Dec. 20, 1966 A. H. PICKERING 3,293,487

ANODE FOR A MAGNETRON HAVING DEVERSE SIZE CAVITY RESONATORS

Filed July 25, 1962 2 Sheets-Sheet 1

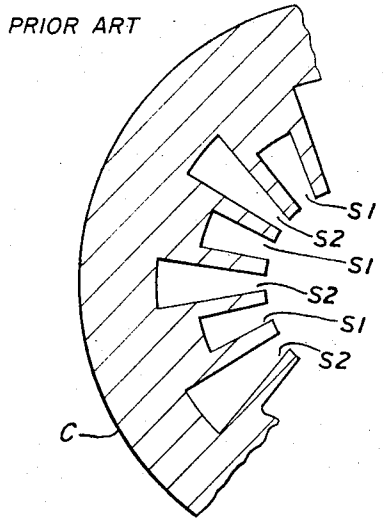

FIG. 1.

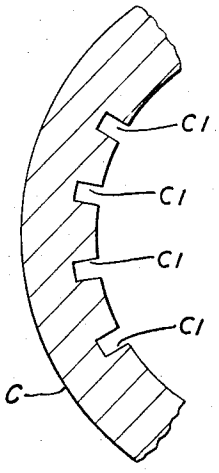

FIG. 2.

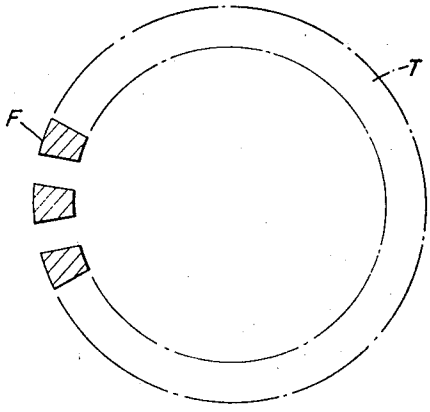

FIG. 3.

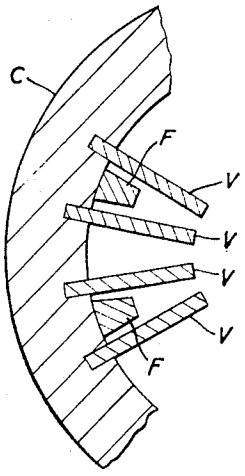

FIG. 4.

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Dec. 20, 1966 A. H. PICKERING 3,293,487
ANODE FOR A MAGNETRON HAVING DEVERSE SIZE CAVITY RESONATORS
Filed July 25, 1962 2 Sheets-Sheet 2

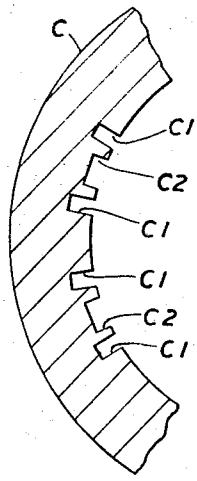

FIG. 5.

FIG. 6.

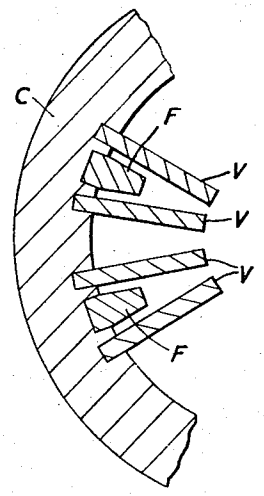

FIG. 7.

FIG. 8.

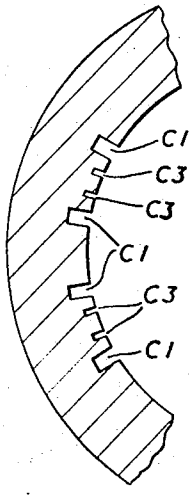

FIG. 9.

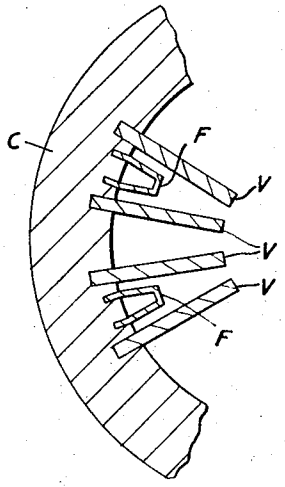

FIG. 10.

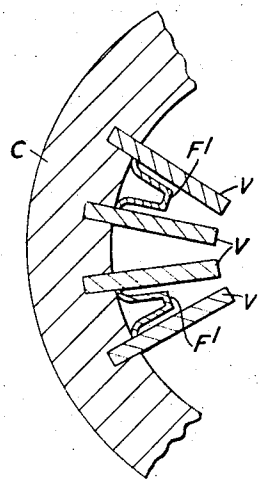

FIG. 11.

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3,293,487

ANODE FOR A MAGNETRON HAVING DEVERSE SIZE CAVITY RESONATORS

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Claims priority, application Great Britain, Oct. 4, 1961, 35,751/61
14 Claims. (Cl. 315—39.65)

This invention relates to cavity magnetrons and more specifically to cavity magnetrons of the well-known so-called "rising sun" type, i.e. the type in which the anode system is provided with radial slot cavities, adjacent ones of which are of different radial lengths. The objects of the invention are to provide improved inexpensive rising sun magnetrons the anode systems of which can be made by manufacturing methods which are substantially more economical and easier to practise than those usually employed at the present time and to provide improved and simple means for manufacturing such anode systems.

The invention is illustrated in and explained in connection with the accompanying drawings, in which: FIGURE 1, which is provided for purposes of explanation, is a sectional view of part of the anode system of a conventional known rising sun magnetron; and the remaining FIGURES 2 to 11 illustrate mangetron anode systems in accordance with the present invention and processes for manufacturing the same.

FIGURE 1 shows part of the anode system of a conventional present-day rising sun magnetron. It consists of a carcase C, usually of copper, in which are formed radial slot cavities S1, S2 of one or other of two different radial lengths, the shorter cavities S1 alternating with the longer cavities S2 round the carcase. The present-day normal method of forming the cavities is either by hobbing or by spark machining. Both are expensive and both involve the manufacture of costly tools of high accuracy since the sizes and shapes of the tools determine the sizes and shapes of the cavities. In manufacture by hobbing the tools have to be made of good quality steel which will withstand the considerable forces involved when pushed into hot copper. Such tools are of limited life and not readily altered, e.g. to enable a tool designed and made to form a cavity of given dimensions to be used if the magnetron frequency is to be changed requiring the formation of a cavity of different dimensions. In manufacture by spark machining the tools are, of course, not subjected to mechanical stresses when in use but they are subjected to very considerable erosion and have, accordingly, very limited life. Tools of the latter type must be replaced after a relatively short time of use if the normal requirement of accurate dimensioning of the cavities is to be satisfied.

The present invention seeks to avoid these defects and to provide rising sun magnetrons anode system of which can be made to high standards of accuracy by methods which are cheaper, easier and more flexible than the above described present day methods, which use tools which are cheaper and last longer than the tools employed in the said present day methods and which are such that the same tools can be used to maufacture anode systems of widely different dimensions.

According to this invention a rising sun magnetron includes an anode system consisting of a metal carcase member, a plurality of separate metal vane members which are fixed to said carcase member so as to project radially inward therefrom at equal angular intervals round the carcase and a plurality of separate metal intermediate members which are also in fixed positions in relation to said carcase member and project radially inward therefrom but

which are of substantially shorter radial length than the vane members so as to project inward for a substantially shorter distance, each intermediate member occupying part of the space between two different adjacent vane members, certain adjacent vane members having an intermediate member between them and other adjacent vane members being without an intermediate member between them.

If, as is normally the case, the rising sun anode system is one in which long and short slot cavities are required to occur alternately round the carcase, there is an even number of vane members and half that number of intermediate members so positioned that these are two vane members between each two successive intermediate members round the carcase.

Preferably each vane member is parallel sided and each intermediate member is tapered in such manner that when the vane and intermediate members are in position the side faces of each intermediate member are parallel to the side faces of the vane members between which it is located. Preferably also the arcuate extent of each intermediate member over at least the major part of its radial length is less than the arcuate extent of each space between adjacent vane members so as to leave a small similar space on each side of each intermediate member between the side faces thereof and the side faces of the adjacent vane members.

Preferably again the vane members are fitted at their outer ends into and fixed in relatively shallow radial vane-receiving slots formed in the carcase.

The intermediate members may be solid or hollow and may be fixed by brazing or the like to the carcase or may be fitted at their outer ends into and fixed in relatively shallow intermediate member-receiving slots formed in the carcase. Where hollow intermediate members are employed they are preferably bent up from sheet metal into approximately tapered U form and the ends of each U-shaped intermediate member are fitted into and fixed in two receiving slots formed in the carcase. Alternatively the ends of each U-shaped intermediate member may be splayed out and fixed by brazing or the like to the vanes on either side thereof near the carcase. Where solid intermediate members are employed they are preferably made from a hollow metal tube of thickness equal to the required radial length of intermediate member by slotting said tube radially. Alternatively they can be made by extrusion. The vane members are preferably made by cutting or stamping them from precision rolled sheet. Where, as is much, preferred, the vane members are fixed in vane receiving slots in the carcase the same vane members may be used for anode systems of different amounts of vane projection and therefore of different frequencies or circuit ratios without change to the broaching tool which cuts the vane-receiving slots in the carcase, by simply altering the inner diameter to which the carcase is bored out—a very simple matter since the boring of the carcase can be done on an ordinary centre-lathe.

FIGURES 2 to 4 illustrate one construction of anode system for a rising sun magnetron in accordance with this invention.

Referring to FIGURE 4 the cylindrical copper carcase or shell C is cut with a number of equally spaced relatively shallow slots C1 in any convenient manner, e.g. by an ordinary broach or slotting machine. These slots which are to receive the vane members are of a depth chosen to give whatever range of selectable vane member radial projection is required. Parallel sided vane members V (FIGURE 4) are cut or stamped from precision rolled sheet copper and are inserted into the slots to the required depth. They are a good fit in the slots and are preferably brazed in position though they may be fixed in other ways. Tapered intermediate members F are preferably made from a cylinder tube T by slotting the

same as indicated in FIGURE 3. Each intermediate member is fixed by brazing to the inside surface of the carcase C between two of the vane members, there being two vane members between the intermediate members of each successive pair round the carcase. Thus, as shown in FIGURE 4, there is first a short cavity, i.e. one with an intermediate member in it between two vane members; then a long cavity, i.e. one without an intermediate member in it between two vane members; then a short cavity . . . and so on with long and short cavities alternating round the anode system. In this way the required alternate long and short cavities are formed. As will be seen from FIGURE 4, the arcuate extent of each intermediate member is less than that of the inter-vane gap in which it is situated so that small similar gaps are left between the side faces of each intermediate member and the adjacent side faces of the vane members between which it is situated. This gap is important inasmuch as its provision ensures that there will be no risk of the vane members being forced out of their correct positions when brazing or soldering takes place. Of course the brazing or soldering of the parts is effected when the said parts are assembled and held in their correct relative positions by a suitable jig (not shown).

Instead of making the intermediate members by cutting them from a cylinder as shown in FIGURE 3, they may be extruded.

FIGURES 5, 6 and 7 show a modification in which intermediate members, assumed to be extruded and one of which is shown at F in FIGURE 6, are fitted into and fixed in additional shallow slots C2 cut in the carcase. The intermediate members are fitted in the slots C2 and brazed or otherwise fixed there.

FIGURES 8, 9 and 10 show a further modified construction in which the intermediate members are hollow instead of solid and are made by bending up sheet copper into an approximately tapered U form. Such an intermediate member is shown in section at F in FIGURE 8. As shown in FIGURE 9, the carcase C is provided with pairs of slots C3 for receiving the ends of the bent-up U-shaped hollow intermediate members, the resulting assembled construction being best shown in FIGURE 10.

FIGURE 11, which is a view like that of FIGURE 2, shows a minor modification of the embodiment of FIGURES 8, 9 and 10. Here again the intermediate members, referenced F', are hollow and made by bending up sheet copper into approximate U form. However, the ends of the limbs of the U, instead of being fixed in slots (C3 in FIGURE 9) which are provided in the carcase for receiving said ends, are splayed outwardly and fixed, for example by welding, to the adjacent vane members and adjacent the inner wall of the carcase. In this way a good deal of not inexpensive carcase slotting is eliminated.

With all these constructions there is a substantial range of inward radial projection of the vane members V available by selecting the depth of penetration of those members in their receiving slots C1. If variation of the inward radial projection of the intermediate members F of F' is required, it is contemplated to effect this by making the intermediate members of different lengths but, owing to the method of manufacture, this is a comparatively cheap and simple matter to do.

It will be seen that the invention lends itself to the ready and economical manufacture of rising sun magnetron anode systems of high precision. The tools employed are reasonably inexpensive and of reasonably long life. Furthermore the way in which they are employed is such that it is not necessary to make new sets of special and expensive tools for each differently dimensioned magnetron to be manufactured.

I claim:

1. A rising sun magnetron including an anode system comprising a metal carcase member, a plurality of separate metal vane members which are fixed to said carcase member so as to project radially inward therefrom at equal angular intervals round the carcase member, and a plurality of separate metal intermediate members which are also in fixed positions in relation to said carcase member and project radially inward therefrom but which are of substantially shorter radial length than the vane members so as to project inwardly for a substantially shorter distance, each intermediate member occupying part of the space between two different adjacent vane members, certain adjacent vane members having an intermediate member between them and other adjacent vane members being without an intermediate member between them.

2. A magnetron as claimed in claim 1 wherein the rising sun anode system is one in which long and short cavities occur alternately round the carcase and there is an even number of vane members and half that number of intermediate members so positioned that there are two van members between each two successive intermediate members round the carcase.

3. A magnetron as claimed in claim 1 wherein each vane member is parallel sided and each intermediate member is tapered in such manner that when the vane members and intermediate members are in position the side faces of each intermediate member are parallel to the side faces of the vane members between which it is located.

4. A magnetron as claimed in claim 1 wherein the arcuate extent of each intermediate member over at least the major part of its radial length is less than the arcuate extent of each space between adjacent vane members so as to leave a small similar space on each side of each intermediate member between the side faces thereof and the side faces of the adjacent vane members.

5. A magnetron as claimed in claim 1 wherein the vane members are fitted at their outer ends into and fixed in relatively shallow radial vane-receiving slots formed in the carcase.

6. A magnetron as claimed in claim 1 wherein the intermediate members are solid.

7. A magnetron as claimed in claim 1 wherein the intermediate members are hollow.

8. A magnetron as claimed in claim 1, the intermediate members being brazed to the carcase.

9. A magnetron as claimed in claim 1, the intermediate members being fitted at their outer ends into and fixed in relatively shallow intermediate member-receiving slots formed in the carcase.

10. A magnetron as claimed in claim 7 wherein the intermediate members are bent up from sheet metal into approximately tapered U form.

11. A magnetron as claimed in claim 10 wherein the ends of each U-shaped intermediate member are fitted into and fixed in two receiving slots formed in the carcase.

12. A magnetron as claimed in claim 10 wherein the ends of each U-shaped intermediate members are splayed out and fixed by brazing to the vanes on either side thereof near the carcase.

13. A magnetron as claimed in claim 6 and having intermediate members made from a hollow metal tube of thickness equal to the required radial length of intermediate member by slotting said tube radially.

14. A rising sun magnetron including an anode system comprising a metal carcase member, a plurality of metal vane members constructed separately from said carcase member and fixed thereto so as to project radially inward therefrom at equal angular intervals round the carcase member, and a plurality of metal intermediate members constructed separately from said carcase member which are also in fixed positions in relation thereto and project radially inward therefrom but which are of substantially shorter radial length than the vane members

so as to project inward for a substantially shorter distance, each intermediate member occupying part of the space between two different adjacent vane members, certain adjacent vane members having an intermediate member between them thereby forming the short resonant cavities of the rising sun magnetron and other adjacent vane members being without an intermediate member between them thereby forming the long resonant cavities of the magnetron.

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