Oct. 22, 1946. W. W. FRITSCHI 2,409,620

OSCILLATION GENERATOR

Filed Jan. 17, 1942

FIG. 1

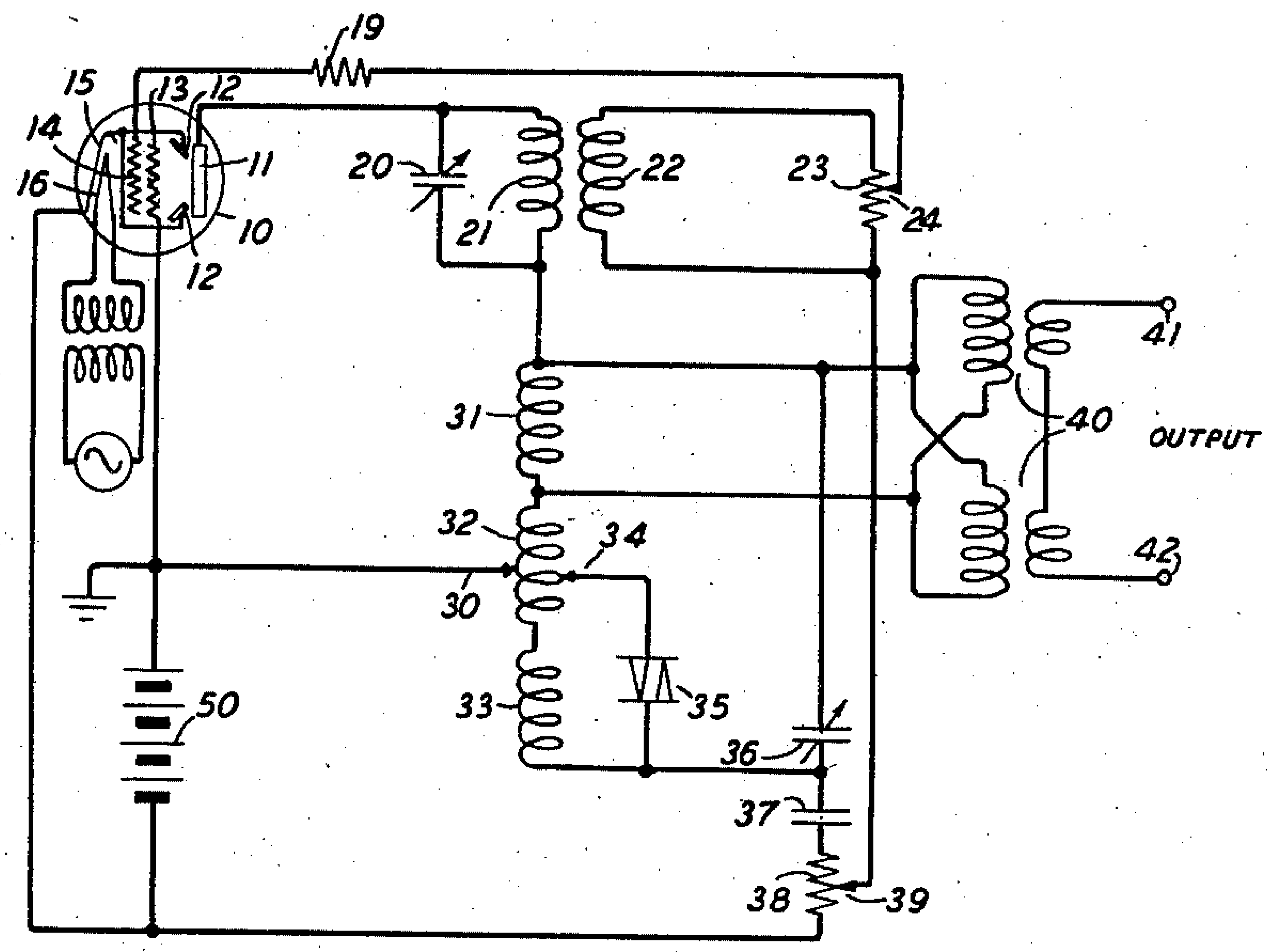


FIG. 2

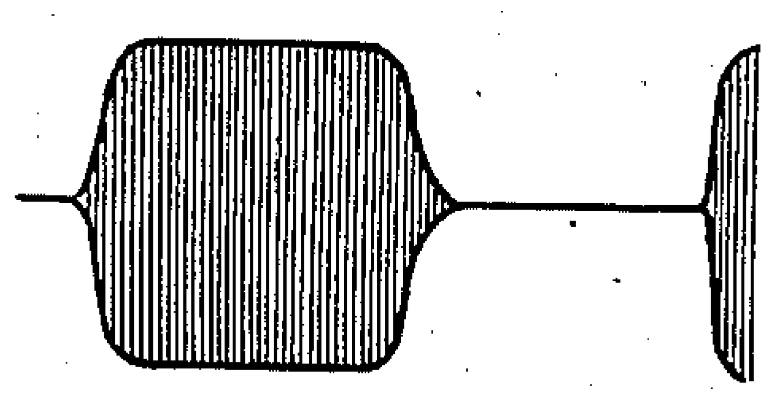
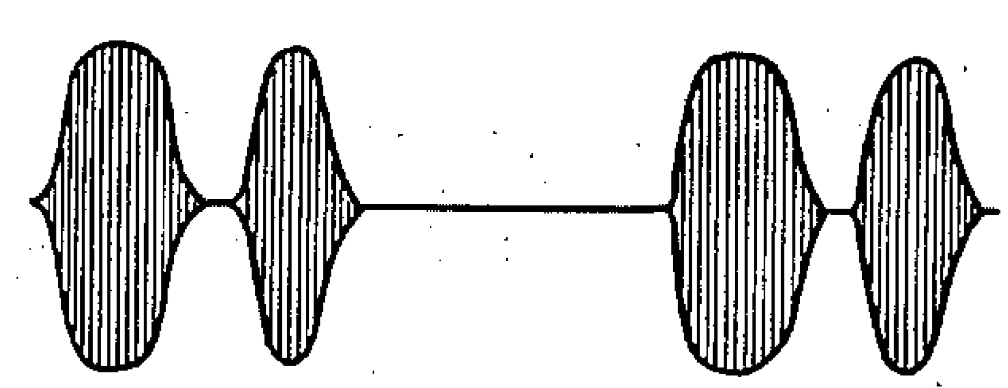


FIG. 3



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OSCILLATION GENERATOR

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7 Claims. (Cl. 250—36)

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This invention relates to oscillators and particularly to vacuum tube oscillation generators of the feedback type.

The invention has for its object the provision of a simple, single vacuum tube oscillator adapted to supply signaling current of a desired frequency interrupted at a desired rate, and the production of sufficient output power in such an oscillator with the amplitude ratios desired and with satisfactory limits of voltage and frequency variation under variable load conditions.

This invention is an oscillator comprising a single vacuum tube arranged to produce oscillations of a desired signaling frequency and to interrupt the signaling frequency at a desired rate. A feature of the invention is a single vacuum tube oscillator designed to simultaneously produce oscillations at the signaling frequency and at the rate of interruption desired, the ratio between the amplitudes of the two frequencies being adjusted so that the feedback of the lower frequency alternately drives the grid potential into a range wherein the amplification is insufficient to sustain oscillation at the higher frequency and into a range wherein oscillation at the higher frequency is sustained. Oscillation at the lower frequency is sustained by the inertia of its tuned circuit and the higher, signaling frequency is thereby effectively interrupted at the rate of the lower frequency of oscillation.

Other features of the invention are the provision of volume limiting means in such an oscillator and the provision of a shunt, having a negative impedance-voltage coefficient, across the network which is tuned to the signaling frequency to obtain a more constant amplitude of the signaling frequency.

A clear and complete understanding of the invention will be facilitated by a description of the oscillator illustrated schematically in the drawing, in which oscillator the invention and its various features are embodied. The invention is not limited to the specific arrangement shown, various modifications being possible within the scope of the invention.

Referring to the drawing which consists of three figures,

Fig. 1 shows an oscillation generator comprising a single vacuum tube 10 arranged to generate oscillations of a desired signaling frequency and to generate oscillations of a desired interrupting frequency at which the oscillations of the signaling frequency are interrupted;

Fig. 2 shows an oscillogram of the output of the oscillator shown in Fig. 1; this envelope shape

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is obtained when the oscillator is designed to satisfactorily regulate the amplitude of the voltage of the signaling frequency; and

Fig. 3 shows the envelope shape when insufficient voltage regulation is provided.

The oscillator shown in Fig. 1 of the drawing comprises a vacuum tube 10, a feedback resistor 19, a variable condenser 20, an induction coil comprising windings 21 and 22, a potentiometer comprising resistor 23 and brush 24, an induction coil comprising windings 31, 32 and 33, impedance element 35, condensers 36 and 37, a potentiometer comprising resistor 38 and brush 39, an output transformer 40, and output terminals 41 and 42. The tube 10 is of the screen grid high amplification type having a thermionic cathode 15, control grid 14, screen grid 13, anode 11, and a pair of electron beam confining plates 12, positioned between the anode 11 and screen grid 13. Reference may be had to the patent to O. H. Shade No. 2,107,520, granted February 8, 1938, for a detailed description of a tube of the preferred structure and character. The cathode 15 is indirectly heated by a heating element 16 in usual manner, and the beam deflecting plates 12 are electrically connected to the cathode. While the tube shown is of the beam type, a high amplification tube without beam deflecting plates may be used. The anode-cathode space current circuit is traced from anode 11 through winding 21 of one induction coil, through winding 31 and a part of winding 32 of the other induction coil, brush 30, and through battery 50 to the cathode 15. The condenser 36 is bridged across the windings 31, 32 and 33 to form a tuned network which is resonant to the desired signaling frequency, for instance 1000 cycles per second; and the variable condenser 20 is bridged across the winding 21 to form a tuned network which is resonant at the frequency at which it is desired that the signaling frequency be interrupted, for instance 15 cycles per second. Condenser 20 is variable to permit adjustment of its capacity to tune the condenser and winding 21 to the desired interrupting frequency. The control grid-cathode circuit is traced from grid 14 through resistor 19, to potentiometer brush 24, through resistor 23 in parallel with winding 22, thence to potentiometer brush 39, through resistor 38 to cathode 15. The control grid is not biased by a direct current source and both the signaling frequency and the interrupting frequency are fed back to the control grid, the amount of feedback being dependent upon the adjustment of brushes 24 and 39. The resistor 19 has a high resistance to limit the grid circuit.

The primary winding of output transformer 40 is bridged across the winding 31 and an impedance element 35 having a negative temperature-voltage coefficient, is bridged across the winding 33 and a part of the winding 32 as determined by the position of brush 34 to limit the amplitude of the oscillations of the signaling frequency. The element 35 may consist of silicon carbide of such dimension and character as to provide the desired range of impedance. By adjustment of brush 33 the portion of induction coil winding 32 which is included in the anode-cathode circuit may be varied and by adjustment of brush 34 the amount of inductance which is shunted by element 35 may be varied. The condenser 37, which is in series with potentiometer resistor 38, is effective to prevent direct current through the resistor.

Assume that the feedback potentiometers have been adjusted to obtain the desired feedback potentials and that the oscillator is placed in operation, for instance, by the closing of the battery connections. Immediately, both of the tuned circuits begin to build up oscillations at a very high rate, the initial impedance of element 35 being high. As the impedance of element 35 decreases, the feedback decreases until a point of stability is reached. Thereafter the element 35 tends to compensate for any changes which affect the amplitude of oscillation, for instance, changes in load, battery voltage and, within limits, the amplification provided by the tube. A similar impedance element may be connected across winding 21 to compensate for such changes in amplitude of the oscillations at the interrupting frequency. Although it is believed to be preferable to operate the oscillator with zero grid bias, as shown in the drawing, satisfactory operation is obtained by providing a negative grid bias, in conventional manner. With zero grid bias, the signaling frequency is interrupted during the positive half cycle of the interrupting frequency; and with a negative grid bias, the signaling frequency is interrupted during the negative half-cycle of the interrupting frequency. When the grid bias is zero, there is current in the grid-cathode circuit during the positive half-cycle of the interrupting frequency; and, with a low enough ratio between the amplitudes of the signaling and interrupting frequencies, the drop in potential in resistor 19 is effective to substantially prevent variation in the grid potential due to the signaling frequency so that oscillation at the signaling frequency ceases. With zero grid bias, there is no grid current and no drop in potential in resistor 19 during the negative half-cycle of the interrupting frequency and the amplification of the tube is sufficient to maintain oscillation at the signaling frequency. If a source of negative grid bias is provided in the control grid-cathode circuit, the instantaneous potential of the grid varies under control of the feedback potentials; and in this case, there is no grid current and no drop in potential in resistor 19 except during excessive peaks in the sum of the instantaneous feedback potentials of both frequencies. With sufficient regulation provided by element 35, such excessive peaks will not occur or will not be sufficiently long in duration to suppress oscillation at the signaling frequency during positive half-cycles of the interrupting frequency; but, during the negative half-cycles, the grid potential is driven to and beyond the oscillation cut-off point by the energy stored in the circuit which is resonant at the interrupting frequency. When this stored energy is dissipated and the grid potential again builds up to and beyond the cut-off point, the signaling frequency reappears. Thus in either case, that is with zero grid bias or with a negative grid bias, the signaling frequency voltage is stopped and started at the interrupting frequency and substantially complete suppression of the signaling frequency is obtained during one half-cycle of the voltage of the interrupting frequency.

The oscillograms shown in Figs. 2 and 3 indicate that the envelope shape of the signaling frequency may be regulated by the character of the negative-impedance element 35, a satisfactory envelope being illustrated in Fig. 2 and an unsatisfactory envelope resulting from insufficient regulation on the part of element 35 being illustrated in Fig. 3. These two oscillograms illustrate the range of envelope shapes which it is possible to obtain through control of the amplitudes of the two frequencies of oscillation by the element 35 and the amount of attenuation in the feedback paths. There is, of course, a limit to this regulating action and the envelope shape shown in Fig. 3 illustrates a case where there is insufficient regulation and the signaling voltage is entirely eliminated when the grid potential decreases to or beyond the cut-off value.

The useful output voltage may be obtained by directly connecting the load to the terminals 41 and 42; or if greater output or better regulation is required, an intermediate amplifier may be provided. The effective length of each period of signaling frequency oscillation is slightly less than the length of the positive half cycle of the interrupting frequency due to a change in frequency during the build-up and decay of the signaling voltage. The effective duration of the signaling voltage is illustrated in Fig. 2.

The advantages of the above-described oscillator over known methods of generating a signaling voltage of desired frequency and periodically interrupting this voltage at a desired rate reside in its simplicity, its low initial cost, and the low cost of maintenance which results in part from the lack of moving parts.

What is claimed is:

1. A signaling current generator comprising a single thermionic tube, two tuned circuits in the anode-cathode circuit of said tube, one of said tuned circuits resonant at a desired signaling frequency, the other of said tuned circuits resonant at a desired lower frequency, feedback connections from said tuned circuits to the control grid of said tube, and means controlling the relative amplitude of the feedback from said tuned circuits to effect a periodic interruption of the oscillations of said signaling frequency at said lower frequency.

2. In an oscillation generator, a single vacuum tube, a network tuned to resonance at a desired signaling frequency, a network tuned to resonance at a desired lower frequency, said networks connected in the anode-cathode circuit of said tube, feedback connections from said networks to the control grid of said tube, means controlling the relative amplitude of the feedback from said networks to effect a periodic interruption of the oscillations of said signaling frequency at said lower frequency, output terminals, and means connecting said terminals to the network tuned to the signaling frequency.

3. In an oscillation generator comprising a single vacuum tube, two tuned networks connected in the anode-cathode circuit of said tube, each of said networks comprising an inductive

winding and a condenser, one of said networks being resonant at a desired signaling frequency, the other of said networks being resonant at a desired interrupting frequency, feedback connections from said networks to the control grid of said tube, means controlling the relative amplitude of the feedback from each of said networks to effect a periodic interruption of the oscillations in said one network at said interrupting frequency, and an impedance element having a negative impedance voltage coefficient shunting a part of the inductive winding of the network which is tuned to said signaling frequency, thereby to regulate the amplitude of the oscillations of the signaling frequency.

4. In an oscillation generator comprising a single vacuum tube, two tuned networks connected in the anode-cathode circuit of said tube, each of said networks comprising an inductive winding and a condenser, one of said networks being resonant at a desired signaling frequency and the other of said networks being resonant at a desired interrupting frequency, an adjustable feedback connection from said one network to the control grid of said tube, an adjustable feedback connection from said other network to the control grid of said tube, output terminals connected to the inductive winding of said one network, and an impedance element having a negative impedance-voltage coefficient connected to the inductive winding of said one network to constitute a voltage regulating load.

5. In an oscillation generator comprising a single vacuum tube, two tuned networks connected in the anode-cathode circuit of said tube, each of said networks comprising an inductive winding and a condenser, one of said networks being resonant at a desired signaling frequency, the other of said networks being resonant at a desired interrupting frequency, feedback connections from said networks to the grid of said tube, a high resistance connected in the grid-cathode circuit, means controlling the amplitude of the feedback from each of said networks to effect the periodic interruption of the oscillations of said signaling frequency at said interrupting frequency, output terminals connected to said one network, and an impedance element having a negative impedance-voltage coefficient connected across a part of the inductive winding of said one network.

6. In an oscillation generator comprising a single vacuum tube, two tuned networks connected in the anode-cathode circuit of said tube, each of said networks comprising an inductive winding and a condenser, one of said networks being resonant at a desired signaling frequency, the condenser of said other network being variable so that the frequency at which said other network is resonant may be adjusted within desired limits, feedback connections from said networks to the grid of said tube, means controlling the amplitude of the feedback from each of said networks to effect the periodic interruption of the oscillations of signaling frequency at the frequency to which said other network is resonant, output terminals connected to said one network, and an impedance element having a negative impedance-voltage coefficient connected to the inductive winding of said one network to regulate the voltage impressed across said terminals.

7. In an oscillation generator comprising a single vacuum tube, two tuned networks connected in the anode-cathode circuit of said tube, a first one of said networks comprising one winding of an induction coil and a condenser, said first network being resonant at a desired low frequency, the second one of said networks comprising windings of an induction coil and a condenser, said second network being resonant at a desired signaling frequency, means comprising another winding of the first-mentioned induction coil and a potentiometer connected across said other winding for impressing an alternating potential of said low frequency on the control grid of said tube, means comprising a potentiometer and a condenser connecting said potentiometer in series with said second network for impressing an alternating potential of said signaling frequency on said control grid, output terminals connected to said second network, and means including an impedance element having a negative impedance voltage coefficient connected across one of the inductive windings of said second network for regulating the amplitude of the oscillations of said signaling frequency, whereby said oscillations are interrupted periodically at said low frequency and the voltage impressed across said terminals is maintained at a desired amplitude.

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