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2,463,416

ANODE FOR STRAPPED MAGNETRONS

Filed May 8, 1946

2 Sheets-Sheet 1

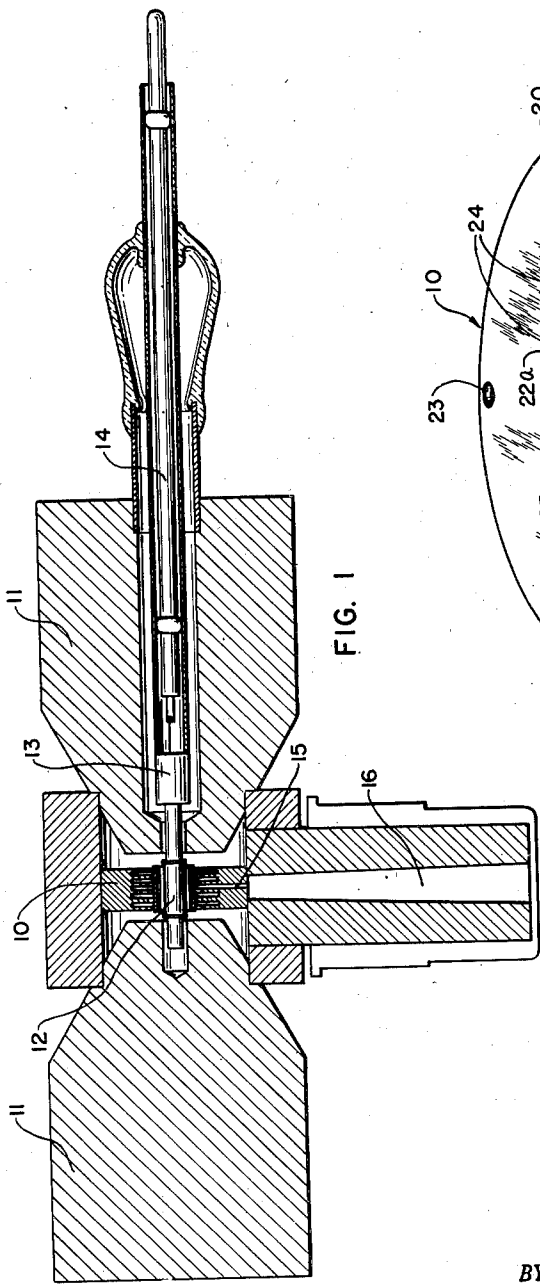


FIG. 1

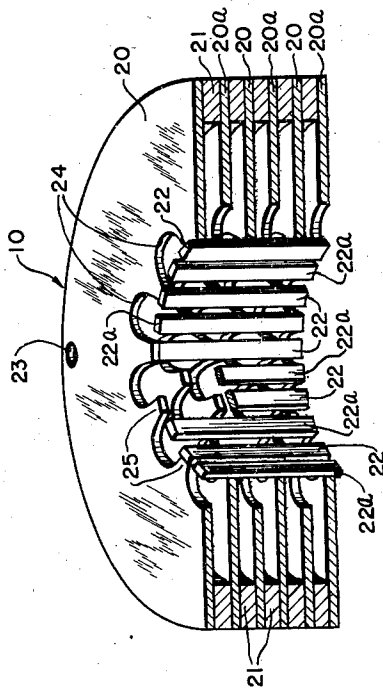


FIG. 2

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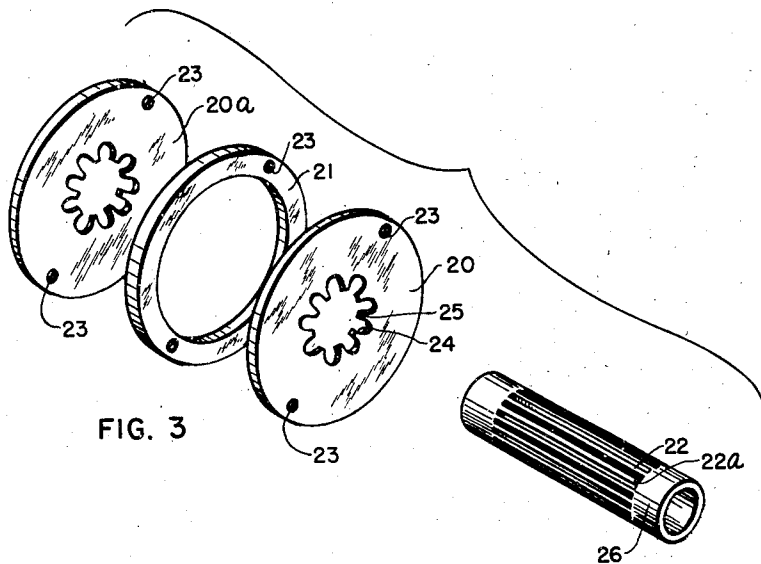
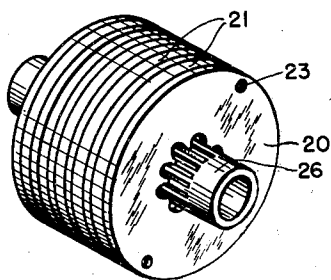


FIG. 4

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ANODE FOR STRAPPED MAGNETRONS

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8 Claims. (Cl. 250—27.5)

1

This invention relates to a built up anode for a strapped magnetron.

One of the objects of this invention is to provide an anode which may be accurately constructed from readily fabricated parts.

Another object of this invention is to provide an anode which may be produced without the use of turning or hobbing operations and which avoids very small spacing between components.

Still another object is to provide an anode which has good mode separation and large power output.

These and other objects will become apparent in the specification and in the accompanying drawing in which:

Figure 1 is a sectional elevational view of the complete anode assembly shown in conjunction with other components;

Figure 2 is a view of the anode assembly;

Figure 3 is an exploded view of the plates and washers utilized in constructing the anode;

Figure 4 is a view of the built up anode with the strap assembly in position.

As shown in Figure 1 the anode 10 is arranged in the usual fashion between the poles 11 of the magnetron. A cathode 12 contains a heater coil, not shown, and extends into the anode and is provided with a cathode extension 13 through which the end of the coil projects and is welded to a heater lead 14 in a manner well known in the art. The cathode extension supports the cathode and acts in addition to conduct away the heat in the cathode. The anode is connected to an output circuit 15 through an impedance transformer 15.

As shown in Figure 2, the anode 10 comprises a series of washers 21 and plates 20 and 20a held together by suitable brazing or soldering at the junctures. The bars or segments 22 and 22a connect together alternating projecting portions 25 in each layer and around the circumference. This construction permits good mode separation and results in other desirable characteristics such as high power output, good voltage-current characteristics as well as ease of construction and feasibility of reproduction of anodes having uniform characteristics.

As shown in Figure 3, plates 20 and 20a are provided with semi-circular cut-out portions 24 and have projecting substantially butt-ended portions 25 between said semi-circular cut-out portions. Plates 20 and 20a are identical and are merely rotated 180° with respect to each other. This results in a relative displacement of projections and indentations equal to an angular

2

distance of one half the spacing between the semi-circular indentations, thus resulting in alternate plates so arranged that the projections of one plate over-lie the indentations of the other. For simplicity in manufacturing, the plates and the washers may be produced in mass production quantities by punching in automatic presses. The material utilized is preferably oxygen free high conductivity copper sheet. The washers are preferably punched from silver coated copper sheet. It should be noted that the plates as well as the washers are provided with a pair of holes 23 diametrically opposite one another for purposes to be described later.

The right hand portion of Figure 3 shows the completed bar assembly prior to insertion into the anode stack. This assembly is made of copper tubing which has previously been coated or plated with silver. By means of a simple milling operation, slots are milled into the tube leaving strips of metal 22 and 22a attached at their ends to the ends 26 of the tube.

In Figure 4, the anode assembly is shown to consist of a stack of alternate washers and plates with alternate plates rotated in the manner shown in Figure 3 and described in connection therewith. Holes 23 facilitate this particular assembly arrangement by receiving close fitting metal pins, not illustrated in the drawing, to insure accurate alignment of portions 25. These pins may be made of silver coated copper in which case they will remain in the assembly after brazing. If desired the pins may be incorporated in the jig assembly described below. In this modification the pins may be made of stainless steel to facilitate their removal after brazing. The strap assembly is inserted so as to provide contact between alternate anode projections both circumferentially and by alternate plates. Thus bars 22 connect projections 25 on plates 20 while straps 22a connect projections 25 on plates 20a, see Fig. 2. The entire assembly as shown in Figure 4 is clamped tightly in a suitable jig means and is placed in a furnace where the silver coating of the strap assembly and of the washers fuses and results in a substantially electrically homogeneous bond between the various parts of the anode assembly. In the case where copper pins are used for aligning the anode members the jig may comprise a simple parallel vise. The completed anode is then turned on a lathe to cut off the surplus tubing at ends 26 of the bar assembly and the resultant anode shown in Figure 2 is complete and ready for subsequent operations of assembly into a tube.

The geometry of the tube is very favorable for producing a good mode separation and in some ways may be likened to an interdigital anode in which a multiple inter-connected interdigital assembly has been utilized. From another point of view it might be considered that the entire anode produced by this invention, with the exception of the longitudinal bars 22 and 22a, consists of strapping whose geometry has been arranged to form an anode body, the tube inductance being supplied by quarter wave sections joining segments 22 and 22a rather than by cavity resonators arranged in a circle as in conventional anodes.

An electrical advantage of this type of anode is that the anode height may be increased, in order to increase the power capacity, to values of the order of one free space wave length without changing the electrical behavior, by merely increasing the number of plates 20 and 20a and washers 21. That is to say, each annular cavity created by a washer 21, together with the coplanar parts of the bars and the cathode, constitutes an independent magnetron oscillator and any number of these up to the limit stated above may be operated in parallel, the bars 22 and 22a serving to hold them electrically in phase. In the figures five such sections are shown in parallel. In this respect the anode here disclosed is like the rising sun anode and differs from the conventional strapped anode, which latter is limited to heights of about one-third free space wave length.

The theory behind the operation of a tube of this type is as follows: Consider a pill box shaped resonator oscillating in its fundamental mode. Such a resonator is desirable for a magnetron oscillator because its additional modes are quite far removed on the high frequency side. In such a simple form, however, the resonator is not suitable for magnetron operation because the radio frequency electrical field is directed axially rather than circumferentially and is independent of angle rather than reversing periodically with angle. If scalloped holes like those in parts 20 and 20a are cut in the top and bottom of the pill box and bars like 22 and 22a are attached so that alternate bars are connected to the top and bottom respectively the required reorientation of the electric field is accomplished without losing the above mentioned advantages of the pill box resonator. Each of the five sections shown and referred to above may be thought of as such a redesigned pill box.

An anode constructed according to these principles is very efficient at frequencies in the range of 20,000 mc./sec. to 30,000 mc./sec., and has a good mode separation. Its output in this frequency range has amounted to over 20 kilowatts, the limitation being due to cathode construction rather than to any characteristics of the anode itself.

While I have shown a single embodiment of my invention, it is obvious that other cavity and strapping configurations and arrangements may be utilized in accordance with these teachings and I therefore do not intend my invention to be limited except within the scope and extent of the appended claims:

I claim:

1. A strapped magnetron anode comprising alternate apertured discs having their inner surfaces serrated and forming projections, washers between said discs for producing a spacing between the latter, and bars connecting only alternate projections within the apertured discs.

2. A method for producing a magnetron anode comprising stacking alternate apertured disc members and washers, inserting a cylindrical unitary segment assembly comprising a plurality of bars connected to each other at their ends, heating said stack and segment assembly to obtain fusion and bonding between the parts, and removing portions of the segment assembly to provide bar members connected to alternate disc members.

3. A magnetron anode comprising alternate apertured discs and washers in electrically conducting relation forming quarter wave sections and bars connecting only alternate discs.

4. A magnetron anode comprising a plurality of spaced, electrically connected, apertured discs said discs being provided with spaced, internally extending projections, and bars connecting only alternate projections in alternate discs.

5. A magnetron anode comprising a plurality of stacked apertured discs and washers, and bars connecting only alternate discs forming an inter-connected interdigital segment assembly.

6. A method for producing a magnetron anode comprising forming a stack of axially aligned apertured disc members separated by axially aligned washers having a fusible outer layer, inserting a unitary bar assembly having a fusible outer layer within the apertured disc members, heating said disc, washer and bar assembly to obtain fusion of the fusible layers and bonding between the elements, and removing portions of the bar assembly to provide a plurality of independent bar members.

7. A magnetron anode comprising a series of stacked apertured discs separated by washers, the outer diameter of said discs and said washers being equal but the inner diameter of said washers being larger than the inner diameter of said aperture discs, the apertures in said discs being centrally-located, circular apertures with scallops radially disposed along the circumference of each aperture, said scallops forming a plurality of radially disposed teeth, said scallops and said teeth having equal dimensions and being equally spaced around the circumference of said aperture, the teeth of one disc being in staggered relationship with respect to the teeth of adjacent discs, whereby the radial axis of one tooth of one disc and the radial axis of a scallop in adjacent disc are in a single plane, and a plurality of bars interconnecting the inner ends of said teeth of alternate discs, the volume between said adjacent discs defining a resonant cavity of the pill-box type in its fundamental mode, and the bars connected to alternate discs assume alternately positive and negative potentials around the circumference of said anode.

8. A magnetron anode as defined in claim 7 in which the axial dimension of said anode is of the order of one free space wave length, said wave being the operating wave of said anode.

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

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Disclaimer

2,463,416.—*Arnold T. Nordsieck*, New York, N. Y. ANODE FOR STRAPPED MAGNETRONS. Patent dated Mar. 1, 1949. Disclaimer filed Oct. 3, 1951, by the assignee, *United States of America*, as represented by the *Secretary of the Army*.

Hereby enters this disclaimer to claims 1, 3, 4, and 5 of said patent.
[*Official Gazette October 30, 1951.*]