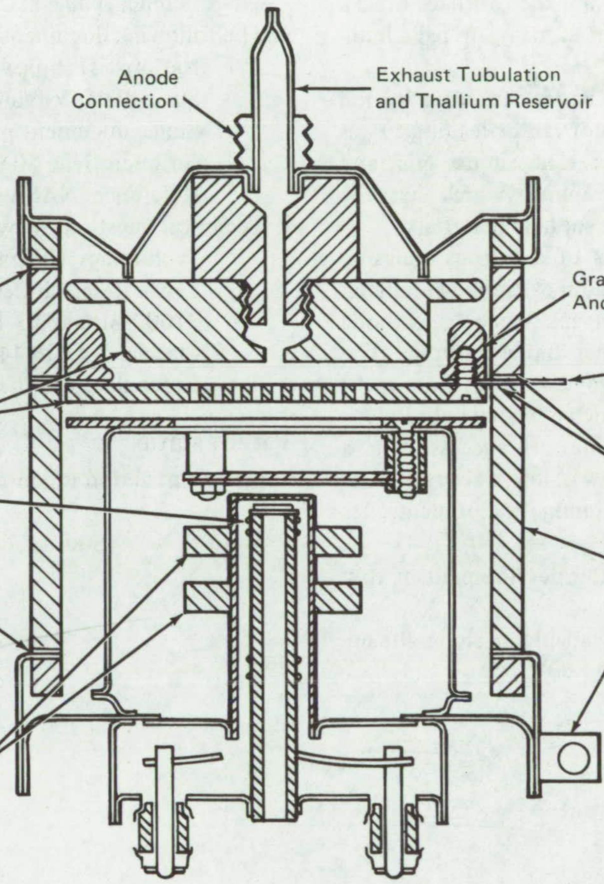
NASA TECH BRIEF
Lewis Research Center

High-Temperature, Long-Life Thyratron



The problem:

Thyratrons require the use of materials which provide long life operation at high temperatures.

The solution:

A thallium and xenon filled thyratron was developed that operates at tube envelope temperatures up to 750°C. This tube performs at peak voltage ratings of 2000V forward and reverse and at an average current rating of 15A for up to 11,000 hours.

How it's done:

Thallium was chosen as the basic working fluid because of its favorable equilibrium-vapor-pressure versus temperature characteristic, its comparatively low ionization potential, and its high work function. The xenon in the initial thallium-xenon mixture is present only during the breaking-in period and early life of the tube (usually several hundred hours or less). Afterward, the xenon is lost through sputtering, and the tube operates on thallium alone. A reservoir, as shown in the figure,

(continued overleaf)

is a one-inch extension of the exhaust tubulation that contains approximately 80 milligrams of liquid thallium which is more than ample to supply the tube requirements during the life of the tube. Thallium vapor is present effectively only when temperatures throughout the tube interior are above 600°C. The pressure of the thallium vapor within the tube is controlled by varying the temperature of this small reservoir by external means (not shown).

The tube envelope is a high-purity (99.9%) alumina ceramic. The seal flanges are an alloy of iron, nickel, and cobalt. The ceramic-to-metal, butt-type seals are fabricated by first preparing the ceramic by applying a tungsten-based metallizing coating to the abutting surfaces. The ceramics thus coated are then furnace brazed (at 1260°C) to the metal flanges using a palladium-cobalt brazing alloy.

Material sputtered from the anode structure by ion bombardment is usually the major factor leading to gas cleanup for inert gas filled tubes. The anode, grid, and shields are fabricated from graphite which has the lowest sputtering rate among the suitable materials.

The matrix cathode consists of a porous tungsten sponge impregnated with barium-calcium aluminate. This structure has much better resistance to cathode sputtering than the conventional oxide cathode. The cathode proper consists of two discs (12 cm^2 each) area-brazed to a tantalum core which is heated indirectly.

Test results show that thallium is successful as a working fluid in that arc drop was low, recovery time was low, and sputtering and contamination of electrodes and insulators was not serious.

Major advances achieved during development of this tube include:

(1) Ceramic-to-metal seals capable of long life in the temperature range to 800°C.

(2) Inter-electrode design to minimize anode and grid emission at high operating temperatures.

(3) Gas clean-up rates under high frequency conditions and associated sputtering.

(4) Cathode structures capable of high emission currents and long life.

Notes:

1. These new tubes can be used in power conditioning circuits where switching, rectifying, inverting, etc., functions are required in a high temperature environment.
2. Underlying work in high temperature tubes is described in Tech Brief 69-10376, "High Temperature, Gas-Filled Ceramic Rectifiers, Thyratrons, and Voltage-Reference Tubes."
3. The following documentation is available from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)
   Reference: NASA CR-1684 (N70-42577),
4. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10134

Patent status:

No patent action is contemplated by NASA.

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