

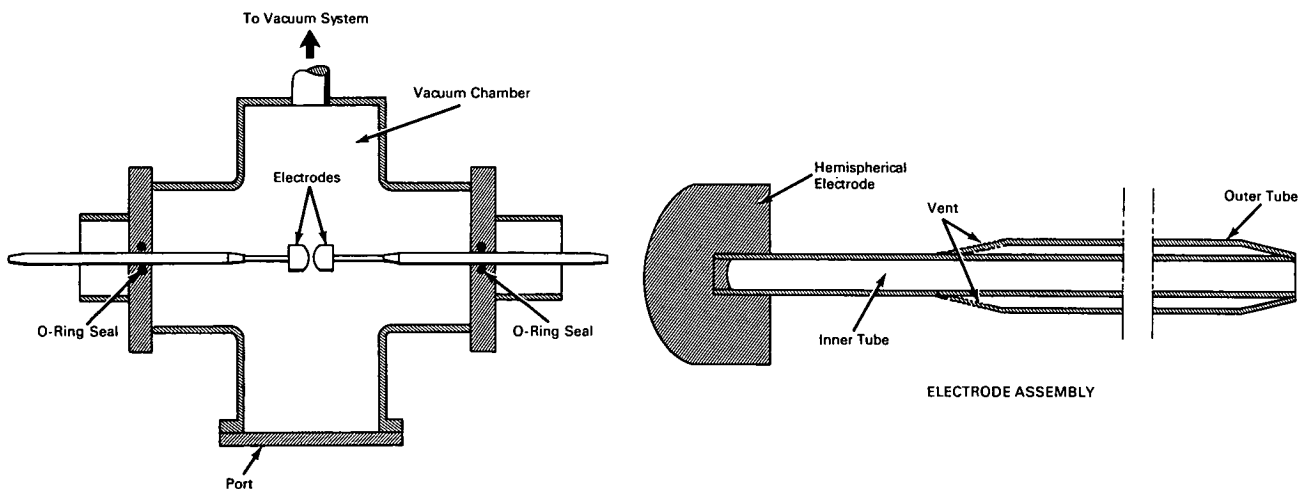


# AEC-NASA TECH BRIEF



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## Cryogenic Cooling Reduces High Voltage Arcing Between Electrodes Operating in a Vacuum



### The problem:

To reduce arcing, or high voltage breakdown, between two closely spaced electrodes operating in a vacuum. Many applications such as ion sources, plasma generators, and electrostatic lenses require closely spaced electrodes in a vacuum with a high voltage applied between them. One of the main problems found in these applications is the tolerance of the electrodes to the high voltage applied to them. As the voltage is increased the arcing between the electrodes rapidly increases.

### The solution:

Cool the electrodes to a temperature of approximately liquid nitrogen ( $-195^{\circ}\text{C}$ ) or lower, to increase the high voltage tolerance of the electrodes in a vacuum. It has been found that cooling the cathode electrode provides the greatest effect in increasing tolerance to high voltage. Cooling the anode electrode

alone or together with the cathode results in only a slight improvement.

### How it's done:

Two 1-1/2-inch diameter hemispherical electrodes are constructed and used as shown in the illustrations. The anode is made of case hardened steel and the cathode of stainless steel. Both electrodes are fine machined, polished, and outgassed. The outer tube is vented to form an insulating barrier between the inner and outer tubes. This insulating barrier prevents the O-ring seals from freezing and causing leakage and loss of vacuum.

In operation, the vacuum chamber is evacuated and liquid nitrogen is introduced into the inner tubes to cool the electrodes to the temperature of liquid nitrogen ( $-195^{\circ}\text{C}$ ). High voltage is then applied to the electrodes through the electrode tubes.

(continued overleaf)

**Notes:**

1. This cooling technique can be applied to electrodes having other than hemispherical shapes. The maximum effect of electrode cooling on high voltage tolerance exists when the electrodes approach a point source configuration.
2. Inquiries concerning this innovation may be directed to:

Office of Industrial Cooperation  
Argonne National Laboratory  
9700 S. Cass Avenue  
Argonne, Illinois 60439  
Reference: B66-10499

**Patent status:**

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief  
Chicago Patent Group  
U.S. Atomic Energy Commission  
Chicago Operations Office  
9800 S. Cass Avenue  
Argonne, Illinois 60439

Source: D. J. DeGeeter  
Particle Acceleration Division  
(ARG-109)