Jan. 8, 1957 P. E. VOLZ 2,777,090

MAGNETRON STRAPPING FOR HIGH POWER

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Fig.1.

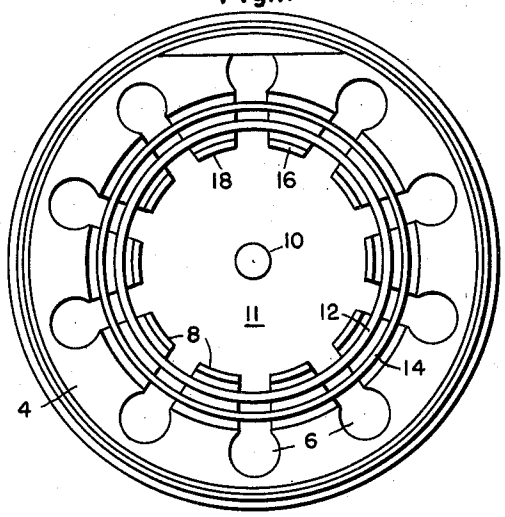


Fig.2.

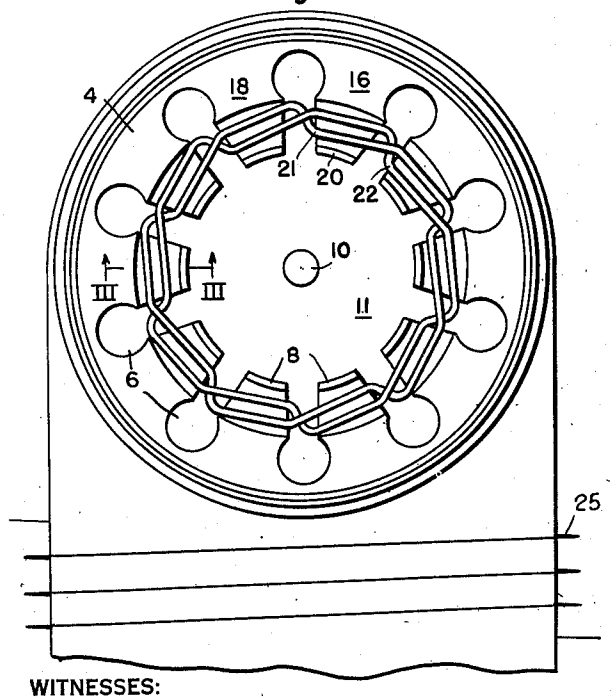
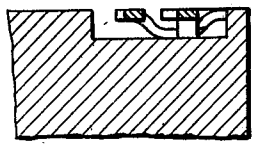


Fig.3.



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MAGNETRON STRAPPING FOR HIGH POWER

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My invention relates to high frequency oscillators, and more particularly to strapping of magnetrons.

In accordance with the prior art of which I am aware, magnetrons have been built with a plurality of cavity resonators arranged in a circular manner about the cathode. The walls of these cavity resonators constitute the anode of the oscillator and an interaction space is provided between the cathode and anode. The successive cavity resonators are arranged so that successive resonators have common walls.

Electrons emitted from the cathode and moving in a cycloidal manner from the cathode in the center of the interaction space to the anode pass by the regions between the anode vanes. In passing by the region between the anode vanes, the electrons set up high frequency electromagnetic oscillations which pass into the cavities and are later drawn off as the output of the magnetron.

In order to overcome the difficulties associated with closely spaced resonant frequencies in magnetrons, strapping between alternate pole tips is desirable. The commonest form of strapping is what is known in the art as double ring strapping. In this arrangement two rings of electrically conducting material extend around the series of cavities near the tips of the vanes or separating walls. Each ring is connected to alternate vane tips, one ring being connected to the odd vane tips, and the other ring being connected to the even vane tips.

Such an arrangement has been found to be reasonably satisfactory for some purposes. However, it has been observed that frequently the power level of the tubes is limited and the tube is permanently damaged due to arcing between the straps and the vane tips. In other words, with a new tube the input power may be increased to a point where the power output is P_1, at which point internal sparking occurs. However, after some period of operation sparking may occur at a lower value of power output than P_1. It is thus demonstrated that there is permanent damage to the tube due to the arcing.

It is accordingly an object of my invention to provide an improved magnetron construction.

Another object of my invention is to provide an improved magnetron strapping arrangement.

Still another object of my invention is to provide means for substantially preventing arcing in a magnetron between the straps and the vanes.

An ancillary object of my invention is to provide a new and useful electrical apparatus.

The invention, with respect to both the organization and the operation thereof, together with other objects and advantages may best be understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which:

Figure 1 is a plan view of a magnetron strapping system in accordance with the teachings of the prior art.

Fig. 2 is a plan view of a magnetron strapping system built in accordance with my invention.

Fig. 3 is a showing in cross-section of part of the apparatus shown in Fig. 2 taken along the line III—III of Fig. 2.

In accordance with my invention I provide a magnetron anode 4 comprising a plurality of cavity resonators 6 arranged in a circular manner. Successive cavity resonators are separated by common walls or vanes 8. In the center of the anode structure 4, surrounded by the vanes 8 and the cavity resonators 6, there is a cathode chamber 11 having in the center thereof a cathode 10.

Exterior to the apparatus shown in the drawing, there is provided a magnetic coil 25 for producing a magnetic field of such a nature as to cause electrons emitted by the cathode 10 to spiral past several of the openings to the cavity resonators 6 before finely striking the vanes 8. The space charge spoke rotation may be counterclockwise or clockwise. The strapping arrangement in Fig. 2 is for a counterclockwise rotation.

In the prior art apparatus shown in Fig. 1, two ring straps 12, 14 of electrically conducting material are provided, which extend around the vane tips, each strap being connected to alternate vanes. However, in this apparatus, the inner strap 12, which is fastened to the first vane 16, is not fastened to the second vane 18. Since the first vane 16 and the second vane 18 are normally at different radio frequency potentials, there is a high potential difference provided between the second vane 18 and the inner strap 12 in the region where the inner strap 12 crosses the second vane 18. There is, therefore, a strong tendency for sparking between the inner strap 12 and the second vane 18. When electrons, spiraling about the cathode 10, strike the second vane 18 some of them will strike in the region where the inner strap starts to cross the second vane 18. Here the electrons may cause an electrical discharge or arc to be set up, which will damage both the strap 12 and the vane 18.

In accordance with my invention a first strap 21 and a second strap 22 are provided. These straps form mechanically-integral bridges connected to the anode block near the tip of the vanes and are recessed into the end of the vanes. The first strap is fastened to the first vane 16 near the tip 20 thereof, but immediately upon leaving the vane 16 on the trailing side thereof, with a counterclockwise space charge spoke rotation, the first strap 21 bends away from the tip 20 of the first vane 16 toward the cavity resonator 6, adjacent the first vane, so that the first strap 21 extends further from the vane tip 20 than does the second strap. The second strap 22 protects the first strap from electron bombardment. Thus, when the straps reach the second vane 18, the second strap 22 is nearest the vane tip and the first strap 21 lies substantially inward from the tip of the vane in the region of the second vane 18. Therefore, the first strap 21 is protected by the second strap 22 from electron bombardment.

The point of transposition, where the first strap 21 crosses under the second strap 22, is located in the space between the first vane 16 and the second vane 18, but in a region near the trailing side of the vane which is protceted by the first vane 16 from electron bombardment. Thus in an apparatus built in accordance with my invention, electron bombardment occurs in a region where there is very little field strength between the exposed strap and the vane tip, and hence there is substantially no tendency toward the production of an R. F. metallic arc.

Although I have shown and described specific embodiments of my invention, I am aware that other modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and the spirit of the invention.

I claim as my invention:

1. In combination: a magnetron anode comprising a

plurality of vanes defining a plurality of cavity resonators, a first strap of electrically conducting material forming a mechanically-integral bridge connected to said anode at points near the tips of all odd-numbered ones of said vanes, a second strap of electrically conducting material forming a mechanically-integral bridge connected to said anode at points near the tips of all even-numbered ones of said vanes, said first strap extending across the even-numbered ones at places more distant from the tips of said even-numbered ones than the places where said second strap is connected to said even-numbered ones, and said second strap extending across the odd-numbered ones of said vanes at places more distant from the tips of said odd-numbered ones than the places where said first strap is connected to said odd-numbered ones.

2. In combination: an anuular magnetron anode comprising a plurality of vanes defining a plurality of cavity resonators, a first single conductor strap of electrically conducting material connected to all odd-numbered vanes of said anode near the tips of said vanes, a second single conductor strap of electrically conducting material connected to all even-numbered vanes of said anode near the tips of said vanes, said first strap extending across the even-numbered vanes at places more distant from the tips of said vanes than the places where said second strap is connected to said vanes, said first and said second straps crossing over each other at points aligned in an axial direction with the spaces between said vanes.

3. In combination: an annular magnetron anode comprising a plurality of vanes defining a plurality of cavity resonators, a first single conductor strap of electrically conducting material connected to all odd-numbered vanes of said anode near the tips of said vanes, a second single conductor strap of electrically conducting material connected to all even-numbered vanes of said anode near the tips of said vanes, said first strap extending across the even-numbered vanes at places more distant from the tips of said vanes than the places where said second strap is connected to said vanes, said first and said second straps corssing over each other periodically, each one of said crossover points being located at a point aligned in an axial direction with a space between a pair of said vanes, and at each crossover point that strap which is fastened to the nearer of said pair being nearest the center plane through said plurality of resonators.

4. A magnetron comprising an anuular anode, said anode comprising a plurality of vanes defining a plurality of cavity resonators, a cathode positioned within the central region of said annular anode, means for producing a magnetic field to cause the space charge spokes emitted from said cathode to rotate in a predtermined direction, a first and a second strap of electrically conducting material connected to alternate vanes of said anode, said first strap connected to odd-numbered vanes and said second strap connected to even-numbered vanes and both recessed in the end of said vanes, said first and second straps crossing over between vanes in a region near the trailing edge of said vanes.

5. A strapping arrangement for a magnetron, said magnetron having an annular anode, said anode having a plurality of vanes defining a plurality of cavity resonators, a cathode positioned within the central region of said annular anode, means for producing a magnetic field to cause the space charge spokes emitted by said cathode to rotate in a predetermined direction, a first strap of electrically conducting material connected to odd-numbered vanes of said anode near the tips of said vanes and recessed in the end of said vanes, a second strap of electrically conducting material connected to even-numbered vanes of said anode near the tips of said vanes and recessed in the end of said vanes, said first strap extending across the even-numbered vanes at places more distant from the tip of said vanes than the places where said second strap is connected to said vanes, said second strap extending across the odd-numbered vanes at places more distant from the tips of said vanes than the places where said first strap is connected to said vanes, said first and second straps crossing over each other at a point between said vanes, said crossover points being located near the trailing edge of said vanes.

6. A strapping arrangement for a magnetron, said magnetron having an annular anode, said anode having a plurality of vanes defining a plurality of cavity resonators, a cathode positioned within the central region of said annular anode, means for producing a magnetic field to cause the space charge spokes emitted by said cathode to rotate in a predetermined direction, a first strap of electrically conducting material connected to odd-numbered vanes of said anode near the tips of said vanes and recessed in the end of said vanes, a second strap of electrically conducting material connected to even-numbered vanes of said anode near the tips of said vanes and recessed in the end of said vanes, said first strap extending across the even-numbered vanes at places more distant from the tip of said vanes than the places where said second strap is connected to said vanes than the places where said second strap is connected to said vanes, said second strap extending across the odd-numbered vanes at places more distant from the tips of said vanes than the places where said first strap is connected to said vanes, said first and second straps crossing over each other at a point between said vanes, said crossover points being located near the trailing side of each of said vanes with respect to said charge spoke rotation.

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