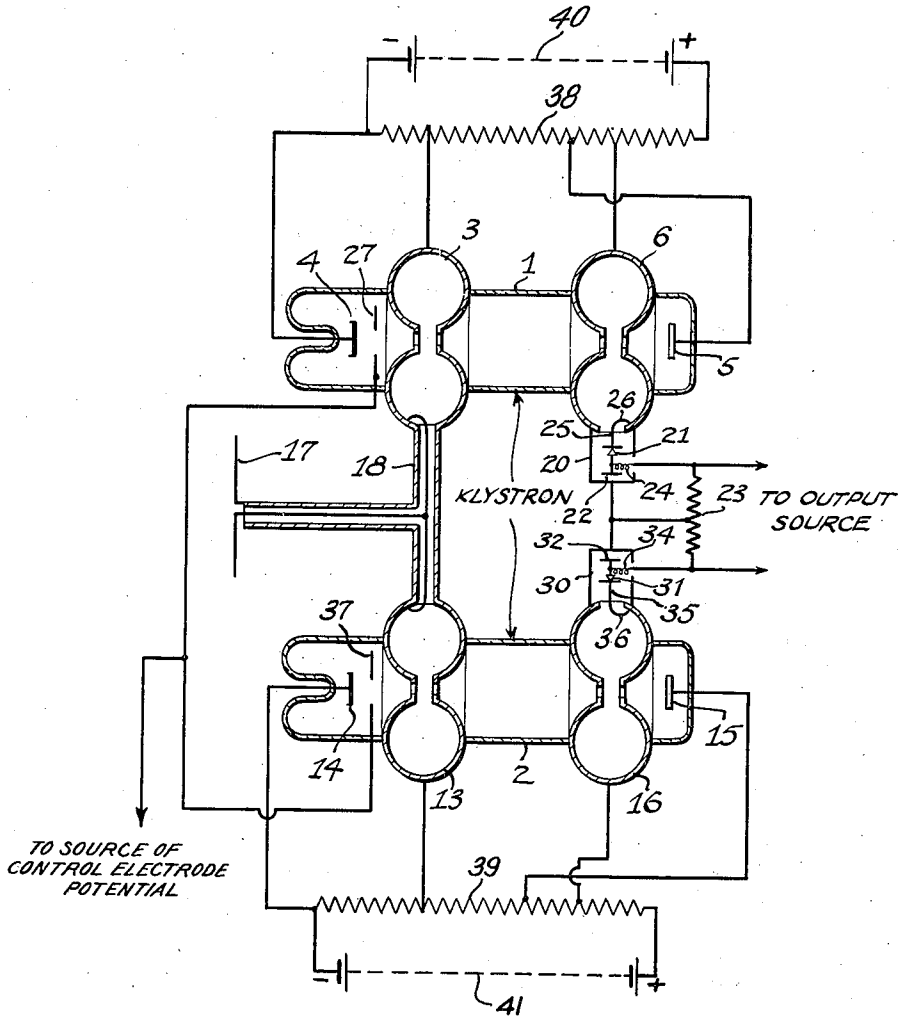
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FREQUENCY DISCRIMINATOR CIRCUITS

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FREQUENCY DISCRIMINATOR CIRCUITS

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4 Claims. (Cl. 250—27)

1

This invention relates to frequency discriminator circuits and is a divisional application from my co-pending application Serial No. 580,821 filed March 3, 1945.

The object of the present invention is to provide an improved frequency discriminator circuit for use with oscillations of very high frequency having a wave-length of the order of centimeters.

According to the present invention a frequency discriminator circuit for use with oscillations of very high frequency is provided, and comprises a velocity modulation electron discharge valve arrangement including two output resonators tuned to different frequencies and arranged to be excited by applied signals, said resonators being associated with a detector circuit for affording a differential output which varies as the frequency of said signals departs from the mean value of the frequencies to which the resonators are tuned.

In order that the invention may be clearly understood and readily carried into effect, the invention will now be described more in detail with reference to the accompanying diagrammatic drawing which illustrates a frequency discriminator circuit according to the invention.

The circuit shown in the drawing comprises a pair of Klystron valves 1 and 2 respectively. The valve 1 comprises an input resonator 3 of toroidal form which serves as a "buncher" for velocity modulating a stream of electrons projecting axially of the resonator between cathode 4 and anode 5. The modulated stream of electrons passes axially of a further resonator 6 similar to the resonator 3, and forms the "catcher" or output resonator of the valve. The valve 2 is similar to the valve 1, and comprises a cathode 14, anode 15, buncher 13, and catcher 16.

The bunchers 3 and 13 may be excited in any suitable way; for example by frequency modulated oscillations or waves collected by an aerial 17, shown as a dipole, and fed to the bunchers through coaxial conductor transmission lines 18. The bunchers 3 and 13 are excited at the same frequency so that the electron streams in both valves are modulated at the same frequency, whereby the catchers or output resonators 6 and 16 are likewise excited at the same frequency. The bunchers 3 and 13 are preferably tuned to the frequency of excitation, but, according to the invention, the catchers 6 and 16 are tuned respectively to frequencies above and below the frequency at which they are excited so that the outputs obtainable from the resonators will vary in opposite senses as the frequency of excitation approaches or recedes from the frequency at which either catcher is tuned. The toroidal hollow resonators 3, 6, 13 and 16 each has the usual humped characteristic of a conventional tuned circuit.

2

The output from the catcher 6 of the valve 1 is fed through a section 20 of coaxial conductor transmission line to a rectifier, constituted by a crystal detector 21, which is connected on one side through a capacitor 22 and a lead connected to the end closure of the transmission line section 20 to the mid-point of a load impedance 23, and through a choke 24 to one end of the load impedance 23 and at its other side via the central conductor 25 of the transmission line section 20 to a loop 26 disposed within the buncher for picking up energy when the buncher is excited. The transmission line section 20 has a length effectively equal to a quarter of a wavelength at the frequency of excitation, so that variations in the impedance in the crystal detector do not affect the tuning of the resonator 6.

The catcher 16 of the valve 2 has an output circuit similar to that of the catcher 6 of the valve 1 and includes a section of coaxial conductor transmission line 30, crystal detector 31, capacitor 32, choke 34 and the half of the load impedance 23 not included in the output circuit of valve 1. With this arrangement the outputs from the two catchers 6 and 16, rectified by the detectors 21 and 31 respectively, will be combined differentially in the load impedance, thus affording a rectified output of which the magnitude and sense will depend on that of the departure of the frequency of excitation of the catchers 6 and 16 from the mean of the frequency at which the two catchers are tuned.

An arrangement according to the invention may be employed for detecting and reducing frequency variations, for example in the manner described in my above identified application, Serial No. 580,821. It may, also, be used for detecting frequency modulation of received oscillations, and in this case the output appearing across the load impedance 23 will be the desired modulation output, and may be applied with, or without amplification to actuate suitable reproduction apparatus, or may be used for other purposes. It will be appreciated that the tuning of the resonators 3, 6, 13, and 16 may be effected in any suitable manner.

While the invention has been described in detail as embodied in an arrangement including two separate valves, it will be appreciated that, if desired, a single valve having two catchers arranged for example so as to be excited in turn by

the velocity modulated electron stream and tuned to frequencies respectively above and below the frequency of excitation, could be employed. With such an arrangement it would be necessary to adjust the impedance in the output circuits of the catchers to insure that the outputs balance at the desired frequency.

In the drawing, the valves 1 and 2 are shown as having control electrodes 27 and 37 respectively which may be arranged to have potentials applied to them for causing anode current to flow in the valves, or for stopping the flow of such current so as to switch the valves on and off as required. The means for energizing the electrodes and resonators of tubes 1 and 2 are as shown in Fig. 2 of my aforesaid parent application. Thus, 40 and 41 denotes sources of potential, each being shunted by a respective potentiometer 38 and 39. Each of cathode 4 and 14 is connected to the respective negative end of potentiometers 38 and 39. The resonators 3 and 6 of tube 1 are connected to respective positive tapping points of potentiometer 38, and resonators 13 and 16 are connected to respective positive tapping points on potentiometer 39. Each of collecting electrodes 5 and 15 is connected to a respective tapping point on its potentiometer 38 and 39 which is less positive than the tapping points of resonators 6 and 16. The control electrodes 27 and 37 are schematically indicated as connected to a common source of control potential, as explained previously.

What I claim is:

1. In a circuit for detecting frequency-variable oscillations of very high frequency, means providing a pair of electron streams, a first pair of cavity resonators respectively arranged to excite the respective streams, means for exciting the resonators with said oscillations, a second pair of cavity resonators respectively arranged to be excited by said streams, said first pair of resonators being tuned in common to the frequency of the exciting oscillations, said second pair of resonators being tuned respectively to frequencies above and below the frequency at which they are excited, means for separately rectifying the output energy of said second pair of resonators, and means for deriving from the rectified energies the differential voltage thereof.

2. In a circuit as defined in claim 1, separate Klystron tubes including a respective one of said streams and one resonator of each of said pairs.

3. In a circuit as defined in claim 1, each of said cavity resonators consisting of a toroidal resonator through which its respective electron stream passes.

4. In a frequency discriminator, a first electron discharge device provided with a pair of toroidal resonators spaced from a cathode, a second electron discharge device provided with a second pair of toroidal resonators spaced from a second cathode, a source of high frequency signals, each of said cathodes providing a respective electron stream passing through each pair of resonators in succession, means coupling said source to the first resonator of each of said pairs thereby to modulate the respective electron streams at the signal frequency, the second resonators of said pairs being tuned to respective frequencies on either side of the signal frequency, a separate rectifier circuit coupled to each second resonator, and means differentially combining the rectified outputs of the rectifier circuits.

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