

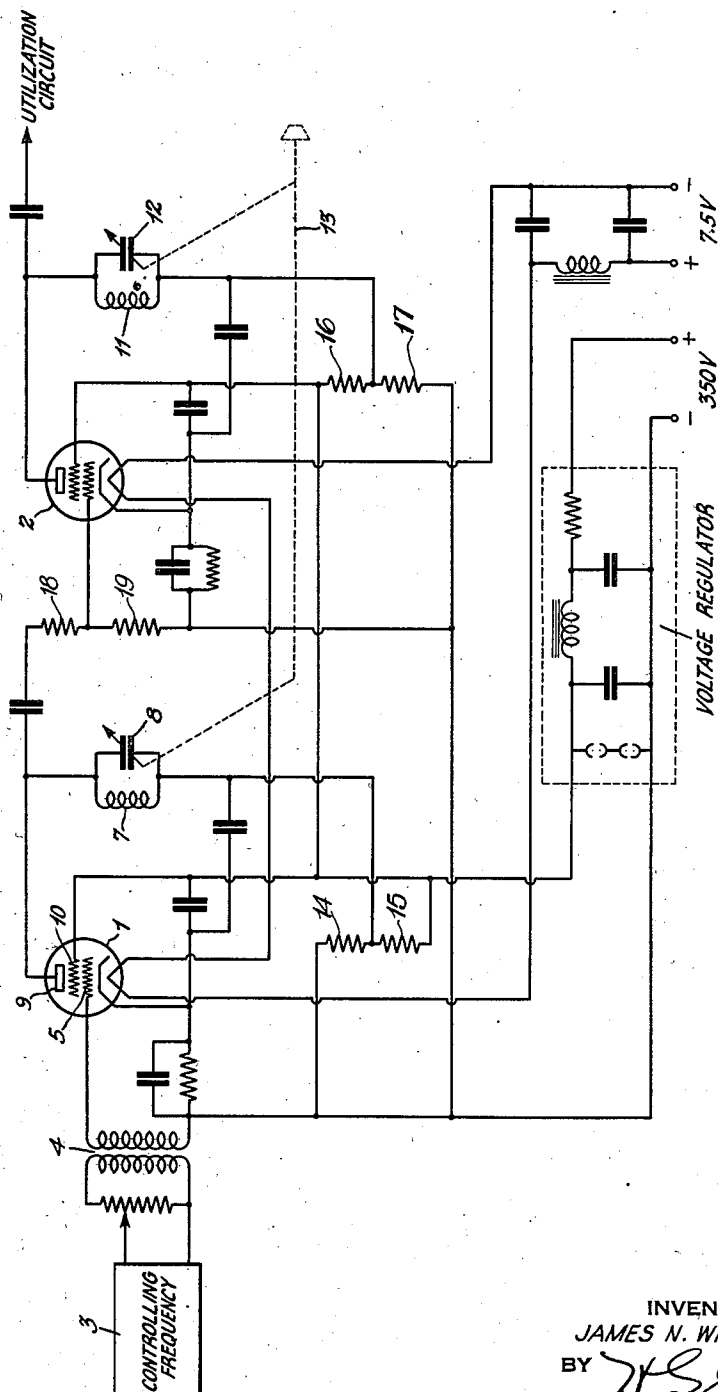
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DYNATRON OSCILLATOR CIRCUIT

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DYNATRON OSCILLATOR CIRCUIT

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This invention relates to electron discharge device oscillator circuits which are adapted to generate energy at frequencies which bear predetermined relationships with respect to the frequency of the applied energy.

An object of the present invention is to provide a simplified and highly efficient oscillator circuit arrangement for generating a substantially pure sinusoidal wave free from distortion.

Another object is to provide such an arrangement whereby there may be obtained with a high degree of accuracy any desired multiple or sub-multiple of a predetermined frequency.

Heretofore in the communication field, there have been used for the generation of harmonic frequencies, both audible and inaudible, such apparatus as multivibrators, Gulstad relays, and over-loaded vacuum tubes. These frequency generators have been found to be highly unstable, and are known to produce waves which are so distorted as to be incapable of use in many circuit arrangements without the employment of additional apparatus, a matter which usually increases the cost of the system and involves the use of unnecessarily complicated circuits. A further disadvantage of these latter arrangements is the difficulty of obtaining satisfactory control of the system at the remote harmonics or sub-harmonics of the fundamental frequency.

The foregoing disadvantages, however, are overcome in accordance with the present invention which provides a simple and highly stable dynatron oscillator system capable of generating substantially pure sinusoidal waves of any desired harmonic or sub-harmonic of the fundamental frequency. By means of the present invention there is obtained a dynatron oscillator which is very desirable, not only from the standpoint of accuracy, dependability, maintenance and cost of construction, but also for the ease with which the different frequencies may be selected.

The accompanying drawing is a preferred embodiment of the invention and is given merely by way of example to illustrate the principles of the invention. Referring to this drawing in more detail, there are shown a plurality of dynatron oscillator circuits in cascade comprising screen grid electron discharge devices 1 and 2 with which there is associated in the input circuit a control or fundamental frequency apparatus 3 having any desired high or low frequency, and to the output circuit of which there may be coupled any desired utilization means, such as an amplifier.

Control frequency apparatus 3 may comprise a tuning fork oscillator or any other suitable means and is coupled by means of transformer 4 to the grid 5 of the tube 1, negative bias for which may be applied in any desired manner. The anode 9 of tube 1 is connected to the high potential side of a tunable, parallel connected, resonant tank circuit comprising an inductance 7 and a variable condenser 8. The screen grid 10 of the tube is arranged to have a higher positive potential than the anode with respect to the cathode.

Coupled to the anode circuit of tube 1 in cascade relationship is the grid of screen grid tube 2 whose elements are arranged in a manner identical with tube 1. A similar tunable output tank circuit 11, 12 is provided for this tube. Both dynatron oscillators 1 and 2 are designed to operate over a region where the anode resistance is negative, the individual output circuits thereof being made to oscillate by utilizing this negative anode resistance.

Separate voltage dividers 14, 15 and 16, 17 are used to supply the proper voltage to the respective anodes of each dynatron oscillator. This construction prevents interaction between tubes 1 and 2 and provides the desired optimum voltage for each oscillator stage.

Similarly, since the tubes function most efficiently as sub-harmonic producers with a low bias, a voltage dividing arrangement 18, 19 may be used to reduce the controlling voltage.

In the operation of the system, the arrangement may be used either as a frequency multiplier or as a so-called frequency divider or sub-harmonic producer, the frequency which is higher or lower than the fundamental controlling frequency being obtained by varying condensers 8 and 12 which change the resonance of the tunable oscillator tank circuits. The frequencies obtainable in each of these tank circuits may be any simple fraction of the controlling frequency.

Although in practice only one dynatron screen grid tube may be used, it has been found desirable in order to obtain perfect control over a rather wide range of variations to use two stages, as shown, both oscillating at the same frequency. This is so because the voltages and various circuit constants required for perfect frequency control at remote sub-harmonics do not lend themselves readily to the production of a desired sine wave output, and for this reason one stage, such as tube 1, may be used for such a purpose as dividing or multiplying the frequency, and the

other stage, tube 2, for producing the necessary sine wave output. Accordingly, both stages may be tuned to oscillate at the desired output frequency, the first being stabilized by the controlling frequency and the second stage being stabilized by the first. Since it is very easy to stabilize one of the circuits by feeding into it, at a very low amplitude, energy of a frequency very close to its output frequency, the tank circuit 11, 12 in the last oscillator is arranged to have a low L—C ratio. In the system just described, the variable condensers 8 and 12 are shown arranged for unicontrol operation, both condensers being operated from a common shaft 13 as indicated in the drawing.

In order to obtain frequencies close together it has been found to be advantageous to have one of the stages, such as oscillator 1, act as a multiplier, while the other stage, that is, tube 2, acts as a divider. In this manner there is available twice as many frequencies, by first multiplying and then dividing, than can be obtained by simply dividing the controlling or fundamental frequency. For example, if the fixed frequency of the controlling apparatus 3 is 810 cycles, then the second, third, fourth and fifth, etc. sub-harmonics will be 405, 270, 202.5 and 162, etc. cycles, respectively, and these are the only sub-harmonic frequencies at which good control can be obtained. However, if it is desired to obtain frequencies between the above-mentioned frequencies the fundamental frequency of 810 cycles may be multiplied by tuning the output circuit of stage 1 to 1620 cycles, and energy of the latter frequency fed into oscillator circuit 2 from whose output circuit 11, 12 there may then be obtained the second, third, fourth, fifth, sixth, seventh, eighth, and ninth, etc. sub-harmonics of the impressed 1620 cycles which will be 810, 540, 405, 324, 270, 231.4, 202.5, 180, etc., respectively. In this latter arrangement, of course, it will not be desired to use unicontrol means between condensers 8 and 12, although such manner of control may be useful between condenser 12 and the output circuit of a succeeding stage.

By exercising great care in adjusting the resonant circuits and plate voltages in the present invention it has been found that any desired remote harmonic or sub-harmonic of the control frequency may be obtained with no difficulty whatsoever. In a particular embodiment used no difficulty was experienced in obtaining frequencies down to 30 cycles and even lower from an 810 or 1620 cycle frequency control.

Although the system of the present invention has been described hereinabove in connection with audible frequencies, it should be distinctly understood that it is not limited thereto since the principles may be applied equally as well to high radio frequencies well above the audible range.

The present invention has been found to be especially useful for generating a tone which may act as a carrier on a line for facsimile or other high frequency keying systems where both the keying frequency and the line tone are synchronized by a common frequency standard, although it will be evident that it may be utilized in various other organizations wherever there is need for any oscillator circuit.

I claim:

1. A harmonic generator comprising a first dynatron oscillator circuit and a second dynatron oscillator circuit, each of said dynatron circuits

comprising an electron discharge device having anode, cathode, screen grid and control electrodes, means for applying to the anode, cathode and screen grid of each of said devices potentials of such values that each device has a negative resistance between its cathode and anode, an input circuit connected between the control electrode and cathode and providing a source of controlling frequency for said first device, an output circuit coupled to the anode of each device comprising a resonant tank circuit, each tank circuit comprising a reactor of such value that its associated output circuit is tuned to a frequency different from said controlling frequency and such that the quotient of the larger of the two frequencies divided by the smaller of the two frequencies is an integer, and means for coupling the output circuit of the first device to the control electrode of the second device.

2. A harmonic generator comprising a first dynatron oscillator circuit and a second dynatron oscillator circuit, each of said dynatron circuits comprising an electron discharge device having anode, cathode, screen grid and control grid electrodes, means for applying to the anode, cathode and screen grid of each of said devices potentials of such values that each device has a negative resistance between its cathode and anode, the potentials applied to said screen grids having higher positive values than those applied to their associated anodes, an input circuit connected between the control electrode and cathode and providing a source of controlling frequency for said first device, an output circuit coupled to the anode of each device comprising a resonant tank circuit, each tank circuit comprising a reactor of such value that its associated output circuit is tuned to a frequency different from said controlling frequency and such that the quotient of the larger of the two frequencies divided by the smaller of the two frequencies is an integer, and means for coupling the output circuit of the first device to the control grid of the second device.

3. A harmonic generator comprising a first dynatron oscillator circuit and a second dynatron oscillator circuit, each of said dynatron circuits comprising an electron discharge device having anode, cathode, screen grid and control electrodes, means for applying to the anode, cathode and screen grid of each of said devices potentials of such values that each device has a negative resistance between its cathode and anode, an input circuit connected between the control electrode and cathode and providing a source of controlling frequency for said first device, an output circuit coupled to the anode of each device, means whereby the output circuit of said first electron discharge device is tuned to a multiple of the controlling frequency, means for coupling the output circuit of the first electron discharge device to the control electrode of the second electron discharge device, means whereby the output circuit of said second electron discharge device is tuned to a sub-multiple of the frequency impressed on said device by said first device, and circuit connections utilizing the energy from said last output circuit.

4. A harmonic generator comprising a first dynatron oscillator circuit and a second dynatron oscillator circuit, each of said dynatron circuits comprising an electron discharge device having anode, cathode, screen grid and control electrodes, means for applying to the anode, cathode and screen grid of each of said devices potentials

of such values that each device has a negative resistance between its cathode and anode, an input circuit connected between the control electrode and cathode and providing a source of
5 controlling frequency for said first device, an output circuit coupled to the anode of each device, means for coupling the output circuit of the first electron discharge device to the control electrode of the second electron discharge device,
10 means whereby the output circuit of said first device is tuned to a sub-multiple of the controlling frequency, means whereby the output circuit of said second device is tuned to a multiple of the frequency impressed on said device,
15 and circuit connections for utilizing the energy from said last output circuit.

5. High frequency apparatus having, in combination, a multi-electrode electron discharge device dynatron oscillator comprising a cathode,
20 anode, control electrode and auxiliary electrode, a source of controlling frequency coupled to said control electrode for impressing thereon a voltage

of a predetermined frequency, means for maintaining said control electrode at a potential which is relatively negative with respect to the cathode thereof, means for maintaining said
5 auxiliary electrode at a positive potential higher than said anode, a parallel tuned circuit comprising an inductance and a variable condenser in circuit with the anode of said oscillator, another similar multi-electrode electron discharge
10 device dynatron oscillator whose control grid is coupled to the anode of said first device, said parallel tuned circuit of said first device being tuned to a frequency which is different from the predetermined frequency of said source of controlling frequency and such that the quotient of
15 the larger of the two frequencies divided by the smaller of the two frequencies is an integer, and said parallel tuned circuit of said second device being tuned to a frequency which bears a harmonic relationship to the frequency of said last
20 parallel tuned circuit.

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