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PRODUCTION OF SHORT ELECTRIC WAVES

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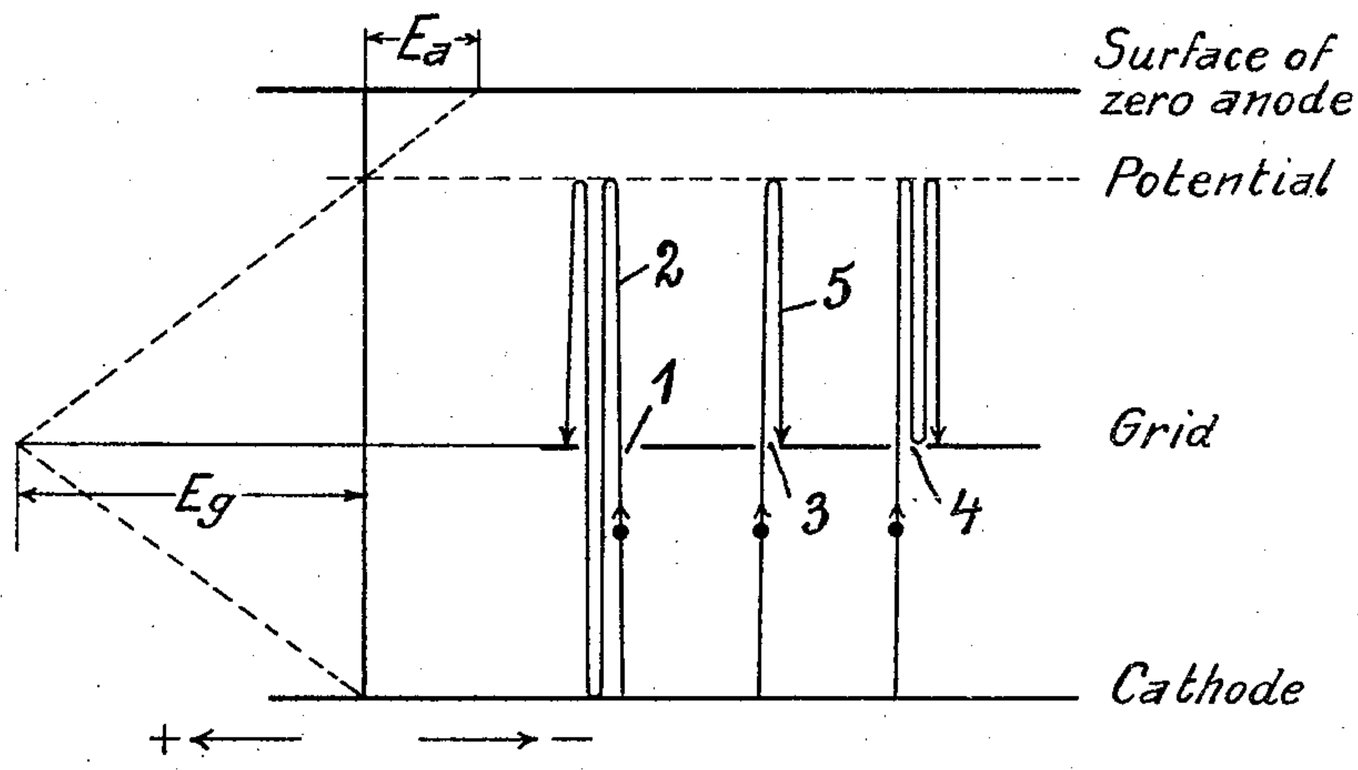

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UNITED STATES PATENT OFFICE

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PRODUCTION OF SHORT ELECTRIC WAVES

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An application for this invention was filed in Germany March 15, 1928.

My invention refers to the generation of short electric waves and more especially to means whereby very short electric waves can be generated in electron tubes.

In the generation of short electric waves by means or regenerative arrangements there is a lower limit occasioned by the fact that the time and transit of the electrons within the tube can no longer be ignored as compared with the period. Consequently the ordinary regenerative coupling conditions as far as they concern the phase relations of the grid and anode alternating potentials are no longer sufficient.

Shorter waves can be generated by the Barkhausen-Kurz method (Zeitschrift für Physik, 21 (1921), page 1) in which the frequency is mainly determined by the stay of the electrons in the inter-electrode space. In contrast with the ordinary method of operating the three-electrode tube, the grid potential is highly positive and the plate potential is negative. Because of the distribution of electric force inside the tube, there is a to and fro movement of the electrons about the grid, since those with high velocity that have passed through the meshes of the grid, are reversed by the retarding field of the anode and are driven back to the grid; they then pass through it a second time and the process is repeated in the grid-cathode space.

The theoretical considerations of Barkhausen and Kurz were confirmed by Scheibe's extended experimental investigations (Annalen der Physik, 73 (1924), page 54).

The present invention, which is concerned with the generation of oscillations, the wave length of which is still considerably shorter than that of the oscillations produced according to the Barkhausen-Kurz method, is based on the observation, that the permeability of the grid is determinative for the appearance of longer or shorter oscillations. The probability, that electrons after having passed once through the grid, will pass through it a second time, is the less, the narrower the meshes of the grid, or in other words the smaller its permeability factor, i. e. the proportion of the free cross-sectional areas of passage to the cross-sectional area covered by the grid wires. I have found that by reducing this factor oscillations can be generated, which are not produced by the swinging of the electrons about the grid, but exclusively by movements of the electrons in the grid-anode space.

In the drawing affixed to this specification and forming part thereof a diagram illustrating the invention is shown by way of example.

Referring to the drawing, Eg is the grid potential in volts in an electron tube. In the case of a grid having wider meshes such as shown at 1, the electrons will swing about the grid, 2 being illustrative of the motion of the electrons which swing about the grid. As the anode has a negative potential the electron reverses in front of it at the position of the surface of zero potential.

If, however, the meshes are narrower as shown for instance at 3 or 4, the case is different. Of course a large part of the electrons emitted by the cathode do not penetrate the grid after their first journey through the grid-cathode space, but strike the grid wires. These electrons impart all their energy to the grid and need not be considered in the generation of oscillations. With the electrons which are reversed in the grid-anode space, but which do not pass through the grid the second time, the case is quite different. On account of their vibratory motion in the retarding field of the anode, the resultant effect of all the electrons having passed the grid is a pendulum-like high frequency movement within the grid-anode space as shown at 4 in the drawing. The frequency of these oscillations is determined

only by the stay of the electrons in the grid-anode space and must therefore be higher than the electron oscillations in the anode-cathode space itself. In the drawing 5 illustrates the motion of an electron which moves to and fro once in the grid-anode space.

Obviously the narrower the mesh of the grid, the lower will be the percentage of electrons that pass through it, until finally no vibratory motion at all takes place about the grid, it being then entirely confined to the grid-anode space.

In order to define the width of the meshes of the grid, the permeability factor D may be used which determines the proportional percentage of the free area of passage offered by the grid and the cross-sectional area covered by the wires. A constant critical permeability factor does not exist, the factor depending upon the electrode potentials and upon the dimensions of the elctrodes. I have, however, found by experiment that the ultra-short waves generated according to this invention are obtained at grid potentials which are the lower, the narrower the meshes of the grid, i. e. the smaller the factor D.

By way of example the following factors determined in connection with an electron tube at different grid potentials Eg are given. The total area covered by the grid was 36 sq. millimetres, the diameter of the anode was 18 millimetres, the anode potential = −20 volts.

E_g	$D_{crit.}$
Volts	*Per cent*
180	82
240	89
270	90
435	92
500	95

As mentioned above, these figures will vary as the anode potential and anode diameter vary.

Obviously, under equal conditions and more especially equal velocity of the electrons the distance covered by the electrons will be shorter in a tube according to this invention than if they are traveling, according to Barkhausen-Kurz, across the entire anode-cathode space. In consequence thereof the frequency obtained is higher and in the average amounts to an octave to the Barkhausen-Kurz frequency.

Various changes may be made in the details disclosed in the foregoing specification without departing from my invention or sacrificing the advantages thereof.

I claim:—

An electron tube for generating ultra high frequency oscillations comprising a heatable cathode, an anode, a grid electrode between said cathode and anode, the proportion of free cross-sectional area of said grid for passage of electrons to the cross-sectional area thereof covered by the grid conductors having such a value that when the proper potentials are applied to the anode, cathode and grid to produce oscillations in the tube by the swinging of the electrons emitted from the cathode the said swinging movement of the electrons is maintained substantially exclusively in the grid-anode space whereby the frequency of the oscillations produced by the swinging of said electrons is substantially increased.

In testimony whereof I affix my signature.

HANS ERICH HOLLMANN.