Sept. 2, 1947. D. A. WILBUR 2,426,656

HIGH FREQUENCY ELECTRIC DISCHARGE DEVICE

Filed Dec. 11, 1944

Fig. 1.

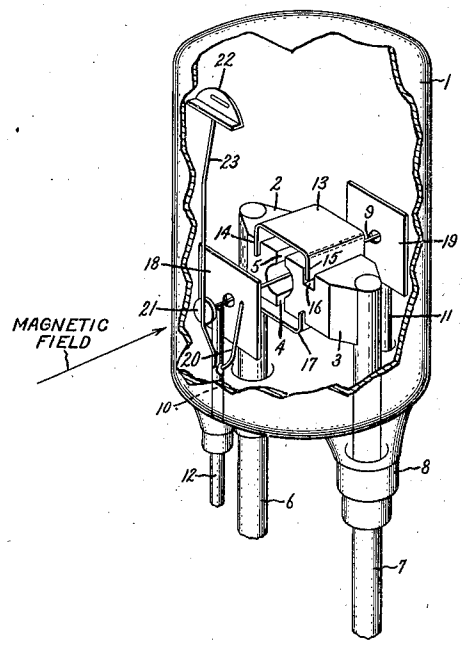


Fig. 2.

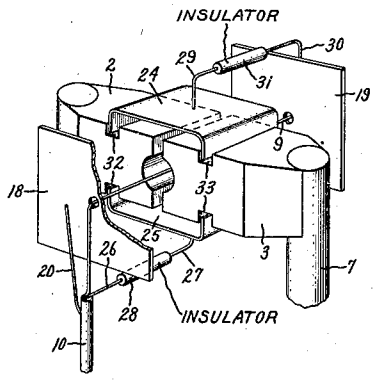
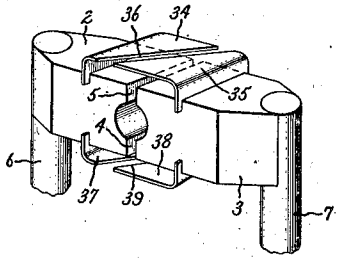


Fig. 3.



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HIGH-FREQUENCY ELECTRIC DISCHARGE DEVICE

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Application December 11, 1944, Serial No. 567,557

10 Claims. (Cl. 250—27.5)

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My invention relates to high frequency electric discharge devices and more particularly to improved shielding arrangements for electric discharge devices of the magnetron type. My present invention is in the nature of an improvement on the invention described and claimed in my joint application Serial No. 567,556, filed concurrently herewith and assigned to the assignee of the present application.

As set forth in the above-identified application, the power which can be taken from a magnetron may be limited by electrons bombarding the envelope. These electrons escape from the gaps between the anode members particularly when the operating frequency is less than the cutoff frequency of the gap. The present invention relates to improved shielding structures for minimizing the escape of the electrons from the interelectrode space, and particularly from the gaps between the anode members, so that the power output of the devices may be increased without damage to the enclosing envelope.

It is an object of my invention to provide a new and improved electric discharge device of the magnetron type.

It is still another object of my invention to provide new and improved shielding structures for preventing bombardment of the enclosing envelope of a magnetron.

In the illustrated embodiments of my invention a magnetron of the split anode type is provided with essentially U-shaped shielding structures spanning each of the gaps between the anode members. In one modification the U-shaped structures are supported from the cathode supports and each has the opposite arms thereof received in recesses formed in the opposite anode faces. In another modification, the U-shaped structures are each supported from one anode member and have arm portions received in recesses in the other anode member. In a third modification, each U-shaped structure includes two members each of which is supported from a different one of the anode members. The base of the U is completed by triangular portions providing a space or slot at an angle with respect to the gap between the anode members.

For a better understanding of my invention, reference may be had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims. In the drawing, Fig. 1 is a perspective view of one embodiment of my invention; Fig. 2 is a perspective view of a modification showing only the electrodes and shielding arrangement; and Fig. 3 is a perspective view of still another modification.

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Referring now to Fig. 1 of the drawing, I have shown my invention embodied in a magnetron device including a generally cylindrical evacuated envelope 1 preferably formed of glass. The envelope encloses an anode structure comprising two anode members 2 and 3 having semi-cylindrical faces arranged in opposed relation to provide a circular array. As illustrated in the drawing, the members 2 and 3 are mounted in mutually spaced relation to provide gaps 4 and 5 between them and are respectively supported by parallel conductors 6 and 7 which extend through one end of the envelope. The conductors 6 and 7 may to advantage be formed of copper tubing and are sealed through the end wall of the envelope 1 by a suitable seal construction which may include a fernico sleeve 8.

A source of electrons in the generally annular space defined by the opposed ends of members 2 and 3 is provided by an elongated cathode 9 which may be a tungsten wire, either uncoated or coated with a suitable electron emissive oxide. The cathode is supported symmetrically between the curved surfaces of anode members 2 and 3 by lead-in conductors 10 and 11 which are sealed through the base of the envelope 1 to provide externally accessible terminals 12 (only one of which is visible on the drawing) for a source of heating current. One of the terminals may also be connected to a source of high negative direct current voltage if the anode is to be operated at ground potential. During the operation of the device as a high frequency oscillator, electrons emitted by the cathode 9 move in the space between the cathode and the faces of the anode members 2 and 3. During a portion of the high frequency voltage cycle, the electrons from the interelectrode space have a tendency to escape from the gaps 4 and 5 and to bombard the glass envelope either at the region of the seal or at other places at which they are directed by the combined action of the electric and magnetic fields existing within the envelope. In order to minimize the escape of electrons and to increase the power which may be taken from the tube at a particular frequency, I provide improved shielding arrangements for minimizing the escape of electrons from the interelectrode space. In the arrangement shown in Fig. 1, a substantially U-shaped structure 13, which as illustrated is a sheet metal punching, is supported from the

anode structure to span the gap 5 between the anode faces. One arm 14 of the punching is received in a slot formed in the anode member 2 and is secured thereto in any desired manner as by soldering or welding. The other arm 15 of the member 13 is positioned in a recess 16 formed in the upper face of the anode member 3 in parallel relation with respect to gap 5. The arm 15 of the U-shaped member 13 is spaced with respect to the side walls of the recess 16. In a similar manner, a U-shaped shield 17 is supported from the anode member 3 and has an arm portion extending to a recess (not shown) in the anode member 2 to span the gap 4. As illustrated in the drawing, the shield members 13 and 17 are longer than the depth of the anode members so that the shield members project beyond the sides of the anode members about $\frac{1}{16}$ inch on each side. In addition to shield members 13 and 17, end shields 18 and 19 are provided. These shields are supported from the cathode conductors 10 and 11, respectively, by means of supporting wires 20, only one of which is visible in the drawing. As illustrated in the drawing, the shields are rectangular and are preferably slightly larger than the generally rectangular space defined by the two shields 13 and 17. The shields are positioned reasonably close to the opposite sides of the anode members 2 and 3, the spacing in the drawing being somewhat exaggerated to facilitate the illustration of the details of construction. A small shield member 21 is supported at each one of the conductors 10 and 11 in line with the openings through the shield members 18 and 19, respectively, to collect electrons escaping around the cathode 9. A suitable getter support 22 may be mounted on a supporting wire 23 which is secured to the cathode lead-in conductor 10.

In Fig. 2 is shown a perspective view of the modification in which shield members 24 and 25, corresponding generally to the shield members 13 and 17 of Fig. 1, are supported in insulated relation with respect to both of the anode members 2 and 3. As illustrated clearly in Fig. 2, shield member 25 is supported from the cathode lead-in conductor 10 by means of supporting wires 26 and 27 which are separated by an insulator 28 which may be a bead of glass. In a similar manner, the shield 24 is supported from the other cathode lead-in conductor by conductors 29 and 30 and a glass bead insulator 31. Both of the side arms of each of the shield members 24 and 25 are received in recesses 32 and 33 formed in the anode members 2 and 3. It is apparent that with the construction shown in Fig. 2 the shield members 24 and 25 are insulated from both of the anode members and are free to assume a potential dependent upon the electrons collected by these shield members.

In Fig. 3 I have shown still another modification of my invention which in certain respects is simpler to support than the shields of the arrangement shown in Fig. 2. In Fig. 3 the U-shaped shielding structures are each made up of two parts supported from the opposite anode members so that the base of the U is cut by a diagonal slot or gap which crosses the gaps 4 and 5 between the anode members. Referring now to Fig. 3, shield members 34 and 35, supported respectively from the anode members 2 and 3, provide a generally U-shaped shielding structure which spans the gap 5 between the anode members. The two parts of the shielding structure are separated by a slot or gap 36 which extends at an angle with respect to the gap 5. This provides an electric field having a component parallel to the magnetic field and, therefore, electrons escaping from the gap are collected on one or the other of shield members 34 and 35. In a similar manner, shield members 37 and 38, supported from anode members 2 and 3 and separated by a gap 39, provide means for minimizing the escape of electrons from the interelectrode space through the gap 4. It will be understood that end shields similar to shields 18 and 19 of Fig. 1 will be employed with the arrangement of Fig. 3.

In order to simplify the drawing, no means has been illustrated for producing a magnetic field. It will be readily understood that this may be produced by electro- or permanent magnet means mounted to provide a magnetic field along the axis of cathode 9 in the direction illustrated in Fig. 1.

In the operation of the devices of the illustrated embodiments of my invention, it will be understood that electrons emitted by the cathode 9 move in curvilinear paths in the interelectrode space under the combined action of a magnetic field along the axis of the cathode and an electric field resulting from a direct current voltage impressed between the cathode and anode members. The motion of the electrons within the interelectrode space excites the anode structure and causes oscillations to be generated at a frequency dependent upon the geometry of the anode structure including anode members 2 and 3 and lead-in conductors 6 and 7 which are short-circuited by a transverse conductor (not shown) at a distance from the envelope 1 which may be adjusted to adjust the operating frequency of the device. I have found that, when operating at frequencies such that a large number of electrons would escape from gaps 4 and 5 were they not shielded, the construction of the present invention is very effective to reduce the escaping electrons to a minimum. While structures such as those of the modifications of Figs. 1 and 2, for example, add considerable capacity coupling between the anode members, this has not been found detrimental within a reasonable range of operating frequencies, and the increase in power output which has been realized from the use of the shielding structures has contributed much to the successful application of the tube.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a substantially cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said space, and shielding means substantially completely covering each of said gaps comprising a pair of substantially U-shaped structures each having at least a portion thereof supported in insulated relation with respect to one of said anode members.

2. A magnetron device adapted to have high power output comprising, an envelope, an anode

structure including a pair of anode members having opposed surfaces and defining between said surfaces a substantially cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said space, and shielding means substantially completely covering each of said gaps comprising a pair of substantially U-shaped structures each supported in insulated relation with respect to one of said anode members.

3. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a substantially cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said space, and shielding means substantially completely covering each of said gaps comprising a pair of substantially U-shaped metal members each having one arm supported from one of said anode members and the other arm received in a recess in the other of said anode members.

4. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said cylindrical space, each of said anode members including a pair of recesses, one located on each of two opposite sides thereof substantially parallel with the gaps between the anode members and a pair of U-shaped shields each supported in insulated relation with respect to both said anode members and each having the opposed arm portions thereof received in a recess of a different one of said anode members.

5. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said cylindrical space, and a pair of U-shaped shields of conducting material each supported in insulated relation with respect to both said anode members and each substantially completely covering one of said gaps.

6. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said cylindrical space, and a pair of U-shaped shields each supported in insulated relation with respect to at least one of said anode members and each substantially completely covering one of said gaps.

7. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a cylindrical space within which

electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said cylindrical space, a pair of conducting members supported from said anode members on opposite sides of one of said gaps and substantially completely covering said gap, said members having portions extending toward one another and terminating short of one another defining a gap at an angle with respect to the gap between the anode members.

8. A magnetron device adapted to have high power output comprising, an envelope, an anode structure including a pair of anode members having opposed surfaces and defining between said surfaces a cylindrical space within which electrons constituting the space charge of the device are adapted to move, said anode members also defining gaps located on diametrically opposite sides of said cylindrical space, a pair of conducting members supported from said anode members on opposite sides of one of said gaps and substantially completely covering said gap said members having triangular shaped portions extending toward one another and terminating short of one another defining a gap at an angle with respect to the gap between the anode members.

9. A magnetron device adapted to have high power output comprising an envelope, an anode structure within said envelope including anode members having opposed surfaces and defining by said surfaces a space charge chamber within which electrons constituting the space charge of said device are adapted to move, said anode members also defining by said surfaces gaps located on the periphery of said space charge chamber, and shielding means for minimizing the escape of electrons from said space charge chamber through one of said gaps comprising a substantially U-shaped structure substantially completely covering said one of said gaps and having at least a portion thereof supported in insulated relation with respect to one of the said anode members defining said one of said gaps.

10. A magnetron device adapted to have high power output comprising an envelope, an anode structure within said envelope including anode members having opposed surfaces and defining by said surfaces a space charge chamber within which electrons constituting the space charge of said device are adapted to move, said anode members also defining by said surfaces gaps located on the periphery of said space charge chamber, and shielding means for minimizing the escape of electrons from said space charge chamber through said gaps comprising a plurality of substantially U-shaped structures each substantially completely covering one of said gaps and each having at least a portion thereof supported in insulated relation with respect to one of the said anode members defining said one of said gaps.

DONALD A. WILBUR.

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

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