate circuits. The plate voltage source is shown at 11.

Instead of using a single condenser 5 across the plates or a single condenser 6 across the grids it may be more convenient in some cases to use individual shunting condensers as shown in Fig. 2 at 15, 16, 17 and 18. The circuit of Fig. 2 also illustrates one use to which the oscillator has been put in practice. The problem was to supply a wave having a frequency of six cycles per second to the relaxation oscillator of a synthetic speech producing system of the type shown in Dudley Patent 2,121,142, June 21, 1938. The relaxation oscillator comprising tube 20 in the right-hand portion of Fig. 2 is the relaxation oscillator shown in Fig. 6 of the Dudley patent. The circuit, however, has been modified by the provision of key 22 which when depressed opens its upper contact and closes its lower contact, thus serially including in the grid circuit of the relaxation oscillator 20 the output terminals of the six-cycle wave generator comprising tubes 1 and 2. This six-cycle wave so modifies the output wave at 21, of the relaxation oscillator 20 as to produce a vibrato effect adding naturalness to the voice in certain cases. This use of the oscillator of the invention as shown in Fig. 2 is given for illustrative purposes only since the invention is capable of general application.

The principle of operation of the circuit of the invention may be more clearly understood from considering Figs. 3 and 4. Fig. 3 shows the oscillator portion of Fig. 2 redrawn to make the interstage circuits more apparent. It is seen that the plate circuit of tube 1 feeds into the grid circuit of tube 2 through an interstage network which consists of the series capacity 3 and a shunt arm on each side of this capacity consisting in each case of a condenser in parallel with the resistance. The interstage network, therefore, is of pi configuration. Since the circuit is entirely symmetrical the interstage network connecting the plate of tube 2 to the grid of tube 1 is of the same type and dimensions. It is understood that this would still be true if the condensers 15 and 16 of Fig. 3 were combined into one condenser 5 of Fig. 1. Likewise the condensers 17 and 18 of Fig. 3 may be combined into the one condenser 6 of Fig. 1.

Fig. 4 shows the phase-frequency characteristic of these two interstage circuits. Since the tubes 1 and 2 are in tandem in the feedback loop and since each tube gives a phase shift of 180 degrees, the two tubes together give the required 360 degrees or zero degree phase shift for pro-

ducing oscillations. This places a requirement of zero phase shift for each of the two interstage networks. Referring to Fig. 4, it is seen that each interstage network has a phase shift varying at extreme frequencies between plus 90 degrees and minus 90 degrees and this characteristic passes rather sharply through the zero phase shift point. This point has been marked  $f_0$  on the drawing to indicate that this is the frequency of oscillation of the circuit. The fact that the phase shift characteristic passes through the zero phase point rather steeply indicates that the circuit operates stably at the frequency corresponding to zero phase shift. This is found to be the case in practice.

Without the shunting condensers 5, 6 of Fig. 1 or 15, 16, 17, 18 of the other figures the wave form produced would approach rectangular. If the shunting condenser or condensers were omitted from only the plate side, the resulting wave would be rounded on one side, for example on the front let us say, but would still be angular on the opposite side. Omission of the shunting condenser or condensers on the grid side only would result in a wave rounded on its opposite side, for example the back, but angular on the front side. Inclusion of the shunting condensers across both the plates and the grids results in the production of a wave which is nearly sinusoidal in form. One reason for this appears to be that the presence of these shunting condensers results in the type of phase characteristic shown in Fig. 4 and that these large shunting capacities effectively shunt harmonic frequencies. In order for the circuit to have this type of phase characteristic the shunt capacity must have reactive impedance which at the frequency of oscillation is smaller than or at least as small as the shunt resistance. In one case used by applicant for generating a six-cycle wave, RCA-56 tubes were used. Referring to Fig. 1, the resistances 12 and 13 were each 125,000 ohms. Condensers 5 and 6 each had a capacity of .5 microfarad. Resistances 7 and 8 were each 27,000 ohms, making a total of 54,000 ohms of which 4,000 ohms were included between the output transformer taps, as illustrated in Fig. 2. Capacities 3 and 4 were each .17 microfarad. In this case it will be seen that the reactive impedance of each of the condensers 5 and 6 at the oscillation frequency was about 50,000 ohms, which is at least as small as or smaller than the resistances 7 and 8 or 12 and 13, respectively, paralleling them.

The invention is not to be construed as limited to the circuit details nor to the values that have been given but the scope is indicated in the claims which follow.

What is claimed is:

1. An oscillation generator comprising two space discharge tubes each having at least triode elements, crossed condensers from plates to grids of opposite tubes, resistive impedance paths from each grid to each cathode and from each plate to each cathode, said tubes, condensers and resistive impedance paths together forming an oscillation generating system, means for altering the wave form of the generated wave comprising a capacity connected between said grids which is large compared to the capacity of either of said crossed condensers and a load circuit for the generated oscillations symmetrically coupled to said discharge devices.

2. An oscillation generator comprising two space discharge tubes each having at least triode elements, crossed condensers from plates to

5 grids of opposite tubes, resistive impedance paths from each grid to each cathode and from each plate to each cathode, said tubes, condensers and resistive impedance paths together forming an oscillation generating system, means for altering the wave form of the generated wave comprising a capacity connected between said plates which is large compared to the capacity of either of said crossed condensers and a load circuit for the generated oscillations symmetrically coupled to said discharge devices.

3. A relaxation oscillator comprising two space discharge tubes having at least triode elements, crossed condensers from plates to grids of opposite tubes, a common connection for the cathodes of said tubes, a resistance between each grid and cathode, a resistance between each plate and cathode, and capacity connected from plate to plate whose reactive impedance at the frequency of oscillation is not greater than the order of magnitude of the sum of the resistance between each plate and cathode.

4. A relaxation oscillator comprising two space discharge tubes having at least triode elements, crossed condensers from plates to grids of opposite tubes, a common connection for the cathodes of said tubes, a resistance between each grid and cathode, a resistance between each plate and cathode, and capacity connected from grid to grid whose reactive impedance at the frequency of oscillation is less than the order of magnitude of the resistance measured from grid to grid.

5. A low frequency oscillation generator comprising two space discharge triodes each having input terminals and output terminals, said triodes being connected with the anode of each coupled to the grid of the other to form a closed path, and two interstage circuits for so connecting said triodes, each interstage circuit comprising only capacities and resistances including capacity in shunt across the input terminals and capacity in shunt across the output terminals of said triodes, said shunt capacities being sufficiently large in relation to the other elements of the interstage circuits to impart to the interstage circuits a phase shift characteristic varying with frequency and passing through the value zero at the frequency of oscillation.

6. A two-stage oscillation generator, each stage having its output coupled to the input of the other stage, each stage including a space discharge device having an anode, a cathode and a grid, each device having substantially 180 degrees phase shift and two interstage circuits for coupling each stage to the other, each interstage circuit having a series branch extending from the plate of one device to the grid of the next device and a shunt branch extending from a point in the series branch to a cathode of the respective device, each such interstage circuit comprising capacity in its series branch and parallel resistance-capacity elements in its shunt branch, the magnitude of the capacity in the shunt branch of each interstage circuit being sufficiently large in relation to the other elements of the respective interstage circuit to cause each such interstage circuit to have zero phase shift at the frequency of oscillation and to exhibit reversal of phase in going through the frequency of oscillation.

7. A relaxation oscillator comprising two space discharge tubes having at least triode elements, crossed condensers from plates to grids of opposite tubes, a common connection for the cathodes of said tubes, a resistance between each grid and

cathode, a resistance between each plate and cathode, and a capacity connected from each plate to cathode at least as large as the order of magnitude of the capacity of one of said crossed condensers.

8. A relaxation oscillator comprising two space discharge tubes having at least triode elements, crossed condensers from plates to grids of opposite tubes, a common connection for the cathodes of said tubes, a resistance between each grid and cathode, a resistance between each plate and cathode, and a capacity connected from each grid to cathode at least as large as the order of magnitude of the capacity of one of said crossed condensers.

9. A relaxation oscillator comprising two space discharge tubes having at least triode elements, crossed condensers from plates to grids of opposite tubes, a common connection for the cathodes of said tubes, resistive impedance from each grid to cathode and from each plate to cathode, said tubes, condensers and resistive impedances constituting a circuit for generating waves rich in harmonics, and means for suppressing the har-

monics and giving a substantially sine wave output comprising capacities in shunt relation to the grid-cathode and plate-cathode circuits of said tubes, said capacities being as large as the order of magnitude of said crossed condensers.

10. A low frequency oscillation generator comprising two space discharge triodes each having input and output terminals, said triodes connected with the anode of each coupled to the grid of the other to form a closed path, and two interstage circuits for so connecting said triodes, each interstage circuit comprising only capacities and resistances and comprising in particular series capacity between the anode of one triode and the grid of the other and resistances in shunt across the output terminals of said one device and across the input terminals of the other together with capacity shunted across each of said resistances, each of magnitude large enough in relation to the resistance which it shunts to cause the phase shift characteristic of the respective interstage circuit to pass through the zero phase at the frequency of oscillation.

RALPH L. MILLER.