Novel Low-Cost, Low-Power Miniature Thermionic Cathode Developed for Microwave/Millimeter Wave Tube and Cathode Ray Tube Applications

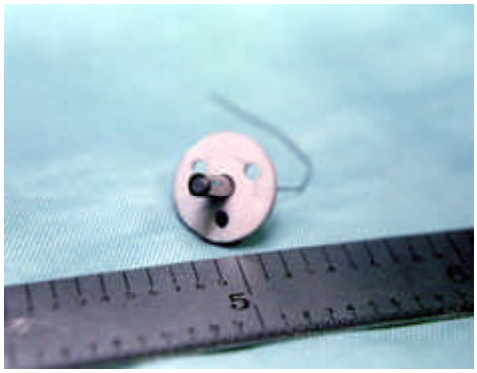
A low cost, small size and mass, low heater power, durable high-performance barium dispenser thermionic cathode has been developed that offers significant advancements in the design, manufacture, and performance of the electron sources used in vacuum electronic devices--such as microwave (and millimeter wave) traveling-wave tubes (TWT's)--and in display devices such as high-brightness, high-resolution cathode ray tubes (CRT's). The lower cathode heater power and the reduced size and mass of the new cathode are expected to be especially beneficial in TWT's for deep space communications, where future missions are requiring smaller spacecraft, higher data transfer rates (higher frequencies and radiofrequency output power), and greater electrical efficiency. Also expected to benefit are TWT's for commercial and government communication satellites, for both low and geosynchronous Earth orbit, with additional benefits offered by lower cost and potentially higher cathode current loading.

A particularly important TWT application is in the microwave power module (MPM), which is a hybrid microwave (or millimeter wave) amplifier consisting of a low-noise solid-state driver, a vacuum power booster (small TWT), and an electronic power conditioner integrated into a single compact package. The attributes of compactness and potentially high electrical efficiency make the MPM very attractive for many commercial and government (civilian and defense) applications in communication and radar systems. The MPM is already finding application in defense electronic systems and is under development by NASA for deep space communications. However, for the MPM to become competitive and commercially successful, a major reduction in cost must be achieved.

The new cathode is expected to make an important contribution to lowering the cost of MPM's and, in addition, offer significant improvements in the electrical efficiency and thermal management, as well as potential reductions in size and mass. Barium dispenser cathodes, with their higher emission current density capability and greater durability, offer brightness, resolution, and lifetimes superior to the alkaline-earth oxide-coated cathodes most commonly used in CRT's. Immediate applications for CRT's are in high-end monitors (such as those for medical imaging, computer-aided design (CAD), and air traffic control), in CRT-based projection displays, and in high-definition television receivers.

FDE Associates of Beaverton, Oregon, developed the miniature barium dispenser cathode under a Small Business Innovation Research (SBIR) contract with NASA Lewis Research Center. The design and fabrication are based on practices used in the production of CRT's, which is one of the most competitive and efficient manufacturing operations in the

world today. The approach used in the design and manufacture of thermionic cathodes and electron guns for CRT's has been optimized for fully automated production, standardization of parts, and minimization of costs. In addition, this approach offers a number of potentially significant benefits for the production of similar components in microwave tubes, among which are low cost, reductions in size and mass, and significantly lower cathode heater power. Although CRT's employ primarily oxide-coated cathodes, CRT manufacturing technology is equally applicable to barium dispenser cathodes.



Support sleeve and ceramic disk mounting for 0.065-in. cathode scale.

FDE is presently using the CRT approach to develop and produce a number of cathode sizes ranging from 0.050- to 0.0250-in. in diameter, with corresponding heater powers ranging from <1.0 to <3.5 W, respectively. In addition to miniature TWT's, the 0.050-in. cathode is applicable to high-resolution, high-performance CRT's that require a high brightness electron source. Low cathode heater power results from a highly efficient thermal design and a novel process for thinning and polishing the cathode support sleeve to reduce heat conduction and radiation losses. The barium source is a 4:1:1-impregnated, die pressed, and sintered tungsten alloy pellet for long life and enhanced electron emission (> 2 A/cm^2), although other compositions, such as the osmium-coated tungsten pellet are just as feasible. Other basic design features include cylindrical mounting (for ruggedness), ceramic disk mounting (standardized drop-in mounting into electron guns), a slip-in cataphoretic-coated heater (low cost and automated production), a heater enclosure separate from the main support sleeve (for power efficiency and enhanced heater life), a nearly all-welded design with limited brazing (automatic assembly and low cost), and the use of simple shapes, drawn or stamped parts and parts joined by mechanical capture (crimping). Emphasis is on standardization of parts and the design of tooling and assembly procedures for automated production. Flexibility in manufacturing allows easy substitution of other cathode sizes.

Find out more at http://www.fdeassc.com/.

Lewis contact: Edwin G. Wintucky, (216) 433-3510, Edwin.G.Wintucky@grc.nasa.gov
FDE Inc. (now e beam, inc.) contact: Bernard K. Vancil, (503) 628-0703, bernie@ebeaminc.com
Author: Edwin G. Wintucky
Headquarters program office: OSS

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