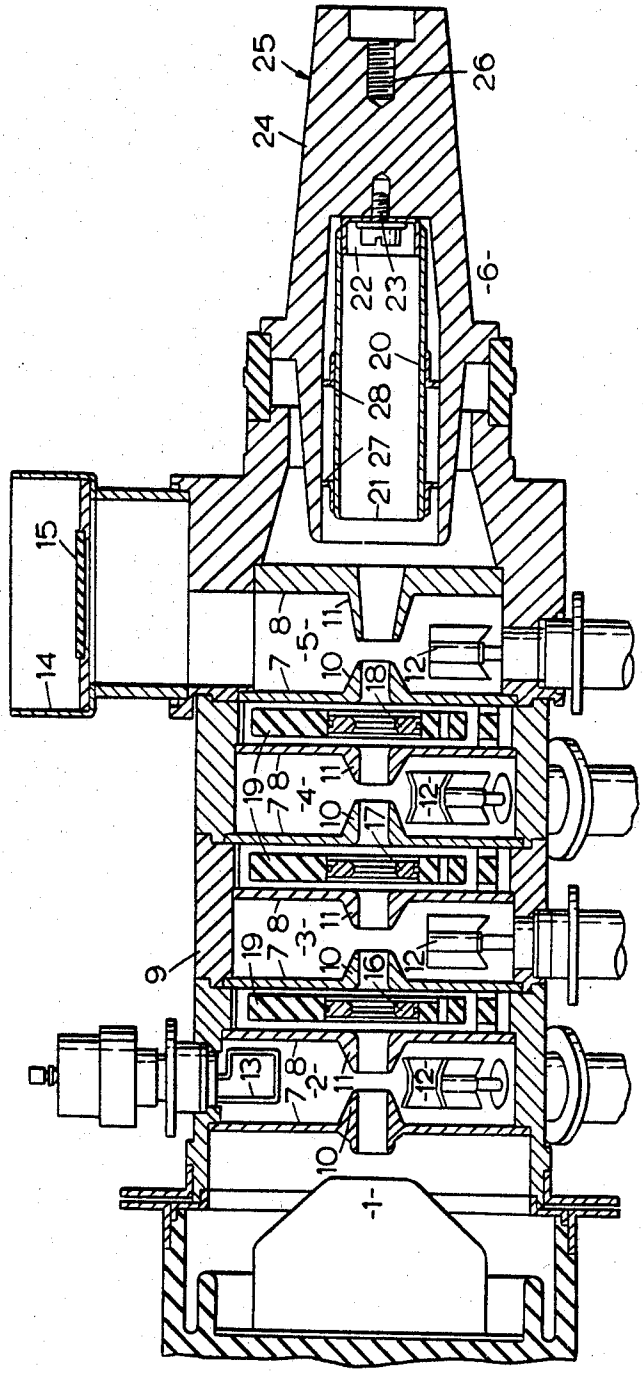
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ELECTRON DISCHARGE DEVICE WITH A GETTERING AND COLLECTING ELECTRODE

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ELECTRON DISCHARGE DEVICE WITH A GETTERING AND COLLECTING ELECTRODE

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ABSTRACT OF THE DISCLOSURE

A klystron or other high power electron discharge device is provided with an electrode for collecting the electrons emitted by the cathode and which also performs a gettering function. The electrode is in the form of a hollow tube of zirconium which is co-axial with the device and which is closed at the end remote from the cathode by a tantalum cap. The other end of the zirconium tube is open to allow the entrance of electrons. The zirconium tube is located in a cylindrical cavity formed in a copper block which serves to conduct heat away from the zirconium tube. In operation of the device a temperature gradient is established along the zirconium tube so that the gettering action is effective for a variety of substances which require different gettering temperatures. The highest temperatures are attained at the end of the zirconium tube which is attached by a tubular cap to the copper block. Tantalum is selected for the metal of the cap since it does not form with either copper or zirconium an alloy which melts at any temperature likely to be attained by the tantalum in operation of the device. Direct contact of the zirconium and the copper is avoided at the high temperature end of the zirconium tube to avoid the formation of zirconium copper alloys which could melt at operating temperatures and ruin the electrode.

This invention relates to electron discharge devices, especially though not exclusively klystrons.

In a klystron, the electrons from the cathode are focussed to form a beam which passes through successive cavities before being collected by a collector electrode. In one form of klystron, the collecting electrode is in the form of a metal tube open at the end facing the cathode but closed at the other end, the latter end being attached to a copper block which forms a housing for the tube. The outer surface of the copper block may be tapered so that a finned cooling member can be applied thereto as a forced fit and anchored thereon. The construction of the collector electrode above described has the object of obtaining a continuous gettering action from the collector electrode and with this in mind, it has been proposed to make the tube of zirconium and to arrange that there is a temperature gradient along the length of the tube, for example by ensuring that thermal conduction from the tube to the copper block is confined mainly to the closed end of the tube. The temperature gradient along the tube is desirable to make the gettering action effective for a variety of substances which require different gettering temperatures. However, it is found in practice that the collector electrodes such as described tend to have a relatively short life.

The object of the present invention is to provide an improved electron discharge device of the kind in which collector electrode is arranged to have a gettering function and according to the present invention in such a device said electrode comprises a number disposed to collect electrons from said source and formed of a metal having a gettering action at an elevated temperature, a block

from a member of a second metal having higher thermal conductivity (for example copper) than said member, and support means supporting said first member from said block and electrically connecting it thereto, the metals being chosen so that, any alloy which is formed by the third metal with either of the first two metals has a melting temperature higher than that of alloys of the first two metals, so that any alloy which is formed will not melt at the temperature likely to be obtained by the adjacent part of the first member.

In a preferred form of the invention the electrode having the gettering function comprises a zirconium tube housed in a copper member which forms part of the envelope of the device, the tube having a tantalum cap fitted at one end and secured to the copper member by a tantalum stud, the tantalum providing the only thermal conduction at that end of the tube between the zirconium and the copper block. The zirconium tube may however be spaced from the copper housing at one or more positions along its length by one or more thin metal spacers which provide a little thermal conduction.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the accompanying drawings, the single figure of which illustrates a longitudinal sectional view of a klystron according to one example of the invention.

The klystron which is illustrated in the drawing is similar in construction to that described in the specification of copending patent application Ser. No. 588,810 filed on Oct. 24, 1966 , by me. The klystron comprises an electron gun **1**, including a thermionic cathode, four resonant cavities **2**, **3**, **4** and **5** and a collector electrode **6**. Each of the cavities is formed by two transverse copper walls and by part of the envelope of the klystron, the transverse walls being denoted by the references **7** and **8** in the case of each cavity and the copper envelope being denoted by the reference **9**. The walls **7** and **8** are formed with drift tubes **10** and **11** in known manner, having central apertures which are co-axial. All the cavities have plungers **12** which can be moved radially within the cavities for the purpose of tuning. The cavity **2** is the input cavity and high frequency signals can be fed to this cavity by way of coupling loop **13**. The cavity **5** on the other hand is the output cavity and is coupled to an output waveguide **14** through a dielectric window **15**. To enable the electrons from the source **1** to be focussed so as to form a concentrated axial beam which passes through the cavities **2**, **3**, **4** and **5** and is finally collected by the collector electrode **6**, electrostatic focusing electrodes **16**, **17** and **18** are provided between each pair of cavities. These electrodes are supported by means of insulators **19** in a desired positional relationship with respect to the cavity walls and envelope of the klystron. They are moreover provided with means whereby they can be maintained at a different potential from the cavity walls and the envelope. The construction of the focussing electrodes **16**, **17** and **18** and of the insulators **19** is described more fully in the aforesaid specification.

The collector electrode **6** comprises a getter member in the form of a zirconium tube **20** open at the end **21** which faces the electron gun **1**. It is closed at the other end by a cap **22** of tantalum having a central aperture for the passage of a stud **23** also of tantalum. The zirconium tube **20** is secured to a copper block **24** by means of the stud **23**, the copper block being in the form of a housing which encloses the tube **20** except at the end **21**. The block is formed with an outer surface **25** on which a finned cooling member can be applied as a force fit and secured by means of a stud engaging the tapped hole **26**. The forward end of the zirconium tube **20** is spaced from the copper block **24** by means of spacing members **27**, **28** which are

such that they provide little thermal conduction from the zirconium tube to the copper block. The spacing members are made in this example of the same metal as the getter member **20**, that is zirconium in the case described, since respective part of the getter member operates at a relatively low temperature when the construction is as described. Although two spacing members are shown, the number may be different, for example, three spacing members may be used. The spacing members may in some cases be made of the same metal as the cap **22**.

When the klystron is operating, a temperature gradient is established along the zirconium tube to produce a continuous gettering action, different temperatures being selective of different substances. The temperature attained at the end of the tube **20** secured to the copper block **24** is normally about 800° C. but it may on occasions reach temperatures of about 1,000° C. Moreover, if the zirconium is in contact with the copper block **24**, a zirconium-copper alloy may form which melts at a temperature about 950° C. and ruins the tube **20** and collector electrode.

However, the construction of the collector electrode **6** is such that only tantalum is in contact with the copper housing at the end of the tube **20** remote from the cathode. Tantalum does not form with either copper or zirconium, an alloy which melts at any temperature likely to be attained by the tantalum parts in the operation of the device.

It will be understood that the invention is not confined to klystrons but may be applied to other electron discharge devices in which an electrode is required to perform a continuous gettering function. The getter member may be made of metals other than zirconium, such as titanium, hafnium, or of alloys of two or all of zirconium, titanium and hafnium. Moreover, the intermediate metal may be other than tantalum, depending on the metal of the tube **20** and the metal of the block **24**. For example, in addition to tantalum, the intermediate metal may be niobium or tungsten, or alloys of two or all of tantalum, niobium and tungsten. Alternatively tungsten may be alloyed with small amounts, less than 10%, of molybdenum.

The getter member **20**, the intermediate metal and the block **24** may include small quantities of other substances which do not affect their operation as described.

Although the invention has been described as applied to a klystron it is equally applicable to other high power electron discharge devices, for example, travelling wave tubes, in which an electrode serves a gettering function.

What I claim is:

1. An electron discharge device comprising:

(a) an evacuated envelope,

(b) an electron emissive cathode in said envelope,

(c) an electron collecting electrode in said envelope,

(d) said electron collecting electrode comprising a tubular member formed of a first metal having a gettering action,

(e) said tubular member being open at one end to permit the entry of electrons from said cathode to be collected by said tubular member,

(f) a block of a second metal having a higher thermal conductivity than said tubular member and formed with a tubular recess,

(g) means securing said tubular member in said recess and electrically connecting said tubular member to said block,

(h) said securing means being formed of a third metal,

(j) said metals being chosen so that any alloy which is formed by the third metal with either of the first two metals has a melting temperature higher than that of the alloys of the first two metals, and

(k) said tubular member having no thermal conductive connection with said block over most of its surface.

2. A device according to claim **1**, in which the end of said tubular member remote from said cathode is also open but is closed by a cap forming part of said support means.

3. A device according to claim **1** including spacing means for spacing said tubular member from the wall of said recess in said block, said spacing means providing relatively little thermal conduction from the tubular member in said block.

4. A device according to claim **1** wherein said first metal is selected from the group consisting of zirconium, titanium, hafnium and alloys of a plurality of zirconium, titanium and hafnium, said second metal is copper, and said third metal is selected from the group consisting of tantalum niobium, tungsten and alloys of a plurality of tantalum niobium and tungsten.

5. A device according to claim **4** wherein said first metal is zirconium, said second metal is copper and said third metal is tantalum.

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