CIRCUIT-ARRANGEMENT FOR CHANGING THE FREQUENCY OF ELECTRICAL OSCILLATIONS

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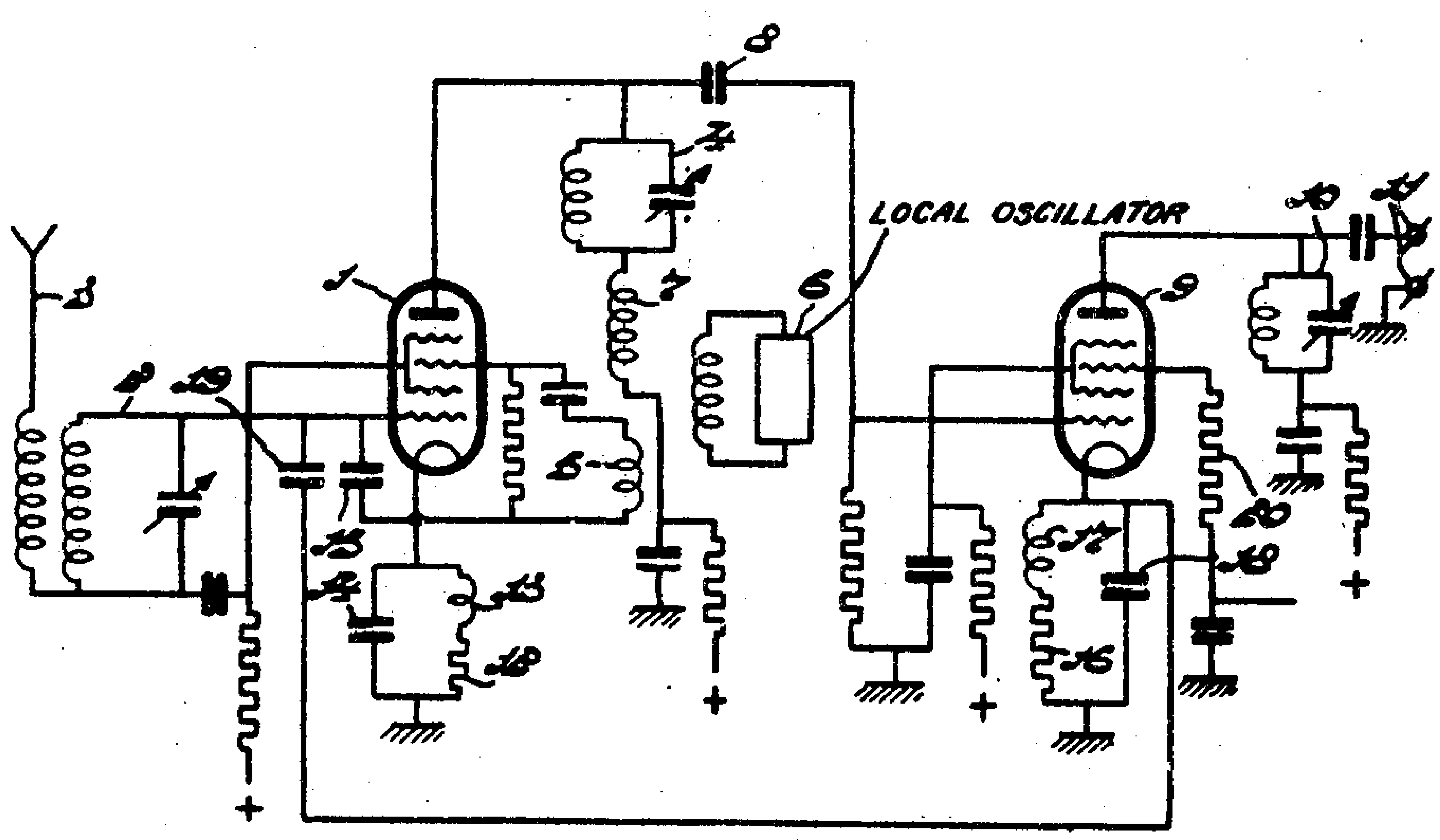

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CIRCUIT ARRANGEMENT FOR CHANGING THE FREQUENCY OF ELECTRICAL OSCILLATIONS

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4 Claims. (Cl. 250—20)

In the copending application, Serial Number 665,010, filed April 26, 1946, there is described a circuit-arrangement for the conversion of frequencies, wherein a positive and a negative feedback for the band of frequencies occupied by the signal to be changed in frequency are simultaneously utilized and wherein the feedback current or voltage for the positive feedback is taken from the circuit of a current-carrying electrode, in which circuit the signal to noise ratio for the said band of frequencies is larger than the signal to noise ratio for the band of frequencies occupied by the signal changed in frequency in the output impedance whereas the feedback current or voltage for the negative feedback is taken from the output impedance through the intermediary of a second frequency-changing stage which acts at the same time as an amplification stage for the signal changed in frequency.

In the embodiment of this circuit-arrangement which has been described, by way of example, in the above identified copending application, the second frequency-changing stage is formed by a hexode in which the (intermediate-frequency) oscillations changed in frequency are supplied to the inner control grid and the local oscillations are supplied to the outer control grid while the feedback voltage for the negative feedback as well as the amplified signal of intermediate frequency are taken from the anode circuit. This embodiment has the drawback that the amplification of the oscillations of intermediate frequency by the hexode cannot be controlled without acting at the same time upon the negative feedback, for if, at the occurrence of a strong signal, the amplification brought about by the hexode would be decreased in the usual manner, this would result in a decrease of the intensity of the negative feedback and therefore of the damping of the input circuit so that a great signal strength would be attended with an increased selectivity. Such an influence exerted on the feedback is of course undesirable.

The invention has for its object to provide a circuit-arrangement with which it is possible to control the amplification of the second frequency-changing stage for the oscillations changed in frequency without simultaneously acting upon the intensity of the negative feedback.

According to the invention, the second frequency-changing stage comprises a discharge tube which has two control grids which are separated from one another by at least one positive grid while the (intermediate-frequency) oscillations changed in frequency are supplied, jointly with

the local oscillations, to the inner control grid and a controlling voltage for the control of the amplification is supplied to the outer control grid, the feedback current or voltage for the negative feedback and the amplified oscillations changed in frequency being taken from the cathode lead and from the anode circuit respectively.

The invention will be explained more fully with reference to the accompanying drawing which represents, by way of example, one embodiment thereof.

The drawing represents a circuit-arrangement for the change of frequency which comprises a hexode 1. The circuit of the inner control grid of this hexode comprises an input oscillatory circuit 2 to which is supplied the signal to be changed in frequency (input signal) which is taken from an aerial 3. The anode circuit comprises an intermediate-frequency circuit 4 across which appear the (intermediate-frequency) oscillations changed in frequency. The circuit of the outer control grid comprises an inductance coil 5 which is coupled to a local oscillator 6 which is represented by a block. The anode circuit of the hexode further comprises an inductance coil 7 which is coupled to the oscillator 6 in the same manner as the coil 5. Jointly with the intermediate-frequency oscillations which occur across the circuit 4, the oscillations of the oscillator frequency which appear across the coil 7 are supplied, through the intermediary of a coupling condenser 8, to the inner control grid of a second hexode 9. This second hexode acts simultaneously as an intermediate-frequency amplifier and as a second frequency changer. The amplified oscillations of intermediate frequency appear across a circuit 10 which is included in the anode circuit of the hexode 9 and are supplied via terminals 11 to the remainder of the circuit-arrangement.

In the cathode lead of the hexode 1 is provided a resistance 12 which serves to generate the required bias voltage for the inner control grid and which has connected in series with it a high-frequency choke coil 13, this series-connection being shunted by a condenser 14. In contrast with usual practice the condenser 14 has so low a capacity that across this condenser is set up an appreciable voltage of the frequency of the input signal supplied to the inner control grid. This voltage is supplied through a condenser 15 to the inner control grid, owing to which a positive feedback for the input signal is obtained. It may be noticed that this positive feedback is obtained owing to the fact, that, together with the condensers

14 and 15, the circuit 2 is connected to the tube 1 in a three-point system of the so-called Colpitts-type.

In the cathode lead of the second hexode 9 is provided in a similar manner a resistance 16 in series with a high-frequency choke coil 17, said series connection being shunted by a condenser 18 of comparatively low capacity. Since, in addition to the intermediate-frequency oscillations, a voltage of the oscillator frequency is also supplied to the inner control grid of the tube 9, a current of the frequency of the input signal is set up in the cathode lead of this tube. The voltage of this frequency which appears across the condenser 18 is supplied through a condenser 19 to the inner control grid of the hexode 1, owing to which a negative feedback for the input signal is obtained. It may be noticed that the voltages of oscillator frequency which are supplied to the hexodes 1 and 9 are mutually in phase and that the tube 1 causes in the known manner a phase displacement of 180° so that the voltage of the input signal frequency which is set up across the condenser 18 is in anti-phase with the voltage across the condenser 14. The consequence thereof is that the feedback brought about by the condensers 18 and 19 is opposite in phase to the feedback brought about by the condensers 14 and 15.

The parts of the circuit arrangement which have hitherto been described function as follows: Since the conversion conductance of a frequency changer is always less than the mutual conductance in the case of amplification, the signal to noise ratio in the intermediate-frequency anode current is always smaller than that in the current of the input signal frequency. Besides, the cathode current always constitutes a smaller noise component than the anode current since the current distribution fluctuations between the anode and the screen grids have no influence on the cathode current. The voltage of the input signal frequency which is set up across the condenser 14 is consequently particularly free from noises in comparison with the intermediate-frequency voltage set up across the circuit 4. By feeding back this voltage, which is comparatively free from noises, in a positive sense to the input control grid, the signal strength is considerably increased whereas the noise increases to a less extent. The positive feedback consequently affords an appreciable improvement in the signal to noise ratio. This entails, however, the drawback that the stability of the circuit-arrangement is decreased and, moreover, that the width of the band which is allowed to pass is decreased. In order to remove these drawbacks negative feedback is utilized at the same time, for which purpose, however, the feedback voltage is taken from the output voltage so that it exhibits the same signal to noise ratio as the output voltage. The favourable signal to noise ratio thus obtained is consequently not disturbed by the negative feedback whilst the stability and the band width are restored. In order to be able to take a feedback voltage of the input signal frequency from the intermediate-frequency output voltage, it is necessary to utilize a second frequency-changing stage which, in order to economize on the need for an additional tube, is combined with the first intermediate-frequency stage in a single tube (the hexode 9).

The circuit-arrangement proposed for this purpose in the previously identified copending application exhibits the drawback that an automatic control of the amplification of the combined intermediate-frequency amplification and second frequency-changing stages was not possible without influencing the effect of the negative feedback. With the circuit-arrangement according to the invention this drawback is eliminated owing to the fact that the control voltage for the automatic control of the amplification is supplied to a second control grid of the tube in question while the feedback voltage is taken from the cathode lead.

In the embodiment, represented, by way of example, in the drawing the controlling voltage is supplied through a resistance 20 to the outer control grid of the hexode 9. Now the controlling voltage acts in the usual manner on the intermediate-frequency anode current and consequently on the output voltage across the circuit 10 but it has no influence on the cathode current so that the effect of the negative feedback is not affected by the control.

What we claim is:

1. A frequency converter system for changing a radio wave into an intermediate-frequency signal comprising a first mixer including an electron discharge device provided with at least a cathode, first and second control grids and an anode, a first resonant circuit tuned to the radio wave and coupled between the first control grid and the cathode, a second resonant circuit tuned to the intermediate-frequency signal and coupled between the anode and the cathode, a feedback network interposed between the cathode and said first and second resonant circuits to develop a positive feedback wave proportional to said radio wave, means to apply said positive feedback wave to said first control grid, a source of local oscillations and means to apply said local oscillations to said second control grid and to said second resonant circuit, a second mixer including an electron discharge device provided with a cathode, a control grid and an anode, means to apply the local oscillations and the intermediate frequency signal appearing in the second resonant circuit of said first mixer as an input to said control grid of said second mixer, a third resonant circuit tuned to the intermediate frequency signal and coupled between the anode of said second mixer and the cathode of said second mixer, a feedback network interposed between the cathode and said third resonant circuit to develop a negative feedback wave proportional to the radio wave produced in said second mixer, and means to apply said negative feedback voltage to the first control grid of said first mixer.

2. A frequency converter system for changing a radio wave into an intermediate frequency signal comprising a first mixer including an electron discharge device provided with at least a cathode, first and second control grids and an anode, a first resonant circuit tuned to the radio wave and coupled between the first control grid and the cathode, a second resonant circuit tuned to the intermediate-frequency signal and coupled between the anode and the cathode, a feedback network interposed between the cathode and said first and second resonant circuits to develop a positive feedback wave proportional to said radio wave, means to apply said positive feedback wave to said first control grid, a source of local oscillations and means to apply said local oscillations to said second control grid and to said second resonant circuit, a second mixer including an electron discharge device provided with a cathode, first and second control grids and an anode, means to apply the local oscillations and the intermediate-frequency signal appearing in the second resonant circuit of said first mixer as an input to the first

control grid of said second mixer, a third resonant circuit tuned to the intermediate frequency signal and coupled between the anode of said second mixer and cathode of said second mixer and a feedback network interposed between the cathode and said third resonant circuit to develop a negative feedback wave proportional to the radio wave produced in said second mixer, means to apply said negative feedback wave to the first control grid of said first mixer, and means to apply an automatic volume control voltage to the second control grid of said second mixer.

3. A frequency converter system as set forth in claim 2 wherein said negative and positive feedback networks each include a radio-frequency choke connected in series with a cathode bias resistor across a capacitor, said capacitor having a value such that a feedback wave is developed across said choke.

4. A frequency converter system as set forth in claim 2, wherein said source of local oscillations is

applied to the second control grid of said first mixer and to said second resonant circuit by means of a transformer having a primary winding connected to said source and a pair of secondary windings, one of said secondary windings being connected in series with said second resonant circuit and the other of said secondary winding being coupled between the cathode and second control grid of said first mixer.

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