

[54] **MAGNETRONS**

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[51] **Int. Cl.**H01j 25/50

[58] **Field of Search**310/8; 315/39.55, 315/39.61, 39.77, 39.57, 39.59; 331/90, 155

[56] **References Cited**

UNITED STATES PATENTS

3,478,247 11/1969 Hull.....315/39.55
 3,478,246 11/1969 Perkins et al.....315/39.55

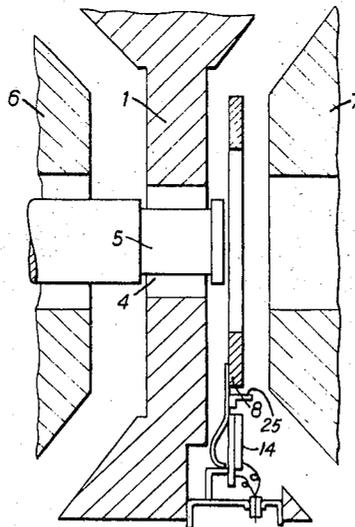
| | | | |
|-----------|--------|--------------------|-------------|
| 2,752,495 | 6/1956 | Kroger..... | 315/39.55 X |
| 3,087,124 | 4/1963 | McLeod, Jr..... | 315/39.61 X |
| 3,440,565 | 4/1969 | Scullin et al..... | 315/39.55 X |
| 3,334,261 | 8/1967 | Plumridge..... | 315/39.55 |
| 3,028,522 | 4/1962 | Pease..... | 315/39.55 X |

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[57] **ABSTRACT**

In a magnetron in which tuning is effected by a movable conductive member adjacent one end face of the anode block whose position is controlled by a piezoelectric transducer inside the envelope of the magnetron the transducer is shielded from the cathode by a layer of glass and/or a metal shield, thus reducing the deterioration of the transducer.

13 Claims, 6 Drawing Figures



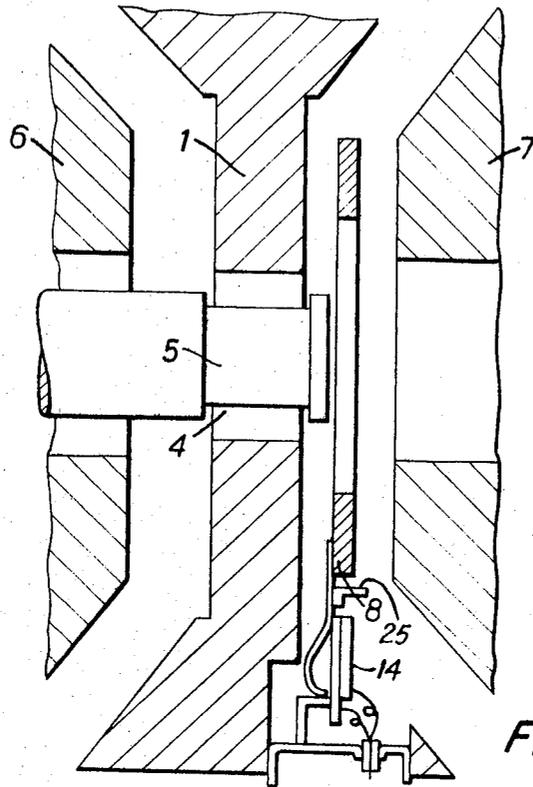


FIG. 1

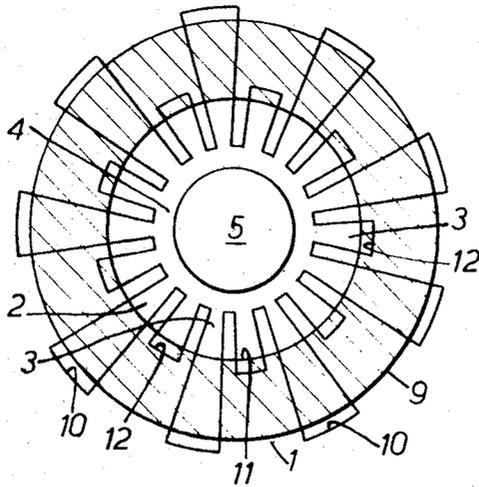


FIG. 2

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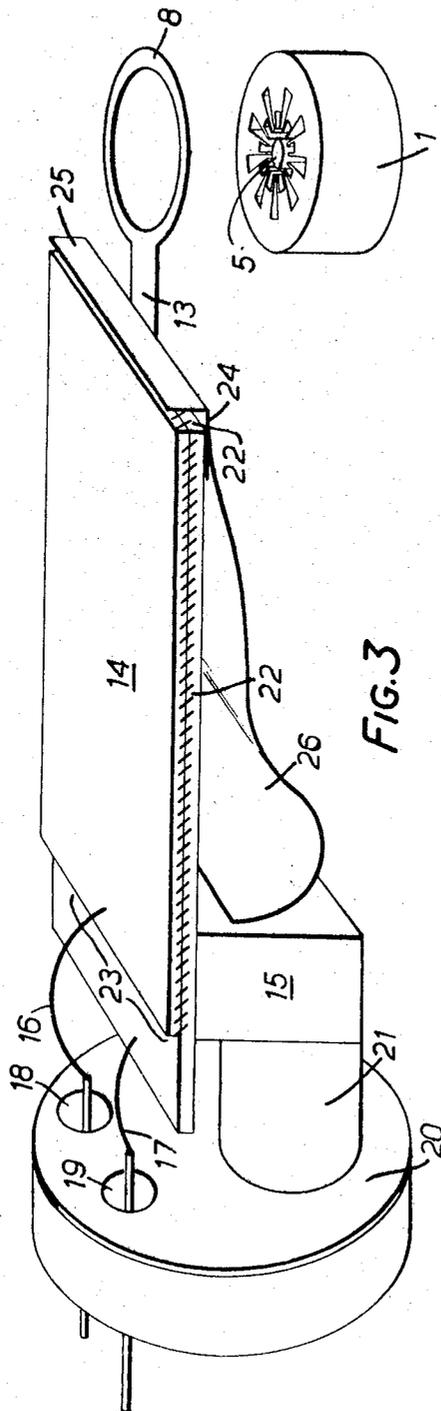
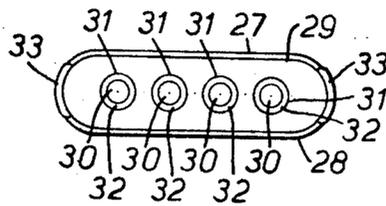
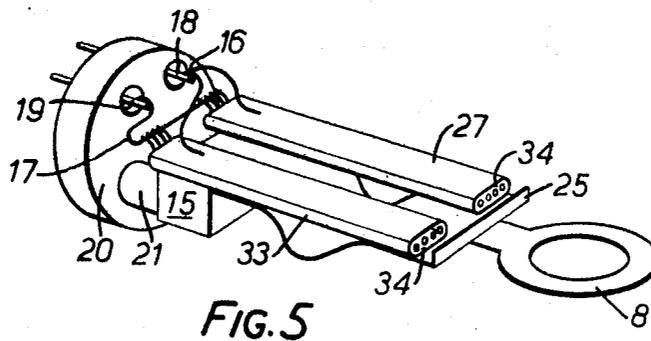
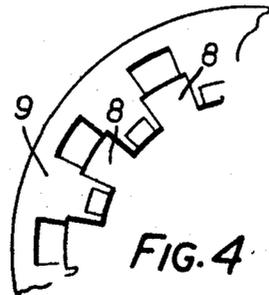


FIG. 3

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MAGNETRONS

This invention relates to magnetrons and more particularly to magnetrons of the kind in which tuning is effected by a conductive member adjacent one end face of the anode block of and movable axially towards and away from said face under the control of a piezo-electric transducer within the evacuated envelope of the magnetron.

It has been found that during service the tuning performance of the piezo-electric transducer tends gradually to deteriorate. Deterioration of the tuning performance of the tube has also been observed to take place during the processing of the tube during manufacture, e.g. cathode activation and ageing. The object of this invention is to provide improved magnetrons of the kind referred to in which the tendency for deterioration of the piezo-electric transducer to occur as above mentioned is reduced.

According to this invention in a magnetron of the kind referred to means are provided for shielding otherwise exposed regions of piezo-electric material forming said transducer from said cathode.

It is believed that the deterioration of tuning performance referred to above was due to a large extent to reaction of the piezo-electric material with gases liberated from the cathode; to the shunting effects of deposits of metal originating from the cathode, particularly on the boundary region between two portions of piezo-electric material forming said transducer when said transducer is of the bimorph type; and to a lesser amount the effects of heat. The provision of shielding means in accordance with the present invention has been found to result in a reduction in the gradual deterioration above referred to.

The shielding means may take the form of a screen mounted in front of the transducer facing the cathode or it may take the form of a deposit of insulating material on otherwise exposed regions of piezo-electric material facing the cathode. In preferred embodiments of the invention both of the above mentioned forms of screening are provided together. The deposit of insulating material is preferably provided to cover all of the edge surfaces of the piezo-electric transducer so that no region of piezo-electric material is exposed.

Preferably the insulating material is glass. The nature of the glass is not critical but a lead glass is preferred in view of its low melting point and good wetting properties. A preferred lead glass has the following mix:

Read Lead 440 gm.

Boric Oxide 132 gm.

Zinc Oxide 30 gm.

Aluminum Hydroxide 18 gm.

The glass film is suitably approximately 0.003 inches thick.

Where, as will usually be the case, the conductive tuning member is mounted on an arm (with which it may be integral) projecting from the end of a piezo-electric transducer which in turn is mounted in cantilever fashion from a relatively massive mounting block, preferably said screen is carried on said arm. Preferably again a heat conductor is connected between said arm and said mounting block in order to conduct away heat absorbed by said screen and said tuning member.

Preferred materials are copper for the arm, tuning member screen and heat conductor and kovar (nickel-copper-iron) for the mounting block.

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In one embodiment of the invention the transducer is of the bimorph type. In another embodiment of the invention the transducer is of the multimorph type.

The invention is illustrated in and further described with reference to the accompanying drawings. In the drawings like references are used for like parts.

In the drawings,

FIG. 1 is a longitudinal section of part of a magnetron of the unstrapped rising sun type tunable by means of an axially movable conductive member.

FIG. 2 is a diagram illustrating the alignment of the movable tuning member of FIG. 1 with the cavities in the anode block of the magnetron of FIG. 1.

FIG. 3 is a perspective view of a piezo-electric bimorph transducer arrangement provided in accordance with the present invention.

FIG. 4 is a part plan view of an alternative configuration for the movable tuning member of FIG. 1.

FIG. 5 is a perspective view of a piezo-electric multimorph transducer arrangement provided in accordance with the present invention and

FIG. 6 is a section of one of the piezo-electric multimorph transducers used in the arrangement of FIG. 5.

Referring to FIGS. 1 and 2 the magnetron consists of an unstrapped rising sun anode block 1 having the usual alternate arrangement of large cavities 2 and small cavities 3. The anode block 1 has an axial bore 4 in which is mounted a cathode 5. The pole pieces mounted on either side of the anode block 1 are referenced 6 and 7. Mounted between one face of the anode block 1 and the pole piece 7 is a tuning member 8 controlled (by the piezo-electric transducer not shown in FIGS. 1 and 2, but shown in FIG. 3) to move axially towards and away from the said face of the anode block 1. The tuning member 8 is a conductive annulus the outer circumference 9 of which aligns approximately with the end walls 10 of the larger cavities 2 whilst the inner circumference 11 aligns approximately with the end walls 12 of the smaller cavities 3. Thus each portion of the tuning member 8 lying over a larger cavity acts as a short circuited turn, the effect of which on the cavity increases as the member 8 is moved near to the face of the anode block 1 to increase the frequency of oscillation, and decreases as the member 8 is moved away from the face of the anode block 1 to decrease the frequency of oscillation.

Referring to FIG. 3, the annular tuning member 8 is formed at the end of, and as part of, a conductive arm 13 of copper. The arm 13 is brazed to the underside of an projects from the end of a piezo-electric transducer 14 of the bimorph type, as known per se. The transducer 14 which consists of two strips of piezo-electric material one on top of the other is mounted in cantilever fashion, on a conductive mounting block 15 of kovar (metal-copper-iron). Connecting leads 16 and 17, for applying energizing potential to the bimorph transducer, are passed out through feed-through seals 18 and 19 in a base member 20 which in turn is sealed into the walls (not shown) of the magnetron.

In accordance with the present invention, the edges 22 of the transducer and the recess 23 formed by the edge of the upper sheet of piezo-electric material and the upper surface of the lower sheet of piezo-electric material is coated with a thin film of glass, as represented by shading, to cover the otherwise exposed regions of piezo-electric material in the upper and

lower sheets. The glass is a lead glass, of film thickness 0.003 inch, having a mix as follows:

Read Lead 440 gm.

Boric Oxide 132 gm.

Zinc Oxide 30 gm.

Aluminum Hydroxide 18 gm.

In addition a sheet 24 of copper is attached with the arm 13 to the lower sheet of piezo-electric material, the end of the sheet 24 being turned up through 90° to form a screen 25 in front of the edge of the transducer facing the magnetron cathode 5. A heat conductive strap of copper is connected between the arm 13 and screen-forming sheet 24 on the one hand and the mounting block 15 on the other hand.

Referring to FIG. 4, in this case the tuning member as an outer boundary of castellated form each extension of the tuner ring 8 covering part of one of the larger cavities in the magnetron block 9. This arrangement provides a tuning rate which is greater than that of the arrangement shown in FIG. 2 in which a plain annulus has the tuning member.

Referring to FIGS. 5 and 6, the general construction of the transducer arrangement is similar to that shown in FIG. 3, but in place of a piezo-electric transducer of the bimorph type, two piezo-electric transducers of the multimorph type are used. Each of the multimorph piezo-electric transducers of FIG. 5 consists of an upper electrode 27 and a lower electrode 28 provided on a piezo-electric ceramic body 29. Within the piezo-electric ceramic body 29 centre electrodes 30 are provided which pass through holes 31. What otherwise would be free space between a wire 30 and the side wall of a hole 31 is occupied by graphite material 32. The exposed region of piezo-electric material along each side of the transducer, between upper electrode 27 and lower electrode 28, is covered by glass material 33. The end faces 34 of the transducer 27 are similarly covered.

I claim:

1. In a magnetron of the type included an anode block having an end face and provided with bore and cavity formations opening onto said end face, a cathode in said bore, and said magnetron defining an evacuated region at and surrounding said end face and in communication with said bore and cavity formations to encompass at least that portion of said cathode within said bore, the combination of:

a piezo-electric transducer disposed in said evacuated region;

a conductive member carried by said piezo-electric transducer for axial movement toward and away

from said end face in response to voltage fluctuations applied to said piezo-electric transducer; and means for shielding the piezo-electric material of said transducer, and especially any boundary region between two portions of piezo-electric material forming said transducer, from said cathode.

2. A magnetron as claimed in claim 1 and wherein said means for shielding comprises a screen mounted in front of the transducer facing the cathode.

3. A magnetron as claimed in claim 1 and wherein said means for shielding comprises a deposit of insulating material on otherwise exposed regions of said piezo-electric material facing the cathode.

4. A magnetron as claimed in claim 1 and wherein said means for shielding comprises a screen mounted in front of the transducer facing the cathode and a deposit of insulating material on otherwise exposed regions of said piezo-electric material facing the cathode.

5. A magnetron as claimed in claim 3 and wherein the deposit of insulating material is provided to cover all of the edge surfaces of the piezo-electric transducer so that no region of piezo-electric material is exposed.

6. A magnetron as claimed in claim 3 and wherein the insulating material is glass.

7. A magnetron as claimed in claim 6 and wherein said glass is a lead glass.

8. A magnetron as claimed in claim 7 and having the following mix:

Red Lead 440 gm.

Boric Oxide 132 gm.

Zinc Oxide 30 gm.

Aluminum Hydroxide 18 gm.

9. A magnetron as claimed in claim 1 and wherein the conductive member is mounted on an arm projecting from the end of said piezo-electric transducer which in turn is mounted in cantilever fashion from a relatively massive mounting block, said means for shielding comprising a screen carried on said arm.

10. A magnetron as claimed in claim 9 and wherein a head conductor is connected between said arm and said mounting block in order to conduct away heat absorbed by said screen and said tuning member.

11. A magnetron as claimed in claim 10 and wherein said arm, tuning member, screen and heat conductor are of copper and said mounting block is of kovar.

12. A magnetron as claimed in claim 1 and wherein said transducer is of the bimorph type.

13. A magnetron as claimed in claim 1 and wherein said transducer is of the multimorph type.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,727,097 Dated April 10, 1973

Inventor(s) Brian Frederick Cooper

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

"[30] Foreign Application Priority Data

July 21, 1971 Great Britain 38,081/70"

should be changed to

--[30] Foreign Application Priority Data

Aug. 6, 1970 Great Britain 38,081/70--.

Signed and sealed this 18th day of December 1973.

(SEAL)
Attest:

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Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

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