May 19, 1959 G. DIEMER ET AL 2,887,606

ELECTRON TUBE FOR DECIMETRE-AND CENTIMETRE-WAVES

Filed June 12, 1953

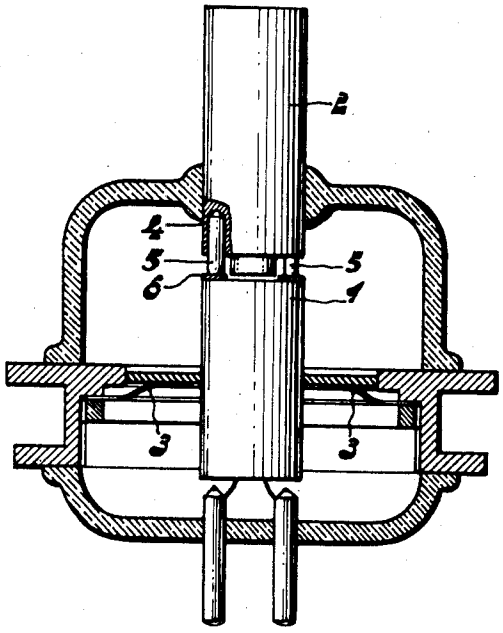



Fig. 1.

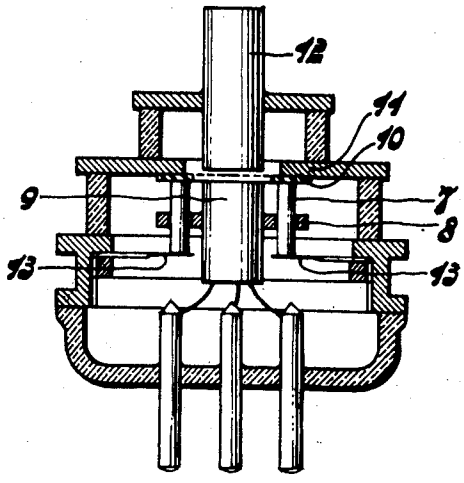



Fig. 2.


INVENTORS
GESINUS DIEMER
HENDRIKUS JOHANNES LEMMENS

BY

AGENT

United States Patent Office 2,887,606 Patented May 19, 1959



2,887,606

# ELECTRON TUBE FOR DECIMETRE- AND CENTIMETRE-WAVES

Gesinus Diemer and Hendrikus Johannes Lemmens, Eindhoven, Netherlands, assignors, by mesne assignments, to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Application June 12, 1953, Serial No. 361,364

3 Claims. (Cl. 313—256)

The invention relates to electron tubes for use at frequencies of more than 300 mc./s., more particularly to such tubes in which at least two electrodes are pressed, under the action of a spring, against spacing and insulating members and in which the cathode has a high operational temperature.

In such tubes use is frequently made of insulating bodies of ceramic material or quartz, which are ground to flatness together with the electrode to which they are secured and which, with the interposition of a spacing foil press against a further electrode under the action of a spring.

As a rule, such insulating bodies are cylindrical. Such constructions have a limitation in that a comparatively large quantity of insulating material finds itself in the proximity of the discharge path, which may give rise to material losses at very high frequencies. In this case the use of materials of low losses is limited, since substantially only ceramic material can be used in such tubes, in which, in general, use is made of highly loaded cathodes having operational temperatures of more than 900° C. A reduction of the quantity of insulating material by the use of thin rods of this material can not be carried out successfully, since the rods are soon deformed during the operation of the tube or during the formation of the cathode. Quartz is substantially unserviceable in such cases, since this material becomes too weak at the said temperatures and is deformed by the constant pressure of the spring.

The invention permits of using very thin insulating rods. According to the invention, an electron tube for use at frequencies of more than 300 mc./s., comprising an electrode system of which at least two electrodes—one of which has an operational temperature of more than 900° C.—are pressed, under the action of a spring, against interpositioned insulating members and are spaced apart by a spacing foil, is characterised in that the insulating spacers between at least these two electrodes are formed in the shape of rods of synthetic sapphire, secured to one of these electrodes and ground to flatness together with this electrode.

It has been found that, at high temperatures, such rods of synthetic sapphire have a very low degree of loss and do not weaken or warp. These rods may, moreover, be very thin. Consequently, the quantity of insulating material in the proximity of the electron space may be extremely small, whilst the transfer of heat along these rods is also very small.

The use of synthetic sapphire as an insulating material has the advantage, in addition to low thermal conductivity, of low losses at high frequencies and even at high temperatures.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawing, in which—

Fig. 1 shows a diode and

Fig. 2 a triode according to the invention.

As shown in Fig. 1, the cathode 1 is held spaced apart



from the anode 2 by a very small distance. The cathode 1 is urged towards the anode 2 by spring 3. The anode 2 is provided with, for example, three apertures 4, in which rods 5 of synthetic sapphire are secured by hard solder, for example, silver or copper. The length of the rods is, for example, 5 mms. and the diameter is only 0.3 to 0.75 mm. The rods project for example by 2 mms. from the bottom in the anode and are ground to flatness together with the bottom end of the anode, i.e., the bottom surfaces of the rods and the anode are flat and lie in the same plane. The spacing foil 6 determines the distance between the anode and the cathode. Since the direction of length of the rods is at right angles to the ground electrode surface, such thin rods may be used, since the rods are subjected only to axial pressure.

The composition of the sapphire rods is very homogeneous and even at high temperatures they are fully resistant to deformation, in contradistinction to ceramic spacing members. The anode-cathode distance may therefore be adjusted to $10\mu$ with a tolerance of $1\mu$. The cathode can be only a cathode having a metallic emissive surface. For the short waves concerned use is preferably made of strongly loaded cathodes at an operational temperature of 1050° C. The temperature for the formation, however, is much higher, i.e. about 1350° C. Since the electrodes 1 and 2 are constantly subjected to spring pressure, the insulating spacers 5 must not lose their rigidity even at this temperature. In this respect synthetic sapphire is very serviceable.

A further advantage is that a glass seal may be provided in close proximity to the rods of synthetic sapphire, so that the rods and the electrode may be ground to flatness before this electrode is sealed in. The length of the electrode inside the tube may therefore be very small, which is a great advantage for the aforesaid high frequencies.

Since only three very thin rods 5 are required, the transfer of heat from the cathode to the anode is very slight. Thus, moreover, a construction is obtained, in which an extremely small quantity of insulating material, which, moreover, has slight dielectric losses, is provided in the proximity of the electron space.

Fig. 2 shows a triode, in which the invention is used for spacing apart the cathode and the grid. Since the grid can not be ground to flatness, the sapphire rods 7 are secured in this case to extensions or to a ring 8 of the cathode 9, for example, by means of platinum solder. The rods 7 are ground to flatness together with the metallic cathode surface and via a spacing foil 10 they press against the grid ring 11. The anode 12 may in this case be secured in the conventional manner. The pressure springs 13, which press the cathode and the grid against one another, apply preferably to the ends of the sapphire rods 7, in order to reduce the transfer of heat.

It is obvious that as an alternative, the tube according to the invention may be constructed in a different manner.

What is claimed is:

1. A high frequency electron discharge tube comprising anode and cathode electrodes having flat opposing parallel surfaces spaced apart by a relatively small distance; a plurality of thin rod-like synthetic sapphire insulating members secured to said anode, all of said insulating members having precisely flat surfaces lying in the same plane as the flat surface of said anode, said insulating members being spaced around said anode immediately adjacent the discharge path of said tube, said insulating members each having a cross-sectional area which is small relative to the cross-sectional area of the discharge path so that the losses of electro-magnetic energy in said insulating members will be small compared to the energy in said discharge path; a spacing

member having a thickness precisely equal to said relatively small distance between said opposing surface of said anode and said cathode, said spacing member being interposed between said flat surface of each of said insulating member and said flat surface of said cathode; and spring means coupled to said cathode for urging said electrodes toward each other whereby the space between the flat surface of said electrodes is determined by the spacing of said spacing member.

2. An electron tube as claimed in claim 1, in which the direction of length of the rods of synthetic sapphire is at right angles to the flat surface of the one electrode.

3. An electron tube as claimed in claim 1 in which the electrode in which the sapphire rods are secured is sealed in glass in the immediate proximity of the area where the rods are secured.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,175,707 | Shardlow | Oct. 10, 1939 |
| 2,455,381 | Morton et al. | Dec. 7, 1948 |
| 2,462,921 | Taylor | Mar. 1, 1949 |
| 2,699,517 | Diemer | Jan. 11, 1955 |
| 2,716,199 | Diemer et al. | Aug. 23, 1955 |
| 2,754,349 | Werner | July 10, 1956 |