April 25, 1950 F. H. CRAWFORD ET AL 2,505,529

TUNABLE MAGNETRON

Filed Jan. 17, 1946

FIG. 1

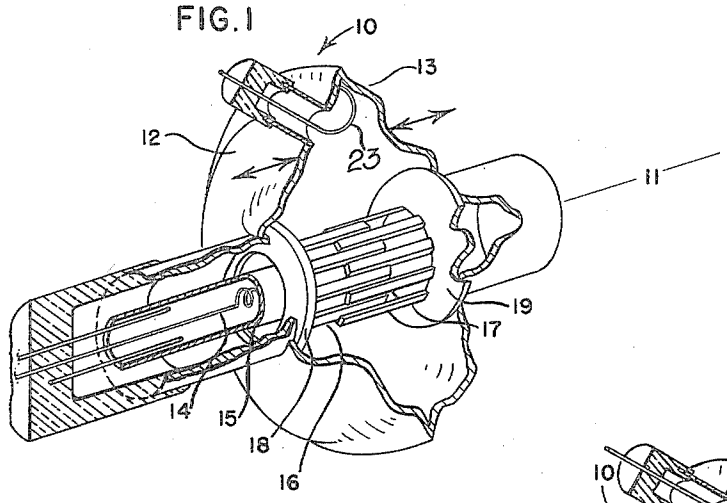


FIG. 2

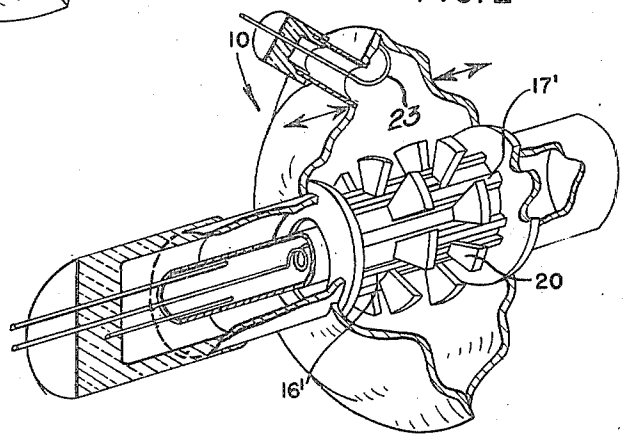
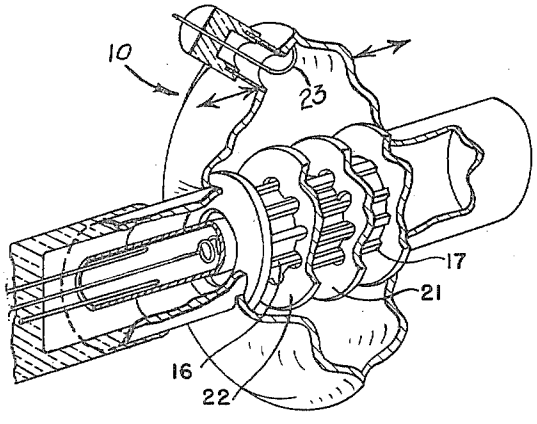


FIG. 3



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Patented Apr. 25, 1950

2,505,529

UNITED STATES PATENT OFFICE

2,505,529

TUNABLE MAGNETRON

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Application January 17, 1946, Serial No. 641,839

6 Claims. (Cl. 250—27.5)

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This invention relates to electrical apparatus and more particularly to tunable magnetrons.

One type of tunable magnetron radio frequency oscillator is the so-called "squirrel cage" magnetron. The squirrel cage magnetron is generally constructed as a cavity resonator having the shape of a figure of revolution within which is placed an axially aligned cathode structure. Concentrically arranged about this cathode and within the cavity resonator is a ring of interleaving anode posts. Alternate posts are connected at one of their ends to one of the end closures of the cavity resonator, the other ends of the posts being free. The other posts are connected at one of their ends to the other end closure of the cavity resonator, the other ends of these posts likewise being left free. The term "squirrel cage" is derived from the appearance of the cylindrical ring formed by these two sets of interleaving anode posts. A magnetic field is maintained parallel to the magnetron axis in the usual fashion.

An important object of the present invention is to provide means for tuning a squirrel cage magnetron.

A further object of the invention is to provide means for tuning a squirrel cage magnetron over a very wide range of frequencies.

A still further object is to provide means for tuning a squirrel cage magnetron without decreasing the rigidity of the magnetron structure.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the present invention the opposite end closures of the cavity resonator are constructed as flexible diaphragms. This construction allows a threefold variation of frequency-controlling dimensions:

(1) Motion of each set of anode posts with respect to the opposite end closure of the cavity resonator.

(2) Motion of the two sets of interleaving anode posts with respect to one another.

(3) Relative motion of the opposite end closures of the cavity resonator.

Other embodiments of the present invention, which result in an increase of the tuning range, terminate the free ends of the anode posts in enlarged surfaces thereby increasing the capacity variation as the posts are moved with respect to the end closures of the cavity resonator.

In the accompanying drawing in which like numerals are employed to designate like parts throughout,

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Fig. 1 is a broken-away, simplified, isometric view of one embodiment of the present invention. The flexible diaphragm-like walls of the cavity resonator and their attached anode posts are movable relative to one another.

Fig. 2 is a similar view of a second embodiment of the present invention. The anode posts are here shown terminated at their free ends in enlarged tab-like surfaces.

Fig. 3 is a similar view of a third embodiment of the present invention. The anode posts of each set are here shown terminated at their free ends in a continuous annular plate. Each of the two annular plates is perforated to allow clearance for the anode posts of the set which is attached to the opposite plate.

In Fig. 1 numeral 10 designates a cavity resonator. Cavity resonator 10 may have any of the customary cavity resonator shapes, and in general will be a figure of revolution circularly symmetrical about an axis 11. The cavity resonator 10 has two opposing flexible diaphragm-like walls or end closures 12 and 13.

Axially aligned along axis 11 are a filament 14 and cathode 15. A ring of interleaving anode posts 16 and 17 is concentrically arranged about cathode 15 and within cavity resonator 10. Alternate anode posts 16 are connected to the end closure 12 by being attached at one end to an annular washer 18 fixed to wall 12. The other anode posts 17 are connected to the end closure 13 by being attached at one end to another annular washer 19 fixed to wall 13.

Means (not shown) are provided for moving diaphragm-like end closure 12 with respect to diaphragm-like end closure 13.

The radio frequency output of the magnetron is taken off in the customary manner by coupling an output loop 23 into cavity resonator 10.

In Fig. 2, wherein is shown a second embodiment of the invention, the structure is similar save that the free ends of anode posts 16' and 17' are constructed as enlarged tab-like surfaces 20.

In Fig. 3, wherein is shown a third embodiment of the present invention, the structure is similar to that shown in Fig. 1 save that the anode posts 16 and 17 are terminated at their free ends in continuous annular plates 21 and 22 respectively. Annular plates 21 and 22 are perforated to allow clearance for the anode posts which are attached to the opposite plate.

In any of these embodiments of the invention, one of the walls 12 or 13 of cavity resonator 10 may be formed as a rigid structure. The output loop would then be coupled in through this rigid

wall in order to minimize instability of the radio frequency output which might otherwise result because of vibration of the flexible diaphragm-like wall.

The operational features of the present invention are as follows:

As has been indicated, relative motion of end closures 12 and 13 results in a threefold variation of frequency-controlling dimensions:

1. Motion of anode posts 16 with respect to end closure 13 and of anode posts 17 with respect to end closure 12.

2. Motion of anode posts 16 and 17 with respect to each other.

3. Variation of the dimensions of cavity resonator 10.

Corresponding to the variation of these frequency-controlling dimensions, there is a variation in the frequency of the magnetron.

The frequency tuning range may be increased by increasing the capacity variation as the anode posts are moved with respect to one another and with respect to the opposing end closures of the cavity resonator 10. This has been done in the device shown in Fig. 2 by the enlarged tab-like surfaces 20. In Fig. 3 the capacity variation has been increased even more by terminating the anode posts at their free ends in the plates 21 and 22.

The increasing of capacity variation as illustrated in Figs. 2 and 3, affects principally frequency-controlling dimension (1) and, to a somewhat lesser extent, frequency-controlling dimension (2).

It is to be noted as an advantage of these designs that the presence of glass within the radio frequency field is unnecessary, and as a result high losses of radio frequency energy are eliminated.

In actual practice a tuning range of the order of $\pm 50\%$ may be obtained for magnetrons utilizing the present invention.

It will be apparent that there may be deviations from the invention as described which still fall fairly within the spirit and scope of the invention.

Accordingly we claim all such deviations which fall fairly within the spirit and scope of the invention as identified in the hereinafter appended claims.

What is claimed is:

1. A tunable magnetron including a cavity resonator having the shape of a surface of revolution with two oppositely disposed end closures, a central cathode disposed substantially along the axis of said resonator, a ring of anode posts concentrically mounted within said resonator about said cathode structure, alternate posts being connected at one end to one of said end closures about said axis and the remaining posts being similarly connected at one end to the other of said end closures, the portions of said end closures about said axis being axially movable with respect to one another for relative longitudinal adjustment of adjacent anode posts thereby varying the frequency of said magnetron.

2. A tunable magnetron as in claim 1 in which the anode posts are terminated at their free ends in enlarged surfaces.

3. A tunable magnetron as in claim 1 in which the anode posts connected to one end closure are terminated at their other ends in one annular plate and the anode posts connected to the other end closure are terminated at their other ends in another annular plate, each of said plates being perforated to allow the clearance of the anode posts which are attached to the other plate.

4. A tunable magnetron including a cavity resonator having two opposing surfaces, a ring of anode posts, a coaxially disposed cathode, alternate posts being connected at one end thereof to one of said surfaces, and the other posts being connected at one end thereof to the other of said surfaces, the portions of said surfaces to which said posts are connected being movable axially of said ring for relative longitudinal adjustment of adjacent anode posts.

5. A tunable magnetron as in claim 4 in which the other ends of the anode posts are terminated in enlarged surfaces.

6. A tunable magnetron as in claim 4 in which the anode posts connected to one surface are terminated at their other ends in one annular plate and the anode posts connected to the other surface are terminated at their other ends in another annular plate, each of said plates being perforated to allow the clearance of anode posts which are attached to the other plate.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,128,237	Dallenbach	Aug. 30, 1938
2,144,222	Hollmann	Jan. 17, 1939
2,167,201	Dallenbach	July 25, 1939
2,409,222	Morton	Oct. 15, 1946
2,414,084	Bowen	Jan. 14, 1947
2,424,886	Hansell	July 29, 1947

FOREIGN PATENTS

Number	Country	Date
449,920	Great Britain	July 7, 1936