Sept. 22, 1953 F. H. CRAWFORD 2,653,276

TUNABLE MAGNETRON TUBE

Filed Jan. 3, 1946

FIG. 1

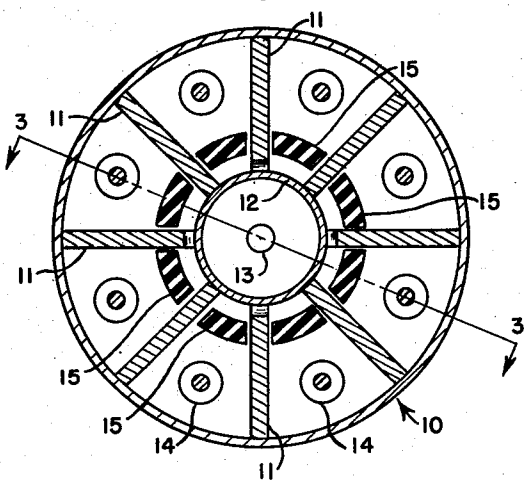



FIG. 2

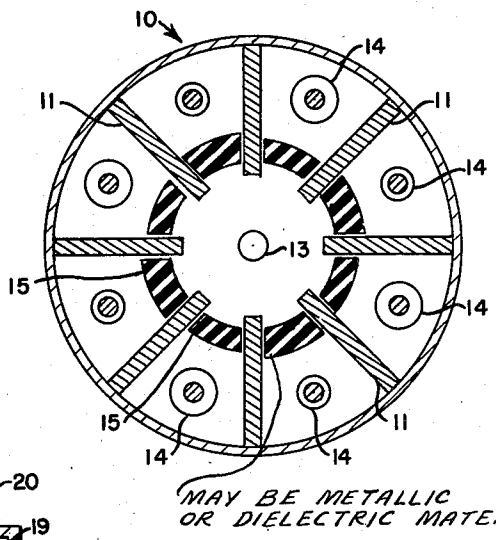
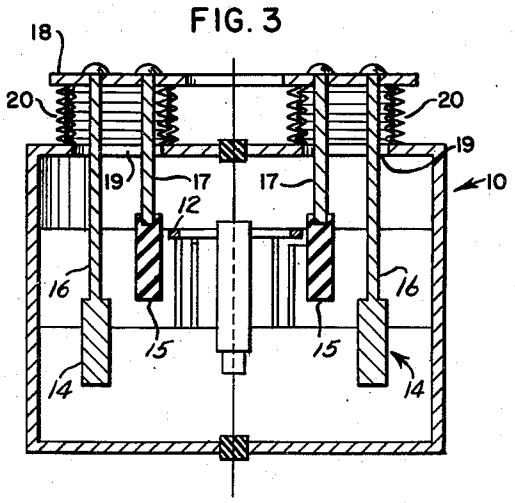



FIG. 3




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## TUNABLE MAGNETRON TUBE

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Application January 3, 1946, Serial No. 638,896

9 Claims. (Cl. 315—40)

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This invention relates generally to ultra-high frequency oscillator tubes. More particularly it relates to an improvement in tunable magnetrons permitting anode segments to be unstrapped.

In the development of oscillators of the magnetron type numerous problems have existed. One of these problems has been due to the fact that this device has been subject to multi-moding and this inclination has necessitated the use of anode strapping. This imposed mechanical limitation upon the flexibility of its use and it added a structural requirement in its fabrication.

It is one of the objects of this invention therefore to improve the construction of magnetron tubes by eliminating the use of anode strapping without permitting the tube to become prone to multimoding.

In general this invention contemplates the use of a magnetron either of the type known to the art as a plural cavity magnetron, or of the type known as a vane type magnetron, combined with tuning elements which can be controllably introduced in a conventional manner into the electric and the magnetic fields of the resonant cavities formed in the magnetron so as to increase or decrease simultaneously the capacitance and the inductance of the resonant cavities, thereby altering the inductance-capacitance (LC) product of the cavities and thus altering the frequency of oscillation. The said associated means, however, are of novel design which avoids the need of anode strapping.

Other objects, features and advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the following description of the invention taken in connection with the accompanying drawing in which:

Fig. 1 is a sectional view of a vane type magnetron having tuning means, the sectional view being taken in a plane which passes through the anode strap and is parallel to the ends of the cylindrical body of the magnetron;

Fig. 2 is a corresponding sectional view of the same type of magnetron as shown in Fig. 1 showing an embodiment of the novel type of the tuning means; and

Fig. 3 is a sectional view, taken in a plane passing through the axis of the cylindrical body of the magnetron along line 3, 3 of Fig. 1, of a broken away top portion of an embodiment of this invention, showing the supporting means of the tuning elements.

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The specific form of mechanical structure employed to support and to move the tuning means is not the major part of this invention but is described in my copending application Serial No. 638,895, filed January 3, 1946 and entitled Tunable Magnetron Tube.

Referring now more particularly to Fig. 1, case 10, vanes 11, strap 12, cathode 13, inductance loading slugs 14 and capacity-varying elements 15 are parts of a vane type of tunable magnetron. The space between adjacent vanes is called a cavity resonator.

An inductance loading element, such as slugs 14, when it is inserted into a resonant cavity in a part of the cavity which offers a relatively large value of lumped inductance, reduces said value of inductance and thus effects the frequency of resonance. The insertion of a capacity-varying element, such as an element 15, into the part of a resonant cavity which offers a relatively large value of lumped capacitance is capable of increasing this lumped capacitance and also effects the frequency of resonance. It is therefore conventional art to employ simultaneously both inductance loading elements and capacity-varying elements arranged so that when moved they quantitatively change the inductive and capacitive parameters in the same direction.

Referring to Fig. 2 it can be seen that the inductance loading elements and capacity varying elements which are installed in adjacent cavities in this improvement are of unequal physical dimensions and therefore have unequal inductive loading and capacitive reactance varying effects, respectively, while those of alternate cavities are equal and that anode strap 12 is not used. It has been found that the use of "non-symmetrical" elements, that is, elements having unequal impedance varying effects in adjacent cavities lessens the tendency to multimoding to such an extent that anode strapping is unnecessary. This permits a simplification in the construction of magnetrons and greater latitude in selecting the sizes and dimensions of other internal elements. It is obvious that "non-symmetry" can be achieved in a variety of ways including using elements having different sizes and different shapes or using elements composed of different materials. Moreover the same principle is fully applicable to magnetrons which are not of the vane type such, for example, as multiple cylindrical cavity magnetrons, and it is applicable whether the capacity-varying elements are composed of a conductive or of a dielectric material.

Referring now to Fig. 3 it will be seen that inductance loading slugs 14 are connected at their upper ends to rods 16 and that capacity-varying elements 15 are connected at their upper ends to rods 17. Rods 16 and 17 are part of the means used to control the positions of these elements. In length rods 17 are shorter than rods 16. This difference in length is such that the beginnings of slugs 14 occur in the same plane as the ends of elements 15. The upper ends of all rods 16 and 17 are fastened into structure 18 which has substantially the shape of a large washer whose outer diameter is approximately equal to the outer diameter of the magnetron. Pairs of rods, each pair consisting of a rod 16 and a rod 17, are free to move into and out of case 10 through holes 19. Each hole 19 is positioned above a cavity resonator of the magnetron and is large enough so that each such pair of rods fit through without touching case 10 at any point. Fastened above holes 19 with air-tight junctions at one of the ends of each of them are Sylphons 20. The other ends of Sylphons 20 are similarly attached to structure 18. In this way rods 16 and 17 are free to be pushed into or withdrawn from case 10 while a high vacuum can be and is preserved within case 10 and, of course, Sylphons 20.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention.

The invention claimed is:

1. A tunable magnetron comprising a plurality of cavity resonators, frequency adjusting means including a plurality of inductance loading conductive elements and a plurality of dielectric insert elements, said inductance loading elements and said dielectric insert elements being appreciably unequal in reactance varying properties in adjacent cavities, all of said inductance loading and all of said dielectric insert elements being adjustably supported within the resonators of said magnetrons.

2. A tunable evacuated magnetron comprising a plurality of cavity resonators, frequency adjusting means including a plurality of conductive capacitative insert elements, said elements being appreciably unequal in size in adjacent cavities and means adjustably supporting said elements within said cavity resonators.

3. A tunable evacuated magnetron comprising a plurality of cavity resonators and frequency adjusting means including a plurality of inductance loading conductive elements, some of said elements being appreciably unequal in size in adjacent cavities and means adjustably supporting said elements within said cavity resonators.



4. A tunable magnetron comprising a plurality of cavity resonators and means including inductance loading conductive elements in two of said resonators for adjusting the inductance of said two resonators, said elements being appreciably unequal in size to avoid multi-moding, whereby the oscillation frequency may be varied.

5. A tunable magnetron comprising a plurality of cavity resonators and means including capacitance-varying insert elements in two of said resonators for altering the capacitive reactance of said two resonators, said elements being appreciably unequal in size, whereby the oscillation frequency may be varied.

6. A tunable magnetron comprising a plurality of cavity resonators and means for varying the oscillating frequency of said magnetron, said means including inductance loading elements in at least two of said resonators for adjusting the inductance of said two resonators, said two elements being appreciably unequal in inductive loading effect to avoid multi-moding.

7. A tunable magnetron comprising a plurality of cavity resonators and means for varying the oscillating frequency of said magnetron, said means including capacitance varying insert elements in at least two of said resonators for altering the capacitive reactance of said two resonators, said elements being appreciably unequal in capacitance varying effect, whereby multi-moding is reduced.

8. A tunable magnetron comprising a plurality of cavity resonators and means for varying the oscillating frequency of said magnetron, said means including impedance varying insert elements in at least two of said resonators, said two elements being appreciably unequal in impedance varying effect.

9. A tunable magnetron comprising a plurality of cavity resonators having the same dimensions, and means resonating at least one of said cavity resonators to a frequency which is appreciably different from that of another of said cavity resonators.

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