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2,310,936

ELECTRON DISCHARGE APPARATUS

Filed April 2, 1941

2 Sheets-Sheet 1

FIG.1.

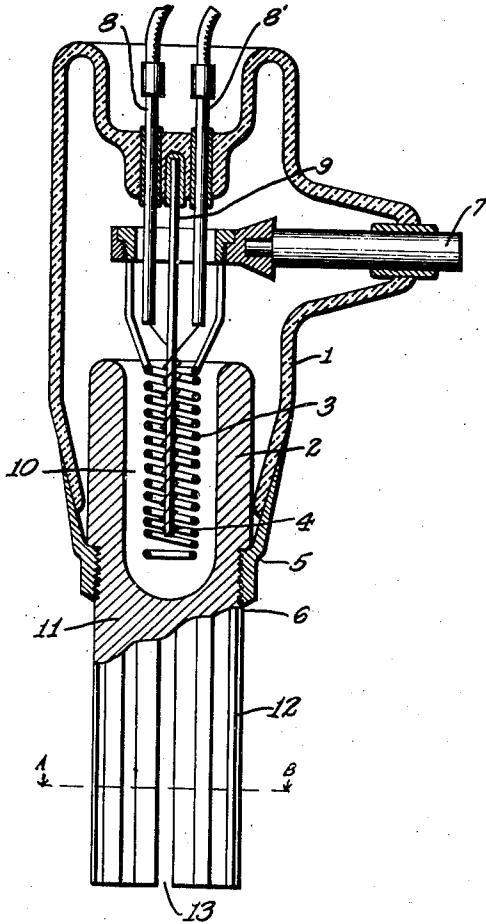


FIG.4.

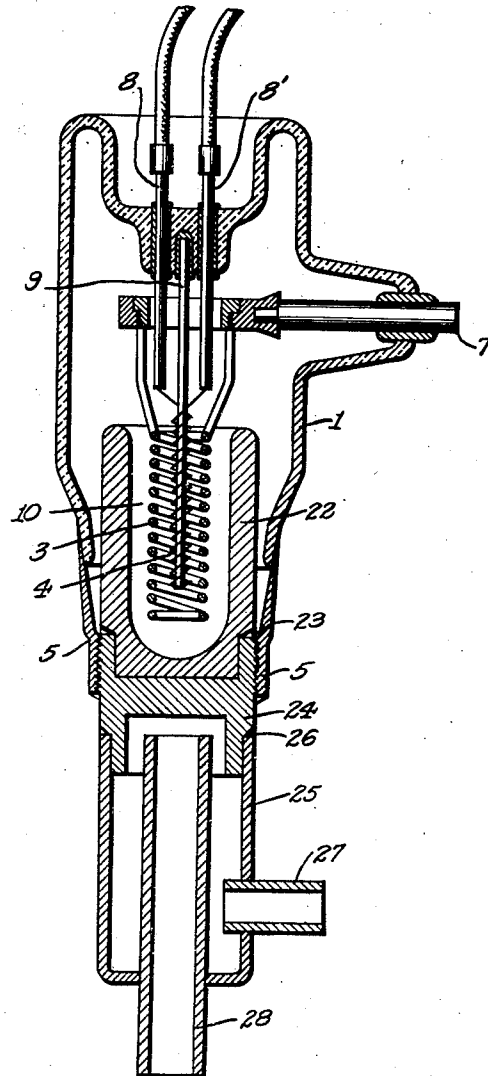


FIG.2.

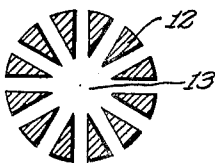
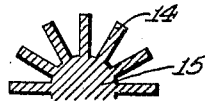


FIG.3.



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FIG. 6.

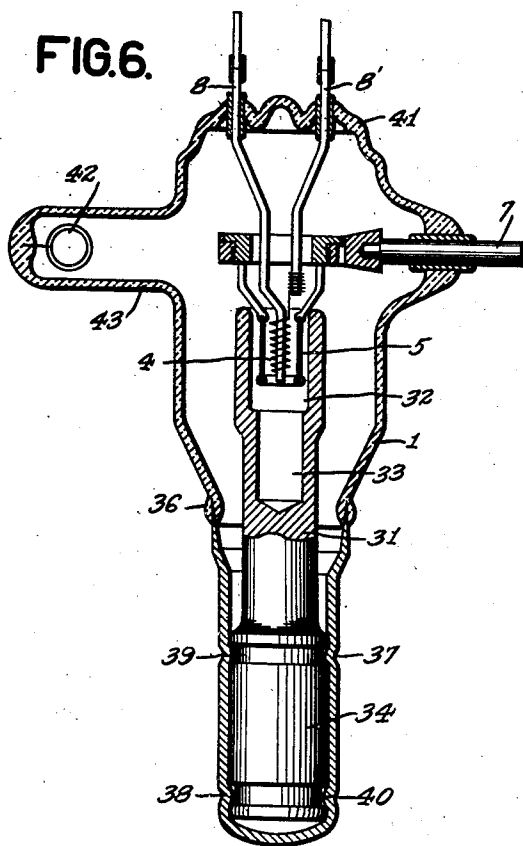


FIG. 7.

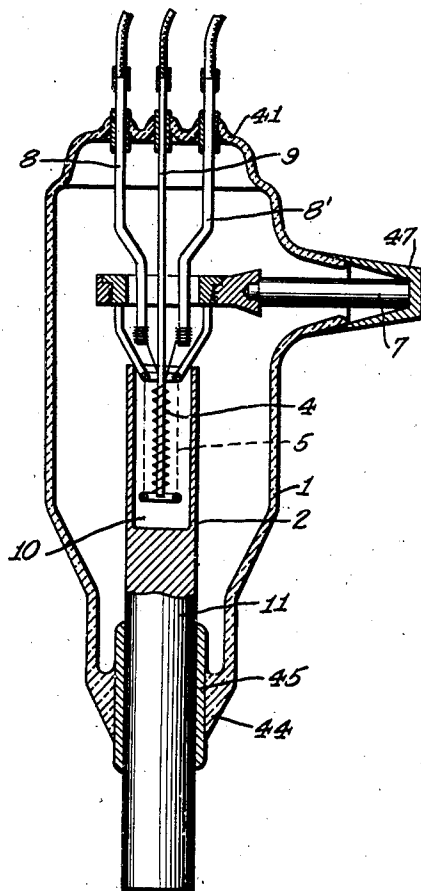
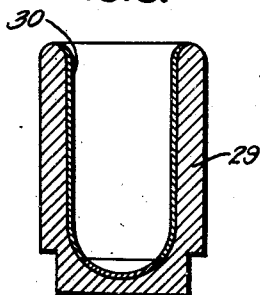


FIG. 5.



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ELECTRON DISCHARGE APPARATUS

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Application April 2, 1941, Serial No. 386,513
In France March 30, 1940

11 Claims. (Cl. 250—27.5)

The present invention relates to improvements in electrode arrangements in electron-discharge apparatus and more particularly to electron-discharge devices in which an electrode, usually the anode, is cooled by some appropriate means to keep it at a temperature which will assure good operation of the device.

In such discharge devices the anode electrode, which is ordinarily provided as a part of the protective envelope of the apparatus extending externally thereof, is designed to be the coldest part of the apparatus. As a result it may collect condensate of gases liberated during operation of the apparatus, which gases may cause deterioration of the cathode depending upon the nature of the latter.

It is a principal object of the invention to provide electron-discharge apparatus in which this inconvenience cannot be harmful to efficient operation of the apparatus.

It is also an object to prevent harmful effects of stray gases upon an anode or cathode, even if the anode or cathode materials would of their nature aid cathode disintegration in present forms of cold-anode tubes.

Another object of the invention is to provide an improved electrode arrangement for electron-discharge apparatus designed to operate at very high frequencies, for example, wavelengths on the order of a meter.

It is also an object to provide improved means whereby an anode may be cooled and yet operate at a temperature greater than that of the coolest portion of the tube envelope.

Another object is to provide an improved external anode structure for a vacuum tube.

Still another object resides in the provision of an anode along which the temperature gradient will be uniformly distributed to avoid excessive localized heating thereof.

A further object is to provide improved cooling means for an external type anode.

It is also an object to provide improved means associated with an anode for avoiding deterioration of a thoriated tungsten filament due to the presence of copper or other material which may, due to impurities, liberate oxygen or other gases.

Other objects and various further features of novelty and invention will hereinafter be pointed out or will become apparent from the following specification, taken in conjunction with the drawings included herewith. In said drawings

Fig. 1 is a cross-sectional elevation representing an electron-discharge device embodying features of the invention;

Fig. 2 is a cross sectional view of a portion of the device in Fig. 1, said view being taken substantially in the plane indicated as A—B;

Fig. 3 is a cross section of a modification of a portion of the device of Fig. 1;

Fig. 4 is a cross-sectional elevation representing another embodiment of electron-discharge apparatus incorporating features of the invention;

Fig. 5 is a cross-sectional view taken in the plane of Fig. 4 and representing a modification of a portion of the apparatus of Fig. 4; and

Figs. 6 and 7 are views in cross-sectional elevation representing two further possible embodiments of electron-discharge apparatus incorporating features of the invention.

The use of thoriated tungsten filaments in electron-discharge apparatus having water cooled copper anodes has not to date been possible because of a deterioration of the filament. It seems that this deterioration consists of a disintegration of the thoriated tungsten filament under the action of the gases which are liberated in the apparatus during operation and are condensed by the anode, which in such apparatus is the coolest part of the structure.

On the other hand, electron-discharge apparatus incorporating features of the invention is particularly designed to use a thoriated tungsten filament, although the particular structural embodiments of the invention may equally well find application in discharge apparatus employing other materials for the emissive filament. The combination of a thoriated tungsten filament with a copper anode is the distinctive feature of the electron-discharge apparatus represented in Fig. 1 in partly sectionalized elevation.

In this embodiment, as in the embodiment of Fig. 4, the structure represented, apart from the novel anode structure and the preferred use of thoriated tungsten on the filament, is otherwise analogous to that of apparatus in common use. It is to be understood, therefore, that the invention is not limited to the structure shown but may be utilized in cooperation with any desired electrode structure.

In the embodiment represented in Fig. 1 a protective envelope 1, in which there is a vacuum, is shown enclosing an anode 2, a grid 3, and a cathode or filament 4. The protective envelope 1 may be sealed for example to a metallic coupling or adapter sleeve 5 screwed to the anode 2, to which it may be soldered to make an air-

Fig. 1 is a cross-sectional elevation represent-

tight seal, as indicated at 6. A transversely extending member 7 for supporting and feeding the grid electrode 3 is shown in the envelope 1 as well as the current leads 8-8' for the filament 4, which may be of double helical form and held at the electric mid-point thereof by a central member 9, sealed within the said envelope 1. The member 7 for supporting the grid may be of tungsten or molybdenum and of large cross section, thus assuring that this connection will offer low impedance to high frequencies.

The active portions of the grid 3 and of the filament 4 may be supported centrally within the interior of a hollowed-out portion 10 of the anode 2. With this arrangement of electrodes, the structure is more readily adaptable to operation at very elevated frequencies, in that electrodes of small surface area may be used with short lead-in connections, as will be clear.

The anode 2, according to features of the invention includes a block of copper, having a hollowed-out portion 10 within the tube proper and an integral portion extending exterior of the envelope 1, as shown at 11. The external portion of the block 11 may be formed with or connected to fin portions for cooling purposes. These fin portions may include, as shown in Figs. 1 and 2, portions having a triangular cross section 12 disposed radially around a central flue 13; or may include, as shown in Fig. 3, radial elements 14 formed integral with a central core or fixed to this core.

In connection with either of the preferred embodiments of cooling means shown in Figs. 2 and 3, it will be observed that efficient cooling may be obtained without increasing the anode diameter—a feature which is particularly desirable in ultra short wave operation, under which circumstances larger radially extending fins have the disadvantage of increasing the inductance and, hence, load and operating characteristics of the tube.

Many forms of coolant may be employed in connection with the above-described cooling means; for example, cooling by forced air ventilation, by circulation of a liquid or gaseous refrigerant within conduits provided in the extending portion 11 of the anode, or by other means in such a way as to maintain the anode at an appropriate temperature to permit it to operate at a temperature well above the temperature of the coldest portion of the protective envelope. The latter is an objective sought for in the embodiment of the present invention in order to avoid disintegration of the filament by the gases condensed by the copper anode.

A preferred coolant system is shown in Fig. 4 in which the anode structure includes an envelope 25 soldered at 26 to the base member 24 and having an input 27 and an output conduit 28 for the coolant used. It is clear, however, that the sheathing form shown is only by way of example and that any other appropriate form may be employed for cooling the base member 24, and hence the anode 22.

A modified anode structure is shown in Fig. 5, and this structure is particularly adaptable to the apparatus of Fig. 4. The anode portion of Fig. 5 includes a hollowed-out copper block 29, the interior surface of which may be coated with a thin layer 30 of molybdenum or tantalum to avoid deterioration of a tungsten filament due to any possible action of the copper; which action may, as above indicated, be a releasing of oxygen or other gases present as impurities in the cop-

per. Such an anode may be installed in the manner shown in Fig. 4, that is to say, joined to some other metallic base portion or may be of the form shown in Fig. 1, that is, the copper block 29 may have an integral portion extending out of the protective envelope 1.

Another possible embodiment incorporating features of the invention is pictured in Fig. 6. In this figure the anode includes, as in the case of the apparatus of Fig. 4, a metal block 31 hollowed out at 32 and 33 (active portions of elements positioned in the hollowed-out portion 32), the hollowed-out portion 33 representing a saving in material and improved temperature-control means for the anode. It will be seen from this figure that the outside diameters and the thicknesses of the portions of the anode surrounding the hollowed-out portions 32 and 33 are different. Such a structure will assure that the upper portion of the anode will not develop too high a temperature, although this portion is further away from the cooling means. To this end, an alternative preferred form of anode may have a cross section and/or a diameter continuously varying longitudinally of the electrode in such a way that the temperature gradient is evenly distributed along the anode.

Obviously such a form of anode may be used in any one of the embodiments described. The anode structure of Fig. 5, which as described was a copper block having an interior coating of tantalum or molybdenum, could just as well have been employed in the apparatus of Fig. 6.

The extending portion of the anode 31, as shown, may be set into a closed copper tube 35 having substantially the same shape as the usual type of external anode in discharge apparatus of this character. The closed copper tube 35 may be sealed directly to the insulating envelope 1 as shown at 36 and may have circumferentially extending formed portions, such as 37 and 38, fitting cooperatively with recessed portions 39 and 40 of the block 34 in order to secure the portion 34 within the tube 35. It is to be understood that the mechanical and thermal union of the block 34 and the tube 35 may also be effected in any other suitable manner, for example, by forcibly threading the interior of the copper tube 35 to the block 34. The tube 35 may in any case be cooled as above indicated in connection with other preferred forms.

The embodiment shown in Fig. 6 represents a structure having electrodes and connections different from those of Figs. 1 and 4. In a preferred embodiment the molded foot portion 41 of the upper portion of the insulating envelope 1 is inverted. The supporting members 8 and 8' passing across this foot portion provide filament lead connections. The filament, instead of consisting of a double helix at the electrical mid-point of the system is shown in the form of a simple helix connected to the two ends of the members 8 and 8'.

The control grid may be of a construction analogous to those in the above-described forms. A getter for absorbing gas liberated by the elements of the apparatus may be provided as shown at 42 in a pocket or lateral tube projection 43 of the insulating envelope 1 in order to prevent undesired coating of tube elements, as will be clear.

The grid 5 may likewise be supported by a molybdenum or tungsten member (serving also as its electrical lead-in connection) which extends

across the insulating envelope 1 and below the inverted foot portion 41.

The structure of Fig. 7 represents an anode modification illustrative of another feature of the invention. The metallic block 11 is formed with a hollowed-out portion 10. The wall 2 of the hollowed-out portion 10 constitutes the anode, and the block 11 is directly sealed to the insulating envelope as shown at 44 by the intermediate means of a sleeve 45 of insulating material in the same way as the electric connections of the other electrodes in the examples of electron-discharge devices described above. The extending portion of the block 11 outside of the envelope 1 may be cooled in any appropriate manner.

It will be seen that electron-discharge apparatus incorporating features of the present invention permits an anode to be cooled to a proper point for assuring good operation of the apparatus while retaining the general disposition of electrodes for short wave operation, that is to say, electrodes having small surface areas and short connections.

The particular advantage of using a thoriated tungsten filament in these structures is that it will permit saturation currents to be obtained—which is advantageous in certain applications of this apparatus, such as in the production of high-power impulses.

While the invention has been described in particular detail in connection with the preferred forms shown, it is clear that it is not limited thereto but may, on the other hand, be modified and adapted in many ways without departing from its scope. For example, it is clear, moreover, that the structures described may be advantageously employed in cases where the filament is of a material other than thoriated tungsten.

Furthermore as already mentioned, the particular structures of the anode described are not to be considered as limiting and may, moreover, be employed with any other desired structure in conjunction with other combinations of electrodes, their connections, and the insulating envelope 1.

What is claimed is:

1. An external type anode for a high frequency electron discharge device, said anode being of generally cylindrical shape and having at one end a cup-shaped hollowed-out portion generally coaxial with the generally cylindrical shape, said hollowed-out portion extending longitudinally inward of said anode to accommodate an electrode structure, said anode further including adapter means for joining said anode to an evacuated envelope, said adapter means extending circumferentially of said anode at a point proximate to the end of said hollowed-out portion opposite said first-mentioned end.

2. An anode in accordance with claim 1, in which the end of said anode opposite said end having said hollowed-out portion is provided with integral heat radiating members.

3. An anode for a high-frequency electron discharge device, said anode being generally uniformly cylindrical over its length, said anode having at one end a generally cylindrical cup-shaped hollowed-out portion, heat radiating means formed from said anode at the other end, and adapter means for joining said anode to an evacuated envelope, said adapter means extend-

ing circumferentially of said anode at a point intermediate a substantial portion of said hollowed-out portion and said heat radiating means.

4. In a high-frequency discharge device of the external-anode type having an evacuated envelope, an electron emissive electrode and an anode, said anode having a cylindrically extending annular portion spaced from and generally coaxial with said electron emissive electrode, said annular portion extending within said envelope, adapter means for joining said anode to said evacuated envelope, said adapter means extending circumferentially of said anode at a point substantially adjacent an end of said emissive electrode, and said emissive electrode being substantially coextensive with said annular portion.

5. A discharge device according to claim 4, in which cooling means are provided integral with said anode and extending externally of said discharge device.

6. A discharge device according to claim 4, in which cooling means are provided integral with said anode and extending externally of said discharge device, said cooling means being of substantially the same diametrical dimensions as the rest of said anode.

7. An anode for a high-frequency electron discharge device, said anode including an electron collecting portion, an adapter portion, and a cooling portion, said adapter portion for joining said anode to an evacuated vessel, said electron collecting portion of said anode extending within said vessel, said adapter portion extending peripherally of said anode at a point intermediate said electron collecting portion and said cooling portion.

8. An anode for a high-frequency electron discharge device, said anode including an electron collecting portion, an adapter portion, and a cooling portion, said adapter portion for joining said anode to an evacuated vessel, said collecting portion of said anode extending within said vessel, said adapter portion extending peripherally of said anode at a point intermediate said electron collecting portion and said cooling portion, said electron collecting portion being removable from the rest of said anode.

9. An electron discharge device of the external anode type, including within an evacuated envelope a generally longitudinally extending thoriated tungsten filament, a grid substantially coextensive and coaxial with said filament, and an anode having a hollowed-out portion substantially coextensive and coaxial with said filament and said grid, the portion of said anode which includes said hollowed-out portion extending within said envelope, cooling means including a plurality of radially extending surfaces integral with said anode, said cooling means being substantially equal in overall diameter to the outer diameter of said anode and adapter means joining said anode to said envelope at a point between a substantial portion of said hollowed-out portion and said cooling means.

10. In an electron discharge device according to claim 9 in which said anode includes a surface of molybdenum adjacent said filament, for the purpose described.

11. An electron discharge device according to claim 9, in which said anode includes a surface of tantalum adjacent said filament for the purpose described.

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