July 27, 1948. P. P. DERBY ET AL 2,445,766

APPARATUS FOR ASSEMBLING PARTS OF ELECTRON DISCHARGE DEVICES

Filed March 28, 1944 2 Sheets-Sheet 1

FIG. 1.

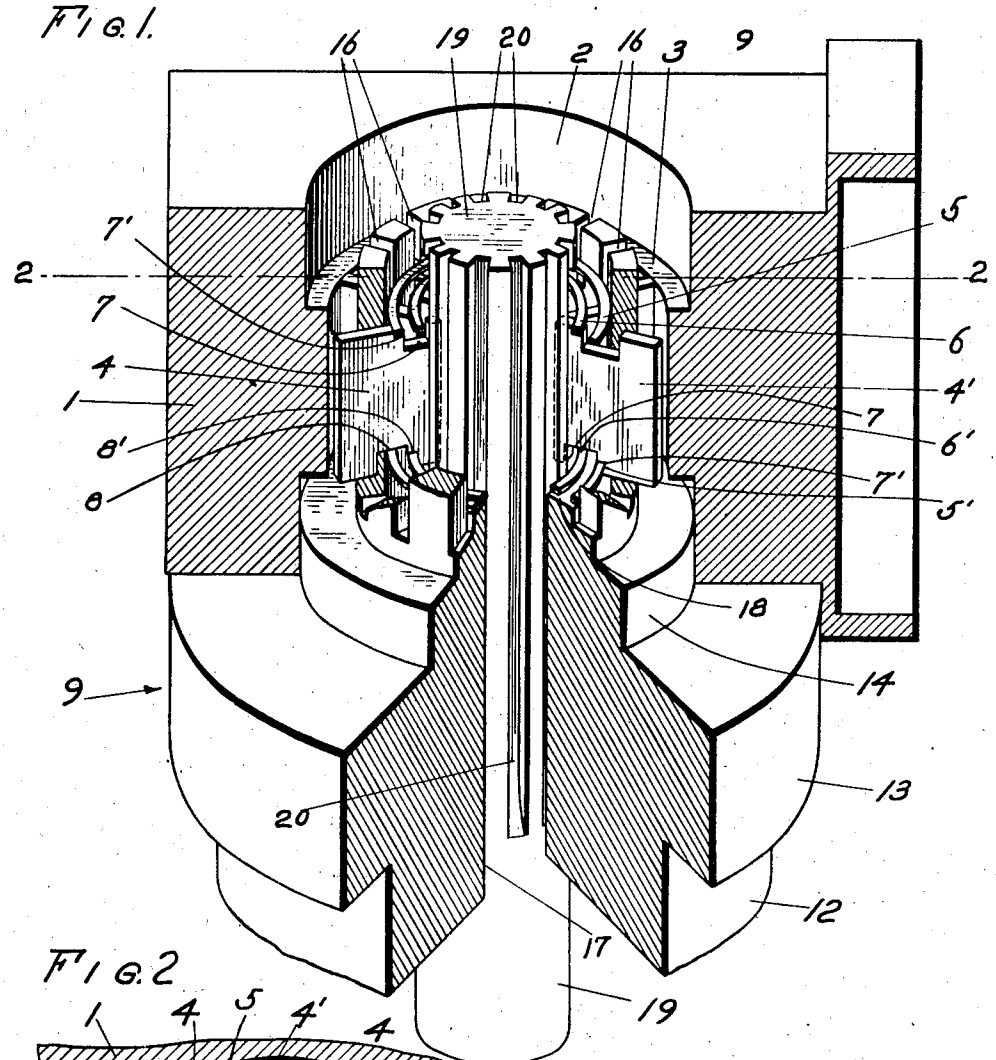
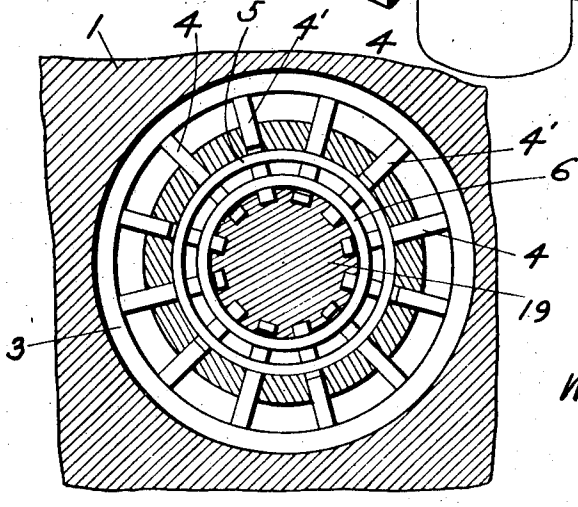


FIG. 2



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2 Sheets-Sheet 2

FIG. 3.

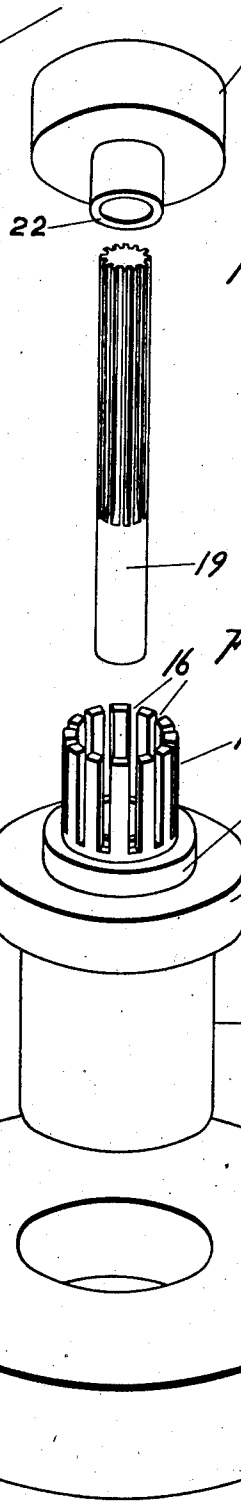


FIG. 4

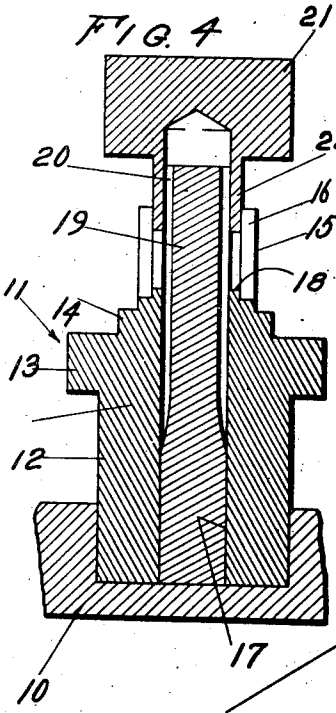


FIG. 5

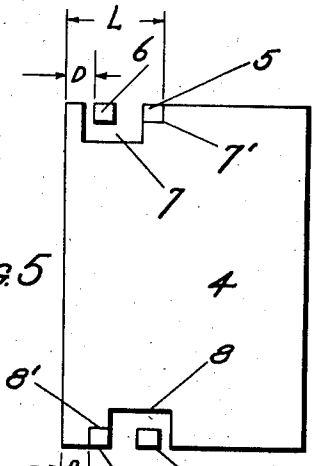
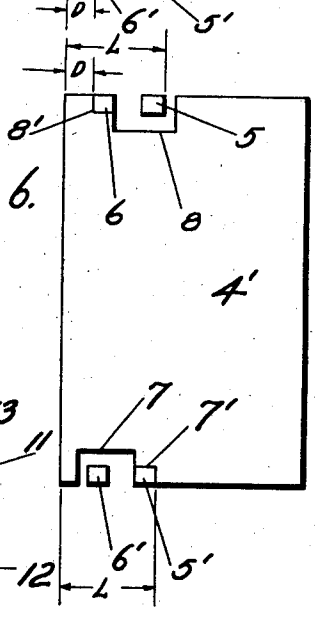


FIG. 6.



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UNITED STATES PATENT OFFICE

2,445,766

APPARATUS FOR ASSEMBLING PARTS OF ELECTRON DISCHARGE DEVICES

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4 Claims. (Cl. 113—99)

1

This invention relates to apparatus for manufacturing the anode structure of hyper and ultra high frequency oscillation tubes of the magnetron type.

In tubes of the type to which the invention relates, the anode structure comprises a metallic block having a cylindrical cavity and a plurality of substantially radially-disposed anode arms projecting inwardly from the wall of said cavity. The space between each pair of arms or plates constitutes a cavity resonator. The frequency of the oscillations produced by such a device depends upon the geometrical configuration of the resonator, and it is important that the anode plates be accurately spaced so that the cavity resonators will be accurately matched. The efficiency of the device depends in large part upon such accurate matching of the cavity resonators.

Heretofore difficulties have been encountered in constructing anode structures of the above type and the art has resorted to relatively complicated and expensive arrangements requiring skilled workmanship to insure the required accuracy. In the copending application of William C. Brown, Serial No. 522,194, filed February 10, 1944, now Patent No. 2,433,339, issued Dec. 30, 1947, there is disclosed a method and apparatus which facilitate the construction of such devices and increase the accuracy with which they may be constructed.

It is an object of the present invention to further improve the accuracy of construction and facilitate the manufacture of such devices, so that the same may be manufactured by relatively unskilled labor with a high degree of accuracy.

Devices of the type to which the invention relates may oscillate not only at the desired frequency determined by the cavity resonators defined by each pair of adjacent anode plates but also as to generate spurious, undesired oscillations due to oscillating circuits provided by non-adjacent anode plates. It has heretofore been found that these spurious undesired oscillations may be minimized by interconnecting the inner ends of alternate anode arms or plates by various strapping arrangements. Such strapping arrangements further complicate the construction of the anode structures of this type and materially increase the difficulties of construction and the cost of manufacture.

It is among the objects of the present invention to provide apparatus for facilitating the construction of such anode structures having a complete strapping arrangement without materially increasing the cost of manufacture or the labor and

2

skill required as compared with unstrapped structures.

The foregoing and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view, with parts in section and parts broken away, of the novel apparatus of this invention;

Fig. 2 is a section taken on line 2—2 of Fig 1;

Fig. 3 shows, on a reduced scale, an exploded perspective view of the jig structure;

Fig. 4 is a vertical section through the jig structure; and

Figs. 5 and 6 show, on an enlarged scale, details of the anode structure.

Referring to the drawings, the anode structure which is to be constructed in accordance with the invention comprises an anode block 1 of highly conductive material, such as copper. The block 1 has a central opening extending therethrough providing a cylindrical cavity 2, which cavity has an annular projection 3 intermediate the ends thereof, from which projection a plurality of anode plates 4 and 4' extend inwardly toward the axis of the cylindrical cavity. The outer edges of the plates 4 and 4' are secured to the face of the annular projection 3 by soldering and the inner edges thereof form a plurality of anode faces adapted to cooperate with a thermionic cathode to be positioned centrally of the cavity 2 in the free space adjacent the inner ends of the plates 4 and 4'. As is well understood in the art, an even number of plates 4 and 4' are provided and the space between each pair of adjacent plates constitutes a resonant cavity.

At points adjacent their inner edges, alternate anode plates 4 are electrically connected together at the upper ends thereof by means of an outer strap 5, while the intervening plates 4' are electrically connected by an inner strap 6. At the lower ends of the anode plates, the plates 4' are connected together by an outer strap 5' and the plates 4 are connected by an inner strap 6'. It will be seen that the strapping arrangement at the lower end of each anode plate is the reverse of the strapping arrangement at the top of the plate; in other words, where the plate is connected to the outer strap 5 at its upper end, the lower end is connected to the inner strap 6' and vice-versa.

In order that the straps 5—6 and 5'—6' may be alternately connected to the anode plates or pass freely adjacent thereto, as required by the above construction, I provide a notch 7 in one

end of each of the plates, which notch has a stepped portion 7' spaced to accommodate the outer strap 5 or 5', and the notch is of such depth and width that the inner strap 6 or 6' may pass freely therethrough without contacting the plate. The opposite end of the plate is provided with a notch 8 having a stepped portion 8' spaced to accommodate the inner straps 6 or 6', and the width and depth of this notch is such that the strap 5 or 5' may pass freely therethrough without contacting the plate. The plates 4 and 4' are identical in construction, but in assembly the position of the notches 7 and 8 is reversed, the plates 4 being positioned with the notch 7 at the upper end, while the plates 4' are positioned with the notch 8 at the upper end.

In order to construct the anode arrangement as described above, I provide a jig 9 comprising a base 10 from which projects a support and positioning member 11. The support 11 has a lower cylindrical portion 12 adapted to fit in a suitable bore in the base 10 and to be held upright thereby.

Above the cylindrical portion 12 is an intermediate flange 13 upon which the lower end of the anode block 1 is adapted to rest and to be centered relative to the jig 9 by a shouldered portion 14 projecting into the opening 2 to a point below the annular projection 3. An upper cylindrical portion 15 having a plurality of slots 16, extending longitudinally thereof, projects upwardly from the shouldered portion 14, concentric with the opening 2, for such a distance that the upper end of the cylindrical portion 15 will project above the annular projection 3 of the anode block 1 when the latter is positioned on the jig. A central opening 17 extends through the support 11 having a lesser diameter than the internal diameter of the cylindrical portion 15, leaving a shoulder 18 between said opening and the internal surface of the cylindrical portion 15. A mandrel 19 extends through the opening 17 and through the slotted cylindrical portion 15 to a point above the upper end of said cylindrical portion, and is provided with splines 20 extending from the upper end thereof, at least as far as the shouldered portion 18. The outer diameter of the mandrel 19 is such that it makes a sliding fit with the opening 17, and the internal diameter of the straps 6 and 6' is substantially the same as the diameter of said mandrel, so that these straps may be slipped on the mandrel and centered thereby. The outer diameter of the straps 5 and 5' is approximately equal to the internal diameter of the slotted cylindrical portion 15 so that these straps make a sliding fit with the interior surface of said cylindrical portion and may be centered thereby. The depth of the splines 20 is made equal to the distance D between the inner edges of the plates 4 and 4' and the stepped portion 8' of the notches 8.

In the manufacture of anode structures of the type described in the foregoing by means of my novel apparatus, the lower straps 5' and 6', which are of conductive material, such as copper, and preferably coated with solder for reasons which will hereafter more fully appear, are first inserted in the jig between the slotted cylindrical portion 15 and the mandrel 19 so that they rest on the internal shoulder 18 with the strap 5' centered by the interior surface of the cylindrical portion 15 and the strap 6' centered by the mandrel 19. One of the anode plates 4 or 4' is inserted into the opening 2, being guided by one of the slots 15 with its inner edge in one of the splines 20 and its outer edge in contact with the surface of

the annular projection 3. Assuming that the plate is to be one of the anode arms 4, it is inserted with the notch 8 at the lower end thereof, and in its lowermost position the plate will contact the strap 6' at the stepped portion 8' of the notch 8 and will be free and clear of the strap 5', as shown in Fig. 5.

It will be understood that the number of slots 16 in the cylindrical portion 15 of the support 11 will correspond to the number of anode plates 4 and 4' desired in the anode structure, and a corresponding number of splines 20 will be provided in the mandrel 19, and therefore if one of the splines 20 is aligned with one of the slots 15, each of the other splines will be aligned with a corresponding slot 15. Accordingly, the next adjacent plate may be inserted in the next adjacent spline and will be guided into position by the corresponding slot 15. This plate is inserted with the notch 7 at the lower end thereof and the notch 8 at the upper end to provide one of the plates 4'. In its lowermost position this plate will contact the strap 5' at the stepped portion 7' of the notch 7 and will be free and clear of the strap 6', as shown in Fig. 6.

The next succeeding plate will be inserted with the notch 8 at the lower end thereof to provide one of the plates 4, and the succeeding plates will be inserted with the notches 7 and 8 alternately in the lowermost position.

In the instance shown, twelve of the plates 4 and 4' are provided, and it will be understood that any even number of plates may be used. When all of the plates 4 and 4' have been positioned in the jig, the strap 6 is inserted, being guided into position by the mandrel 19, and it will be seen that this strap will rest upon the stepped portion 8' of the notches in the plates 4', and its upper surface will be flush with the upper edge of these plates. The strap 5 is inserted, being guided into position by the interior surface of the cylindrical portion 15, and it will be seen that this strap will rest on the stepped portion 7' of the notches 7 in each of the plates 4, the distance L between the inner edge of the plates and outer edge of the stepped portion 7' of the notch 7 being equal to the distance from the base of any spline 20 to the interior surface of the cylindrical portion 15.

The straps 5 an 6 are of conductive material and are preferably coated with solder, the same as straps 5' and 6'. The preferred solder for this purpose is an eutectic alloy of silver and copper.

After the plates 4 and 4' and the straps 5, 5' and 6, 6' have been assembled in the jig, as described in the foregoing, a weight 21, having an annular boss 22 projecting centrally therefrom, is placed on the jig to hold the parts in position for soldering. For this purpose the annular boss 22 has an internal diameter corresponding to the outer diameter of the mandrel 19 and an external diameter corresponding to the internal diameter of the slotted cylindrical portion 15, so that when the weight is positioned on the jig the boss 22 will project into the annular space between the mandrel 19 and the cylindrical portion 15, and bear at its lower end on the straps 5 and 6. The straps 5 and 6 are tamped into place by the boss and are held in the desired position in the stepped portions 7' and 8', respectively, of the notches 7 and 8 with the upper surfaces of the straps flush with the upper edges of the plates 4 and 4'. The lower straps 5' and

6' are similarly maintained in position by the shoulder 18.

The parts of the assembly may now be secured together by soldering, and it is for this purpose I prefer that each of the straps 5, 5' and 6, 6' be provided with a thin coating of solder, preferably an eutectic alloy of silver and copper. The outer edges of the plates 4 and 4' may be provided with a thin coating of solder for securing the plates to the annular projection 3 of the block 1, or preferably a thin ring of the solder may be placed at the upper outer ends of the plates 4 and 4' adjacent the cylindrical surface of the annular projection 3. The entire assembly may then be placed in a furnace having a non-oxidizing atmosphere and heated to a temperature sufficient to melt the solder. The solder secures the straps 5, 5' and 6, 6' to the plates 4 and 4' at the points of contact in the stepped portions 7' and 8' of the notches 7 and 8, and the outer edges of the plates are secured to the cylindrical surface of the projection 3. Where a ring of solder is provided adjacent the upper outer ends of the plates, as described, it is found that the solder on melting tends to flow downwardly along the lines of contact between the cylindrical surface and the edges of the plates and fill the interstices therebetween.

In order to prevent the solder from uniting any parts of the anode assembly to the jig, all parts of the latter are provided with surfaces to which the solder does not fuse. Preferably all parts of the jig are made of or surfaced with stainless steel and the surfaces oxidized. The solder does not unite with such a surface, and after baking the completed anode assembly may be readily removed from the jig.

It will be seen that the jig structure above described and the procedure employed provide an efficient means and method for rapidly and accurately assembling anode structures of the type described. The splines 20 and the slots 16 provide two spaced guides for each of the plates 4, 4' and insure more accurate angular spacing of the plates while facilitating the ease with which they may be placed in position. The utilization of the inner surface of the cylindrical portion 15 as a guide and centering means for the outer straps 5 and 5' and the outer circumference of the mandrel 19 as a guide and centering means for the inner straps 6 and 6' insures that these straps will be accurately spaced and positioned without requiring great time, care or skill on the part of the operator.

While there has been herein described a preferred form of the invention, other embodiments thereof within the scope of the appended claims will be obvious to those skilled in the art from a consideration of the form shown.

What is claimed is:

1. An apparatus for assembling the component parts of the anode of an electron-discharge device comprising: a central member having a plurality of splines defining a plurality of slots extending longitudinally thereof; and a cylindrical member concentric with said central member; said cylindrical member having a plurality of slots extending longitudinally thereof; the slots of said cylindrical member, throughout their major extent, being directly opposite, in register with, and radially spaced from the slots of said central member.

2. An apparatus for assembling the component parts of the anode of an electron-discharge device comprising: a cylindrical member having a central opening extending longitudinally therethrough; and a central member, having a plurality of splines defining a plurality of slots extending longitudinally thereof, positioned in said central opening; said cylindrical member having an internal wall spaced from said central member, and a plurality of slots extending longitudinally thereof; the slots of said cylindrical member, throughout their major extent, being directly opposite, in register with, and radially spaced from the slots in said central member.

3. An apparatus for assembling the component parts of the anode of an electron-discharge device comprising: a base portion having a central cylindrical bore; a cylindrical member having a sliding fit in said cylindrical bore of said base portion; and a central member extending through said cylindrical member and having a plurality of splines defining a plurality of slots extending longitudinally thereof; said cylindrical member having an internal wall spaced from said central member, and a plurality of slots extending longitudinally thereof; the slots of said cylindrical member, throughout their major extent, being directly opposite, in register with, and radially spaced from the slots in said central member.

4. An apparatus for assembling the component parts of the anode of an electron-discharge device of the type having a plurality of plates projecting radially from the interior wall of a cylindrical cavity, and having alternate plates electrically connected adjacent the inner ends thereof by an annular ring of conductive material, comprising: a central member having a plurality of splines defining a plurality of slots extending longitudinally thereof; and a cylindrical member concentric with and spaced from said central member, and having a plurality of slots extending longitudinally thereof; the slots of said cylindrical member throughout their major extent, being directly opposite, in register with, and radially spaced from the slots in said central member; said central member having an outer diameter corresponding to the internal diameter of said ring.

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