NASA TECH BRIEF

Ames Research Center

Control of Oscillations in a Discharge Circuit

The problem:

A crowbar system is frequently included in a pulsed, undamped capacitor-discharge circuit to arrest oscillations. The systems customarily used for this purpose require active elements such as thyratrons and spark-gap triggers, which are costly and complex; a simple, economical alternative was desired.

The solution:

Include in the discharge circuit a series damping element which increases in resistance with current and time.

How it's done:

The damping element is a resistor made of tungsten wire; tungsten has a high melting point, low specific heat, and a large resistance—temperature coefficient. The resistance of the tungsten wire is low during the first quarter cycle of oscillation while the current is increasing, but since the temperature of the wire increases as heavy currents pass through it, its resistance will be very high during the time (second quarter cycle) when the discharge current of the circuit is decreasing. Thus, the circuit progresses from an underdamped state during the early portion of the discharge to a critically damped or overdamped state in the late portions of the discharge while the current is falling. The required resistance during the decay of the discharge can be obtained only if the resistive element has a positive temperature coefficient of resistivity and if its temperature increases rapidly because of joule heating. Since the duration of a pulsed capacitive discharge is short, heat generated in the resistor is not dissipated, and its temperature rises exponentially as a function of time.

The required length and diameter of the tungsten wire are computed by equations obtained from an analysis of the behavior of an oscillatory circuit in which the resistance is a function of current and time. In actual performance tests, the results of the mathematical analysis were verified with a T-tube plasma generator and accelerator powered by a bank of charged capacitors. Although the impedance of the plasma load varies during operation, it is low with respect to the computed critical damping resistance; thus, it is possible to obtain meaningful comparison between experimental results and theory.

Consideration has been given to the possibility of using a precooled superconducting wire as the damping resistance to obtain minimum risetime and maximum peak current in a discharge.

Note:

Requests for further information may be directed to:

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Reference: TSP 72-10304

Patent status:

No patent action is contemplated by NASA.

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Category 01