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TUNABLE GENERATOR FOR ULTRA HIGH FREQUENCIES

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Fig. 1.

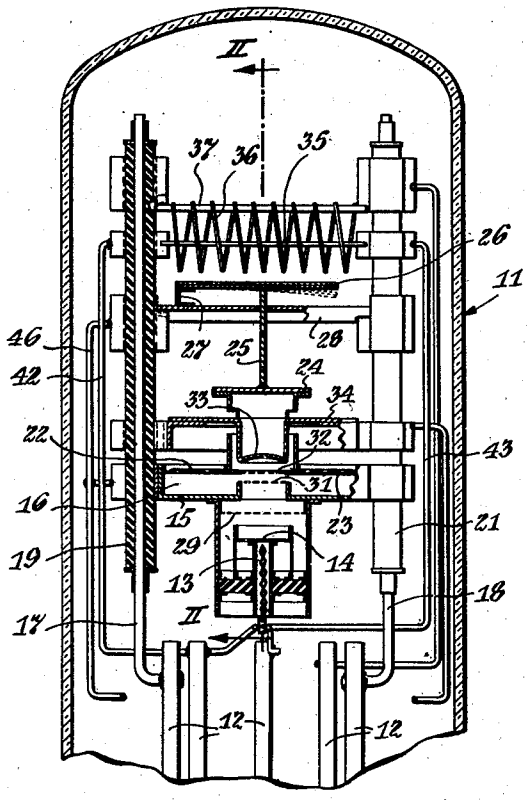


Fig. 2.

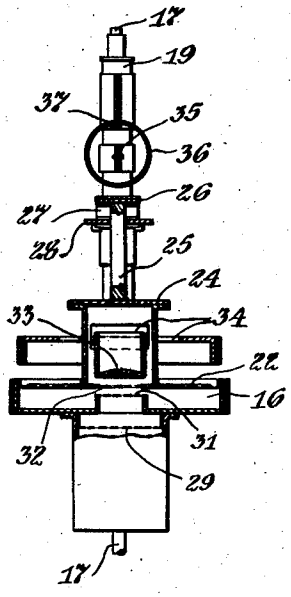
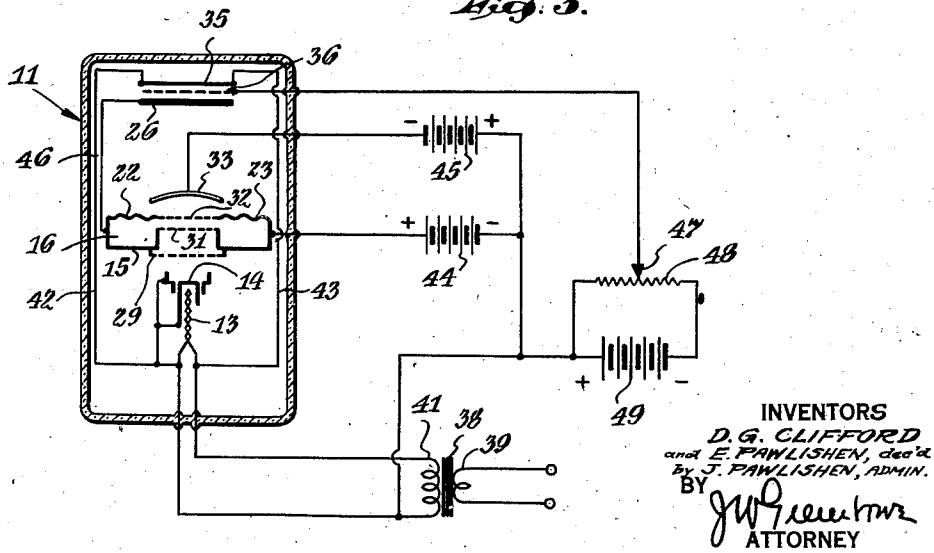


Fig. 3.



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TUNABLE GENERATOR FOR ULTRA HIGH FREQUENCIES

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9 Claims. (Cl. 315—5)

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This invention relates to ultra-high frequency devices and generators for electricity of ultra-high frequency, and more particularly to such having tunable resonant cavities enclosed in evacuated envelopes.

The principal object of the invention, generally considered, is to provide an electronic device comprising an evacuated envelope enclosing a cavity resonator associated with other elements for effecting the desired result, said resonator having a flexible wall, temperature-responsive means in said envelope for adjusting the position of said wall to tune the resonator, means to effect a heating discharge to said temperature-responsive means, and means for controlling the intensity of said discharge in order to properly tune the resonator.

Another object of the invention is to provide for the tuning of resonant cavities in the evacuated envelopes of ultra-high frequency generators by means avoiding time delay and possiblity of leaks.

A further object of the invention is to provide a device for generating electricity of ultra-high frequency, consisting of an evacuated envelope enclosing a main cathode, a cavity resonator through which an electron stream from said main cathode may pass, bimetallic means for moving a flexible wall of said resonator to tune the same, and means for effecting an independent, accurately-controllable, discharge to said bimetallic means to accurately position said flexible wall to effect tuning.

Other objects and advantages of the invention, relating to the particular arrangement and construction of the various parts will become apparent as the description proceeds.

Referring to the drawings illustrating the invention:

Fig. 1 is a fragmentary axial sectional view of an electron device for generating electricity of ultra-high frequency and involving one embodiment of the invention.

Fig. 2 is a fragmentary axial sectional view on the line II—II of Fig. 1, in the direction of the arrows.

Fig. 3 is a wiring diagram for the apparatus of Figs. 1 and 2.

The use of a cavity resonator as an integral part of an electronic device brought about certain problems in connection with tuning such a resonator by change of its physical dimensions, when in the evacuated device. Early methods involved the use of flexible diaphragms. Later, tuning was effected by the insertion of metallic

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slugs into reentrant seals. Cavity resonators wholly enclosed in vacuum may be tuned by thermal means, either by expansion of a thin walled piece of tubing or by filaments working against springs. Certain difficulties, however, are inherent in both of these methods, although they will function.

In considering the possibility of using bimetallic elements to accomplish tuning, it was found very difficult to obtain a bimetallic strip having two necessary qualifications, first, sufficient width and thickness to have mechanical rigidity, and second, sufficient electrical resistivity to give a volt-ampere characteristic in a range consistent with practical application. A filament may be employed to heat the bimetallic strip, but thermal delay and other disadvantages make this undesirable.

In accordance with the invention, we effect the desired tuning of a cavity resonator in an evacuated envelope by employing a bimetallic strip and making it the anode of a small triode. Such triode includes a source of electrons, which may be a filament of any suitable material or an indirectly heated cathode. Between this source and the bimetallic element, functioning as an anode, is a grid structure controlling the flow of electrons from the source of electrons to the bimetallic element.

By virtue of this construction, we provide heating power due to electron bombardment, whereby the device will respond more rapidly than a strip heated by radiation from a filament, and effect control by a negative grid which requires substantially no power. We thus simplify control circuits external to the tube but required for its operation.

Now referring to the drawings in detail, the reference numeral 11 designates an evacuated envelope which may be generally cylindrical and made from an appropriate dielectric such as glass. The envelope is rigid throughout and does not need to have any moving parts projecting therethrough in order to embody the invention. Lead-in conductors or elements 12 are shown for making the desired connections. Two of these elements connect with an incandescible filament 13 for heating an associated cathode 14 to electron-emitting temperature. The cathode 14 has its upper or active surface desirably coated with electron emission material, such as alkaline earths.

The structure which surrounds the filament 13 and cathode 14 may be of generally conventional construction and carried by the lower or base-

adjacent wall 15 of a cavity resonator 16 which wall is in turn carried by support members 17 and 18, of nickel or other desirable material, enclosed in ceramic insulating cylinders 19 and 21, and carried by a pair of lead-in conductors 12. The upper or opposite wall of the cavity resonator 16, consists of a resilient metal plate 22 which may be generally annular in plan and carry concentric corrugations 23 for increasing its effective flexibility. The central portion of the plate 22 is connected to a hollow yoke structure 24 which is in turn connected through a strut 25 to approximately the center of a bimetallic plate 26. One edge of the plate is mounted, as by welding on a channel member 27, the latter in turn carried by a rigid cross brace 28 extending between and supported on the ceramic members 19 and 21.

In operation, a beam of electrons is directed axially of the envelope from the cathode 14, through a grid 29 carried by the cathode structure, a grid 31 carried by an upstanding or axially directed flange defining an opening in the lower wall 15 of the cavity resonator 16, and a grid 32 carried by the upper or flexible wall 22 of the resonator and spanning the central opening in the yoke structure 24, after which said electrons engage and are reflected back from a member 33. The reflector 33 is mounted on a transverse bracing structure 34, supported by the ceramic members 19 and 21.

From the above, the construction will be recognized as a hollow body resonant micro-wave generator of the reflex type, called a reflex klystron, wherein the upward or forwardly moving electrons are bunched in passing through the constriction between the grids 31 and 32, giving up energy while passing back therethrough in bunches on the reflected or return path. Tuning of the resonant chamber 16 may, therefore, be obtained by changing the spacing between the grids 31 and 32 and the distance between the walls 15 and 22.

To make such a change we provide a means for heating the bimetallic element 26 to cause the same to flex down, or toward the main cathode 14, from the position shown in full lines to that shown in dotted lines, to thereby move the flexible wall 22 and its associated grid 32 closer to the lower or base-adjacent wall 15 defining the cavity resonator 16. Such action lowers the generated frequency, as will be understood by those skilled in the art. It will also be understood that such devices may be constructed so that when the bimetallic element 26 is at room temperature, the frequency generated may be a little higher than that desired. The frequency desired may then be produced by heating the bimetallic element 26 to the necessary extent.

Mounted above the bimetallic element 26, or on the other side from the cathode 14, is a control cathode 35 which may be an incandescible filament or indirectly heated electron emissive surface, the ends of which are supported by the insulating cylinders 19 and 21. In the present embodiment we have shown a helical coil 36 surrounding the cathode 35 so as to control the electronic stream between it and the bimetallic element 26. This, however, is not essential, as a grid disposed entirely between the cathode 35 and bimetallic element 26 may be employed. This grid 36 is shown supported by a wire 37 the ends of which are respectively secured to the insulating cylinders 19 and 21.

The mode of operating the generator of Figs. 1 and 2 will be apparent from the wiring diagram

of Fig. 3. The reference character 38 represents a transformer, the primary winding 39 of which is supplied from a suitable source of power which may be 60 cycle alternating current. The secondary winding 41 supplies power to the cathode heating filament 13, as well as by the shunt wires 42 and 43 to the heating means of auxiliary or control cathode 35. The cavity resonator including the walls 15 and 22 is maintained at a positive potential with respect to the cathode 14, as represented by the battery 44, while the reflector 33 is made negative with respect to said cathode 14, as represented by the battery 45. The bimetallic element 26 is shown maintained at the same potential as the walls of the resonant chamber 16 by electrical connection 46 and the potential of the control grid 36 is manually variable, being governed by moving a pointer 47 of a rheostat or voltage divider 48, the ends of which are connected across a source of direct current such as battery 49.

It will, therefore, be seen that by making the voltage of the control grid 36 more or less negative with respect to the electron-emitting auxiliary cathode 35, the discharge of electrons therefrom to heat the bimetallic element 26 to the desired temperature, may be accurately controlled. Thus the position of the flexible wall 22 and its associated grid 32 may be adjusted to make the frequency of the generated electricity that desired, within the limits allowed by the structure.

From the foregoing, it will be seen that there is provided an electron device for generating ultra-high frequency in which all the essential parts are enclosed in an evacuated envelope, even including the bimetallic means for tuning the resonant cavity by changing the physical dimensions thereof and the spacing of the grids associated therewith. It will be noted that only one extra base pin or terminal is required, that is for the grid 36, since the control cathode may be operated in parallel with the main cathode and the bimetallic element directly connected to the resonant chamber.

Although a preferred embodiment of the invention has been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

We claim:

1. An ultra-high frequency generator of the reflex klystron type, comprising an evacuated envelope, a main electron-emissive cathode, a cavity resonator through which said cathode may discharge a beam of electrons, a reflector electrode at the opposite side of the resonator from said cathode, support means for said members, one of the walls of said resonator through which said beam passes being flexible, a bimetallic plate with one end rigidly secured to said support means, a structure straddling said reflector electrode and connecting a portion of said bimetallic plate which is spaced from its secured end to the flexible wall, a control cathode disposed adjacent said bimetallic plate and toward the end of said envelope remote from said main cathode, a grid between said control electrode and plate, potential source means coupled to said plate and main cathode for making said plate function as an anode for said control cathode, an electrical supply source adapted to be manually varied in potential, and connections thereto from said main cathode and grid for regulating the potential of the latter, to thereby govern the intensity of a heating electron bombardment between said con-

trol cathode and bimetallic plate, and by virtue of the corresponding movement of said element upon changing its temperature, adjustably position said flexible wall to effect a desired tuning of said device.

2. An ultra-high frequency device comprising a main electron-emissive cathode, a cavity resonator adjacent thereto, bi-metallic means having one end fixed with respect to the device, allowing the remainder to have flexing movement to and from said resonator, means connecting a movable portion of said bimetallic means to said resonator, a control cathode disposed adjacent said bimetallic means, a grid disposed between said control cathode and said bimetallic means, potential-source means coupled to said bimetallic means and control cathode for making said bimetallic means function as an anode for said control cathode, an envelope enclosing all of said elements, connections from said control cathode to a source of current for effecting an electron discharge from said control cathode through said grid to said bimetallic means to heat the same to a desired temperature, a manually-variable electrical supply source, and connections thereto from said control cathode and grid for regulating the potential of the latter to control said electron discharge therethrough and the corresponding heat effect on the bimetallic means to adjustably distort said cavity resonator and effect a desired tuning.

3. An ultra-high frequency device comprising a main electron-emissive cathode, a cavity resonator adjacent thereto, a wall of said resonator being flexible, bimetallic means having one end fixed with respect to the device, allowing the remainder to have flexing movement to and from said resonator, means connecting a movable portion of said bimetallic means to said flexible wall, a control cathode disposed adjacent said bimetallic means at a side thereof opposite the main electron-emissive cathode, a grid disposed between said control cathode and said bimetallic means, potential-source means coupled to said bimetallic means and control cathode for making said bimetallic means function as an anode for said control cathode, an envelope enclosing all of said elements, connections from said control cathode to a source of current for effecting an electron discharge from said control cathode through said grid to said bimetallic means to heat the same to a desired temperature, a manually-variable electrical supply source, and connections thereto from said control cathode and grid for regulating the potential of the latter to control said electron discharge therethrough and the corresponding heat effect on the bimetallic means to adjustably position said flexible wall and effect a desired tuning.

4. An ultra-high frequency device comprising an evacuated envelope, a main electron-emissive cathode, a cavity resonator adjacent said cathode in said envelope, said resonator having a flexible wall, a bimetallic plate having one end fixed in said envelope so that upon heating, the remainder will flex toward said resonator, means connecting an intermediate portion of said plate to said flexible wall, a control cathode in said envelope adjacent said plate and disposed remote from said main cathode, a grid between said control cathode and plate, potential-source means coupled to said plate and control cathode for making said plate function as an anode for said control cathode, connections from

said control cathode to a source of current for effecting electron discharge from said control cathode through said grid to said plate, a manually-variable electrical supply source, and connections thereto from said control cathode and grid for regulating the potential of the latter to control said electron discharge therethrough and the consequent heating of said bimetallic plate to adjustably position said flexible wall and effect a desired tuning.

5. A discharge device comprising an evacuated envelope enclosing a main cathode, a cavity resonator through which an electron stream from said main cathode may pass, one of the walls of said resonator being distortable, bimetallic means operably connected to said distortable wall, a control cathode, a grid therefor, potential-source means coupled to said bimetallic means and control cathode for making said bimetallic means function as an anode for said control cathode, connections from said control cathode to a source of current for effecting an independent discharge to said bimetallic means to quickly heat it to a desired extent, a manually-variable electrical supply source, and connections thereto from said control cathode and grid to control said independent discharge to vary the heating of the bimetallic element and thereby the physical dimensions thereof to accurately position said distortable wall and effect tuning of the resonator.

6. A tuning device for an electron-discharge element through which a discharge may pass from a main electron source in an evacuated envelope, comprising temperature-responsive means enclosed therein and attached to said element, a control cathode, a grid therefor, potential-source means coupled to said temperature-responsive means and control cathode for making said temperature-responsive means function as an anode for said control cathode, connections from said control cathode to a source of current for effecting an independent electron discharge to said temperature-responsive means, a manually-variable electrical supply source, and connections thereto from said control cathode and grid to vary the heating of the temperature-responsive means and thereby its physical dimensions to vary the physical dimensions of said element and effect a desired tuning.

7. A discharge device comprising an evacuated envelope, a main electron source therein, and a tuning device for an element through which a discharge may pass from said source, comprising bimetallic means attached to said element, a control cathode, a grid therefor, potential-source means coupled to said bimetallic means and control cathode for making said bimetallic means function as an anode for said control cathode, connections from said control cathode to a source of current for effecting an independent electron discharge to said bimetallic means, a manually-variable electrical supply source, and connections thereto from said control cathode and grid to vary the heating of said bimetallic means and thereby the physical dimensions thereof to vary the physical dimensions of said element and effect a desired tuning.

8. An ultra-high frequency device comprising a main electron source, a cavity resonator adjacent thereto, temperature-responsive means attached to said resonator to vary physical dimensions thereof, a control cathode adjacent said temperature-responsive means, a grid for

said control cathode, potential-source means coupled to said temperature-responsive means and control cathode for making said temperature-responsive means function as an anode for said control cathode, an envelope enclosing all of said elements, connections from said control cathode to a source of current exterior of said envelope for effecting an electron discharge through said grid between said control cathode and temperature-responsive means, a manually-variable electrical supply source, and connections thereto from said control cathode and grid for regulating the potential of the latter to control the heating effect produced by said discharge and adjustably distort said resonator to effect a desired tuning.

9. An ultra-high frequency device comprising a main electron source, a cavity resonator adjacent thereto, a wall of said resonator being flexible, temperature-responsive means connected to said flexible wall, a control cathode disposed adjacent said temperature-responsive means but relatively remote from said main electron source, a grid for said control cathode, potential-source means coupled to said temperature-responsive means and control cathode for making said temperature-responsive means function as an anode for said control cathode, an envelope enclosing all of said elements, connections from said control cathode to a source of current exterior of said envelope for effecting an electron discharge through said grid between said control cathode and temperature-responsive means, a manually-variable electrical supply source, and connections thereto from said control cathode and grid for regulating the potential of said grid to control the heating effect produced by said discharge and adjustably position said flexible wall to effect a desired tuning.

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