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SUBHARMONIC GENERATOR

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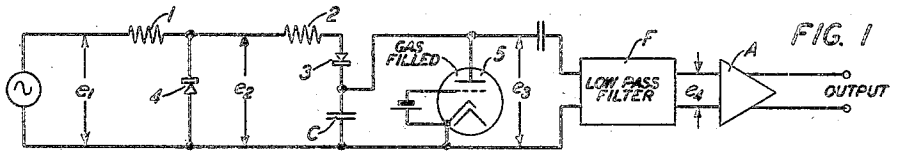

FIG. 1

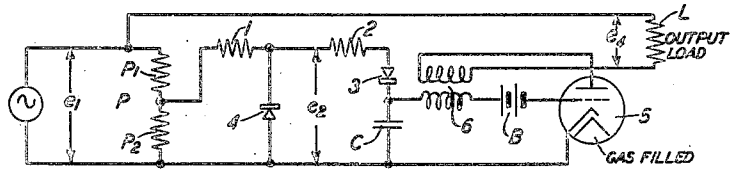

FIG. 2

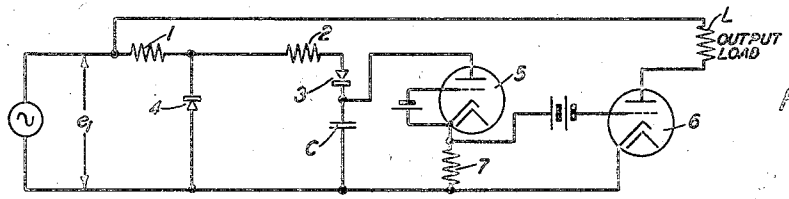

FIG. 3

FIG. 1a

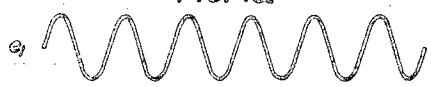

FIG. 1b

FIG. 1c

FIG. 1d

FIG. 2a

FIG. 2b

FIG. 2c

FIG. 2d

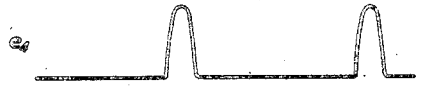

FIG. 2e

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SUBHARMONIC GENERATOR

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4 Claims. (Cl. 172—281)

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This invention relates to a frequency changer wherein alternating current of one frequency is converted to current of a lower or subharmonic frequency and more specifically to a simple, compact and light-weight converter for obtaining 20 cycles or other low frequency from a primary alternating current source, for example 60 cycles, for use as a ringing current supply in telephone systems, for transmitting signals to actuate bells, relays, switchboard drops or other devices and under certain conditions, a simple compact and light-weight generator for the purpose is desirable.

The present invention relates to such a device for use where an alternating current source of power is available, for example 110 volts 60 cycles, which device can by the proper choice of circuit elements be caused to deliver alternating current of 20 cycles or other low frequency which represents a subharmonic of the frequency of the supply source.

The invention will be understood from the following description when read in connection with the accompanying drawings:

Fig. 1 of which represents in schematic form the fundamental concept of a so-called ringing current generator, as above referred to, employing a single gas-filled discharge tube, in which amplification is employed to obtain the desired output power, Figs. 1*a*, 1*b*, 1*c* and 1*d* represent changes in frequency and voltage in the supply source between the input and output circuits of the device.

Fig. 2 represents a modified arrangement whereby output power is obtained without amplification, Figs. 2*a*, 2*b*, 2*c* and 2*d*, the voltage and frequency changes occurring in this arrangement, and

Fig. 3 represents a still further modification employing two gas-filled discharge devices.

Referring to Fig. 1, alternating current power of voltage e_1 for example 60 cycle 110 volts, is supplied to a condenser C in series with a pair of resistances 1, 2, and a rectifying varistor 3 of the copper oxide or selenium type. A second varistor 4 is connected in parallel to resistance 2, first resistor 3, and condenser C and in an opposite conducting direction to varistor 3.

During the positive half of each cycle of the supply current, condenser C will be charged and a voltage built up thereon at a rate inversely proportional to the product of the capacity and the total series resistance. The voltage across the condenser C will therefore build up in steps from successive half cycles as shown in Fig. 1c.

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The purpose of varistor 4 is to effectively cut off the negative half cycles, as shown in Fig. 1*b* and thus prevent reduction of voltage across condenser C during the negative half cycles of the input or supply source.

The anode and cathode of a gas-filled discharge tube 5 are connected across condenser C and when its voltage reaches a valve which will overcome a predetermined negative bias on the control electrode of the tube, a discharge will occur, thus decreasing the tube resistance and quickly discharging condenser C to the sustaining voltage across the tube whereupon the discharge ceases and the tube resistance increases to its initial high value following which the voltage step-build-up on the condenser is repeated as shown in Fig. 1*c*.

The voltage wave across the tube 5, having a peak voltage e_3 as shown at 6, Fig. 1*c*, represents a subharmonic of the supply frequency and in the present case, where the peak voltage and tube breakdown occurs during the third step of the condenser build-up, the frequency of the voltage wave is the third subharmonic of the supply source.

A low-pass filter F in the output circuit connected across the tube serves the purpose of removing higher harmonics and the resulting output wave is represented by Fig. 1*d*. An amplifier A can be included in the output of the filter to obtain the desired power.

Referring to Fig. 2 which shows a modified arrangement for obtaining a desired subharmonic of a supply frequency, which arrangement delivers power without further amplification, comprises a condenser C charged step-by-step from a source of voltage e_1 in the manner described for Fig. 1. The cathode and control electrodes of the gas-filled tube 5 are connected across the condenser C in series with a source of negative grid bias potential B and the secondary winding of a transformer 6, and the anode and cathode of the tube are connected in series with load L and the primary winding of transformer 6 across the supply source. When the potential builds up on condenser C to a voltage sufficient to overcome the negative bias on the control electrode of the tube, the tube breaks down and the resulting plate current from the positive half cycle of the supply source flows in the load L in series with the primary winding of transformer 6 which is connected in such a direction that as soon as a discharge takes place, a series of rapidly decaying oscillations occur in the grid-cathode circuit of the tube as shown in Fig. 2*c* which soon reduces the condenser charge below the voltage

necessary to re-fire the tube when the main discharge ceases at the end of the positive half cycle. The output voltage wave e_4 having peaks of E_4 amplitude, are shown in Fig. 2*d*. An analysis of the wave of Fig. 2*d* by Fourier's series shows that the fundamental component has a frequency one-third that of the power supply and a peak voltage amplitude of $E=0.122E_4$, as shown in Fig. 2*e*. Condenser C is charged in steps as before and discharges through tube 5 in series with a relatively high resistance 7. The drop across this resistance, when tube 5 discharges, fires tube 6 from the positive half wave of the supply source, the discharge current of this tube being applied to the load L.

The present invention discloses a simple and compact arrangement for obtaining any subharmonic of a primary source of alternating current power, it being noted that production of a desired *n*th subharmonic requires uniform condenser charging increments or steps in number equal to *n*—1 where the tube breakdown and discharge occurs in the early part of the *n*th step.

The outstanding advantages of this method of subharmonic generation for telephone ringing or other similar purposes, as described in the foregoing, are (1) low weight, (2) small space, (3) freedom from mechanical movement and elimination of vibrating contacts, and (4) ability to quickly change from one subharmonic to another if found desirable.

What is claimed is:

1. In a frequency reducer for generating a wave which is a desired subharmonic of a base frequency supply, the combination with a source of alternating current of predetermined frequency, a condenser, means for charging said condenser by uniform voltage increment from said supply source, a gas-filled discharge tube having an anode, a cathode and a control electrode, a load circuit including said source, anode and cathode, a control circuit for said tube including said condenser, cathode and control electrodes, means in said control circuit for maintaining said tube in a non-conducting condition until a predetermined number of charging increments have been applied to said condenser, whereupon said tube becomes conducting and a wave is produced in said output circuit having a frequency equal to that of the supply source frequency divided by the number of charging increments applied to the condenser, and other cooperating means in said control and output circuits, for causing rapidly decaying oscillations in said control circuit in response to conduction of said tube, to decease the charge on said condenser.

2. In a frequency reducer for generating a wave which is a desired subharmonic of a base frequency supply, the combination with a source of alternating current of predetermined frequency, a condenser, means for charging said condenser by uniform voltage increments from said supply source, a gas-filled tube having an anode, a cathode and a control electrode, a load circuit including said source, anode, cathode and the primary winding of a transformer, a control circuit for said source including said condenser, a secondary winding of said transformer, a source of bias potential, said cathode and said control electrode, said bias potential being of such a value and polarity direction that said tube is maintained in a non-conducting condition until a predetermined number of charging increments had been applied to said condenser, whereupon said tube conducts and a wave is produced in said output circuit having a frequency equal to that of the frequency of the supply source, divided by the number of charging increments supplied to the condenser, said transformer windings being so connected that said output wave causes rapidly decaying oscillations in said control circuit to decrease the charge on said condenser.

3. In a frequency reducer for providing an alternating current which is a submultiple of the frequency of a supply source, a source of predetermined frequency alternating current, a condenser, means for progressively charging said condenser in uniform voltage increments from said source, a gas-filled discharge tube connected to said condenser and arranged to conduct at a predetermined voltage charge thereon, an output circuit for said tube including said source, and means responsive to current flow in said output circuit for reducing the charge on said condenser.

4. In a subcycle generator, a source of alternating current of predetermined frequency, a condenser, means for progressively charging said condenser in uniform voltage steps from said source, a gas-filled tube having an output circuit including said source, a control circuit for said tube including said condenser arranged to cause said tube to conduct at a predetermined voltage charge on said condenser, and cooperating means in said output and control circuit responsive to current flowing in said output circuit to cause a reduction of the charge on said condenser.

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No references cited.