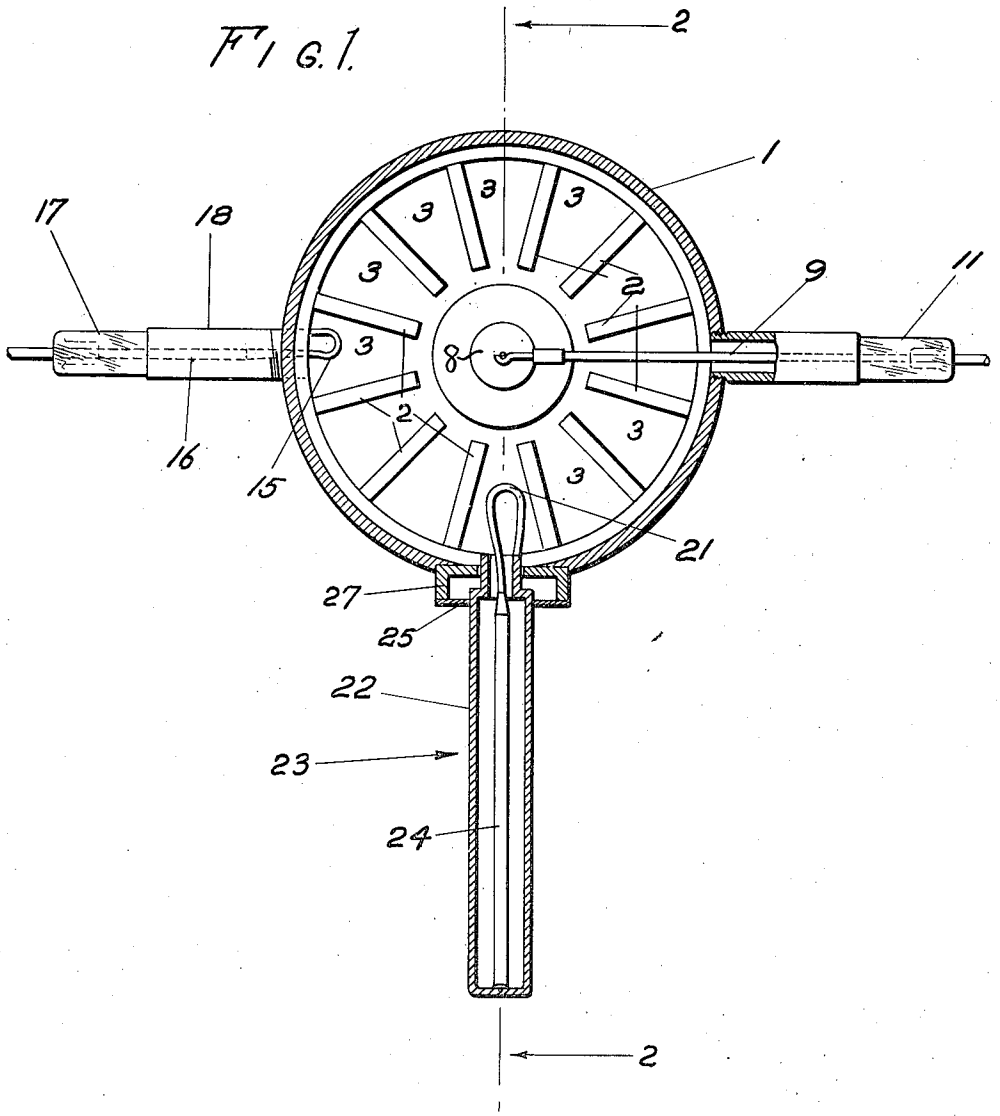
Oct. 26, 1948. E. N. KATHER 2,452,056

ELECTRICAL DISCHARGE DEVICE

Filed July 20, 1944 2 Sheets-Sheet 1

FIG. 1.



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FIG. 2.

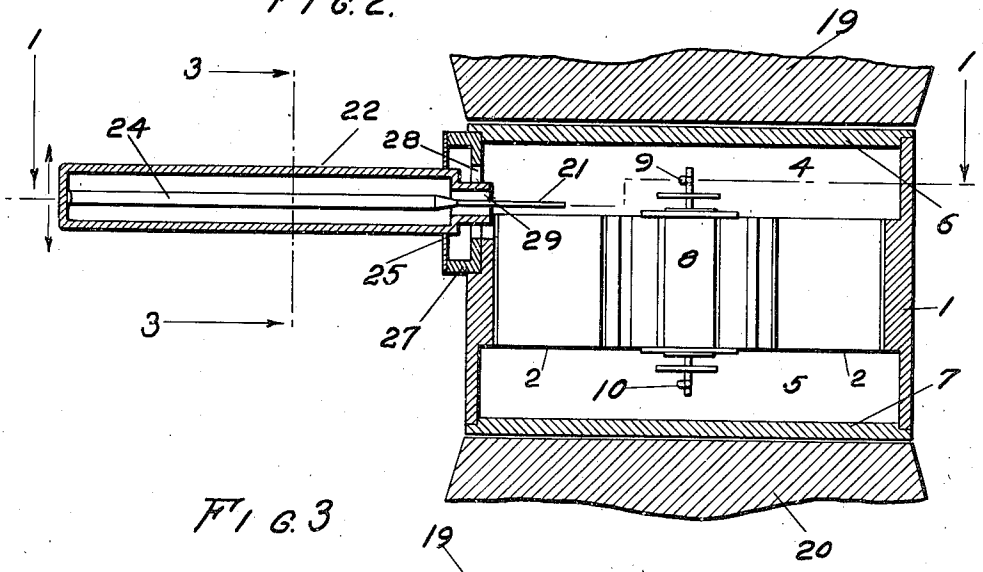
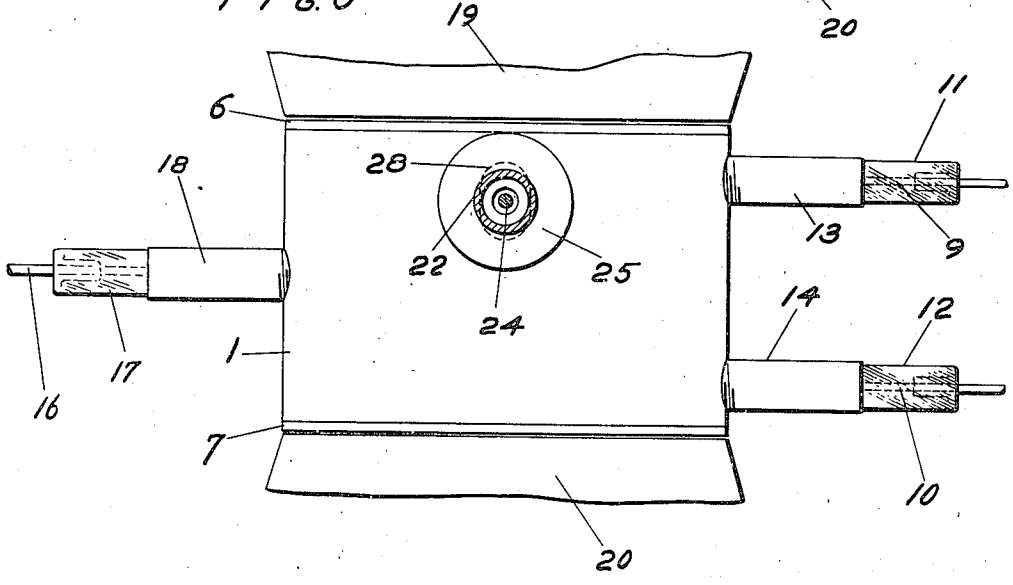


FIG. 3



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ELECTRICAL DISCHARGE DEVICE

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10 Claims. (Cl. 250—27.5)

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This invention relates to an electron discharge tube of the type adapted to generate ultra high frequency oscillations, and more particularly to one in which the frequency of one or more resonant circuits within the tube determines the frequency of the oscillations produced.

In such devices it is frequently desirable to vary, within limits, the frequency of the oscillations generated by the tube.

It is among the objects of this invention to provide a novel and efficient means for varying the frequency of the oscillations generated by the tube while the tube is in operation.

In such devices various factors beyond the control of the operator may alter the frequency at which the tube is resonant. For example, a change in the operating temperature may alter the resonant frequency.

A further object of the invention is to provide a means for varying the frequency of the oscillations generated by the tube which will also function as a frequency stabilizer to maintain the oscillations generated at the desired adjusted frequency regardless of changes in the operating conditions.

The above and other objects of the invention will be fully set forth in the following detailed description, taken in conjunction with the accompanying drawings in which:

Fig. 1 shows a transverse section through a magnetron constructed in accordance with my invention;

Fig. 2 shows a section taken on line 2—2 of Fig. 1; and

Fig. 3 shows a partial side elevation, partial section taken on line 3—3 of Fig. 2.

Referring to the drawings, there is shown a magnetron comprising a block 1 of conductive material, such as copper. A plurality of anode arms 2 project radially from the interior surface of the block 1 providing therebetween a plurality of resonant cavities 3. Hollow end sections 4 and 5 covered by end caps 6 and 7 are provided at each end of the block 1. A cathode 8 is provided centrally of block 1 adjacent the inner ends of the anode arms 2 and is supported by lead-in conductors 9 and 10 extending through the hollow end sections 4 and 5. Lead-in conductors 9 and 10 are sealed in glass seals 11 and 12 mounted at the outer ends of conductive pipes 13 and 14, respectively. The conductive pipes 13 and 14 are hermetically secured within the wall of the block 1 adjacent the end sections 4 and 5. Within one of the resonant cavities 3 is a coupling loop 15 having one end connected to a lead wire 16. The

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lead wire 16 is sealed through a glass seal 17 mounted at the outer end of a conductive pipe 18 hermetically secured within the wall of the block 1. The other end of the coupling loop 15 is secured to the inner end of the conductive pipe 18. Magnetic poles 19 and 20 are provided adjacent the end caps 6 and 7 to create a magnetic field extending longitudinally of the device.

When such devices are energized, oscillations are set up from which energy may be derived by the coupling loop 15 and led out of the tube by lead wire 16 and conductive pipe 18 which constitute a coaxial transmission line. On the exterior of the tube the high frequency oscillations may be conducted to any suitable utilization circuit by a continuation of the concentric line or any other transmission line in a manner known in the art.

In the operation of such devices a capacity exists between the cathode 8 and the face of each of the anode arms 2. Also capacitances exist between the side walls of adjacent anode arms 2. The interior walls of the resonant cavities 3 constitute inductances. The anode is so designed and spaced relative to the cathode that the capacitances and inductances described constitute circuits which are tuned. The construction so far described is such that these circuits are resonant at a predetermined frequency depending upon the geometry of the tube. The device is intended to operate so that each cavity 3 forms a circuit tuned to the frequency at which each of the other cavities 3 oscillates.

In order to vary the frequencies of the oscillations generated by the tube, I provide a coupling loop 21 extending into the end section 4 closely adjacent to one end of one of the cavities 3. One end of the loop 21 is connected to the inner end of an outer tubular conductor 22 of a section of coaxial line 23 having an inner conductor 24. The other end of the loop 21 is connected to said inner conductor 24. The outer end of the coaxial line 23 is closed and the line is supported near its inner ends by a flexible diaphragm 25, which diaphragm has a central opening through which the outer tubular conductor extends and in which it is hermetically sealed. The diaphragm 25 is soldered or otherwise integrally connected along its peripheral edge to the rim of a cup-shaped member 27, the joint constituting an hermetic seal. The cup-shaped member 27 is mounted upon one end of the block 1, a portion of the block 1 being cut away for this purpose, and the cup-shaped member soldered or otherwise secured to the side wall of the block 1 in a manner to secure an hermetic seal therewith. An elongated open-

ing 28 is provided in the base of the cup-shaped member through which a reduced end 29 of the outer tubular conductor 22 extends. The dimensions of the elongated opening 28 are such that the inner end 29 of the outer tubular conductor 22 may be moved upwardly and downwardly within the opening.

The length of the coaxial line 23 is fixed to give a predetermined reactance as determined by the tube and load characteristics. This length is such that the coaxial line is approximately resonant at the operating wave length but nevertheless off to one side at resonance. The length may be taken either side of resonance depending on the tube and load characteristics, in the one case the reactance of the coaxial line will be inductive and in the other case its reactance will be capacitive. In either case the line 23 constitutes a reactance coupled in the oscillatory circuit of the tube by the loop 21. By applying pressure to the outer end of the coaxial line 23, the coupling loop 21 may be moved relative to the resonant cavity 3, the diaphragm 25 flexing for this purpose, so that the loop will be closer to or farther from the oscillatory field of this cavity and thereby the coupling between the coaxial line and the resonant cavity may be varied. An increase in coupling caused by moving the loop 21 closer to the resonant cavity 3 increases the amount of the reactance coupled in the oscillatory circuit. Movement of the loop in this direction changes the frequency at which the circuit provided by the system is resonant. By moving the loop farther from the cavity, the coupling therebetween is decreased and the resonant frequency of the system is accordingly changed.

Preferably the ratio of the inner diameter of the outer tubular conductor to the outer diameter of the inner conductor is made equal to 3.6. In other words these parts are dimensioned to provide a high Q and since the coaxial line is approximately resonant at the operating wave length but nevertheless off to one side at resonance, that is, the resonant frequency of the coaxial line is slightly different from the resonant frequency of the system, the line will tend to pull the system back to the adjusted frequency whenever the system tends to vary from the predetermined frequency. Thus the device provides both a tuning means and a means for stabilizing the frequency of the system.

From the above description it will be seen that the invention provides a novel and efficient means for varying within limits the frequencies of the oscillations generated by the tube at the will of the operator while the tube is in operation. Furthermore, where the inductively coupled line is made approximately resonant at the operating wave length of the tube but nevertheless off to one side at resonance, the invention provides a frequency stabilizing effect at the adjusted frequency.

While there has been herein described an illustrative embodiment of the invention, other embodiments within the scope of the appended claims will be apparent to those skilled in the art from a consideration of the embodiment shown and the teachings hereof. For example, the invention may be applied to tubes of the type having a resonant cavity determining the frequency of the oscillations produced other than the specific magnetron shown. The coupling loop may be made adjustable relative to the resonant cavity by means other than the specific means shown and the circuit providing the reactance

connected to the adjustable coupling need not necessarily be a coaxial line.

What is claimed is:

1. A magnetron comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line having one end thereof opening into said envelope and the other end thereof hermetically sealed, a coupling loop coupling said coaxial line to said resonant circuit, and means carried by said envelope and adjustably supporting said coaxial line to enable the movement of said coupling loop relative to said resonant circuit to vary the inductive coupling therebetween.

2. A magnetron comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line including an outer tubular conductor and an inner coaxial conductor, one end of said outer tubular conductor opening into said envelope and the other end thereof being hermetically sealed, a coupling loop connected at one end to said outer tubular conductor and at its opposite end to said inner conductor and extending into said envelope coupling said coaxial line to said resonant circuit, and means carried by said envelope and adjustably supporting said coaxial line to enable the movement thereof to thereby move said coupling loop relative to said resonant circuit to vary the inductive coupling therebetween.

3. A magnetron comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line including an outer tubular conductor and an inner coaxial conductor, one end of said outer tubular conductor opening into said envelope and the other end thereof being hermetically sealed, a coupling loop connected at one end to said outer tubular conductor and at its opposite end to said inner conductor and extending into said envelope coupling said coaxial line to said resonant circuit, said coaxial line being movably mounted and hermetically sealed in a wall of said envelope whereby said coupling loop is movable relative to said resonant circuit to vary the inductive coupling therebetween.

4. A magnetron comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line having one end thereof opening into said envelope and the other end thereof hermetically sealed, said coaxial line being approximately tuned to the frequency of said resonant circuit, a coupling loop coupling said coaxial line to said resonant circuit, and means carried by said envelope and adjustably supporting said coaxial line to enable the movement of said coupling loop relative to said resonant circuit to vary the inductive coupling therebetween.

5. A magnetron comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line including an outer tubular conductor and an inner coaxial conductor, one end of said outer tubular conductor opening into said envelope and the other end thereof being hermetically sealed, a coupling loop connected at one end to said outer tubular conductor and at its opposite end to said inner conductor and extending into said envelope coupling said coaxial line to said resonant circuit, said coaxial line being approximately tuned to the frequency of said resonant circuit and movably mounted and hermetically sealed in a wall of said envelope to thereby enable the movement of said coupling loop relative to said resonant circuit to vary the inductive coupling therebetween.

6. An electron discharge device comprising: an evacuated enveloped, electrode elements within said envelope providing a resonant circuit, a circuit separate from said electrode elements providing a reactance, a coupling loop carried by said reactance circuit and extending into said envelope, in spaced relationship to said resonant circuit, for inductively coupling said resonant and reactance circuits, and means carried by said envelope and adjustably supporting said reactance circuit to enable variation of the spacing between said coupling loop and said resonant circuit for varying the coupling therebetween.

7. An electron discharge device comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a circuit separate from said electrode elements approximately tuned to the frequency of said resonant circuit and providing a reactance, a coupling loop carried by said reactance circuit and extending into said envelope, in spaced relationship to said resonant circuit, for inductively coupling said resonant and reactance circuits, and means carried by said envelope and adjustably supporting said reactance circuit to enable variation of the spacing between said coupling loop and said resonant circuit for varying the coupling therebetween.

8. An electron discharge device comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line having one end thereof opening into said envelope and approximately tuned to the frequency of said resonant circuit but off to one side at resonance providing a reactance, a coupling loop carried by said coaxial line and extending into said envelope, in spaced relationship to said resonant circuit for inductively coupling said resonant circuit and said coaxial line, and means carried by said envelope and adjustably supporting said coaxial line to enable variation of the spacing between said coupling loop and said resonant circuit for varying the coupling therebetween.

9. An electron discharge device comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line having one end thereof opening into said envelope and approximately tuned to the frequency of said resonant circuit but off to one side at resonance providing a reactance, a coupling loop, carried by said coaxial line, inductively coupling said resonant circuit and said coaxial line, said coaxial line being movably mounted to vary the spacing between said coupling loop and said resonant circuit and thereby vary the coupling between said line and circuit.

10. An electron discharge device comprising: an evacuated envelope, electrode elements within said envelope providing a resonant circuit, a coaxial line having one end opening into said envelope and the other end hermetically sealed and approximately tuned to the frequency of said resonant circuit but off to one side at resonance providing a reactance, a coupling loop inductively coupling said resonant circuit and said coaxial line, a flexible diaphragm mounted in a wall of said envelope and hermetically sealed therewith, said coaxial line being sealed in an opening through said diaphragm whereby movements of said line vary the spacing between said coupling loop and said resonant circuit for varying the coupling therebetween.

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