Sept. 16, 1952 J. M. L. JANSSEN 2,611,093

MIXING CIRCUIT

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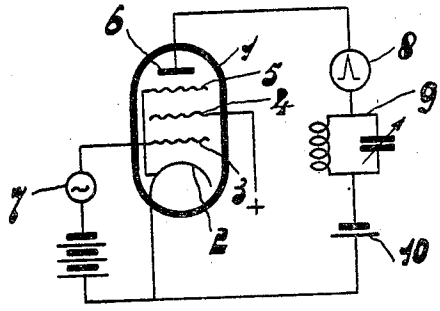

Fig. 1.

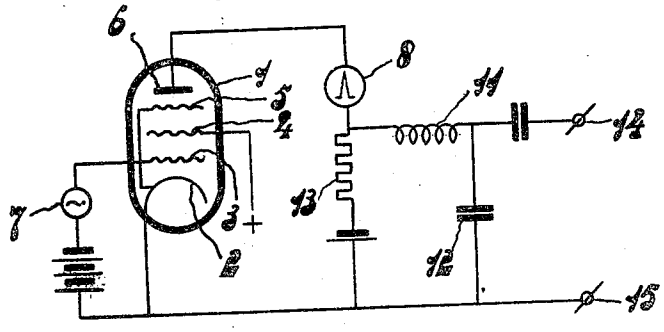

Fig. 2.

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MIXING CIRCUIT

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5 Claims. (Cl. 250—36)

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This invention relates to a mixing circuit comprising a discharge tube which contains at least a cathode, a control grid, a screen grid and an output electrode and whose control grid is supplied with one of the signals to be mixed.

According to the invention, the other signal, which is constituted by periodical short pulses, is fed to the output electrode which has such a bias voltage that it has only current passing through it during the occurrence of the pulses, the desired beat frequency being obtained from the circuit of the output electrode.

The circuit according to the invention has the advantage of making it possible to obtain output voltages whose frequency equals the sum or the difference of the frequency fed to the control grid and of any harmonic of the pulse frequency fed to the output electrode, the conversion mutual conductance being very high and practically independent of the order of the harmonic chosen. Thus, for example, the use of the circuit according to the invention even makes it possible to derive a considerable output voltage whose frequency equals the difference of the frequency supplied to the control grid and of the hundredth harmonic of the pulse frequency.

The circuit according to the invention can therefore be used with advantage for the development of a large zone of accurately adjustable frequencies ranging for example between zero and 20 M cycles/sec. In addition, as an alternative the circuit according to the invention can be used for frequency measurements, the measurement being undertaken by the ascertainment of the difference frequency between the frequency to be measured and the most proximate harmonic of a well known frequency.

In order that the invention may be clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawing, in which two embodiments are shown, Fig. 1 being the schematic diagram of a first preferred embodiment of the invention and Fig. 2 being the schematic diagram of the second embodiment.

Referring to Fig. 1, a discharge tube 1 comprises a cathode 2, a control grid 3, a screen grid 4 having a positive bias applied thereto, a suppressor grid 5 connected to the cathode and a plate-like output electrode 6. The control grid 3 and the cathode 2 have arranged between them a source of voltage 7 which supplies one of the two signals to be mixed. The other signal, which is constituted by periodical short pulses, is supplied by a source of voltage 8 arranged between the

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output electrode 6 and the cathode 2. An output voltage of the desired beat frequency is obtained from an oscillatory circuit 9 tuned to this frequency and also included in the circuit of the output electrode.

By means of a source of direct voltage 10 the output electrode 6 is supplied with a low negative bias voltage in such manner that this electrode has only current passing through it during the occurrence of the pulses supplied by the source of voltage 8. It is now found that if the circuit 9 is correctly tuned, said circuit being for this purpose preferably tunable throughout a large zone, an output voltage can be secured whose frequency equals the sum or the difference of the frequency of the source 7 and of any harmonic of the pulse frequency supplied by the source 8.

The frequency of the source 7 is preferably made variable throughout a band whose width is at least equal to half the fundamental frequency of the source 8 so that the constant use of a higher harmonic of the source 8 for mixing permits of a continuous band of frequencies known with great accuracy being obtained.

Fig. 2 shows a circuit suitable for use in undertaking frequency measurements, the frequencies to be measured being supplied to the control grid 3 and the circuit of the output electrode 6 including in addition to a source of voltage 8 a low pass filter which is constituted by an inductance 11 and a condenser 12 and which is shunted by a leak resistance 13 so far as direct currents are concerned. The limit frequency of this filter is approximately equal to half the fundamental frequency of the source 8, so that at the output terminals 14 and 15 only the difference frequency between the frequency to be measured and the most proximate harmonic of the pulse frequency supplied by the source 8 occurs. This difference frequency can be measured accurately by means of a calibrated low frequency oscillator. By a coarse frequency measurement, the harmonic of the source 8 which is to be added to the difference frequency measured for obtaining the frequency to be measured is then ascertained.

What I claim is:

1. A circuit-arrangement for producing an output voltage, whose value is a function of the frequency relation existing between an oscillatory wave and one component in the harmonic spectrum of periodic voltage impulses, comprising an electron discharge tube provided with a cathode, a grid and an anode, a grid-cathode circuit for said tube, an anode-cathode circuit for said tube, an impedance network connected in the anode-

cathode circuit of said tube, means to apply an oscillatory wave to the grid-cathode circuit of said tube, and means to apply periodic voltage impulses to said anode-cathode circuit to render said tube conductive solely during the occurrence of said impulses, said impulses having a duration which is short with respect to the interval between successive impulses, said network having a frequency response characteristic whose frequency width does not exceed the fundamental frequency of said impulses by which there is yielded an output voltage whose value is a function of the frequency relation existing between said wave and the most proximate component in said spectrum.

2. A circuit-arrangement for producing an output voltage, whose value is a function of the frequency relation existing between an oscillatory wave and the most proximate component in the harmonic spectrum of periodic voltage impulses, comprising an electron discharge tube provided with a cathode, a grid and an anode, a grid-cathode circuit for said tube, an anode-cathode circuit for said tube, a low-pass filter having its input connected in the anode-cathode circuit of said tube, means to apply an oscillatory wave to the grid-cathode circuit of said tube, and means to apply periodic positive voltage impulses having a predetermined repetition rate to said anode-cathode circuit to render said tube conductive solely during the occurrence of said impulses, said impulses having a duration which is short relative to the interval between successive impulses, said filter having a band-pass characteristic whose frequency width does not exceed approximately half the rate of said impulses whereby said filter yields an output voltage whose value is a function of the frequency relation existing between said wave and the most proximate component in said spectrum.

3. A circuit-arrangement for producing an output voltage, whose value is a function of the frequency relation existing between an oscillatory wave and the most proximate component in the harmonic spectrum of periodic voltage impulses, comprising an electron discharge tube provided with a cathode, a grid and an anode, a grid-cathode circuit for said tube, an anode-cathode circuit for said tube, a low-pass filter having its input connected in the anode-cathode circuit of said tube, means to apply an oscillatory wave to the grid-cathode circuit of said tube, means to apply a bias potential to said anode-cathode circuit to maintain said tube normally non-conductive, and means to apply periodic voltage impulses having a predetermined periodicity to said anode-cathode circuit to render said tube conductive solely during the occurrence of said impulses, said impulses having a width which is short relative to the interval between successive impulses, said filter having a band-pass characteristic whose frequency width is less than approximately half the periodicity of said impulses whereby said filter yields an output voltage whose value is a function of the frequency relation existing between said wave and the most proximate component in said spectrum.

4. A circuit-arrangement for producing an output voltage, whose value is a function of a frequency relation existing between an oscillatory wave and the most proximate component in the harmonic spectrum of periodic voltage impulses, comprising an electron discharge tube provided with a cathode, a grid and an anode, an oscillatory wave source connected between said grid and said cathode, a low-pass filter connected between said anode and said cathode, a periodic voltage impulse source interposed between said anode and said filter to render said tube conductive solely during the occurrence of said impulses, said impulse source producing impulses at a predetermined rate and having a duration which is short relative to the interval between successive impulses, said filter having a band-pass characteristic whose frequency width is substantially equal to one-half the rate of said impulses.

5. A circuit-arrangement for producing an output voltage, whose value is a function of a frequency relation existing between an oscillatory wave and the most proximate component in the harmonic spectrum of periodic voltage impulses; comprising an electron discharge tube provided with a cathode, a grid and an anode, an oscillatory wave source connected between said grid and said cathode, a low-pass filter connected between said anode and said cathode, a bias supply interposed between said cathode and said filter to maintain said tube normally non-conductive, a periodic voltage impulse source interposed between said anode and said filter to render said tube conductive solely during the occurrence of said impulses, said impulse source producing impulses having a predetermined periodicity and a duration which is short relative to the interval between successive impulses, said filter having a band-pass characteristic whose frequency width is substantially equal to one-half the periodicity of said impulses.

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