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Self-Protected Electrodes Limit Field-Emission Current

The problem:

Electric breakdown, or arcing, in vacuum tubes and similar devices can occur at minute projections on the electrode surfaces. When an electric field is applied, these projections carry larger charge concentrations than the remaining areas. In operation, whenever field-emission current is increased between two electrodes, arcing occurs at the projections. The process is progressively destructive. Arcing causes more projection on the metal surface. The projections in turn attract further breakdown until much of the electrode surface is destroyed.

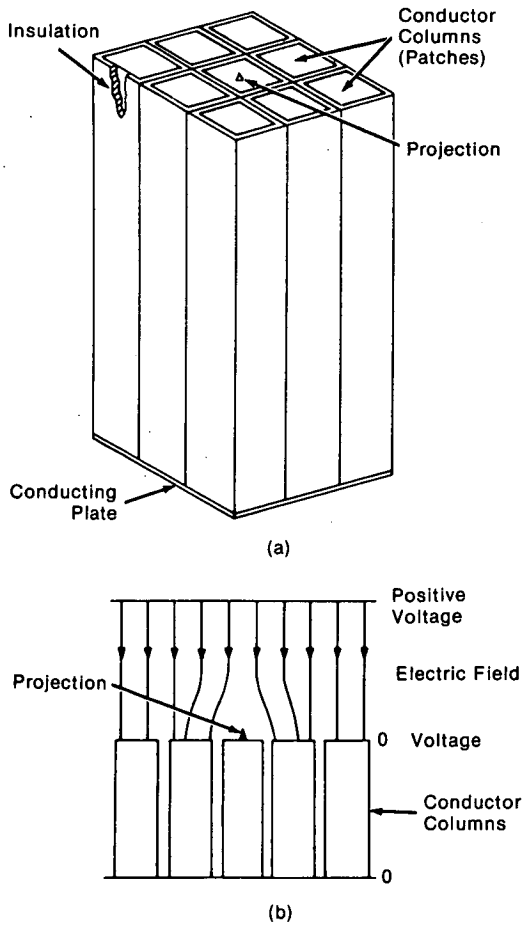

Figure 1. Cathode Design Using Square-Shaped Conductor Columns: (a) Electrode Configuration; (b) Field Distribution During Arcing (Note: Field-Emission Current Is Directed Opposite to the Electric-Field Lines)

The solution:

New self-protected cathodes have been developed which limit field-emission current to a safe value.

How it's done:

One cathode includes an array of square-shaped conductor columns, as shown in Figure 1. The columns are electrically interconnected by a conducting plate on the bottom. Above this plate the columns are insulated from each other. Each column provides field-emission current.

If any one conductor patch contains a projection, charge distribution becomes uneven. The projection will accumulate a high negative charge, leaving the remaining patch area more positive with the surrounding patches. This potential difference reduces the applied field at the affected patch. As a result, the field-emission current is limited during arcing. Arcing lasts only until the projection is removed, after which normal operation is restored.

Another cathode includes an array of rodlike conductors, as shown in Figure 2. These are also electrically interconnected on the bottom by a conducting plate and provide the sources of field-emission current. A layer of insulation above the plate separates the conductors. The layer is covered by a control film made of conducting material. The film is isolated from each conductor.

(continued overleaf)

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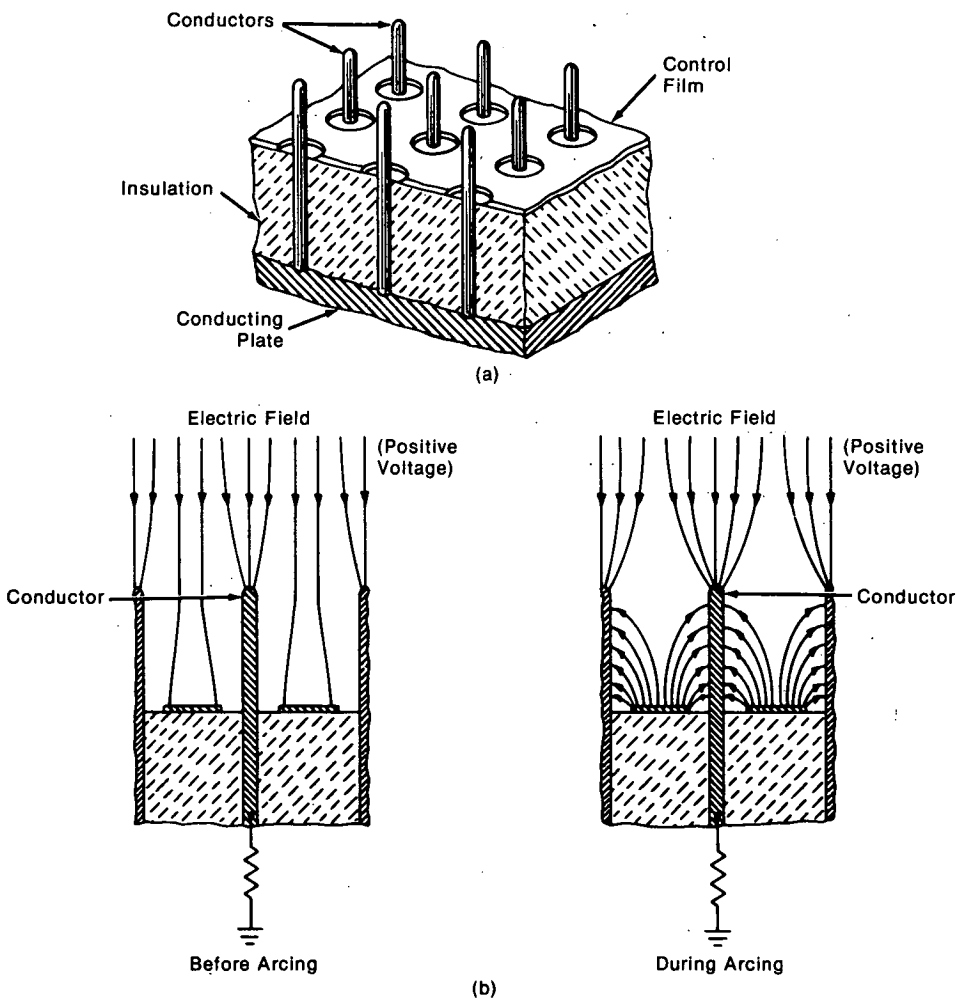

Figure 2. Cathode Design Using Rodlike Conductors:
(a) Cathode Section: (b) Field Distributions Before and During Arcing
(Note: Field-Emission Current Is Directed Opposite to the Electric-Field Lines)

Note:

Requests for further information may be directed to:

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Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,671,798). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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