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Sato et al.

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[45] **Apr. 1, 1975**

[54] **ANODE STRUCTURE FOR MAGNETRON**

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[73] Assignee: **Hitachi Ltd.**, Tokyo, Japan

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[30] **Foreign Application Priority Data**

Dec. 20, 1972 Japan 47-145538

[52] **U.S. Cl.** **315/39.69**, 315/39.51, 315/39.75

[51] **Int. Cl.** **H01j 23/22**

[58] **Field of Search** 315/39.69, 39.65, 39.51, 315/39.75

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Assistant Examiner—Saxfield Chatmon, Jr.
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[57] **ABSTRACT**

A magnetron is disclosed which comprises one or more equalizing rings each including a cylinder portion and a plurality of protrusions. Part of each anode vane is cut out in a rectangular shape to form a groove for supporting the equalizing ring, and the protrusions from one of the equalizing rings are projected inwardly radially toward the axis of the cylinder portion and at the same time projected from an axial end of the cylinder portion in the direction substantially parallel to the axis of the cylinder portion, in such a manner that a radial end fo the protrusion is brought into contact with that side wall of the support groove which is nearer to the anode while an axial end thereof is in contact with the bottom of the support groove thereby to fix the equalizing ring in position.

10 Claims, 13 Drawing Figures

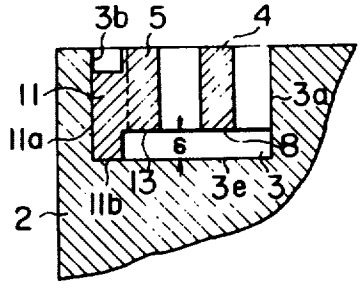


FIG. 1
PRIOR ART

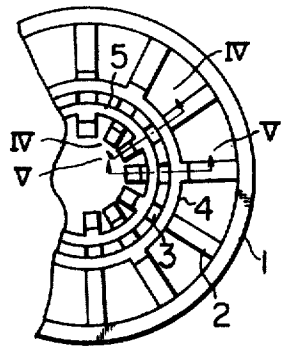


FIG. 2
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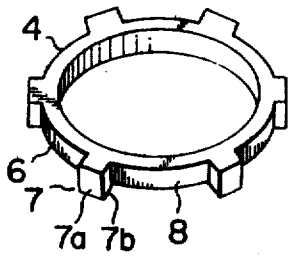


FIG. 3
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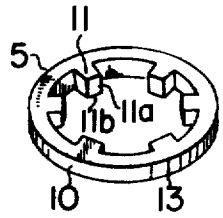


FIG. 4
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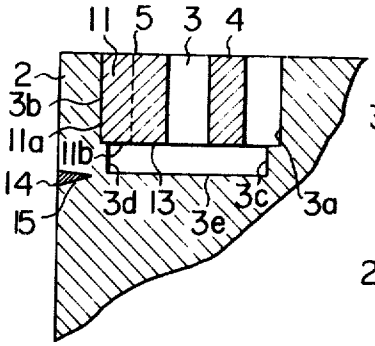


FIG. 5
PRIOR ART

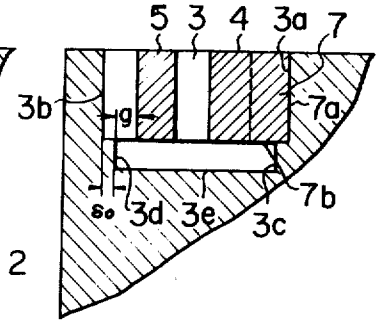


FIG. 6

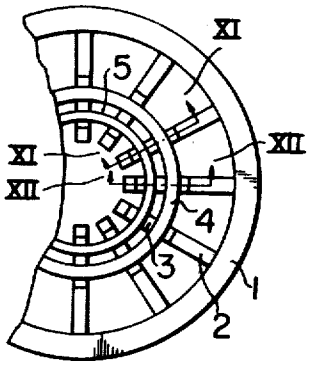


FIG. 7

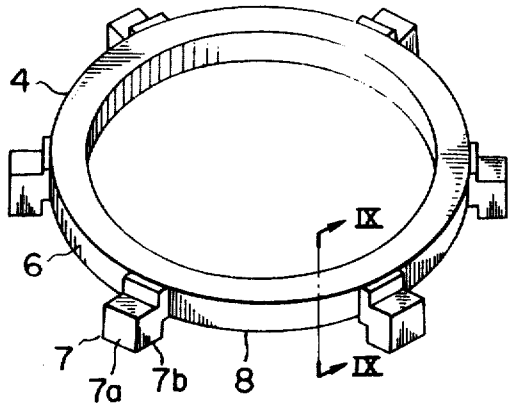


FIG. 8

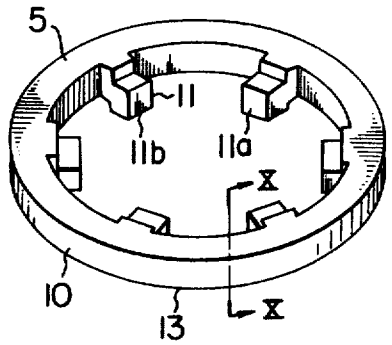


FIG. 9

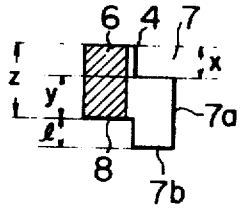


FIG. 10

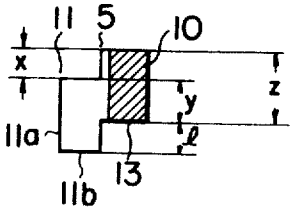


FIG. 11

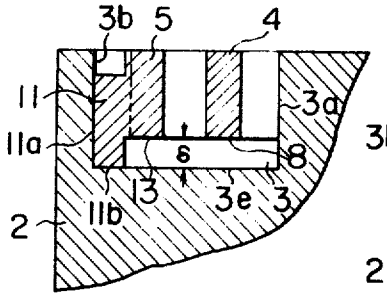


FIG. 12

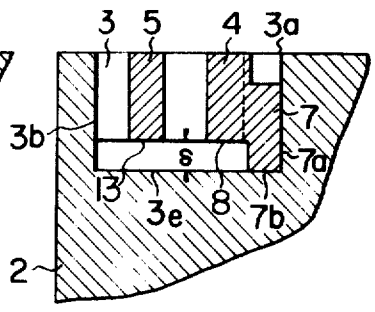
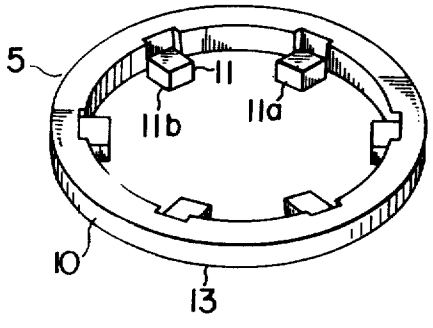


FIG. 13



ANODE STRUCTURE FOR MAGNETRON

The present invention relates to a magnetron with an equalizing ring or more in particular to an anode structure of the magnetron with the equalizing ring.

Prior art and the present invention and the advantages of the latter will be described in detail with reference to the accompanying drawings, in which:

FIG. 1 is a plan view showing the essential parts including an anode structure of a conventional magnetron with equalizing rings mounted on the anode vanes;

FIGS. 2 and 3 are perspective views of outer and inner equalizing rings respectively used with the conventional magnetron shown in FIG. 1;

FIGS. 4 and 5 are sectional views taken along lines IV—IV and V—V respectively in FIG. 1;

FIG. 6 is a plan view showing the essential parts including the anode structure with equalizing rings mounted on the anode vanes according to the present invention;

FIGS. 7 and 8 are diagrams showing perspective views of outer and inner equalizing rings respectively used in the magnetron shown in FIG. 6;

FIG. 9 is a sectional view taken along line IX—IX in FIG. 7;

FIG. 10 is a sectional view taken along line X—X in FIG. 8;

FIG. 11 is a sectional view taken along line XI—XI in FIG. 6;

FIG. 12 is a sectional view taken along line XII—XII in FIG. 6; and

FIG. 13 is a perspective view showing another embodiment of the inner equalizing ring used in the magnetron according to the present invention.

An anode structure of a conventional magnetron with double equalizing ring construction is such that, as shown in FIGS. 4 and 5, a support step 3*c* is formed in each of the grooves 3 for supporting the equalizing rings, which support step supports as shown in FIG. 1 outer and inner equalizing rings 6 and 10 in the form of plate or cylinder with a plurality of outer and inner protrusions respectively formed integrally therewith in the same plane with the plate or cylinder, that is, with the bottom surfaces 7*b* and 11*b* of the protrusions being arranged flush with the bottom surfaces 8 and 13 of the plate or cylinder respectively. In FIG. 1, reference numeral 1 shows an anode cylinder, numeral 2 anode vanes projected radially inwardly from the inner periphery of the anode cylinder 1, numeral 3 grooves for supporting the equalizing rings, which grooves are formed in the anode vanes 2 and in the shape as shown in FIG. 4 or FIG. 5, numeral 4 an outer equalizing ring an example of which is shown in FIG. 2, and numeral 5 an inner equalizing ring an example of which is as shown in FIG. 3.

With reference to FIG. 5, the outer equalizing ring 4 has protrosions 7 each end 7*a* of which is in contact with the side wall 3*a* of the support groove 3, whereas the bottom 7*b* of the protrusion 7 is fixedly disposed on the step 3*c* into position so as to connect every other anode vane 2. In like manner, the inner equalizing ring 5 has, as shown in FIG. 4, the end 11*a* of the protrusion 11 in contact with the side wall 3*b* of the support groove 3, while the bottom surface 11*b* of the protrusion 11 is disposed and fixed into position on the step 3*d* so that the anode vanes other than those contacted by the outer equalizing ring 4 are connected.

The above-mentioned anode construction of the conventional magnetron has the disadvantages that the forming of the step in the support groove is accompanied by a complex manufacturing process, that the inserting of the equalizing ring into and fixing it in the support groove requires high skill, that the forming of the step in the support groove causes the thermal conductivity of the anode vanes to be reduced and that, for the anode structure without any step, the positioning of the equalizing ring on the anode vane requires the use of a jig, which results in an increased number of manufacturing steps and fitting sections, thus making it difficult to maintain a desired dimensional accuracy.

Another serious disadvantage of the abovementioned anode structure lies in that the continual operation of the magnetron often causes a crack to develop in or around the support groove, thereby shortening the useful life of the magnetron. More specifically, the anode cylinder 1 of the magnetron, during operation, increases in temperature and hence the inside diameter thereof expands, while the anode vane 2 which increases in temperature more than the anode cylinder tends to extend inwardly toward the center of the cylinder with such a force as to offset the tendency of the anode cylinder 1 to expand outwardly, so that the position of the support groove 3 of the anode vane 2 changes very little with respect to the center of the anode. The equalizing rings 4 and 5, however, because of their positions near the end of the anode vanes 2, are greatly increased in temperature, resulting in a great thermal expansion thereof. In view of the fact that the equalizing rings 4 and 5 are fixed in the support grooves of the anode vanes of a low coefficient of thermal expansion, both the vanes and the equalizing rings are subjected to a great thermal stress. In the construction as shown in FIG. 4, the bottom surface 11*b* of the inner equalizing ring is in spaced relationship with the bottom 3*e* of the equalizing ring support groove and therefore a large torque or tensile stress develops in the face 14 of the anode vane 2 which is opposed to the cathode, with the result that the anode vane 2 develops a crack 15 or is damaged or greatly distorted in case of continual operation of the magnetron. As part of efforts to obviate such disadvantages, the increasing of the size of δ_0 in FIG. 5 to reinforce the end of the anode vane inconveniently leads to the tendency for occurrence of sparks or touch because of a decreased size of *g*. This makes it necessary to limit the length of δ_0 to the order of 0.2mm.

An improvement on the above-mentioned anode construction shown in FIGS. 1 to 5 comprises an outer equalizing ring having a cylinder portion with a plurality of protrusions projected axially from one axial end of the cylinder portion and with the end of each of the protrusions bent outwardly substantially at right angles and an inner equalizing ring having a cylinder portion with a plurality of protrusions projected axially from one axial end of the cylinder portion and with the end of each of the protrusions bent inwardly substantially at right angles. This improvement involves such complicated manufacturing processes that the production of only the inner equalizing ring requires press molds for as many as six steps.

Accordingly, it is an object of the present invention to provide a magnetron with an anode construction which is not damaged or distorted by temperature increase during its operation.

Another object of the invention is to provide a magnetron having an anode construction easily manufactured and assembled.

According to the present invention, there is provided a magnetron comprising an anode cylinder, a plurality of anode vanes projected inwardly radially from the inner periphery of the anode cylinder, and an equalizing ring having a cylinder portion and a plurality of protrusions projected from the cylinder portion and adapted to be fitted in the support grooves of the anode vanes, in which each of the support grooves constituts a rectangular recess formed in the anode vane, and each of the protrusions is projected from the cylinder portion radially inwardly toward the axis of the cylinder portion and at the same time substantially parallelly with the axis, the end of the radially-projected portion of each of the protrusions being in contact with that side wall of one of the support grooves which is nearer to the axis of the anode cylinder, the end of the axially-projected portion thereof being in contact with the bottom of the one of the support grooves thereby to fix the equalizing rings in position.

The present invention will be explained with reference to FIGS. 6 to 13.

In the drawings, like reference numerals show like component elements or members shown with reference to the conventional construction illustrated in FIGS. 1 to 5.

In FIG. 6 showing the construction of the anode of the magnetron according to the present invention, reference numeral 1 shows an anode cylinder, numeral 2 a plurality of anode vanes projected radially inwardly from the inner periphery of the anode cylinder 1, numeral 3 rectangular grooves formed in the anode vanes 2 to support equalizing rings, numeral 4 an outer equalizing ring an example of which is shown in FIG. 7, and numeral 5 an inner equalizing ring an example of which is shown in FIG. 8, both of the equalizing rings connecting the anode vanes alternately.

The outer equalizing ring 4 shown in FIG. 7 comprises a cylinder portion 6 and a plurality of protrusions 7 projected outwardly from the cylinder portion 6 in such a manner that the end of each of the protrusions 7 extends downward substantially in parallel with the axis (not shown of the cylinder portion 6 by a shearing process applied thereto whereby the bottom surface 7*b* of the protrusion 7 is projected downward from the lower end 8 to constitute a level different from that of the bottom of the cylinder portion 6. In this way, the end of the protrusion is brought into contact with both the side wall and bottom of the support groove simultaneously.

The inner equalizing ring 5 shown in FIG. 8 has a cylinder portion 10 and a plurality of protrusions 11 projected inwardly radially from the inner periphery of the cylinder portion 10 in such a manner that like the outer equalizing ring 4 the end of each of the protrusions 11 is projected substantially in parallel with the axis (not shown) of the cylinder portion 10 by a shearing process applied thereto whereby the bottom 11*b* of the end of the protrusion 11 is at a different level from the bottom 13 of the cylinder portion 10.

In order to mount the equalizing rings 4 and 5 on the anode vanes, as shown in FIGS. 11 and 12, the outer equalizing ring 4 and inner equalizing ring 5 are inserted in the rectangular support grooves 3 cut in the anode vanes in such a manner that the protrusions 7 and 11 provided on the equalizing rings 4 and 5 respectively are coupled with alternate ones of anode vanes 2, while the ends 7*a* and 11*a* of the protrusions 7 and 11 are brought into contact with the side walls 3*a* and 3*b* respectively of the support groove 3, the bottom surfaces 7*b* and 11*b* of the protrusions 7 and 11 being in contact with the bottoms 3*e* of the support groove 3, thereby fixing the equaling rings into position.

With reference to FIGS. 9 and 10, in the event that the length *l* of the extension from the bottoms 8 and 13 of the protrusions 7 and 11 is excessively great, the relative length *y* of the junction between the cylinder portion 10 and the protrusion 11 is lessened and thereby the mechanical strength thereof decreased, often resulting in a crack being developed in the junction. For this reason, *l* should preferably be equal to or less than *y* and should be equal to or less than one half of the length *z* of the cylinder portion. If the length *l* is too small, by contrast, the gap δ between the bottom 3*e* of the support groove 3 of the anode vane 2 and the bottom surfaces 8, 13 of the cylinder portion (shown in FIGS. 11 and 12) which is almost equal to *l* is accordingly decreased, causing short-circuiting by possible solder flow during the soldering process or microwave voltage sparking between the equalizing ring and the vanes due to such small gap. Therefore, *l* should preferably be maintained equal to or greater than 0.4mm.

It will be understood from the above description that the anode construction of the magnetron according to the invention makes the manufacture of the equalizing rings very easy on one hand, and the fact that the support groove formed in the anode vane is in the shape of a simple rectangle facilitates the processing thereof. This eliminates the need for an additional step as in the conventional magnetron construction, thereby maintaining a superior thermal conductivity of the anode vanes. Further, because the equalizing rings are of cylinder type, an adequately great amount of electrostatic capacity is stored as desired. Furthermore, the fact that the equalizing rings are easily placed into position precludes the use of a positioning jig. Also, in view of the fact that the bottom 11*b* of each protrusion of the inner equalizing ring is secured directly to the bottom 3*b* of the support groove, continual operation of the magnetron does not cause any crack to develop in any part of the anode vanes due to an increased strength of the anode vanes.

Instead of the above-described construction in which both the inner and outer equalizing rings are provided with stepped protrusions, a crack in the anode vanes may be prevented by providing the stepped protrusions only on the inner equalizing ring. Further, even though the protrusions of the equalizing ring shown in FIGS. 7 and 8 are formed by a shearing process while keeping the cylinder portion intact, a shearing process may be applied to cut into the inner equalizing ring as shown in FIG. 13. Also, the double-ring construction shown in the embodiment referred to above may be replaced by a single equalizing ring construction.

What we claim is:

1. An anode structure for a magnetron comprising an anode cylinder;

plural anode vanes radially inwardly projecting from the inner periphery of said anode cylinder; and

a first equalizing ring and a second equalizing ring, each of said equalizing rings being fitted in a plurality of support grooves formed in said anode vanes,

said first equalizing ring including a first cylinder portion having a predetermined height and first protrusions projecting from said first cylinder portion,

said second equalizing ring including a second cylinder portion having a predetermined height and second protrustions projecting from said second cylinder portion; and wherein

each of said support grooves constitutes a rectangular recess formed in a respective anode vane, and

each of said first protrusions is formed by an offset parallelepiped projection which is substantially parallel with the axis of said first cylinder portion, and is substantially flush with and has the same height as said first cylinder portion and extends from said first cylinder portion radially inwardly toward said axis, whereby said first protrusion has a radially inwardly projecting portion and an axially projecting portion, the end of the radially-projecting portion of each of said first protrusions being in contact with that side wall of a selected one of said support grooves which is nearer to the axis of said anode cylinder, the end of the axially-projecting portion thereof being in contact with the bottom of said selected one of said support grooves, to thereby fix said first equalizing ring in position.

2. An anode structure for a magnetron according to claim **1**, in which the offset length of said axially projecting portion of said first protrusion is substantially not less than 0.4mm and not more than one half of the height of said first cylinder portion.

3. An anode structure for a magnetron according to claim **1**, in which each parallelepiped projection is offset integrally with a part of said first cylinder portion.

4. An anode structure for a magnetron according to claim **3**, in which the offset length of said axially projecting portion of said first protrusion is substantially not less than 0.4mm and not more than one half of the height of said first cylinder portion.

5. An anode structure for a magnetron according to claim **1**, in which each of said second protrusions is formed by an offset parallelepiped projection which is substantially in parallel with the axis of said second cylinder portion and is substantially flush with and has the same height as said second cylinder portion and extends from said second cylinder portion radially outwardly, whereby said second protrusion has a radially outwardly projecting portion and an axially projecting portion, the end of the radially-projecting portion of each of said second protrusions being in contact with that side wall of one of the support grooves other than those contacted by said first equalizing ring which is far from the axis of said anode cylinder, the end of the axially-projecting portion thereof being in contact with the bottom of said one of said other support grooves to thereby fix said second equalizing ring in position.

6. An anode structure for a magnetron according to claim **5**, in which said parallelepiped projection extending from said second cylinder portion is offset integrally with a part of said second cylinder portion.

7. An anode structure for a magnetron according to claim **6**, in which said parallelepiped projection extending from said first cylinder portion is offset integrally with a part of said first cylinder portion.

8. An anode structure for a magnetron according to claim **7**, in which the offset length of said axially projecting portion of said first protrusion is substantially not less than 0.4 mm and not more than one half of the height of said first cylinder portion.

9. An anode structure for a magnetron according to claim **5**, in which the offset length of said axially projecting portion of said second protrusion is substantially not less than 0.4 mm and not more than one half of the height of said second cylinder portion.

10. An anode structure for a magnetron according to claim **8**, in which the offset length of said axially projecting portion of said second protrusion is substantially not less than 0.4 mm and not more than one half of the height of said second cylinder portion.

* * * * *