Aug. 30, 1949. H. W. GARBE 2,480,462

TUNABLE MAGNETRON

Filed Jan. 7, 1944

FIG. 1

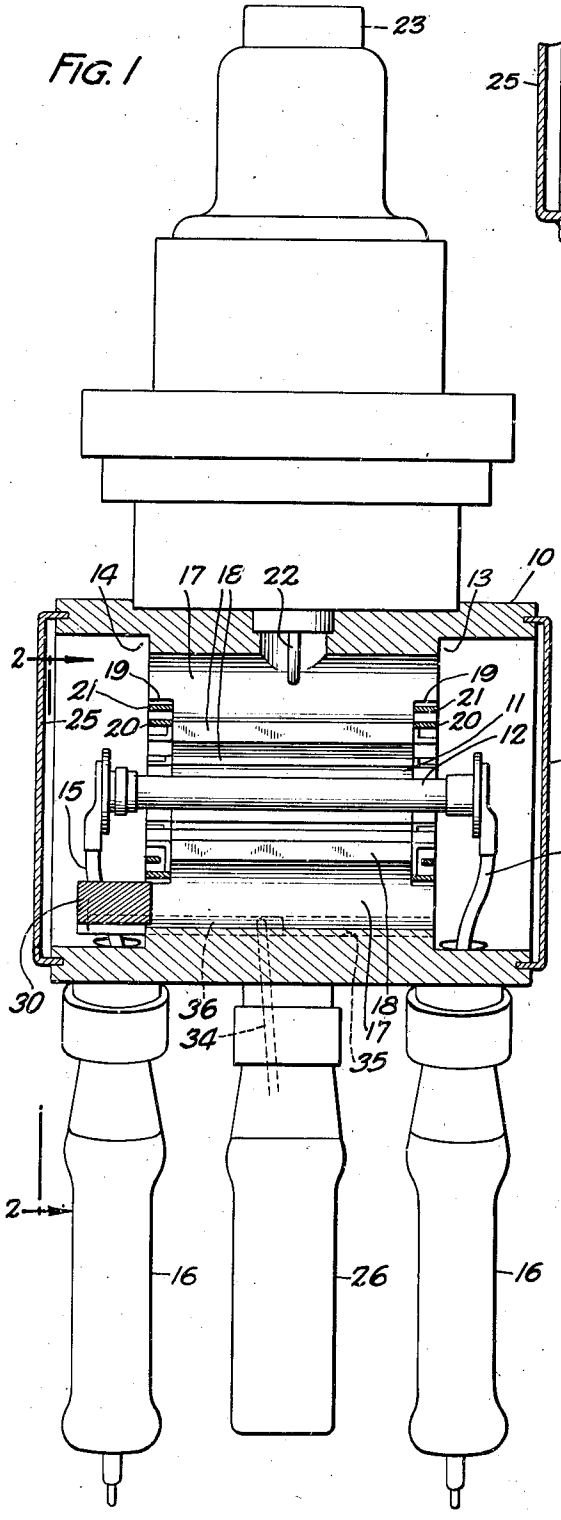


FIG. 3

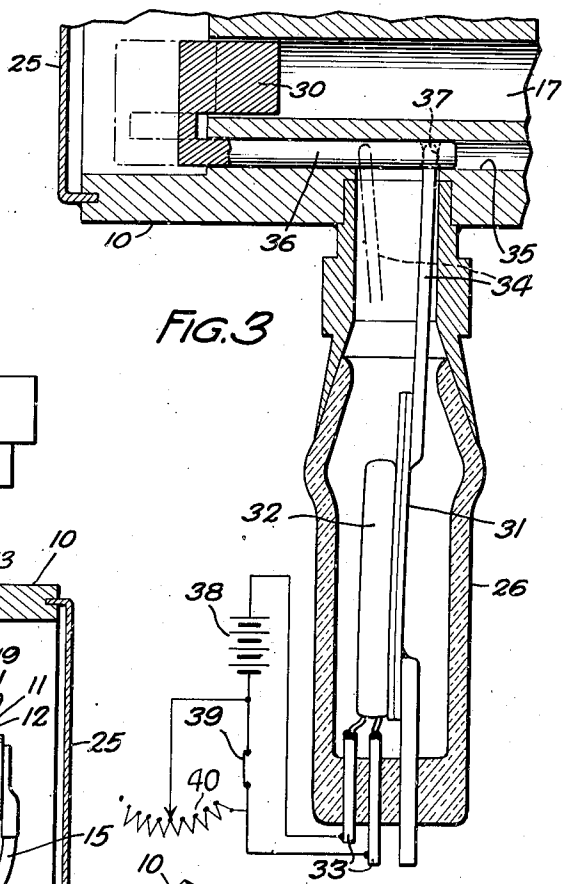
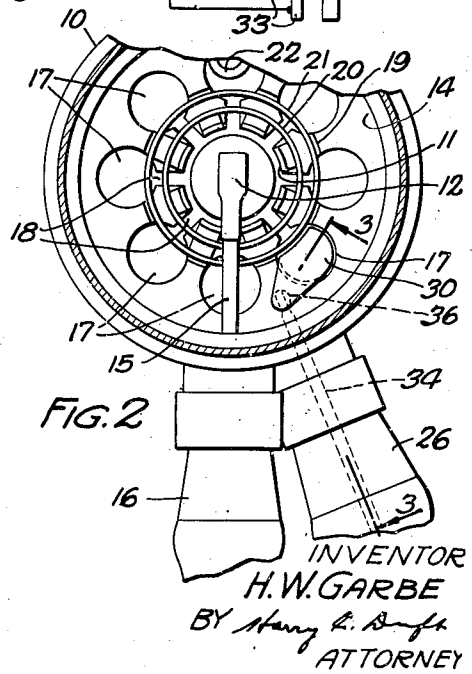


FIG. 2



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TUNABLE MAGNETRON

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1 Claim. (Cl. 315—40)

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This invention relates to tunable magnetrons and more particularly to a method of and apparatus for varying the output frequency of a magnetron oscillator.

Magnetron oscillators of the type consisting, in their simplest form, of a two-element tube with a cylindrical plate structure and a co-axial filament used with a magnetic field parallel to or nearly parallel to the filament, are widely used as generators of ultra high frequency oscillations. In the operation of electronic apparatus employing a magnetron oscillator, it is sometimes desirable to be able to vary the frequency of the magnetron oscillator, as, for example, where the frequency employed is jammed by enemy action. While several methods are known for varying the frequency of magnetron oscillators, they involve extensive changes in the tuning of the various elements of the oscillator circuit and cannot be readily employed.

An object of the present invention is to provide an efficient and effective method of and apparatus for readily varying the output frequency of a magnetron oscillator.

In accordance with one embodiment of this invention, the frequency of a magnetron oscillator may be switched to another predetermined frequency or several other predetermined frequencies by moving one or more plugs into one or more of the planetary apertures of the magetron anode body to decrease the volumetric size of the resonant cavity, the plug being moved preferably by a bi-metallic strip to which it is connected and which is provided with a remotely controllable heater element.

Other objects and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the drawings, wherein

Fig. 1 is a side elevation, partly in section, showing a magnetron oscillator tube constructed in accordance with one embodiment of the present invention;

Fig. 2 is a fragmentary, vertical sectional view along the line 2—2 of Fig. 1; and

Fig. 3 is an enlarged vertical sectional view along the line 3—3 of Fig. 2.

Referring now to the drawings and particularly to Fig. 1 thereof, a magnetron oscillator tube is there illustrated comprising a cylindrical anode block 10, which may be made of copper, and which has formed therein an axially extending cylindrical cathode chamber 11 in which a cylindrical cathode 12 is disposed having a suitable heater element positioned therein. Cylindrical

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recesses 13 and 14 are formed in the right and left ends, respectively, of the block 10, as viewed in this figure, and the ends of the cathode 12 extend into these recesses where they are connected to rigid supporting leads 15. The leads 15 are vertically disposed and their lower ends extend through tubular glass seals 16 mounted on the lower side of the anode block 10. Suitable current supplying means, not shown, may be connected to these leads to provide the current required for the cathode heater element.

Radially spaced about the cathode chamber 11 are eight planetary axially extending cylindrical apertures 17 which are connected to the center of the cathode chamber 11 by eight radial slots 18. The cathode chamber, the planetary apertures and the slots cooperatively form the resonant cavity, the volumetric size of which is one of the factors which determine the frequency of oscillation of the magnetron. Two small circular straps 20 are mounted in suitable circular recesses 19, formed at either end of the anode block 10 within the recesses 13 and 14, as shown, and are welded to alternate areas between the planetary apertures 17, while two other circular straps 21 of somewhat greater size than the straps 20 are mounted concentrically of the straps 20 and connect the alternate areas between the planetary holes not connected by the straps 20. A pickup loop 22 extends downwardly from an output lead 23, which is mounted on the upper side of the anode block 10, into the upper of the planetary apertures 17, the loop being electrically connected to the output lead 23.

End plates 25 are welded to either end of the anode block 10 and the entire tube is sealed against air. After the various parts of the tube have been assembled and the end plates welded into place, the air in the tube is substantially completely evacuated through a pumping tube 26 which is connected to the lower end of the anode block 10 and is spaced between the cathode filament leads 16, as shown in Figs. 1 and 2.

The total volumetric size of the resonant cavity formed by the eight planetary apertures, the slots and the cathode chamber, directly affects the frequency of the magnetron oscillator, and a reduction in the total volumetric size will proportionately reduce this frequency of oscillation. By moving a plug 30, of suitable diameter to fit closely within a planetary aperture, into one of these planetary apertures, it will be apparent that the volumetric size of the planetary apertures, and therefore of the resonant cavity, will be reduced. It has been found, in accordance with this in-

vention, that by inserting a plug in one of the planetary apertures, the output frequency of the magnetron oscillator may be materially changed and may be switched from the normal operating frequency to a predetermined other frequency without affecting the efficiency of the unit.

In accordance with one embodiment of this invention, which may be practiced with very slight modification of the magnetron unit, the plug **30** may be moved into the end of one of the planetary holes **17** by a bi-metallic element **31** which may be mounted, as shown in Fig. 3, in the pumping tube **26**. A heater element **32** is positioned adjacent the high expansive side of the bi-metallic element **31** and is provided with leads **33** which extend through the base of the sealed pumping tube **26** and are connected to a suitable source **38** of current, such as a battery. A switch **39** is provided for controlling the actuation of the heater element **32**. A bar **34** is welded to the upper end of the bi-metallic strip **31** and the upper end of the bar extends into a small, longitudinally extending aperture **35** formed mid-way between two of the planetary holes **17**, as shown in Fig. 2. An integrally formed rod shaped portion **36** which extends to the right, as shown in Fig. 3, of the plug **30**, is slidably positioned in the hole **35** and is provided with a notch **37** into which the upper end of the rod **34** extends. It will be apparent, thus, that moving of the rod **34** from one side to the other will cause movement of the plug **30** either into or out of the planetary hole **17** with which it is associated. The bi-metallic strip is preferably pre-loaded so that the operating temperature of the magnetron tube will not cause it to move, that is, the additional heat of the heater element **32** should be necessary to cause any movement of the bi-metallic element **31**.

In the operation of the tuning device, when it becomes desirable to change the frequency of oscillation of the magnetron tube, the switch **39** is closed and current is applied to the heater element **32** to cause the bi-metallic strip to move the rod **34** attached thereto to the right as viewed in Fig. 3. This causes the plug **30** to enter the planetary hole **17** with which it is associated. It will be apparent that the device could be made continuously adjustable by employing a rheostat **40** to adjust the current supplied to the heater element **32** instead of the switch **39**. The tuning device could be made remotely controllable by locating the switch **39** on the control panel of the apparatus with which the magnetron is to be used.

While it is believed that the foregoing tuning device is the simplest method of readily varying the frequency of the magnetron oscillator and would involve the least modification of the magnetron tube, it would involve no departure from the spirit or scope of the present invention to substitute for the heater element and bi-metallic strip, a solenoid which obviously could be remotely controlled, or a Sylphon type bellows, either of which could be connected to the plug **30** so as to impart the desired movement thereto, and both of which could be operated by remotely controllable means.

What is claimed is:

A variable frequency magnetron tube including an anode body having a cathode chamber, an aperture therein and a slot leading from said chamber to said aperture, a tubular pumping seal connected to said anode body for evacuating the air therefrom, a plug receivable in said aperture for varying the volumetric size of the interior of said tube to alter the frequency of oscillation of the magnetron, a bi-metallic strip mounted within said tubular pumping seal and having its upper end movable upon the application of heat, means movably connecting the upper end of said bi-metallic strip to said plug, means positioned in said pumping seal for heating said bi-metallic strip to move said plug into or out of said aperture, and means extending out of said seal for supplying electrical current to said heating means.

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