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ELECTRIC WAVE CIRCUIT

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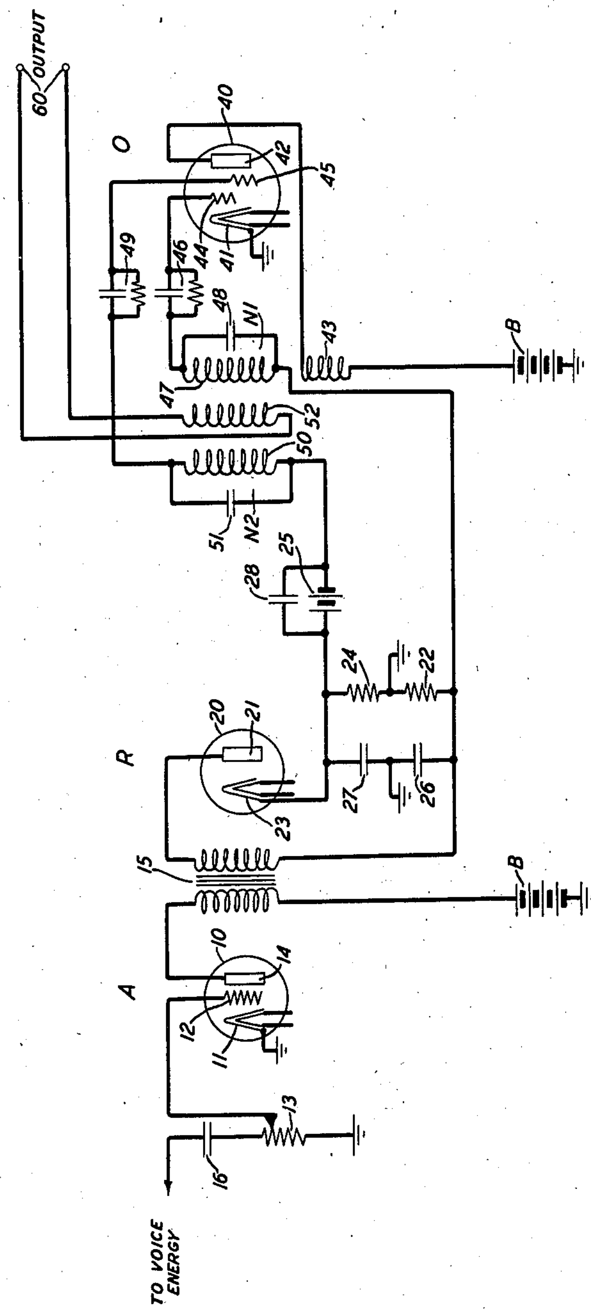

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ELECTRIC WAVE CIRCUIT

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5 Claims. (Cl. 250—36)

This application relates to electric wave circuits and, more particularly, to a multifrequency oscillations-generating circuit.

Many communication systems involve the use of a plurality of high frequency electric or carrier waves. In power line carrier frequency telephone systems, for example, it has been proposed to use one carrier wave for signaling purposes and a second or more carrier waves for talking purposes between the subscriber stations coupled to the power line. In power line carrier frequency telephone systems, for example, it has been proposed, also, to use voice-operated devices which function in such a manner that a subscriber's carrier frequency is produced only when he is talking and his receiver is sensitive to signals only when he is listening. If the frequency output of a multifrequency oscillations-source is controlled by voice frequency signals, then one of its frequencies could be used for the carrier while the other could be employed as the beat oscillator frequency in a heterodyne receiver. Thus, when voice signals are present, the carrier frequency is produced, which enables transmission, while at the same time the beat frequency for the heterodyne receiver is not produced so that the receiver is disabled. Similarly, when voice signals are absent, the heterodyne beat frequency is present and the receiver is enabled, while the carrier frequency is absent, so that the transmitter is disabled.

From the standpoint of economy and simplicity of circuit, it would be desirable if the high frequency waves required in the particular system could be obtained from a single source and preferably with the use of a single electron discharge device. When a single electron discharge device is used, a plurality of tuned circuits each resonant at a different frequency are associated with it and means are provided for selecting the particular tuned circuit enabling the generation of sustained oscillations of the desired frequency. It would be advantageous to have this selection of tuned circuits take place automatically and, when only two different frequencies are involved, to have the shifting from one frequency to the other be correlated with biasing potentials applied to a plurality of grids or control electrodes embodied in the discharge device.

An object of the invention is to improve and simplify multiple frequency oscillations-generating circuits.

In accordance with the invention, a pair of tuned circuits are associated with two grids in a multigrid electron discharge device in which each of the grids is arranged to function as a control electrode for a separate electron stream between the cathode and the anode of the discharge device. Each of the tuned circuits is located in a cathode-grid circuit and is suitably coupled to the cathode-anode circuit so that there is regenerative feedback with respect to each of the tuned circuits. The potentials on the grids are initially such that one grid is biased beyond cut-off whereby sustained oscillations are prevented in the tuned circuit associated with it. The oscillations generated in the other tuned circuit may be detected at suitable output terminals for the electric circuit. Associated with the cathode-grid circuits is means responsive to voice frequency signals or currents to reverse the initial bias conditions of the grids, whereby the formerly enabled and disabled oscillations-generating circuits are respectively disabled and enabled so long as voice frequency signals are incoming to such means.

A more complete understanding of the invention will be obtained from the detailed description that follows taken in conjunction with the appended drawing, the single figure of which discloses a circuit arrangement embodying the invention.

The circuit comprises an amplifier stage A, a rectifier or detecting stage R and an oscillator stage O. The amplifier stage comprises a three-electrode vacuum tube or electron discharge device **10** having an indirectly heated cathode **11** connected to ground, a control electrode or grid **12** connected to the input potentiometer **13**, and an output electrode or anode **14** connected to the primary winding of transformer **15**. The input potentiometer, shown in series with a capacitance **16**, is connected to a suitable source of electrical energy, for example, of voice frequency currents or signals. Anode potential and space current for the tube **10** are supplied from battery B or from an equivalent rectifier.

The rectifier stage comprises a diode or two-electrode vacuum tube **20**, the anode **21** of which is connected to one terminal of the secondary winding of transformer **15**, the other terminal of the secondary winding being connected to ground through a resistor **22**. The indirectly heated cathode **23** is also connected to ground through a second resistor **24**, the junction of the cathode and of resistor **24** being connected with the high potential or positive terminal of a current source or battery **25**. By-pass condensers **26**, **27**, **28** are connected in shunt with each of the resistors **22**, **24** and with battery **25**.

The oscillator stage comprises a multigrid vacuum tube or electron discharge device 40 comprising an indirectly heated cathode 41 connected to ground, an anode 42 connected through coil 43 to the positive terminal of battery B, and a pair of grids or control electrodes 44, 45. One grid 44 is connected through a grid-biasing resistor and by-pass condenser network 46 and a tuned circuit N1 comprising a coil 47 and condenser 48, to the non-grounded end of resistor 22. The other grid 45 is connected through a second grid-biasing resistor and by-pass condenser network 49 and a second tuned circuit N2 comprising a coil 50 and condenser 51, to the negative terminal of battery 25. The tuned circuits N1 and N2 are proportioned to respond to or be resonant at two different frequencies F1, F2 respectively. The cathode-anode circuit coil 43 is coupled to the coils 47, 50, the latter being coupled to a fourth or oscillator-stage output coil 52 whose ends are connected to a pair of output terminals 60.

Each of the grids 44, 45 of tube 40 is arranged to control a separate electron stream between the cathode 41 and anode 42, and is initially biased by virtue of grid current flow in the resistors of neworks 46, 49. In the absence of any additional bias on either grid, such initial bias is not sufficient to prevent sustained oscillations in each of the tuned circuits N1, N2 as a result of the feedback through coil 43 from the cathode-anode circuit to the cathode-grid circuits. Battery 25, however, in the absence of any output from the rectifier 20, provides such an additional negative bias on the grid 45 that the latter is over-biased and sustained oscillations in the tuned circuit N2 are prevented. The oscillator output appearing at the terminals 60 will be, therefore, a wave of frequency F1 only.

When voice frequency currents or signals are impressed on the cathode-grid circuit of the amplifier tube 10 through the potentiometer 13, the amplified signals are applied to the electrodes of the rectifier tube 20 through the transformer 15. The rectifier output is developed across the resistors 22, 24. The potential drop across resistor 24 opposes that of the battery 25, the bias on the grid 45 becoming that provided by the network 49 whereby sustained oscillations of frequency F2 are generated in tuned circuit N2 and appear across the terminals 60. Simultaneously, the potential developed across resistor 22 over-biases the grid 44, whereby generation of sustained oscillations in the tuned circuit N1 is prevented. The oscillator output frequency is thus shifted from frequency F1 to frequency F2. When the signal input to the amplifier terminates, the oscillator circuit restores to its original condition, inasmuch as the potential of the battery 25 is no longer balanced or opposed by a potential across resistor 24, and no biasing potential is developed across resistor 22.

If the circuit described were included in each of the subscriber stations in a power line carrier frequency telephone system, the output terminals 60 would be connected to the power line through suitable intermediate circuits at the station. The intermediate circuit would include an appropriate signaling key so that the normal output frequency F1 would be supplied to the power line only by operation of the key in accordance with the signaling code prescribed for the system. The voice frequency currents or signals for causing the shift in the circuit output from frequency F1 to frequency F2 could be a portion of the voice frequency currents generated by the subscriber at the station in talking. The circuit, however, is not to be considered as limited in utility to such a system, but is adapted to be incorporated in any system in which a source of a plurality of electric waves of different frequencies is required.

What is claimed is:

1. An electric circuit comprising an electron discharge device having a cathode, an anode and a pair of control electrodes, a feedback connection from said anode to each of said electrodes, an oscillatory circuit connected between each electrode and said cathode, means for biasing said electrodes to potentials disabling one and enabling the other of said oscillatory circuits, and means for simultaneously changing the bias on said electrodes enabling and disabling respectively the formerly disabled and enabled oscillatory circuits.

2. An electric circuit comprising an electron discharge device having a cathode, an anode and a pair of control electrodes, a feedback connection from said anode to each of said electrodes, an oscillatory circuit connected between each electrode and said cathode, means for biasing said electrodes to potentials disabling one and enabling the other of said oscillatory circuits, and audio frequency operated means for simultaneously changing the bias on said electrodes enabling and disabling respectively the formerly disabled and enabled oscillatory circuits.

3. An electric circuit comprising an electron discharge device having a cathode, an anode, and a pair of control electrodes; a feedback coil and a source of anode potential and space current in series between said cathode and anode; a grid-cathode circuit comprising one of said grids, a grid leak and condenser network, an oscillatory circuit resonant to a preassigned frequency, a source of biasing potential for said one grid for biasing it to beyond cut-off, a resistor and said cathode; a second grid-cathode circuit comprising the other of said grids, a second grid leak and condenser network, a second oscillatory circuit resonant to a preassigned second frequency, a second resistor and said cathode; said resistors having a terminal in common at cathode potential and said feedback coil being coupled to said oscillatory circuits; an output coil coupled to said oscillatory circuits; and means for developing a potential across said resistors, whereby the effect on said one grid of said source of biasing potential is balanced out and the second grid is biased to beyond cut-off.

4. An electric circuit comprising an electron discharge device having a cathode, an anode and a plurality of grids each arranged to control a separate electron stream between said cathode and anode, a pair of resistors connected in series, a connection from one outer end of said series-resistors to one of said grids, said connection including a source of potential for biasing said one grid to block one of said electron streams, a connection from the other outer end of said series-resistors to a second one of said grids, said second grid normally being biased to a potential to maintain a second electron stream, and means connected to the outer ends of said series-resistors causing current flow through said resistors whereby, so long as said current flow continues, the potential difference developed between the ends of one resistor counteracts the electron stream blocking effect of the source of biasing potential connected to said one grid and the po-

tential difference developed between the ends of the other resistor biases said second grid and the latter blocks said second electron stream.

5. An electric wave circuit comprising an electron discharge device having a cathode, an anode and a plurality of grids, each grid being arranged, to control a separate electron stream between said cathode and anode, a pair of resistors connected in series and having a common terminal maintained at cathode potential, a connection from one outer end of said series-resistors to one of said grids, said connection including a network tuned to a preassigned frequency and a source of potential for biasing said one grid to block one of said electron streams, a connection from the other outer end of said series-resistors to a second grid, said second connection including a second network tuned to a preassigned second frequency and said second grid normally being biased to maintain a second electron stream, a feedback coupling from the cathode-anode circuit to each cathode-grid circuit whereby sustained oscillations of said second frequency are generated in said second network, and means connected to the outer ends of said series-resistors for establishing current flow therethrough whereby, so long as said current flow continues, the potential difference developed between the ends of one resistor counteracts the electron stream blocking effect of said source of biasing potential and enables generation of sustained oscillations of preassigned frequency in the first-mentioned tuned network, and the potential difference developed between the ends of the other resistor biases said second grid such that the latter blocks said second electron stream and said second tuned network is disabled as to generation of sustained oscillations at said second frequency.

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