

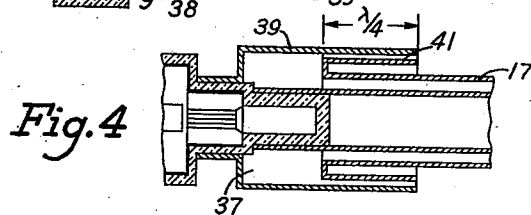
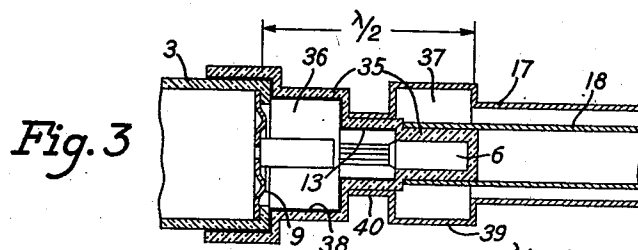
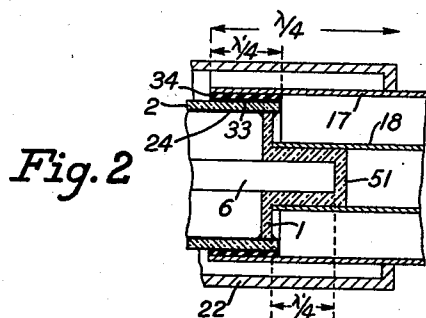
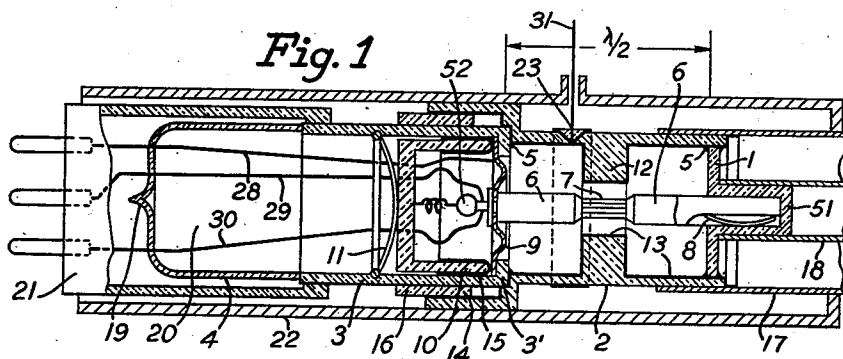
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ELECTRON TUBE DEVICE FOR ULTRA SHORT WAVES

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ELECTRON TUBE DEVICE FOR ULTRA
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many; vested in the Alien Property CustodianApplication May 13, 1941, Serial No. 393,263
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2 Claims. (Cl. 250—27.5)

The invention relates to electron tube devices for generating, amplifying or receiving ultra short waves particularly of a wave length of less than 1 metre. More specifically the invention relates to tubes comprising a hollow space constructed with metallic surfaces and serving as a frequency determining electromagnetic resonator (hollow space resonator).

Ultra short wave electron tubes somewhat similar to this type of resonator are described for example in the U. S. A. Patents 2,128,233 (filing date March 1, 1935), 2,128,234 (filing date May 6, 1935) and the applications Serial Number 738,001 (filing date August 1, 1934) and Serial Number 171,148 (filing date October 26, 1937). As will be seen, the invention relates to electron tubes in which the surfaces of the hollow space resonator consist of a ceramic material coated with a good electrical conductor.

According to the invention a hollow space resonator is used, the volume of the hollow space being limited by the inner surfaces of the walls of a hollow body (which may be constructed as a single integral unit or may be formed of several individual parts). A second body having a conductive outer surface is disposed in the inner of the first mentioned hollow body and will be hereafter called an inner conductor. Preferably this inner conductor is constructed as a grid along one part of its length. One of the novel features of the invention is that the hollow body consists of ceramic material which is coated on its inner surface with a layer of metal which is suitable for use in high frequency electrical circuits, while the inner conductor also being of hollow construction, consists of metal which may be coated with a metallic layer also adapted for high frequency technique.

The ceramic hollow body should be constructed of a material having small dielectric losses. Preferably such materials comprise pure magnesium silicate compounds. The metallic coating of the inner surfaces of the ceramic hollow body are constructed of thin layers of a metal which is suited for use in high frequency electrical circuits, as for example silver, copper or the like. These layers may be formed of a deposit by cathode rays.

A tube constructed according to this invention has several important advantages. Compared with tubes having metallic resonator walls, the tubes with ceramic walls are of lighter weight and of smaller dimensions than the first mentioned tubes. In spite of this the ceramic tube is very strong mechanically. The smaller dimen-

sions and the lightness in weight are of special importance, if a tube is to be used in portable ultra short wave devices, for instance as in aeroplanes or the like.

A further advantage lies in the fact that it is possible to safely and firmly support the electrodes at the walls of the ceramic hollow body. Thus disturbances which ordinarily follow a buckling of the walls or similar disadvantages caused by the heat radiated by the electrodes can be largely avoided and the presence of the so-called microphonic effect can be absolutely eliminated.

Furthermore a special advantage which is obtained by employing a device constructed according to this invention is that the ceramic parts carrying the electrodes have a very small coefficient of expansion. The metal cover of the ceramic body which serves as an electrode and as a resonator surface has as a result of its small thickness the same thermal expansion as the ceramic body itself. Therefore it is certain that with variations of temperature the resonance frequency of the hollow space resonator remains practically constant and that after a relatively short time of heating of the cathode the desired working frequency of the tube can be obtained. In order to compensate for the expansion of the metal parts in the ceramic hollow body the supports of these parts may be constructed of an elastic membrane.

It is a preferred embodiment of this invention that not only are the electrodes formed as a cover for the ceramic walls and contact the same with relatively large surfaces but also that the other metallic electrode supports are provided with large surface areas which are in contact with the walls. Thus an extraordinary large dissipation of heat takes place. This heat loss results from the conduction of heat of the metallic parts to the ceramic walls. As will be seen, I employ the ceramic parts to form wholly or at least partly the wall of a vacuum vessel. The ceramic wall however is in contact with the outer atmosphere and for this reason it is maintained at a relatively low temperature. I also contemplate the use of a cooling medium which flows through channels formed in the wall of the resonator or cooling the tube by the use of radiators.

Further features of the invention become apparent when read in the light of the accompanying drawing.

As illustrated in Fig. 1 the electron tube comprises a resonator formed as a concentric Lecher system. The hollow space resonator is evacu-

ated and is formed of a cylindrical ceramic part 2 which is closed at one end by ceramic plate 1 while the other end is closed by the cylindrical part 3 which is provided with a glass tube or bulb portion 4. Parts 1, 2 and 3 are fused together by glass fusing, enamel fusing, or by a conductive metal such as a semi-conductor, in a vacuum tight manner. The glass bulb 4 contains the leads 28, 29, 30 for the direct current and is provided with a seal-off tip 19 which is constructed in the well known manner. Instead of the glass bulb 4 a ceramic plate may be used to close the cylindrical part 3, means being provided for passing the current leads therethrough.

In the inner portion of the evacuated hollow space resonator a system of electrodes is arranged which consists of a cathode grid and an anode brake field electrode. As is seen in the drawing the anode brake field electrode is connected with the outer conductor of the hollow space resonator while the grid forms part of the inner conductor.

According to this invention, the ceramic part 2 serves as a support for the metallic outer conductor and for the anode of the tube. In order to accomplish this dual purpose the ceramic cylinder 2 has a cover of metal on its inner surface, preferably made of silver. This cover (drawn with thick lines) can be made by a cathode ray deposit or in a mechanical manner or may be burned into the ceramic wall. It is preferred to make such cover extraordinarily thin so that it can be led through the seals of the body at 5 to the outside without difficulty, thus serving as the lead-in wires for the high frequency conductor and the direct current conductor.

The support of the inner conductor of the resonator consists of the grid 7 and a part 6 having a pipelike construction. A hollow projection 51 is formed in the ceramic plate 1 adapted to receive the part 6 of the inner conductor (which is made of copper), the part 6 being maintained in position against the wall of the projection 51 by a spring clip 8 in order that violent motion transmitted to the apparatus will not shift the position of the electrodes. Heat generated by the electrodes will be quickly conducted away and dissipated by the thermic contact of part 6 with the wall of the hollow projection 51. At the other side of the cylindrical part 2 opposite plate 1 the inner conductor 6 is supported by a corrugated metallic membrane 9 adapted to equalize and compensate for the variations of the length of the inner conductor produced by heat. The membrane 9 is preferably formed like a cap and is pressed against the offset 3' of part 3 by the ceramic part 10 and the spring clip 11.

The cathode is arranged in the center of the inner conductor 6, 7. It may be constructed as a tungsten filament or with special advantage as an indirectly heated oxide coated cathode. When using an oxide coated cathode an additional grid can be arranged between same and the grid 7. In Fig. 1 I have shown the end of the cathode 52 with its heating wires 29 and 30.

As I have illustrated in Fig. 1, the space between the electrodes 7 and 13 is relatively small and when the resistance of the resonator becomes high a portion is provided having a larger inner diameter at those points which do not form the discharge space. In this embodiment of my invention the outer conductor 2 is formed as an annular flange 12 in the sphere of the electrode

system. If desired the cylindrical part 2 and the flange 12 can be made of one piece.

In the illustrated embodiment the direct current connections are provided at one side and the high frequency current connections are provided at the other side of the tube except for the aerial connection 23. In this embodiment the hollow space resonator to the right is connected to the concentric energy line with outer conductor 17 and inner conductor 18. The outer conductor 17 is preferably galvanically connected to the outer conductor 13 of the resonator. As mentioned above the metallic cover of the ceramic part can be led through the bulb 4 to the outside and serves as a contact with the outer conductor 17 of the energy line. In some cases the coupling can be made capacitively by constructing outer conductor 17 in such a manner that it surrounds the ceramic part so far that the layers 13 and 17 are oppositely disposed over a certain length especially along a length of $\lambda'/4$. Here λ' is symbolic of the wave length of the oscillations measured in the ceramic material.

The inner conductor 18 of the energy line is connected capacitively to the inner conductor 6, 7 by the conductor 18 which surrounds the projection 51, the length of which is equivalent to the value $\lambda'/4$. In some cases a galvanic contact is also possible and is sometimes advantageous. This contact may be obtained by providing a metallic cover for the continuation 51 which is provided with a radial bore through which the metallic cover is led to the outer atmosphere, the bore being sealed by glazing. Thus a galvanic contact between the conductors 6 and 18 is made.

The conduction of heat is made easier by the connection between the conductors 17 and 18 through the ceramic wall.

The opposite end of the resonator is short circuited by the capacities formed by the covers 14 and 15. In this manner the space 20 is decoupled from any high frequency effect, the space containing the direct current leads and other elements. In order to control the decoupling as well as the wave length of the resonator the capacity of the covers 14 and 15 can be made variable. This result may be obtained by employing an insulating ring 16 (preferably made of a ceramic material) adapted to slide in the ceramic part 3 of the tube.

The electrode leads extend through the glass wall 4 and are connected to metallic connecting plugs which extend through the walls of a base 21. If preferred the tube may be closed by a ceramic plate instead of a glass seal and the lead-in wires may consist of metallic strips which extend through the ceramic plate. Instead of the commonly used plug pins the socket plate may be provided with metallic covers having apertures formed therein. I also contemplate employing lead-in wires which may extend through the ceramic wall. With respect to the embodiment shown in Fig. 1, the ceramic tube is bored at 23 and the metal coating is led from the inner surface to the outer surface of the tube. The metal coating may, if desired, encircle the outer side of the ceramic tube 2. The bore 23 is sealed against air leakage by a glass stopper, or other means. The current lead-in wire connected with the metal coating is numbered 31. In some cases it may be preferred to lead the direct current lead-in wire for the anode through the base.

In order to protect the assembled unit an additional metal tube 22 is being provided which encloses all of the several elements, except for portions of the conductors 17 and 18.

In Fig. 2 an arrangement different from that of Fig. 1 is shown. In this embodiment the coupling of the outer conductor 17 with the outer conductor 24 of the resonator takes place in a capacitive manner. To keep radiation losses at a minimum the device is constructed in such manner that the metallic coating 24 is continued at 33 along the seal to the outer surface of the ceramic body 2. Between the metal coating 33 and the conductor 17 a ceramic dielectric material 34 is inserted. The coupling condenser is constructed of a length equal to $\lambda/4$. The metal protecting tube 22 similar to that shown in Fig. 1 encloses the outer conductor 17 for a length equal to one-quarter wave length.

In another very suitable modification the evacuated ceramic body is provided with an inner metal coating forming one part of the resonator. Such a device is shown in Fig. 3. This device is constructed essentially in a manner similar to the resonator shown in Fig. 1. The resonator is constructed having a length equivalent to $\lambda/4$, the electrode system as well as the electron stream being positioned in a potential loop. As is seen in the figure, only one-half of the hollow space is evacuated. A cylindrical step-like ceramic vessel symmetric about its longitudinal axis is provided, the inner surface being coated with a metallic element and being airtightly sealed at one end by a ceramic part which joins a ceramic base plate. The inner conductor 6 is supported in a manner similar to that shown in Fig. 1. A ceramic wall separates the evacuated part 36 from the non-evacuated part 37. Both parts are coupled by the coating 13 which serves as an anode as well as the metallic part 40 of the outer resonator, these parts forming a capacitance coupling. This coupling, of course, may be constructed as shown in Fig. 2. If desired a galvanic coupling may be employed. The energy line 17, 18 is coupled to the resonator in such manner that by extending the outer conductor 17 over the wall 39 of resonator part 37 while a capacitance coupling exists between the inner conductor 18 of the energy line and the inner conductor 6 of the resonator.

Fig. 4 illustrates how the part 37 of the hollow space resonator may be constructed to eliminate the formation of unwanted high frequency currents and to avoid energy losses.

As shown in the drawing, the part 17 is formed with a bent over and reversely extending flange portion 41 which is held in spaced relation with respect to the line 17. The element 17 is formed integrally with the portion 41 and is axially slidable with respect to the longitudinal axis of the element.

The flange portion 41 is constructed of a length equal to $\lambda/4$. It is to be noted that an air space is provided intermediate the wall 39 and the flange 41. Hence, the element 17 is capacitatively coupled with the wall of the resonator. As will be readily appreciated a resonator constructed according to this modification will serve to pre-

vent the formation of undesired high frequency currents on the outside of the conductor 17.

What I claim is:

1. An electron tube device for generating, amplifying and receiving ultra high frequency electromagnetic oscillations having a length of less than one metre, said device comprising a hollow substantially cylindrical metal tube open at both of its end portions having inner and outer conductor members, said tube having a radially inwardly extending flange portion adapted to engage an outer conductor of a concentric energy line, a substantially cylindrical tube of ceramic material supported at one of its end portions by said outer conductor, the other of said end portions engaging the inner surface of said metal tube, said tube of ceramic material being provided with a radially inwardly extending ring intermediate its ends, said ring having an opening, said tube of ceramic material being provided with a thin metallic coating on the inner surface thereof, and in contact with said metallic tube, said coating extending over said intermediate ring, a ceramic plate sealing that end of said ceramic tube engaged by said outer conductor air tightly, said plate being provided with an outwardly extending hollow projection having mounted on the exterior surface thereof the inner conductor of the said concentric energy line, said wall of said ceramic tube having an opening formed therein, a metallic ring surrounding said ceramic tube, means fusing said metallic ring and said metallic inner surface lining of said ceramic tube air tightly through said opening in said wall of said ceramic tube, a current lead-in wire in metallic contact with said metallic ring, a second ceramic tube mounted air tightly within said first ceramic tube and spaced therefrom for a portion of its length, said second ceramic tube being provided with an inwardly radially extending shoulder portion, a metallic diaphragm mounted within said second ceramic tube and adapted to be sealed against said shoulder portion, a substantially cylindrical hollow ceramic collar having an open and a closed end, positioned within said second ceramic tube, said open end being provided with a metallic coating extending for a portion of its length on the exterior and interior sides thereof, resilient means mounted within said second ceramic tube adapted to urge said collar against said diaphragm, a closure member secured to the open end of said second ceramic tube, a base member mounted at one end on said second said ceramic tube, said base member being provided at its other end with contact pins, said contact pins being provided with lead-in wires, said wires extending air tightly through said closure member and said collar member making contact with said cathode.

2. An electron tube device for generating, amplifying and receiving ultra high frequency oscillations of less than one metre as defined by claim 1, and means capacitatively coupling said outer conductor with said metallic coated ceramic tube.

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