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ELECTRON TUBE DEVICE FOR ULTRA SHORT WAVES

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Fig.1

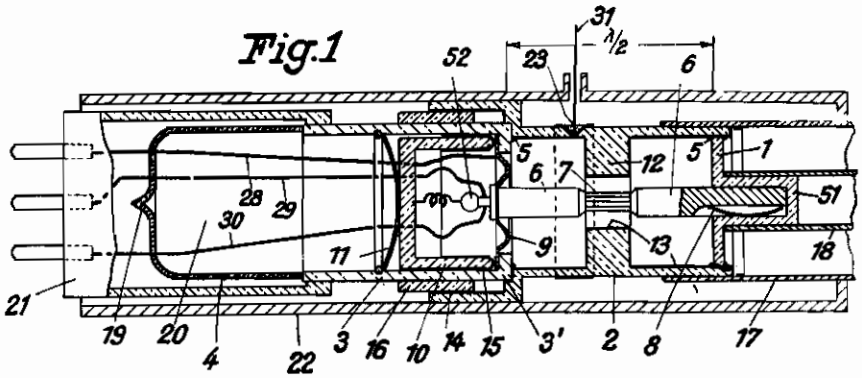

Fig.2

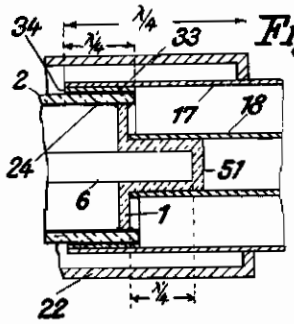

Fig.3

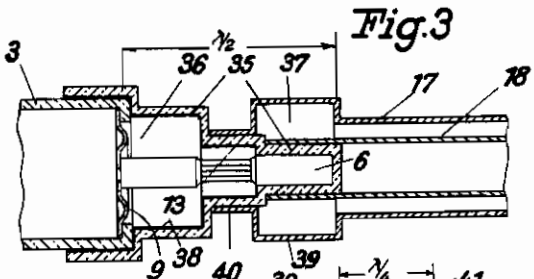

Fig.4

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ELECTRON TUBE DEVICE FOR ULTRA SHORT WAVES

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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. Especially the invention relates to tubes comprising a hollow space constructed of metallic surfaces and serving as frequency determining electromagnetic resonator (hollow space resonator).

Ultra short wave electron tubes with such resonator are described f. i. in the USA Patents 2,128,233 (filing date March 1st 1935), 2,128,234 (filing date May 6th 1935) and the applications serial number 738,001 (filing date August 1st 1934) and serial number 171,148 (filing date October 26th 1937). More specifically the invention relates to electron tubes at which the surfaces of the hollow space resonator are consisting of a ceramic material coated with a cover of well electrical conductivity.

According to the invention a hollow space resonator is used being limited by the inner surface of a hollow body (which also may consist of different single parts) and the outer surface of a second body being arranged in the inner of the first mentioned hollow body and being called an inner conductor. Preferably this inner conductor is constructed as a grid along one part of its length. It is a special feature of the invention that the hollow body consists of ceramic material which is coated on its inner surface with a layer of metal being suitable for high frequency technics whilst the inner conductor preferably being built hollow, consists of metal which also may be coated with a layer of metal being suitable for high frequency technics.

The ceramic hollow body should possess small dielectric losses. Preferably such materials are suitable being based upon pure magnesium silicates. The metallic coating of the inner surfaces of the ceramic hollow body are preferably thin layers of a metal being suitable for high frequency technics f. i. silver, copper or the like. These layers f. i. can be made of a deposit by cathode rays.

A tube according to the invention has essential advantages. Compared with tubes of metallic resonator walls the tubes with ceramic walls have a smaller weight and smaller dimensions than those first mentioned. In spite of this the ceramic tube is very resistable in mechanical as well as in technical respect. The small dimensions and the small weight are of special importance, if a tube is being used in ultra short wave devices for portable stations f. i. in aeroplanes or the like.

It is further advantageous that it is possible to support safely and firmly the electrodes at the walls of the ceramic hollow body. Thus disturbances as a follow of buckling caused by heating the electrodes or parts of the walls or similar disadvantages, can be avoided largely. Also the presence of the socalled microphon effect practically can be avoided absolutely.

Furthermore it is a special advantage that at the device according to this invention the ceramic parts carrying the electrodes has a very small coefficient of expansion. The metal cover of the ceramic body serving as an electrode respectively as a resonator surface namely has consequently of its small thickness the same small thermical expansion like the ceramic body itself. Therefor it is certain that at variations of temperature the resonance frequency of the hollow space resonator practically does not vary and that already after relative short time of heating of the cathode the wanted frequency for working of the tube can be received. For getting and compensating an expansion of single metal parts in the ceramic hollow body the supports of these parts may be constructed elastically f. i. like a membrane.

It is a more preferred embodiment of the invention that not only the electrodes being formed as a cover of the ceramic walls are touching same with relatively large surfaces but also the other electrodes resp. their metallic supports touch the walls with large surfaces. Thus an extraordinary strong dissipation of heat is taking place. This loss is being caused practically exclusively by conduction of heat of the metallic parts to the ceramic walls. Furthermore those ceramic parts at the same time are able to form wholly or at least partly the wall of the vacuum vessel. The ceramic wall however is connected with the outer atmosphere and naturally for this reason is being cooled relatively well. One also can additionally cool the vacuum vessel by a cooling medium flowing round the resonator resp. flowing through channels of the wall or otherwise by radiators.

Further single features of the invention are explained by the following description of some embodiments of this invention. These are illustrated in the accompanying Figures 1–4.

According to Fig. 1 the electron tube has a resonator shaped as a concentric Lecher system. The wall of the evacuated resonator hollow space is essentially formed by a cylindric ceramic part 2 which is closed at one frontside by ceramic plate 1 whilst at the other frontside same is being closed by the also cylindric part 3 with the glass

tube 4. Parts 1, 2 and 3 are fused together by a glass fusing or an enamel fusing resp. by a conductive metal (especially semi conductor) in a high vacuum tight manner. The glass bulb 4 contains the fusings 28, 29, 30 for the direct current and the pump conduit 19 not being described separately. Instead of the glass bulb 4 also a ceramic plate closing the cylindric part 3 and containing the current leads can be used.

In the inner of the evacuated hollow space resonator the system of electrodes is arranged consisting of cathode grid and anode (resp. brake field electrode). The anode resp. brake field electrode leads into the outer conductor of the hollow space whilst the grid forms part of the inner conductor.

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

The support of the inner conductor of the resonator consisting of the grid 7 and parts 6 usefully made pipe-like according to this invention is constructed as a tilt 51 in the ceramical plate 1. The part 6 of inner conductor (made of copper) is put into the tilt and is pressed against the wall by a spring clip 8 so that also by violent motion no variations of position of the electrodes are caused. At the same time a well conduction of the heat of the electrodes is guaranteed by the thermical contact of part 6 with the wall of the tilt 51. At the other side of the cylindrical part 2 turned away from plate 1 the inner conductor 6 is supported by a corrugated metallic membrane 9 being able to equalize the variations of the length of the inner conductor caused by the heating. The membrane 9 preferably being formed like a cap 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 centre of the inner conductor 6, 7. It may be constructed as a tungsten filament or with special advantage as an oxide coated cathode preferably heated indirectly. In using an oxide coated cathode an additional grid can be arranged between same and the grid 7. In Figure 1 only the end of the cathode 52 with the heating wires 29, 30 is to be seen.

At the place of the electron stream the electrodes 7 and 13 as well as the cathode have a very less distance from each other in respect to the running periods which need the electrons for their ways. For reaching a high fly wheel resistance the resonator is provided with a larger inner diameter at that point which does not form the discharge space. At the embodiment according to the invention the outer conductor 2 is forming a ring like roll 12 in the sphere of the electrode system thus forming a recess. By the safe and firm support of the inner conductor 6, 7 in the cylindric continuation 51 a punctual observance of the less distance of electrodes free from objections is guaranteed. The cylindric part 2 and the roll 12 can be made of one piece.

At 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 exceptional the aerial connection 23. At the embodiment the hollow space resonator to the right is continued to the concentric energy line with outer conductor 17 and inner conductor 18. The outer conductor 17 is connected preferably galvanically to the outer conductor 13 of the resonator. As mentioned above the metallic cover of the ceramic part can be led through the sealing 5 to the outside and serving as a contact with the outer conductor 17 of the energy line. In some cases the coupling can be made capacitively by the outer conductor 17 surrounding the ceramic part so far that the layers 13 and 17 are opposited each other along a certain length especially along a length of $\lambda'/4$. Here is λ' 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 8, 7 by the conductor 18 surrounding the continuation 51 especially along a length being equivalent to the value $\lambda'/4$. In some cases also a galvanic contact is possible and sometimes advantageous. It can be realized by a metallic cover of the continuation 51 which is provided with a radial boring through which the metallic cover is led to the outer sphere, said boring being sealed by a glazing. Thus a galvanic contact between the conductors 6 and 18 is made.

The conducting of heat takes easier place too by the well connection between the conductors 17 resp. 18 and the ceramic wall.

The opposite end of the resonator is short circuited for the high frequency by capacities formed by the covers 14 and 15. In this manner the space 20 is discoupled for high frequency's sake, said space containing the direct current leaders and especially serving for the vaporizing of a getter (with the aid of high frequency heating). For controlling the discoupling as well as the wave length of the resonator the capacity of the covers 14 and 15 can be made variable. This can be realized by an insulating ring 16 (preferably made of ceramic) being arranged shiftable at the ceramic part 3 of the tube.

For supporting the electrode leadings through the glass wall as well as the plug pins in the drawn embodiment a separate socket 21 is provided. At another preferred embodiment at which the tube is closed by a ceramic plate instead of a glass seal the leading-in-wires are advantageously made by metallisings led through the ceramic plate. Instead of the commonly used plug pins the socket plate as connections has simple metal covers with holes. Also the leading-in wires for the direct current voltage to the anode may be led through the ceramic wall. Regarding the embodiment according to Fig. 1 the ceramic tube is bored at 23 and the metal coating is led from the inner to the outer part of the tube. F. i. the metal coating may surround the outer side of the ceramic tube 2 like a circlelike ring. The boring 23 is high vacuum tightly sealed f. i. by a glass stopper. The current leading-in wire connected with the metal coating is numbered 31. In some cases it may be better to lead the direct current voltage leading-in wire for the anode also through the socket.

For sake of protection of this arrangement an additional metal tube 22 is being provided.

In Fig. 2 an arrangement different from that of Fig. 1 is shown. At 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 lesser radiation losses the arrangement is constructed in such manner that the metallising **24** is continued at **33** along the seal to the outer of the ceramic body **2**. Between the metal coating **33** and the conductor **17** a further dielectric material **34** also better made of ceramic material is arranged. The coupling condenser thus has a length of $\lambda/4$. The metal protecting tube **22** already shown in Fig. 1 covers the outer conductor **17** purposely along one quarter wave length.

At another very suitable embodiment of the invention the evacuated ceramic body having an inner metal coating is forming only one part of the resonator. This simple way gives the possibility to fasten besides the evacuated part of the resonator also means for the variations of the tuning or means for the coupling, same being constructed and managed much easier than in an evacuated body. Such a device is shown in Figure 3. This device is principally constructed like the device according to Fig. 1. The resonator equivalent to a length of $\lambda/4$ and the electrode system as well as the electron stream is to be found in a potential loop. As to be seen from the drawing only one half of the hollow space is evacuated. A cylindric symmetric step like ceramic vessel is provided the inner surface being metallised and being high vacuum tightly closed at one end by a ceramic part eventually joined with a ceramic base plate. The inner conductor **6** is supported in a similar manner as per Fig. 1. The ceramic wall separates the evacuated part **36** from the non evacuated part **37**. Both parts are coupled with the coating **13** serving as anode as well as the metallic part **40** of the outer resonator, this parts forming a coupling capacity. This coupling of course may be constructed as shown in Fig. 2. Furthermore a galvanic coupling is possible. The energy line **17**, **18** is coupled to the resonator f. i. in such manner that the outer conductor **17** immediately passes over in the wall **39** of resonator part **37** whilst between the inner conductor **18** of the energy line and the inner conductor **6** of the resonator a capacitive coupling exists.

Figure 4 shows how part **37** of the hollow space may be varied in respect to its dimensions. The outer conductor **17** of the energy line at its end is made shiftable like a telescope and is being coupled with the wall of the resonator by a capacity **14** having in axial direction a length of $\lambda/4$ which serves besides the purpose of avoiding of radiation losses. Further-more the collar like part **41** is provided for avoiding high frequency currents at the outside of the conductor **17** thus also avoiding radiation losses.

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