May 30, 1950 G. C. SZIKLAI ET AL 2,509,280

CATHODE-DRIVEN OSCILLATOR

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Fig. 1.

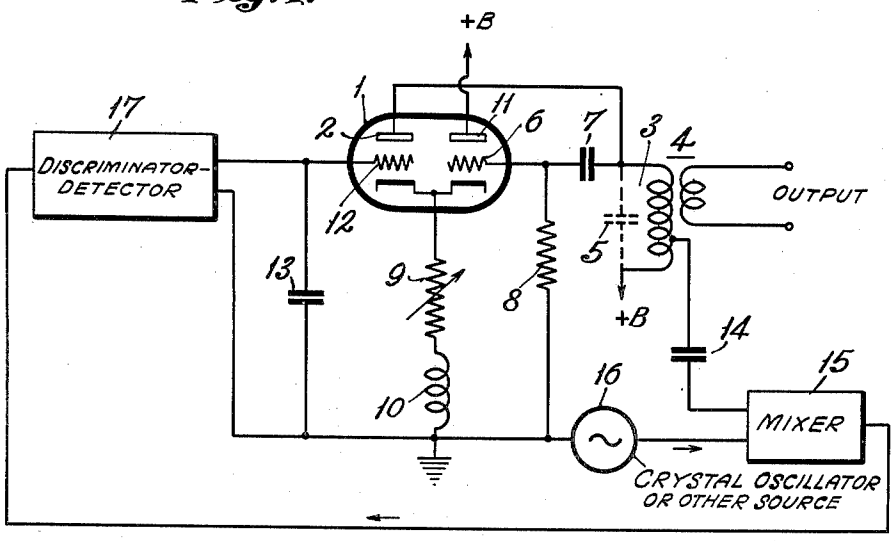
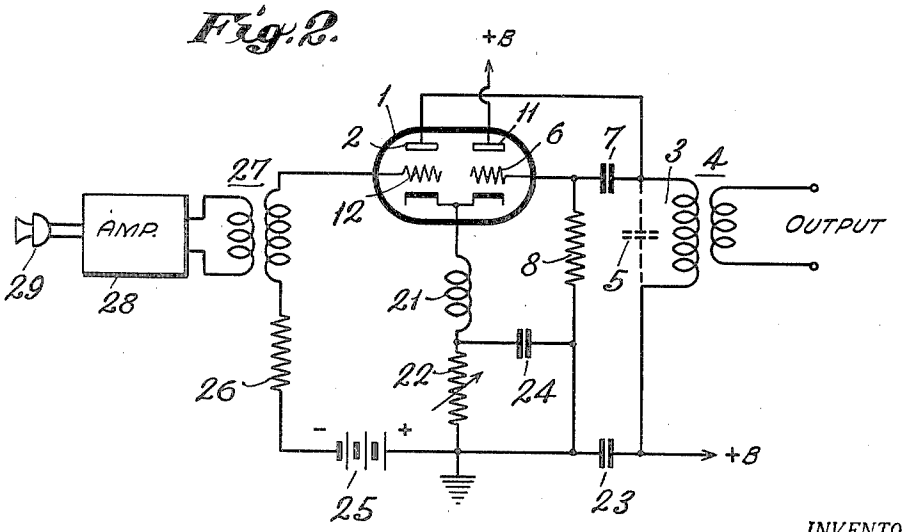


Fig. 2.



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CATHODE-DRIVEN OSCILLATOR

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5 Claims. (Cl. 250—36)

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This invention relates to cathode driven oscillators, particularly of the type known as two-terminal oscillators.

Heretofore, it has been the practice to use a so-called reactance tube coupled across the tuned circuit for controlling the frequency of the oscillations generated. Such an arrangement adds to the capacity across the tank circuit, lowers the impedance and reduces the stability of the oscillator. The added capacity also complicates the design of the tank circuit and renders it difficult to adjust the various parameters so as to provide satisfactorily stable operation at a desired frequency or range of frequencies.

Accordingly, it is an object of our invention to provide a simple vacuum tube circuit arrangement having two terminals across which a negative resistance is developed for controlling the frequency and the constancy of amplitude of the oscillations generated.

It is another object of our invention to provide a tunable oscillator having two triode electron discharge structures so connected as to provide dual swinging of their cathodes by interconnection thereof.

It is another object of our invention to provide a cathode driven oscillator, the output from which may be connected directly to the input of a utilization device.

It is still another object of our invention to provide means in an oscillator of the type above described for varying the bias on both tubes by means of a common cathode resistor so that the overall gain and the negative resistance may be varied.

Another object of our invention is to provide means for stabilizing the frequency of a cathode driven oscillator of the type above described.

Still another object of our invention is to provide means for frequency modulating the output of a cathode driven oscillator of the type above described.

Our invention will now be described in more detail, reference being made to the accompanying drawing in which

Fig. 1 shows illustratively a preferred circuit arrangement for carrying out certain of the objects of our invention which include that of maintaining a constant frequency and a constant amplitude, and

Fig. 2 shows another circuit arrangement illustrating the use of our invention for purposes of producing a frequency modulated output.

Referring first to Fig. 1 we show therein a

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twin triode discharge tube 1 in which each of the two triode structures includes a cathode, an anode and a control grid. The two cathodes may, however, be tied together within the envelope of the tube, or they may be of unitary structure. In place of the twin triode tube, two separate triodes may, of course, be employed.

The anode 2 in one triode section is coupled to one terminal of a parallel tuned circuit 3 composed in this case of the primary winding of a transformer 4 in parallel with a capacitor 5. Capacitor 5, however, may be simply the inherent capacitance of the transformer primary winding itself. For this reason it has been shown dotted. In other cases a physical embodiment of the capacitor 5 may be used. The control grid 6 in the second triode section is coupled across a capacitor 7 to the same terminal of the tuned circuit 3 as is connected to the anode 2 of the first triode section. A resistor 8 of high impedance connects the grid 6 to ground.

The common cathode circuit includes an adjustable resistor 9 in series with a suitable choke 10. The use of this choke 10 is, however, optional.

Feedback potentials are supplied to the grid 6 across capacitor 7. The two triode sections are also intercoupled by the common cathode circuit. Anode potential is supplied from any suitable source (not shown) indicated by the terminal marked +B. This terminal enables D. C. current to be fed through the primary winding of transformer 4 and thence to the anode 2. The +B terminal also supplies anode potential to the anode 11 in the second triode section.

In carrying out the object of controlling the frequency of the oscillations generated we provide means for varying the D. C. bias on the grid 12 in the first triode section. In the selection of such means we have considerable latitude. The choice depends upon the application of the oscillator output to a specific requirement. In one case the prime consideration may be to maintain the frequency constant within the closest possible limits. In another case it may be desirable to vary the frequency to a considerable degree for purposes of frequency modulation. Fig. 1 illustrates an embodiment of the invention wherein the oscillations generated in the tube 1 are caused to "track" with the output from another source 16, herein shown as a crystal oscillator. The frequency of the oscillator 1 may bear any harmonic or subharmonic relation to that of the source 16. It should be

understood, however, that our invention is in no way limited in its application to such circuits as are shown in the drawing to be associated with the oscillator per se.

As shown in Fig. 1 the input circuit for the first triode section may be traced from ground through the output side of a discriminator-detector and thence to the control grid 12 in the first triode section. A relatively large capacitor 13 is connected between the grid 12 and ground. Output energy from the oscillator may be derived through the transformer 4 whose secondary is connected to terminals of any suitable utilization device.

A portion of the output from the oscillator may be taken from a tap on the primary winding of transformer 4 and fed through a capacitor 14 to one input circuit of a mixed device 15. A second input circuit for this mixer device receives oscillations generated in a crystal controlled oscillator 16 having a frequency which may be suitably heterodyned with the output of the main oscillator to produce a lower frequency which varies largely with the frequency of the main oscillator. The output from the mixer device 15 is then carried to a discriminator-detector 17 where rectification takes place and the output is made available as a variable D. C. bias to be applied to the grid 12 in the first triode section of the main oscillator.

In the operation of the circuit arrangement shown in Fig. 1 the mutual transconductance of the first section is varied by the bias applied to the grid 12 as a function of the rectified energy component derived from the discriminator-detector 17. This rectification component in turn is dependent upon the frequency of output from the mixer device 15. If, therefore, the output from the main oscillator departs from its nominal frequency this will vary the frequency and consequently the energy value of the feedback current from the mixer 15 to the discriminator-detector 17. The gain in the main oscillator and the negative resistance in the circuit between the anode 2 and the grid 6 are, therefore, varied in such a way as to maintain constant the frequency of the oscillations generated. We have found for example that in an oscillator designed for normal operation at 50 mc. the frequency could be brought back to normal by the use of the illustrated automatic frequency control circuit consisting of units 15, 16 and 17, even though the frequency without this automatic frequency control would deviate by as much as ±75 kc. The bias variation applied to the grid 12 in this case was not greater than ±1 volt. The overall gain and the negative resistance are, of course, controlled by suitable adjustment of the resistor 9 in the common cathode-to-ground circuit.

Referring now to Fig. 2 we show therein certain elements which appear also in Fig. 1 and are given like reference numbers. Fig. 2 illustrates an application of our invention to the requirements of a frequency modulation transmitter. The tube 1 with its two triode sections is thus shown where the anode 2 and grid 12 are in the first section and the anode 11 and grid 6 are in the second section. The cathode-to-ground circuit in this case includes a choke 21 in series with an adjustable resistor 22.

Grid 6 is connected to ground through resistor 8 in Fig. 2 the same as in Fig. 1. The primary winding of transformer 4 constitutes the inductive element of tank circuit 3 and may also possess inherently a sufficient distributed capacitance to constitute it as a tank circuit per se. In certain cases, however, a physical embodiment 5 of the capacitance of the tank circuit may be provided.

Capacitor 7 intercouples the grid 6 in the second section and the anode 2 in the first section, where the anode 2 is also connected to one terminal of the tuned tank circuit 3. The other terminal is coupled to ground across a capacitor 23 and is also connected to the positive terminal of a suitable direct current source marked +B. The anode 11 in the second section is also positively connected to this source. A capacitor 24 is effectively in shunt with the adjustable resistor 22.

The input circuit in the first triode section may be traced from ground through a biasing source 25, thence through a grid resistor 26 and the secondary winding of a transformer 27 to the grid 12. The primary winding of transformer 27 is disposed in the output circuit of an amplifier 28. Modulations from any suitable source such as a microphone 29 are fed to the input side of the amplifier 28. Optionally, of course, the modulations may be derived from any other type of pickup device such as might be used in a television system, a facsimile system or other source of signals.

In carrying out our invention according to the embodiment of Fig. 2 it will be seen that the frequency of the oscillations generated in the twin triode tube 1 may be varied by varying the D. C. bias on the grid 12 through the transfer of energy from the amplifier 28 across the windings of the transformer 27. This D. C. bias has the effect of varying the negative resistance periodically or in accordance with the modulations.

In the absence of a modulation source a component of D. C. energy from any desired control source may be applied to produce variations in the potential drop across the resistor 26, and in this case the transformer 27 may be eliminated. The circuit arrangement is, therefore, useful for frequency modulation either in a transmitter or in other applications where it is desired to vary the frequency of the oscillator as a function of a variable D. C. bias on the grid 12.

In order to adapt our invention to other requirements such, for example, as those of a frequency modulation receiver, it will be appreciated that any desired type of wave source 16 may be employed, and one which is not necessarily a crystal oscillator. Such a source, if it be an antenna on which incoming frequency-modulated signals are collected, would be useful to supply energy for heterodyning with the output from the oscillator 1, as in the mixer stage 15, as shown in Fig. 1. The consequent control of the grid 12 in tube 1 will be fully understood in view of the foregoing description.

In a physical embodiment of our invention as shown in Fig. 2 it has been shown that a variation of ±1 volt in bias voltage applied to the grid 12 may result in a frequency swing of as much as 200 kc. The simplicity of the circuit for accomplishing these results, as compared with what was heretofore considered as a structural requirement for stabilized frequency control in an oscillator, may be well appreciated by those skilled in the art. No reactance tube is necessary. The circuit has been otherwise shown to be greatly superior to circuit arrangements of the prior art which were available for such uses as are contemplated for the instant invention.

We claim:

1. An oscillator comprising a pair of electron discharge structures each having an anode, a cathode, and a grid, a frequency determining circuit coupled between the anode of a first one of said structures and a circuit point of substantially fixed reference potential, a condenser coupling that anode to the grid in the second one of said discharge structures, means intercoupling said cathodes, said means comprising a common impedance connected from said cathodes to ground, means for applying a direct current bias to the grid of said first one of said structures independent of that on the grid of the other of said structures, means for maintaining the potential of the anode in the second said structure substantially fixed, a source of modulation energy and means to modulate the frequency of oscillations generated and controlled by said energy including means for varying the direct current bias potential which is applied to the grid in the first one of said structures.

2. A frequency controlled oscillator comprising an electron discharge device having cathode, anode and grid electrodes arranged for emission in each of two discharge paths, a common cathode impedance of adjustable ohmic value connected between the cathodes and ground, a frequency determining circuit having inductance and capacitance in parallel and connected between the anode of the first discharge path and a point of fixed potential, a condenser coupling that anode to the grid in the second discharge path, means for maintaining a substantially fixed potential on the anode in the second discharge path, a source of relatively low frequency waves, and means for applying a D. C. bias potential to the grid in the first discharge path which differs from that resulting from said common cathode impedance and which varies as a function of the amplitude of said low frequency waves, whereby the output from said oscillator is caused to be frequency modulated.

3. In an oscillator of the type comprising a twin triode discharge tube in which the anode of a first discharge path is capacitively coupled to the control grid of a second discharge path and the cathode element is common to the two discharge paths, a common cathode-to-ground impedance which is adjustable to control the gain in said oscillator, a resonant circuit connected between the anode of the first discharge path and a point of fixed reference potential, a direct connection from the anode of the second discharge path to said point, means for applying a direct current bias to the grid of said first discharge path independent of the potential drop across said cathode to ground impedance, means for varying the mutual transconductance of the first discharge path, said means comprising an input circuit connected between ground and the grid of the first discharge path, and means including a source of modulating potentials suitably coupled to said input circuit for varying its bias, whereby the generated oscillations are frequency-modulated.

4. An oscillator comprising a pair of electron control structures having a first electrode, a control electrode and a second electrode, means to apply direct operating potentials between a point of reference potential and the second electrode of each of said structures, a frequency determining circuit interposed between the second electrode of one of said structures and said point of substantially fixed reference potential, means coupling the second electrode of said one structure to the control electrode of the other structure with reference to alternating current variations, common impedance means coupling said first electrodes to said point of reference potential, means to apply direct bias potential to the control electrode of said first structure independently of the control electrode of said second structure and independent of the potential drop across said common impedance means, and means to vary the bias applied to the control electrode of said first structure to vary the frequency of the oscillations produced.

5. An oscillator comprising a pair of electron control structures having a first electrode, a control electrode and a second electrode, means to apply direct operating potentials between a point of reference potential and the second electrode of each of said structures, a frequency determining circuit interposed between the second electrode of one of said structures and said point of substantially fixed reference potential, means coupling the second electrode of said one structure to the control electrode of the other structure with reference to alternating current variations, common impedance means coupling said first electrodes to said point of reference potential, means to apply a direct bias potential to the control electrode of said first structure independently of the control electrode of said second structure and independent of the potential drop across said common impedance means whereby an alternating output potential of fixed amplitude is produced, and means to vary the bias applied to the control electrode of said first structure to vary the frequency of said output potential.

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