(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 316 092 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 88310043.0

(51) Int. Cl.⁴: H01J 25/587

(22) Date of filing: 26.10.88

(30) Priority: 12.11.87 GB 8726539

(43) Date of publication of application: 17.05.89 Bulletin 89/20

(84) Designated Contracting States: AT BE CH DE ES FR GR IT LI LU NL SE

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(54) Magnetron Anodes.

(57) A magnetron anode (3) has a main body (4) and a plurality of vanes (5), the main body and vanes being formed respectively of two materials of differing thermal expansivities. As a result the shift in frequency with temperature change can be controlled.

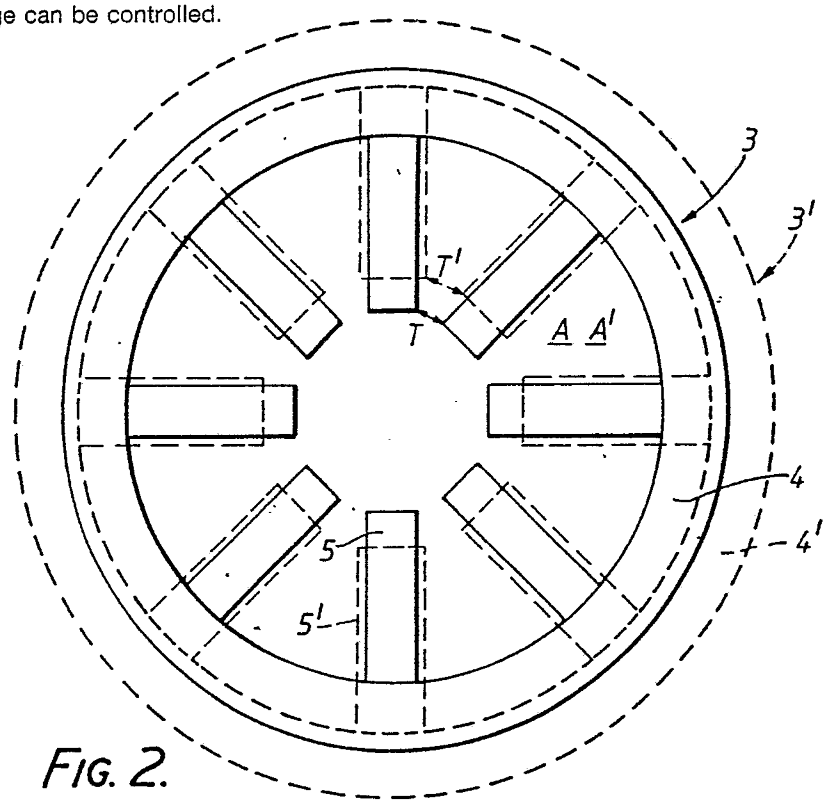

FIG. 2.

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MAGNETRON ANODES

This invention relates to anodes for use in magnetrons.

One common type of magnetron anode is shown in plan view in Figure 1 and comprises an outer cylinder 1 bearing a number of vanes 2, the whole structure usually being formed from copper.

In operation, the cavities between the vanes resonate electrically, and the resonant frequency determines the operating frequency of the magnetron.

The resonance frequency of the cavities varies with the temperature of the anode due to thermal expansion of the anode. In many applications a magnetron may be expected to operate at any temperature in the range -50°C to + 100°C, so the change in the resonance frequency of the anode may be quite significant. As a result, the operating frequency of the magnetron will alter noticeably across its operating temperature range.

At present this change in frequency with temperature is usually controlled or compensated for by the use of tuning circuits which mechanically alter the dimensions of the anode so as to keep its resonant frequency constant. This is not very satisfactory, however, because the servo-mechanisms and control system required to achieve this are complex and relatively expensive.

If it is necessary to produce a magnetron having the lowest possible change in operating frequency with temperature, the whole anode can be constructed from a material having a low thermal expansivity. However, such an anode will always exhibit some change in resonant frequency with temperature also, such materials are often unsuitable for use in an anode because of other properties required for anode material, such as high termal and electrical conducitivity, nonmagnetism and no outgassing when heated in a vaccum.

In some uses it maybe desired to produce an magnetron having a resonant frequency which does alter with temperature, it is only possible to have the resonant frequency decrease as temperature increases.

This invention provides an anode for use in a magnetron, the anode comprising a main body portion and a plurality of vanes,characterised by the body being formed from a first material and the vanes being formed from a second material, the first and second materials having different thermal expansivities.

The resonant frequency f of a magnetron anode is related to its capacitance C and inductance L by the equation:

$$f \propto \sqrt{\frac{I}{LC}} \qquad 1.$$

Referring to Figure 1 a known anode is shown, the inductance of the anode is proportional to the area A between adjacent vanes. The capacitance of the anode is inversely proportional to the separation T between the tips of adjacent vanes.

Substituting in equation 1,

$$F \propto \sqrt{\frac{T}{A}} \qquad 2.$$

When the anode heats up and expands, the ratio of T and A changes and as a result the resonant frequency alters.

By using the invention, it is possible to arrange the rates of change of T and A with temperature to be such that the variation of the resonant frequency of the anode with temperature can be controlled without the use of external circuitry.

Preferably, the first material has a greater thermal expansivity than the second material. This allows the resonant frequency of the anode to be made proportional, rather than inversely proportional, to temperature or preferably independent of temperature.

It is preferred to form the main body of the anode from copper and the vanes from molybdenum because these materials have very good electrical and thermal conductivities and have widely differing thermal expansivities and are both non-magnetic.

An anode embodying the invention will now be described by way of example with reference to the accompanying figures, in which:

Figure 2 shows an end view of a magnetron anode employing the invention.

Referring to Figure 2 a magnetron anode 3 is shown in solid lines in a first low temperature position and in dashed lines 3/ in a second higher temperature position.

The anode is formed from an outer copper main body 4,4′ and eight molybdenum vanes 5,5′. The molybdenum vanes, 5,5′ are secured to the copper main body 4,4′ by plating the vanes 5,5′ with nickel and then copper and then brazing them to the main body, 4,4′.

As the temperature of the anode 3,3′ rises, all of its component parts expand. The expansion of the main body 4 to 4′ pulls the vanes 5 outward and the vanes 5 also expand into positions 5′. As a result of this expansion, the area A expands to A′ and the vane separation T expands to T′. As the vanes 5,5′ are formed of molybdenum and the main body 4,4. is formed of copper, they expand differentially and the relative rates of change of A and T with temperature can be selected to be the same by choosing an appropriate profile for the vanes 5.

Although the invention has been described with reference to an 8-vaned magnetron anode it is applicable to magnetron anodes of any type.

Materials other than molybdenum and copper could be used, provided that they had differing thermal expansivities and their other properties were suitable for use in a magnetron anode.

Claims

1. An anode for use in a magnetron, the anode comprising a main body portion and a plurality of vanes, characterised by the body being formed from a first material and the vanes being formed from a second material, the first and second materials having different thermal expansivities.

2. An anode as claimed in claim 1 in which the thermal expansivity of the first material is greater than the thermal expansivity of the second material.

3. An anode as claimed in claim 2 in which the dimensions of the anode and the thermal expansivities of the two materials are such that the frequency of the resonant cavities defined by the anode is unaffected by changes in anode temperature.

4. An anode as claimed in any preceding claim in which the first material is copper and the second material is molybdenum.

5. An anode for use in a magnetron comprising a cylindrical annular main body portion formed of copper and a plurality of inwardly pointing radial vanes made of molybdenum.

6. A magnetron employing an anode as claimed in any preceding claim.

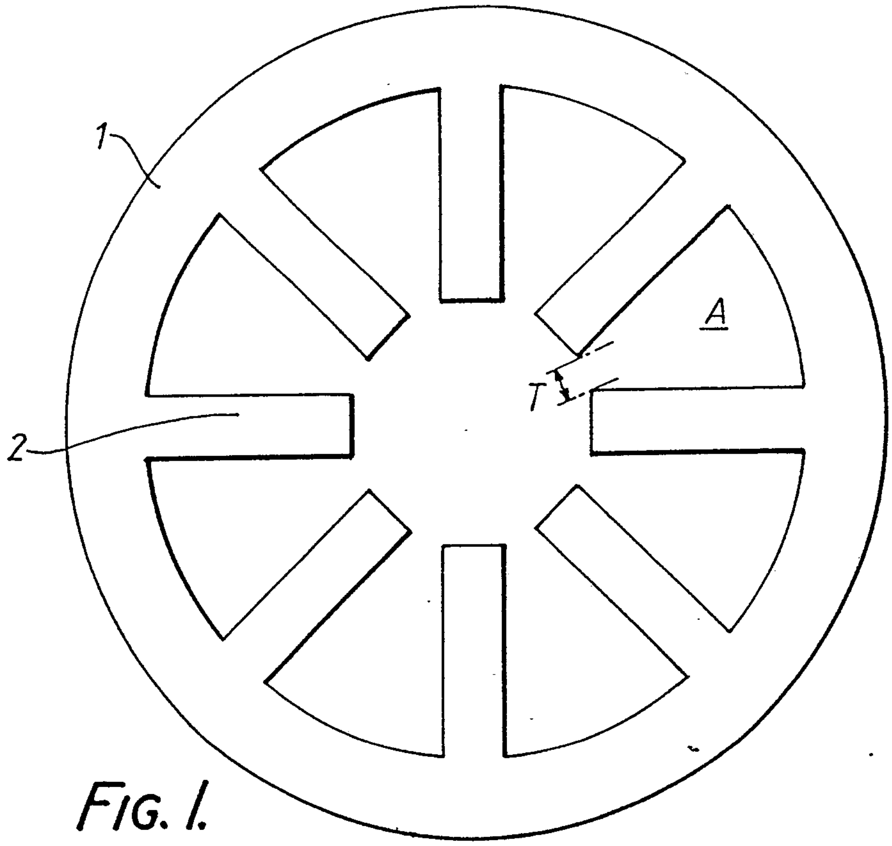

FIG. 1.

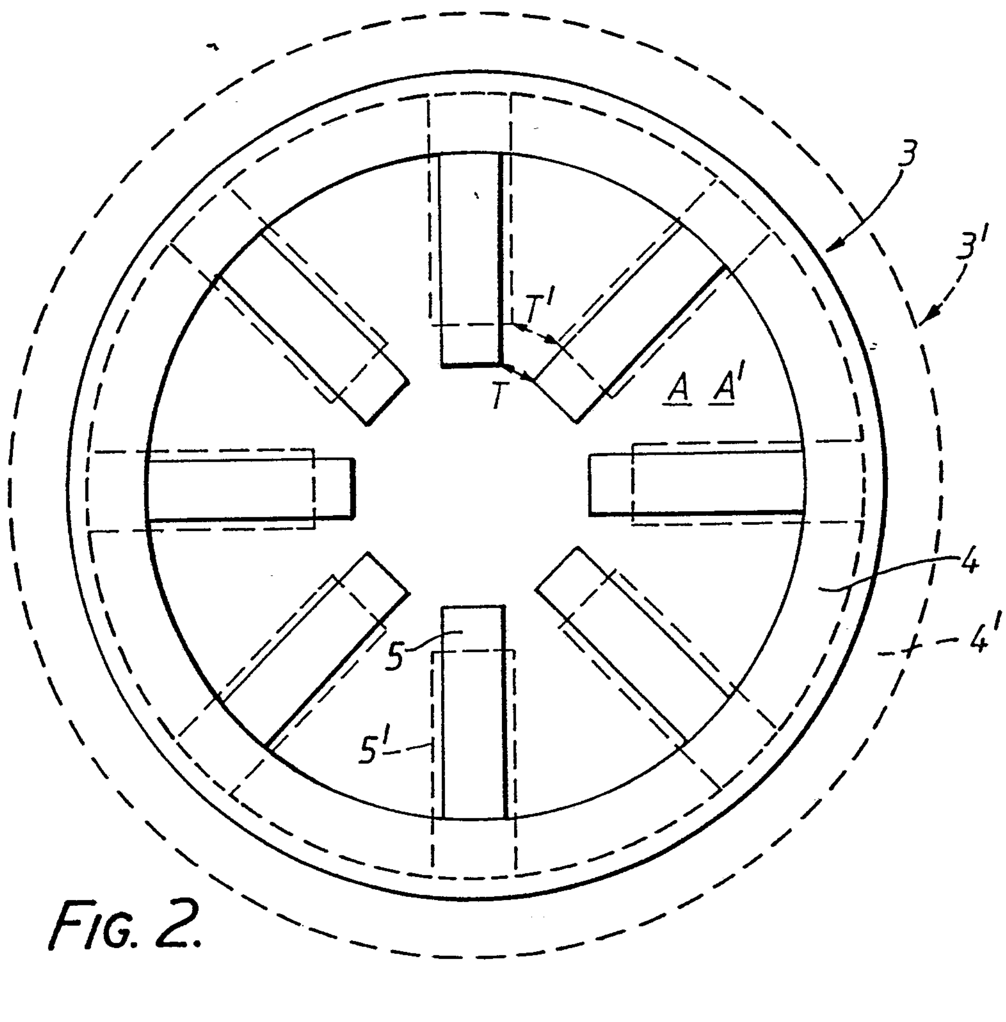

FIG. 2.

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EUROPEAN SEARCH REPORT

Application Number

EP 88 31 0043

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-2 810 094 (P.P. DERBY et al.) * Whole document * ---	1-6	H 01 J 25/587
A	US-A-2 444 419 (R.J. BONDLEY) * Column 2, lines 50-51; figure 2 * ---	4,5	
A	US-A-2 852 720 (P.W. CRAPUCHETTES) * Column 2, line 60 - column 3, line 25; figures * -----	4,5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			H 01 J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17-02-1989	LAUGEL R.M.L.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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& : member of the same patent family, corresponding document