Prevention of Parasitic Oscillations in Electron Beam Tubes

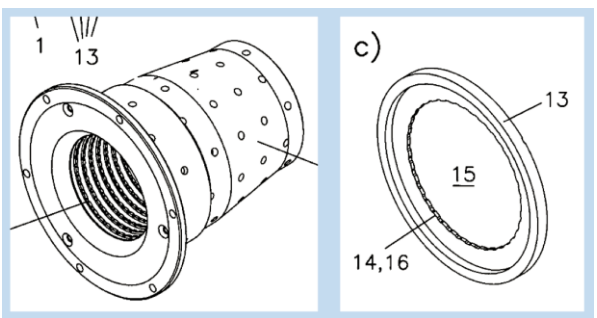
The innovation relates to a device for preventing parasitic oscillations in electron beam tubes. It comprises a beam tunnel subject to an axial static magnetic field. The tunnel is equipped with ceramic and metal rings arranged alternately in the axial direction. These rings yield a structure on the inner surface preventing the harmonic rise of spurious oscillations that could otherwise damage the tube. The technology is ready for use in the non--fusion domain and was patented by the inventors Manfred Thumm and Gerd Gantenbein.

Description of the technology

Electron beam tubes are primarily used for the contactless transfer of high energy by means of high frequency electromagnetic oscillations. Typical application examples are gyrotrons (>1 MW & 100-200 GHz), magnetrons, klystrons or traveling-wave tubes. The physical principle is based on the interaction between an electron beam and a RF frequency in a hollow waveguide, where the high frequency power is taken from the cycling motion of the electrons. The electrons are generated by means of an electron emitter, accelerated by means of a static electric field and pass a beam tunnel prior to entering a resonator. The electrons are guided by strong external axial magnetic field. The electrons are travelling on spiral shaped trajectories. The rotation frequency is defined by the strength of the magnetic field and the relativistic mass of the electrons. In the case of vacuum tubes, undesirable spurious oscillations can occur. Such oscillations reduce the efficiency significantly and may even cause damage and destruction as a consequence of thermal overload. The technology innovation suppresses such undesirable oscillations and reduces their impact on the electron beam itself.

Innovation and advantages of the offer

To suppress the undesirable oscillations, alternately arranged metal rings with corrugations on the inner surface and ceramic rings are used, that yield a structure on the inner surface preventing the harmonic rise of spurious oscillations. The advantage of this design over conventional methods is the easy retrofitting through simple exchange of components. The metal rings are typically made of copper yielding a high electric conductivity combined with a low high frequency damping. The ceramic rings are preferably made of oxide ceramic. They have to be suitable for high vacuum, provide electric isolation and mechanically workable. The chosen material provides a high damping of parasitic oscillations.



Example Beam Tunnel (left) with alternately arranged ceramic and metal rings (right) (Source: WO 2011/006588 A1)

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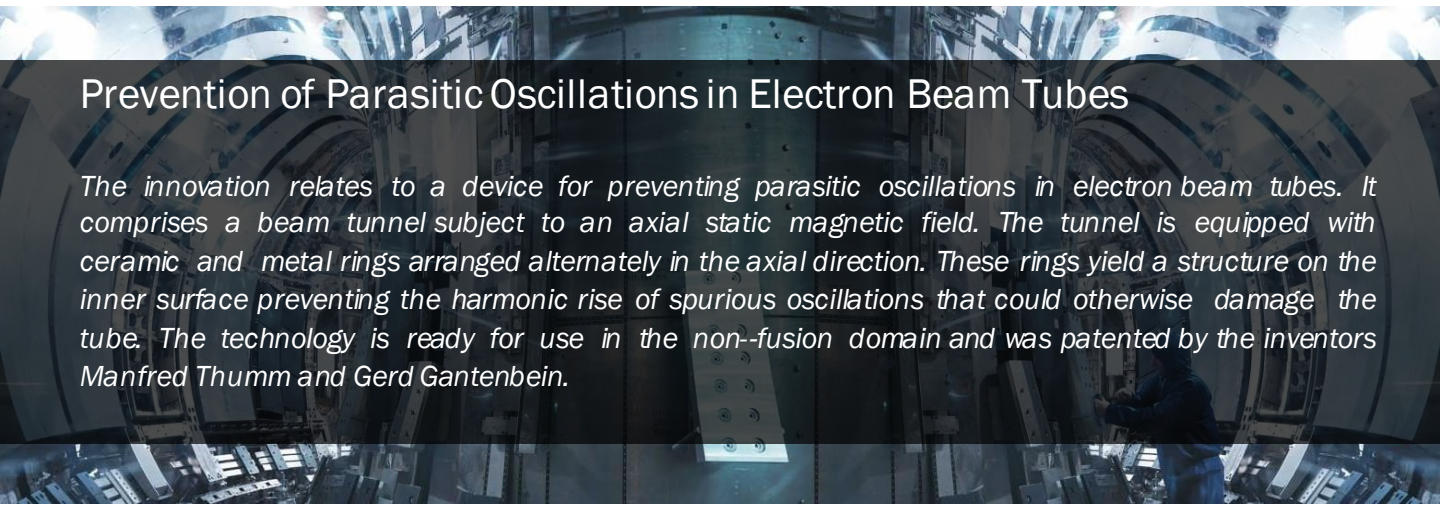

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Non-fusion Applications

The technology has successfully been applied on the Nuclear Fusion domain. Further application areas are space as well as (test) facilities outside the fusion domain applying contactless high--energy transfers via electron beams.

Application to space domain for HF communication, i.e. Traveling Wave Tubes (TWT) for HF generation in communication satellites, as well as for TV and Radio.

EUROfusion Heritage

The innovative means of suppressing spurious oscillations in electron beam tubes was developed at the Karlsruhe Institute of Technology (KIT). Such tubes are used to for the contactless transfer of energy for gyrotrons, magnetrons, klystrons or traveling--wave tubes. It was successfully tested and patented and is ready for use in other (test) facilities outside the fusion domain.

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