July 19, 1938. J. B. DOW 2,124,189

CONSTANT FREQUENCY OSCILLATOR SYSTEM

Filed Feb. 11, 1931

FIG. 1

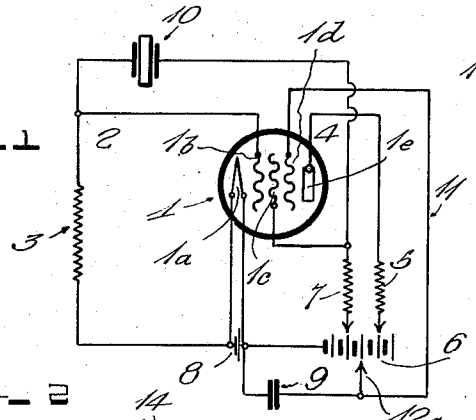


FIG. 3

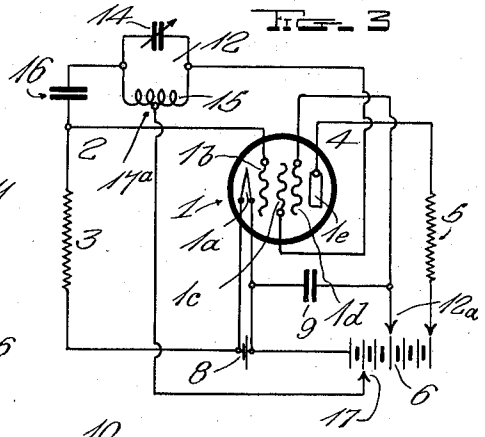


FIG. 2

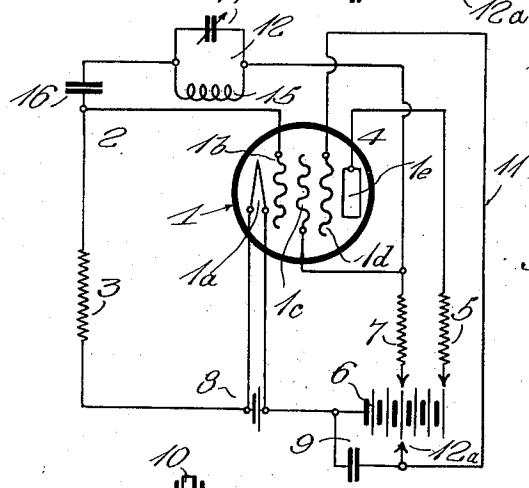
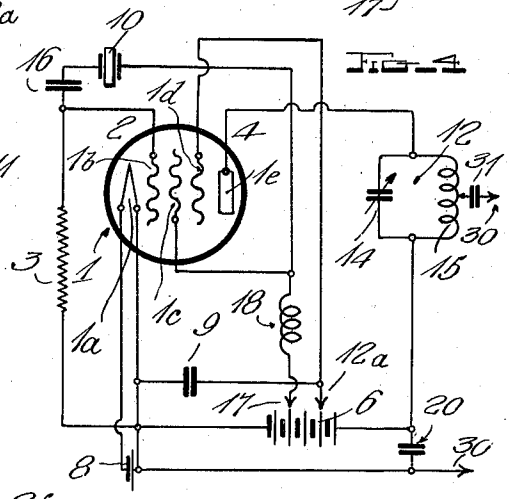


FIG. 4



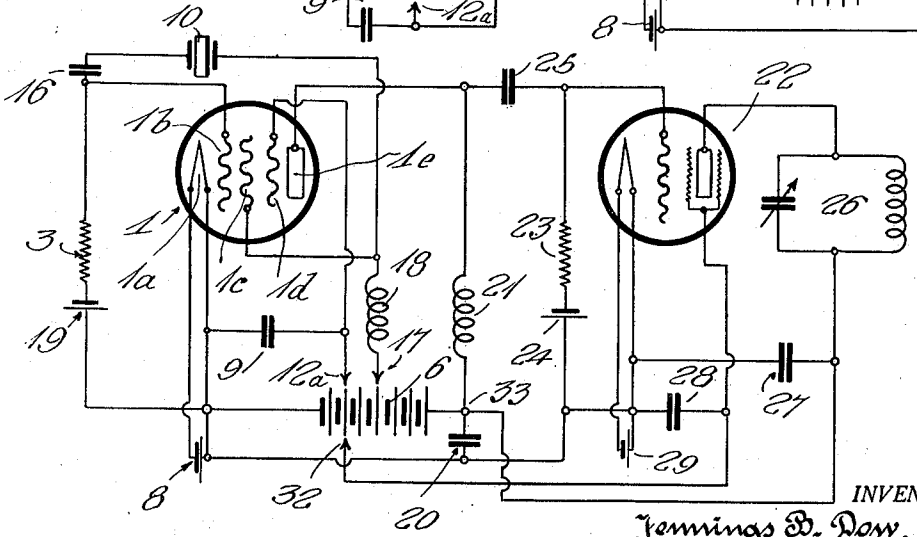


FIG. 5

INVENTOR.
Jennings B. Dow,
BY
Robert A. Lavender
ATTORNEY.

Patented July 19, 1938 2,124,189

UNITED STATES PATENT OFFICE

2,124,189

CONSTANT FREQUENCY OSCILLATOR SYSTEM

Jennings B. Dow, Alexandria, Va.

Application February 11, 1931, Serial No. 515,129

22 Claims. (Cl. 250—36)

My invention relates broadly to high frequency oscillation systems and more particularly to a constant frequency oscillator circuit.

One of the objects of my invention is to provide a circuit arrangement for a constant frequency oscillator employing a five-element electron tube for the precision control of high frequency circuits.

Another object of my invention is to provide an electrical circuit arrangement for interconnecting a frequency determining element with the electrodes of a five-element electron tube by which constant frequency oscillations are generated independent of changes in load on the output of the oscillator system.

A further object of my invention is to provide a constant frequency oscillator circuit having means in the electron tube structure connected with the circuit for shielding the control grid and inner anode electrostatically from the outer anode, whereby oscillations may be accurately sustained at a predetermined frequency.

A still further object of my invention is to provide an arrangement of oscillator circuits employing an electron tube having a cathode, a control grid, an inner anode, an outer anode, and a shield connected with the circuits of the oscillator and arranged to shield those elements of the tube which are associated with the frequency determining portion of the circuit from the outer anode which is associated exclusively with the output circuit.

Other and further objects of my invention reside in a precision oscillator circuit as set forth more fully in the specification hereinafter following by reference to the accompanying drawing, wherein:

Figure 1 diagrammatically illustrates the oscillator circuit of my invention; Fig. 2 shows a modified arrangement of oscillator circuit constructed according to my invention; Fig. 3 illustrates a further modified form of oscillator circuit embodying the principles of my invention; Fig. 4 shows a form of oscillator circuit operating under control of a piezo electric crystal element and arranged in simplified form; and Fig. 5 shows a method of coupling an oscillator circuit of my invention to a power amplifier for feeding high frequency energy at constant frequency to a transmission circuit at desired amplitude.

In the oscillator system of my invention I employ a five-element electron tube including a cathode, a control grid, an inner anode, a shield and an outer anode, with a potential supply system for properly energizing the circuits interconnecting the electrodes, and a frequency determining element connected with the control grid and inner anode. The arrangement of my output circuit and shield element results substantially in the precision operation of the circuit independent of effects of loading on the output of the oscillator. Among the novel features of the circuit, I purposely avoid electrostatic or other conventional forms of coupling between the output circuit and those portions which determine the frequency of oscillation. The new principle in circuit structure which I employ, namely, the use of an auxiliary element associated with the electron stream and the external portion of the output circuit, and the shielding of this auxiliary element electrostatically from those elements of the tube which are directly involved in oscillation generation, is applicable to all known forms of electron tube oscillator circuit. Moreover, this auxiliary element which I have for purposes of this disclosure termed the outer anode element, and its electrostatic shield element, may take many forms of construction and disposition with respect to the other elements of the tube.

Referring to the drawing in detail, reference character 1 designates the electron tube employed in the system of my invention, the tube having a cathode 1*a*, a control grid 1*b*, an inner anode 1*c*, a shield element 1*d* and an outer anode 1*e*. The grid circuit for the tube system is designated at 2 including a leak resistance 3 connected between the control grid 1*b* and the cathode 1*a*. The output circuit for the oscillator system is designated at 4 including the impedance 5 and source of potential 6. A connection is taken from the source of potential 6 through impedance 7 to the inner anode 1*c*, and from the inner anode 1*c* a connection extends to one electrode of the piezo electric crystal element indicated at 10, the opposite electrode of which is connected to the control grid 1*b* of the electron tube 1. The cathode 1*a* is heated from the source of potential indicated at 8. A condenser 9 is connected between one side of the cathode circuit 1*a* and the connection 11 which extends to the shield element 1*d* from the tap 12*a* on the potential source 7 providing a radio frequency by-pass path between the shield element 1*d* and the cathode.

Electrodes 1*a*, 1*b*, and 1*e* may take the usual forms of construction given the cathode, control grid and anode of three element tubes. I have found it satisfactory to make the inner anode 1*c* in the form of an ordinary grid. The shield electrode 1*d* should preferably take the form of a comparatively fine grid or screen such as

is customary for shielding or screening electrodes.

In Fig. 2, I have shown a resonant circuit 12 connected in place of the piezo electric crystal element 10 for determining the frequency of oscillation of the oscillator system. The resonant circuit 12 includes an inductance 15 shunted by variable condenser 14. The resonant circuit is connected in series with blocking condenser 16 and disposed between the inner anode 1c and the control electrode 1b, as shown. The condenser 9 functions in a manner similar to the correspondingly numbered element in Fig. 1 for providing a short radio frequency path between the shield element 1d and the cathode 1a.

Fig. 3 shows a modified arrangement of oscillator circuit in which the impedance 7 is eliminated for simplifying the circuit. In this arrangement, the inductance 15 of the resonant circuit 12 is tapped at 17a at the midpoint of the inductance, and a connection taken to a point 17 on the high potential source 6 for impressing a positive potential upon the inner anode 1c. The shield element 1d is connected to a point of potential 12a on potential source 6 as shown, and the condenser 9 provides a short radio frequency path from the shield element to the cathode, as shown.

In Fig. 4, a further modified form of oscillator circuit has been illustrated wherein the generic impedances 5 and 7 are replaced by more specific forms. An inductance 18 is connected in lieu of impedance 7 to a tap 17 on high potential source 6. The opposite end of the inductance 18 connects to the inner anode 1c and also to one electrode of piezo electric crystal element 10. The output circuit 4 in the arrangement shown in Fig. 4 includes the resonant circuit 12 which consists of inductance 15 shunted by variable condenser 14. The high potential source 6 is shunted by by-pass condenser 20. The output of the oscillator is connected to the circuit 30 through coupling condenser 31. The shield element 1d is connected to the point 12a of positive polarity on battery 6, as shown.

The oscillator of my invention may be coupled to a power amplifier circuit in the manner illustrated in Fig. 5. In this arrangement the power amplifier is indicated as including electron tube 22 having the input circuit thereof coupled through blocking condenser 25 with the output circuit of the oscillator 1. The coupling between the oscillator and the power amplifier is direct in character and includes the coupling inductance 21. The control grid 1b is biased from battery 19 through impedance 3. The shield element 1d has a positive potential impressed thereon from tap 12a on potential source 6. The condenser 9 affords a radio frequency path from the shield element to the cathode, as heretofore explained. The power amplifier 22 is in the form of a shield grid tube having its cathode heated from potential source 29 and the anode energy supplied from tap 33 on potential source 6 through resonant circuit 26. The potential source 29 serves to energize the cathode of the power amplifier tube 22. Condensers 27 and 28 provide radio frequency by-pass circuits in different parts of the amplifier system. Tap 32 connects to the shield grid of amplifier 22.

The frequency determining portion of each of the above described oscillator systems is electrostatically shielded from the work circuit anode by means of the shield element 1d, consequently the only coupling between the work circuit anode and the frequency determining portion of the system is that which is afforded by virtue of the electron stream therebetween. This coupling may conveniently be called electron coupling and the method of coupling through an electron stream may be termed electronically coupling.

I have found that the oscillator circuit of my invention equipped with the shield element arranged as described, operates efficiently for the sustaining of oscillations at constant frequency, and while I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, a resonant circuit included in circuit between said cold elements, circuits interconnecting said elements and said resonant circuit for the generation of oscillations, the output circuit of said generator including in circuit an additional cold element and said cathode element, and means for electrostatically shielding said additional cold element from said first mentioned cold elements.

2. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, an electromechanical vibrator included in circuit between said cold elements, circuits interconnecting said elements and said electromechanical vibrator for the generation of oscillations, the output circuit of said generator including in circuit an additional cold element and the cathode element of said tube, and means for electrostatically shielding said additional cold element from said first mentioned cold elements.

3. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, a resonant system included in circuit between the cold elements of said electron tube, circuits interconnecting said elements and said resonant system for the generation of oscillations, the output circuit of said tube including in circuit at least one additional cold element and the cathode element of said tube, and means for electrostatically shielding said last mentioned cold elements from said first mentioned cold elements.

4. An oscillation generator comprising an electron tube having oscillation-generator-electrodes and an auxiliary electrode for deriving oscillatory output energy from said generator, means including a source of electrical energy and circuits interconnecting the same with the oscillation-generator-electrodes of said tube for generating and sustaining oscillations therein and means for electrostatically shielding said oscillation-generator-electrodes from said auxiliary electrode.

5. In an electron discharge apparatus in which at least three electrodes associated with the discharge are disposed in circuit and comprise in combination with said circuit an oscillation generating means, and an additional electrode associated with said discharge is connected through an additional circuit to at least one of said first mentioned electrodes, the method of minimizing

changes in the frequency of oscillation of said means due to changes in the electrical constants of said additional circuit, which consists in substantially electrostatically shielding said first mentioned electrodes from said additional electrode.

6. In an electron discharge apparatus in which at least three electrodes associated with the discharge are disposed in circuit and comprise in combination with said circuit an oscillation generating means, and an additional electrode associated with said discharge is connected through an additional circuit to at least one of said first mentioned electrodes, the method of minimizing changes in the frequency of oscillation of said means due to changes in the electrical constants of said additional circuit, which consists in substantially electrostatically shielding said first mentioned electrodes from said additional electrode for potential variations across said additional circuit of frequency corresponding to that of said oscillation generating means.

7. In an electron discharge apparatus in which at least three electrodes associated with the discharge are disposed in circuit and comprise in combination with said circuit an oscillation generating means, and an additional electrode associated with said discharge is connected through an adjustable resonant circuit to at least one of said first mentioned electrodes, the method of minimizing changes in the frequency of oscillation of said means due to changes in the electrical constants of said adjustable resonant circuit, which consists in substantially electrostatically shielding said first mentioned electrodes from said additional electrode.

8. The method of stabilizing the frequency of oscillation of an oscillation generator employing an electron discharge tube having at least three electrodes connected for the generation of oscillations and an additional electrode constituting a part of a work circuit, which comprises, electrostatically shielding said additional electrode from said first mentioned electrodes and electronically coupling said additional electrode to at least one of said first mentioned electrodes.

9. In an electron tube circuit, an electron tube including a cathode element, a control element and an anode element, the said elements containing in circuit a resonant circuit and suitable sources of electric energy so connected as to provide means for oscillation generation, the said electron tube including an additional anode element associated with an external circuit including a source of electric energy and a connection with the cathode element of said electron tube, and means substantially electrostatically shielding said first mentioned elements from said additional anode element.

10. In an electron tube circuit, an electron tube including a cathode element, a control element and an anode element, the said elements containing in circuit an electromechanical vibrator and suitable sources of electric energy so connected as to provide means for oscillation generation, the said electron tube including an additional anode element associated with an external circuit including a source of electric energy and a connection with the cathode element of said electron tube, and means for substantially electrostatically shielding said first mentioned elements from said additional anode element.

11. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, an electromechanical vibrator, circuits interconnecting said elements and said electromechanical vibrator and constituting in combination means for the generation of oscillations, the output circuit of said generator including in circuit an additional cold element and said cathode element, and means for electrostatically shielding said first mentioned elements from said additional cold element, said last mentioned means comprising a grid-like shield element positioned in said tube between said additional cold element and said first mentioned elements and having a low reactance connection with said cathode element and means for maintaining said shield element electropositive with respect to said cathode element.

12. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, an electromechanical vibrator, circuits interconnecting said elements and said electromechanical vibrator and constituting in combination means for generating oscillations, the output circuit of said generator including in circuit an additional cold element and said cathode element, and means for substantially electrostatically shielding said first mentioned elements from said additional cold element for potential variations across said output circuit of frequency corresponding to that of said oscillations, said last mentioned means comprising a grid-like shield element positioned in said tube between said additional cold element and said first mentioned elements and having a connection of negligible impedance at the frequency of said oscillations with said cathode element.

13. An oscillation generator in accordance with claim 12 wherein means are provided for maintaining said grid-like shield element electropositive with respect to said cathode element.

14. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, a resonant system, circuits interconnecting said elements and said resonant system and constituting in combination means for the generation of oscillations, the output circuit of said tube including in circuit at least one additional cold element and said cathode element, and means for electrostatically shielding said first mentioned elements from said additional cold elements, said last mentioned means comprising a grid-like shield element positioned in said tube between said additional cold elements and said first mentioned elements and having a low reactance connection with said cathode element and means for maintaining said shield element electropositive with respect to said cathode element.

15. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, a resonant circuit, circuits interconnecting said elements and said resonant circuit and constituting in combination means for generating oscillations, the output circuit of said tube including in circuit at least one additional cold element and said cathode element, and means for substantially electrostatically shielding said first mentioned elements from said additional cold elements for potential variations across said output circuit of frequency corresponding to that of said oscillations, said last mentioned means comprising a grid-like shield element positioned in said tube between said additional cold element and said first mentioned elements and having a connection of negligible impedance at the frequency of said oscillations with said cathode element.

16. An oscillation generator in accordance with claim 12 wherein means are provided for maintaining said grid-like shield element electropositive with respect to said cathode element.

17. In an oscillation generator comprising an electron tube having a cathode element and two cold elements, a frequency determining device, circuits interconnecting said elements and said frequency determining device and constituting in combination means for the generation of oscillations, the output circuit of said tube including in circuit at least one additional cold element and said cathode element, means for electrostatically shielding said first mentioned elements from said additional cold elements, said last mentioned means comprising a grid-like shield element positioned in said tube between said additional cold elements and said first mentioned elements and having a low reactance connection with said cathode element, and means for maintaining said shield element electropositive with respect to said cathode element.

18. A piezo electric oscillating circuit comprising an electron tube having a cathode, a control grid, an inner anode, an electrostatic shield, and an outer anode, positioned in the order named, a source of electrical energy for supplying the cathode heating current and anode potential, the negative side of said anode potential source being connected to the cathode, the positive side of said anode potential source being connected to the inner anode through an impedance, means for maintaining the electrostatic shield at a suitable positive potential with respect to the cathode, the positive side of said anode potential source being connected to the outer anode through an impedance, means for biasing the control grid at a suitable potential with respect to the cathode, said cathode, control grid, inner anode, and their external circuits comprising an oscillation generator, and a piezo electric crystal with its electrodes disposed in circuit between the control grid and inner anode for determining the frequency of oscillation.

19. A source of high frequency energy comprising an electron tube having a cathode, a control grid, an inner anode, an electrostatic shield, and an outer anode, a source of energy for supplying the cathode heating current and anode potential for said tube, the negative side of said anode potential source being connected to the cathode, an impedance connected between the positive side of said anode potential source and said inner anode, external circuits, one of which is resonant, between said cathode, control grid and inner anode, said cathode, control grid, inner anode and their external circuits comprising an oscillation generator, a connection between said anode energy source and said electrostatic shield for maintaining the latter at a suitable positive potential with respect to the cathode, a second impedance connected between the positive side of said anode potential source and said outer anode, said second impedance and said outer anode forming merely the output circuit for said source of high frequency energy.

20. A source of high frequency energy comprising an electron tube having a cathode, a control grid, an inner anode, an electrostatic shield, and an outer anode, a source of energy for supplying the cathode heating current and anode potential, the negative side of said anode energy source being connected to the cathode, an impedance connected between the positive side of said anode potential source and said inner anode, external circuits including an electromechanical vibrator disposed between said cathode, control grid and inner anode, the said cathode, control grid, inner anode and their external circuits comprising the oscillation generating means for said source, a connection between said shield and said anode energy source for maintaining the electrostatic shield at a suitable positive potential with respect to the cathode, a bypass condenser connecting the electrostatic shield and cathode, the positive side of said anode potential source being connected to the outer anode through an impedance, said outer anode and said last mentioned impedance forming merely the output circuit for said source of high frequency energy.

21. An oscillation generator comprising, an evacuated container, an electron emission element in said container, a plurality of cold electrodes in said container, said cold electrodes being spaced progressively from said electron emission element, a frequency determining circuit including a capacitive reactance connecting in push-pull relation the cold electrodes nearest to said electron emission element a connection between this frequency determining circuit and the emission element, a circuit connected between another of said cold electrodes and said electron emission element, said last named circuit being magnetically isolated with respect to said first named circuit, a shielding electrode located between said last named electrode and said other electrodes, and a circuit of low radio frequency impedance connecting said shielding electrode to said emission element.

22. An oscillation generator comprising a thermionic tube having an evacuated container, an electron emission element in said container, a pair of grid-like electrodes in said container, an anode electrode in said container, circuits including an inductive reactance connecting each of said grid-like electrodes to the electron emission element, said inductive reactances being coupled to produce sustained oscillations in said tube and circuits when said grid-like electrodes and emission element are energized, a circuit connecting said anode to said electron emission element, a shielding electrode located between said anode electrode and said grid-like electrodes, and a circuit of low radio frequency impedance connecting said shielding electrode to said electron emission element.

JENNINGS B. DOW.