This invention relates to improved getters for vacuum devices, such as electron tubes, and more particularly to an improved getter structure characterized as having a high temperature gradient and a large surface area to volume ratio.

During the fabrication and subsequent use of devices which utilize a relatively high vacuum, such as electron tubes, it is necessary to remove from the interior of the vacuum envelope various occluded gases which may be detrimental to the proper operation of the device. For example, certain gases within the vacuum envelope of an electron tube tend to produce various detrimental effects, such as cathode poisoning and ionization, which impair the operating characteristics and life of the tube.

Vacuum pumping of the tube during fabrication fails to eliminate all of the undesirable gases. Also, the electrodes and other structure enclosed within the vacuum envelope may absorb or adsorb undesirable gases or contain impurities capable of producing undesirable gases when heated by subsequent operation of the tube. Consequently, operation of the tube heats such electrodes and structures causing them to give off the undesirable gases within the vacuum envelope.

These undesirable gases may be greatly reduced by the use of getters within the vacuum envelope which function, when heated, to remove the undesirable gases. The getter material reduces the undesirable gases by chemically combining with the gases to form inert and harmless compounds or by holding such gases by a sorption process.

Since various gases getter at different temperatures, it is desirable that the getter material have a temperature gradient when it is heated. Also, for efficient operation it is desirable that the getter material have a large exposed surface area for gettering the undesirable gases. Since different getter materials getter different gases at different temperatures, it may be desirable to utilize more than one type of getter material. Further, for economy reasons, it is desirable that the getter structure be easily and readily fabricated.

Accordingly, an object of this invention is to provide an improved getter structure.

Another object of this invention is to provide an improved getter structure for an electron tube which getter is caused to have a temperature gradient during operation of the tube.

Still another object of this invention is to provide an improved getter having a large surface area available for gettering various gases.

A further object of this invention is to provide a getter structure which may utilize a combination of different gettering materials.

A still further object of this invention is to provide an improved getter structure that is easily and economically fabricated.

Briefly described, the improved getter structure of the present invention comprises a plurality of parallel and substantially equal length refractory metal rods held or otherwise secured together to form a bundle of said rods. The bundled rods are placed within the envelope of a vacuum device, such as an electron tube, so that one end of the bundle is near or adjacent an energizable source of heat, such as the heater (filament) of an indirectly heated cathode, and the other end of the bundle of rods is thermally coupled to a heat sink so that a temperature gradient is produced along the length of said rods when the heat source is energized. If desired, the rods may be fabricated from unlike refractory metals in order to aid the gettering of various gases.

These and other features, objects and advantages of the present invention will be readily apparent from consideration of the following detailed description relating to the annexed drawings in which:

FIGURE 1 illustrates a typical electron tube which may utilize the improved getter structure of this invention;

FIGURE 2 illustrates in partial cross-section an embodiment of the present invention in an electron gun which may be used in the device of FIGURE 1;

FIGURE 3 illustrates in cross-section the getter structure used in the electron gun shown in FIGURE 2; and

FIGURE 3A is an end view of the structure illustrated in FIGURE 3 taken along the line A—A.

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, there is illustrated in FIGURE 1 an electron tube, such as a klystron, which includes a gun section 11 for producing an electron beam, a radio frequency interaction section 12 and a collector section 13. As is well known to those skilled in the art, the electron gun section, the interaction section and the collector section are hermetically united in axial alignment to provide a substantially vacuum tight envelope and to enable the projection of the electron beam produced by the gun section 11 through a series of drift tube sections 14 each of which terminates within a cavity 15, 16 or 17.

Referring now to FIGURE 2, there is illustrated in partial cross-section an electron gun that may be utilized in the klystron shown in FIGURE 1. The electron gun assembly includes a first support member having a truncated conical cross-section 18 one end of which has a radially extending flange 19 which is secured to a metal base plate 20 by brazing, welding or by any suitable fastening means, such as screws 21. The base plate 20 is fabricated from any suitable metal, such as copper, and may comprise a portion of the vacuum envelope of the klystron shown in FIGURE 1. The end of the first support member remote from the base plate 20 is a cylindrical section 22 to which is secured, such as by brazing or spot welding, the lower end of a second support member 24 which is also cylindrical.

A dish-shaped, indirectly heated cathode is secured to the end of the cylindrical second support member 24 remote from the base plate. The cathode is centrally apertured 26 and has an electron emissive surface 27 on its concave surface. Axially spaced from the convex non-emitting portion of the cathode is a heater assembly including filament or heaters 31 having an electrically non-conductive coating thereon and which are pressed into conformation with the concave emissive surface of the cathode by means of a concave heater shield 29. The heater shield is also centrally apertured 30 so that the aperture 30 in the heater shield is in alignment with the aperture 26 in the cathode. Dish-shaped heat reflectors 32 are mounted adjacent the heater assembly and function to reflect heat back toward the cathode. An annular mounting ring 23 is secured to the exterior surface of the cylindrical section 18 of the first support member. Secured to this annular ring 23 is a third support member 25 which fits over the second cylindrical support cylinder 24. A focus electrode 26 is secured within and at the end of the third support member 25 which lies adjacent the cathode.

A getter structure generally indicated by the reference character 40 has one of its ends thermally secured to the
3 base plate 20 and its other end adjacent the aperture 30 in the heater assembly. Referring now to FIGURES 3 and 3A which more clearly illustrate the getter assembly 40, it is seen that the getter container is a plurality of rods 41--41. The rods are held together to form a cylindrical shape and are secured together at one end by fastening means 42 which may be a metal wire. The other end of the rods is held together by the apertured U-shaped, retaining member 43. The retaining member is applied by bending radially outwardly the extreme end portion of those rods 41 located at the circumference of the stack in a manner as illustrated in FIGURE 3. The stacked rods are then passed through the aperture in the retaining plate 43 after which the apertured plate is folded into a substantial U-shape as illustrated in FIGURE 3. The wire fastening means 42 is applied after the retaining member or plate is secured to the rods. The retaining plate is then spot welded, brazed or otherwise secured to the base plate 20 as shown in FIGURE 2. The end of the rods 41 adjacent the aperture 30 are then fastened in the base plate 20 and may be held in position by aperturing the heat reflectors 32 so that the reflectors limit the transverse movement of the stacked rods 41 in a manner as illustrated in FIGURE 2. However, any such movement is substantially eliminated by securing the rods to the retaining member 43. Which of rods 41 which comprise the gettering structure are fabricated from a gettering material, such as a refractory metal selected from the group consisting of zirconium, titanium, tantalum, columbium, hafnium and thorium.

The operation of the electron gun illustrated in FIGURE 2 is such that application of operating potential to the heaters 31 causes them to generate heat which in turn causes the emissive surface 27 of the cathode to emit a stream of electrons. These electrons are in turn focused into a narrow beam by the focus electrode 26. As will be obvious to those skilled in the art, a D.C. potential is generally applied to the focus electrode and/or the cathode. The heat generated by the heaters also heats the end of the plurality of rods 41 adjacent the aperture 30 in the heater assembly. However, since the end of the plurality of rods 41 remote from the heater assembly is thermally coupled to the base plate 20 which functions as a heat sink, a temperature gradient is produced along the length of the plurality of rods. For example, it was found that if the end of the rods adjacent the heater were heated to a temperature of 800 to 900°C, the base plate distant from the heater assembly was at a temperature of about 300°C or less. This temperature gradient is desirable inasmuch as different gases getter at different temperatures. For example, hydrogen will getter at the bottom and cooler portion of the rods 41 and other gases, such as oxygen, nitrogen, carbon dioxide, carbon monoxide and methane, will be getter at the hotter end of the rods 41.

Further, since the molecules of gas gettered are very small, the surface area of each cylindrical rod 41 is available for gettering even though the rods are held together in a bundle. However, the number of each rod is decreased thereby increasing the number of rods for a given volume, the surface area available for gettering is increased. Therefore, the use of a plurality of rods, even though closely packed as illustrated in FIGURES 2, 3 and 3A, provides a very high surface area per unit volume which is available for gettering.

The electron beam passing through residual gases within the vacuum envelope of the klystron illustrated in FIGURE 1 will ionize at least a portion of such gases. The ions thus produced are accelerated back to the cathode due to the negative potential thereon, pass through the aperture 28 in the cathode, through the aperture 30 in the heater assembly and are absorbed by the end of the rods 41 adjacent the aperture 30 in the heater shield 29. It is to be understood that the subject invention is not limited to operating with an apertured cathode for the getter structure illustrated in FIGURES 2, 3 and 3A functions equally well even though the cathode and heater assembly are not apertured. Further, the present invention is not limited to the heaters 31 being axially spaced from the cathode. Rather, the getter structure illustrated in FIGURES 3 and 3A may be utilized in any vacuum device having a heat source and a heat sink for producing a temperature gradient along the length of the getter structure. Also, the end of the rods 41 remote from the heat source need not be thermally coupled to a heat sink for this end of the rods may be held at a lower temperature by radiation, such as by using suitable cooling fins, etc.

The fastening means 42 used to secure together one end of the rods 41 is preferably fabricated from a refractory metal, such as titanium, and may be wire as illustrated in FIGURE 3A. A refractory metal is used because other metals, such as nickel and copper, would alloy with the titanium and zirconium metal rods 41 at the high temperatures which are present at the end of the rods adjacent the heater. The retaining plate 43 which thermally couples the rods to the base plate 20 can be fabricated from a non-refractory metal, such as nickel or copper, because the temperature at this end of the rods 41 does not get hot enough to cause the metal to alloy with the refractory metal rods when a proper heat sink is utilized. Further, since various gettering materials getter various different gases, some of the rods 41 may be fabricated from one type of gettering material and the other rods may be fabricated from another or other types of gettering material. For example, the plurality of rods 41 may comprise rods fabricated from zirconium, titanium, tantalum, columbium, hafnium or thorium. The number of rods fabricated from a particular type of gettering material can be determined by the particular type of gases which need to be gettered.

What has been described is an improved gettering structure which has a large surface area per unit volume available for gettering gases, a temperature gradient along its length for gettering various gases, is easily constructed and permits the use of more than one type of gettering material to aid in the gettering of various gases. The getter structure comprises a plurality of parallel refractory metal rods secured together to form a bundle of said rods, one end of the bundle being located adjacent a heat source and the other end of the bundle thermally coupled to a heat sink.

It should be understood, of course, that the foregoing detailed description relates only to a preferred embodiment of this invention and that numerous modifications and alternations may be made therein without departing from the spirit and scope of this invention as set forth in the appended claims.

What I claim is:

1. In an electron device having a substantially vacuum-tight envelope including an energizable heat source within said envelope, an improved getter structure comprising a plurality of parallel rods having one end located adjacent said heat source.

2. Claim 1 wherein the other end of said rods are thermally coupled to a heat sink.

3. Claim 1 wherein said rods are bundled together.

4. Claim 3 wherein said rods are fabricated from refractory materials selected from the group consisting of zirconium, titanium, tantalum, columbium, hafnium and thorium.

5. An electrode tube comprising a substantially vacuum-tight envelope including a getter structure within said envelope, said getter structure including a plurality of parallel metal rods secured together to form a bundle of said rods, and means within said envelope to produce a temperature gradient along the length of said rods.

6. Claim 5 wherein said rods are of substantially equal length, and wherein said bundle of rods is closely packed.
7. An electron beam tube comprising an envelope, an indirectly-heated cathode structure within said envelope, said cathode including a disk-shaped member to provide a concave emissive surface and a convex non-emissive surface, and a getter structure associated with said cathode and including a plurality of parallel cylindrical metal rods secured together to form a bundle of said rods, cathode heater means within said envelope and located near one end of said rods for producing a temperature gradient along the length of said rods.

8. Claim 7 wherein said rods are fabricated from at least one refractory metal selected from the group consisting of zirconium, titanium, tantalum, columbium, hafnium and thorium.

9. An electron tube comprising an envelope including a metallic base plate at one end of said envelope, an electron gun assembly within said envelope, an electron gun assembly within said envelope and supported on said base plate, said electron gun including an indirectly-heated cathode, and a getter structure having one of its ends thermally coupled to said base plate and its other end adjacent said cathode whereby application of operating potential to said indirectly-heated cathode produces a temperature gradient along the length of said getter structure, said getter structure including a bundle of parallel refractory metal rods with one end of said rods being adjacent said cathode and the other end of said rods being thermally coupled to said base plate.

10. Claim 9 wherein said indirectly-heated cathode has a centrally apertured disk-shaped member to provide a concave emissive surface and a convex non-emissive surface and wherein said other end of said getter structure is located adjacent said aperture in the disk-shaped member of said indirectly-heated cathode.

No references cited.

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