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OSCILLATION GENERATOR

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Fig. 1.

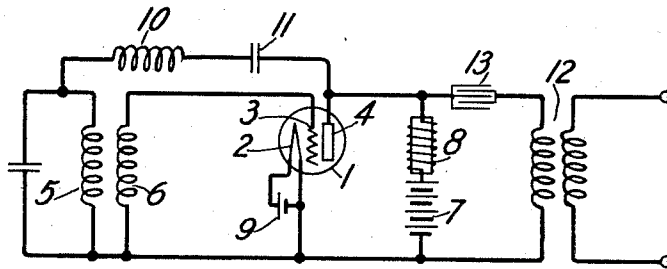
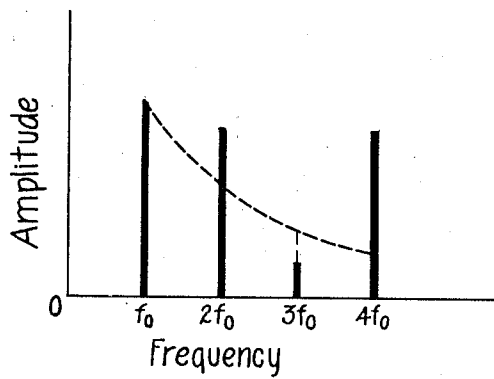


Fig. 2



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UNITED STATES PATENT OFFICE.

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OSCILLATION GENERATOR.

Application filed January 27, 1926. Serial No. 84,056.

This invention relates to oscillating circuits and more particularly to circuits including a space discharge oscillator adapted to generate a plurality of harmonically related frequencies.

An object of the invention is to increase the intensity of certain of the harmonic waves, naturally present in an oscillation circuit using a space discharge oscillator, to values substantially equal to the intensity of the fundamental wave.

Another object is to provide a simple space discharge oscillator circuit, adapted to generate a plurality of waves harmonically related and of substantially equal intensities.

In one form of the invention the circuit of a space discharge oscillator, of any well known type, is modified to create a resonant shunt path between the anode and the cathode of the oscillator whereby a low resistance circuit is provided for waves of a selected harmonic frequency. In addition the selected harmonic waves may be re-impressed upon the grid of the oscillator, the result being that a large current of the frequency of the selected harmonic is caused to flow in the space path of the oscillator, in which it combines with the fundamental wave to produce two other waves, of the summation and difference frequencies. The useful output consists of the fundamental wave and the two waves produced by modulation, the selected harmonic wave being largely suppressed in the load circuit by the resonant shunt between the anode and the cathode of the tube.

The general method of the invention is to amplify selectively at least one harmonic of the fundamental wave generated by an oscillator and to impress the selected wave upon the oscillating device in such manner that it modulates the fundamental wave.

The invention will be described in detail in connection with one particular embodiment, but it is to be understood that it is not limited to the specific form disclosed, but only in accordance with the appended claims.

Of the drawings, which form part of the detailed description, Fig. 1 represents an oscillating system in which the invention is embodied, and Fig. 2 is a diagram illustrative of the operation of the invention.

The system of Fig. 1 is essentially a space discharge oscillator of the tuned anode cir-

cuit type, having the special feature of a multiple tuned anode circuit. Space discharge tube 1, having a cathode, a control electrode, and an anode, designated respectively by 2, 3 and 4, is energized by battery 7, which furnishes the space current through choke coil 8, and by battery 9, which heats the filamentary cathode. The anode circuit comprises inductance 10 and capacity 11 in series and in series with anti-resonant circuit 5, the inductive element of which is coupled to an inductive winding 6 in the control electrode circuit of the discharge tube.

A transformer 12 is connected to the anode and cathode of the discharge tube whereby the waves generated in the system may be transmitted to a load circuit, either directly or through an intermediate amplifier. A capacity 13 in series with the primary winding of the transformer prevents the short circuiting of the space current source.

The coupling between anti-resonant circuit 5 and the grid circuit of the discharge tube causes the system to generate oscillations at the resonance frequency of circuit 5. On account of the non-linear properties of the discharge tube these oscillations include not only the fundamental frequency, but also a series of harmonically related frequencies; the waves of the harmonic frequencies, however, being of much smaller energy than the fundamental wave.

The circuit is arranged to increase selectively the energy of the second and the fourth harmonic waves. For this purpose the anode circuit is proportioned to resonate as a whole at the frequency of the intermediate harmonic, namely the third. The third harmonic current in the space path, which results from the non-linear properties of the tube while oscillating at the frequency determined by the resonance frequency of circuit 5, is accentuated by the feedback coupling between circuit 5 and the grid circuit.

The large third harmonic current produces little or no energy in the load circuit, since the tuned anode circuit is a zero impedance shunt to the load circuit at that frequency. By modulation with the fundamental wave, however, the third harmonic produces strong waves of the second and fourth harmonic frequencies which are efficiently transmitted to the load circuit.

A feature of the method of operation is

that self-oscillation is confined to the single frequency of the fundamental, the possibility of singing at the third harmonic being prevented by the virtual short circuiting of the anode circuit. One advantage of this feature is that the output waves from the system are kept in a true harmonic relation, which would be difficult to maintain if the wave, with which the fundamental is modulated, were produced by self-oscillation.

Fig. 2 shows diagrammatically the composition of the output waves from the system of Fig. 1. The ordinates of the chart represent amplitude and the abscissæ frequencies. The heavy vertical lines indicate the amplitudes of the various harmonics up to the fourth actually produced by the system, while the dotted line indicates the amplitudes of the harmonics usually present in a tuned anode circuit oscillator of the ordinary type. It is found that the second and fourth harmonics can be increased in amplitude nearly to that of the fundamental wave, the third harmonic as already described being largely suppressed.

By selecting a different harmonic than the third other combinations of waves in the output can be obtained, for example first, third, and fifth harmonics. Or again, by adding a second resonant circuit in parallel with inductance 10 and capacity 11, the anode circuit may be made resonant to both the third and the seventh harmonics in which case augmented waves of the second, fourth, sixth and eighth harmonic frequencies would be obtained.

What is claimed is:

1. A system for generating simultaneously waves of a plurality of harmonically related frequencies, comprising a space discharge device having a cathode, an anode, and a control electrode, paths connecting said cathode to said control electrode and said anode respectively, a parallel resonant circuit in the path between said cathode and said anode having impedance mutual to both of said paths, whereby oscillations are produced at a frequency determined by said resonant circuit, and additional impedances associated with said tuned circuit, said impedances being so proportioned that the path between said anode and said cathode has substantially zero impedance at a harmonic frequency of the generated oscillations.

2. An oscillating circuit comprising a space discharge device having a discharge path and a control electrode, a circuit including in series said discharge path and a network of reactive impedances, the elements of said network being proportioned to make the network anti-resonant at a pre-assigned frequency and resonant at a harmonic of said frequency, and impedance means for coupling said network and said

control electrode, whereby the discharge device is caused to generate oscillations of said preassigned frequency.

3. Means for generating waves of a plurality of harmonically related frequencies, said means comprising an oscillating circuit, a three-electrode space discharge device having input and output electrodes, means associating said circuit with said input and output electrodes to produce self sustained oscillating currents, said oscillating circuit including a path between the output electrodes of said device which is of substantially zero impedance at a frequency harmonically related to the frequency of the self sustained oscillations, said device being so controlled that the waves transferred from said oscillating circuit to said input electrodes through said associating means are combined by said device.

4. Means for generating waves of a plurality of harmonically related frequencies comprising a space discharge oscillator, including a space discharge path and a control circuit, having included in series with the space discharge path a reactive network, and in the control circuit an element coupled with said network, said network being anti-resonant at the frequency of the fundamental oscillations, and resonant at a harmonic frequency thereof, whereby the intensity of the harmonic frequency current in the discharge path is greatly increased and whereby additional harmonic waves are generated by the intermodulation of the fundamental wave and the augmented harmonic.

5. A system for generating simultaneously waves of a plurality of harmonically related frequencies, comprising a non-linear electric discharge translating device having input electrodes and output electrodes, and feed back means between said output electrodes and said input electrodes, said means including resonant means whereby the feedback potential corresponding to a certain frequency is increased so as to cause the device to generate sustained oscillations at such frequency, and said feeding means also including resonant means whereby a sufficient potential of a harmonic frequency is fed back to said input electrodes to cause said device to regeneratively amplify currents of such harmonic frequency but insufficient to cause the device to produce self-sustained oscillations at such harmonic frequency.

6. The method of accentuating certain harmonics in the wave generated by a distorting oscillator, using an electric discharge device having input and output electrodes and a feed-back circuit, which comprises causing the oscillator to generate oscillations having a fundamental frequency and harmonic frequencies, feeding back from the

output electrodes to the input electrodes a potential corresponding to a certain harmonic of said fundamental frequency in such a manner as not to produce sustained oscillations at said harmonic frequency and combining said fed-back harmonic with said fundamental in said device to produce combination waves whose frequencies are coincident with the frequencies of certain other harmonics of said fundamental resulting from the normal operation of the oscillator, and utilizing the waves corresponding to the last mentioned harmonics accentuated by the super-position of said combination waves of the same frequency.

In witness whereof, I hereunto subscribe my name this 25th day of January, A. D. 1926.

FRANCIS X. RETTENMEYER.