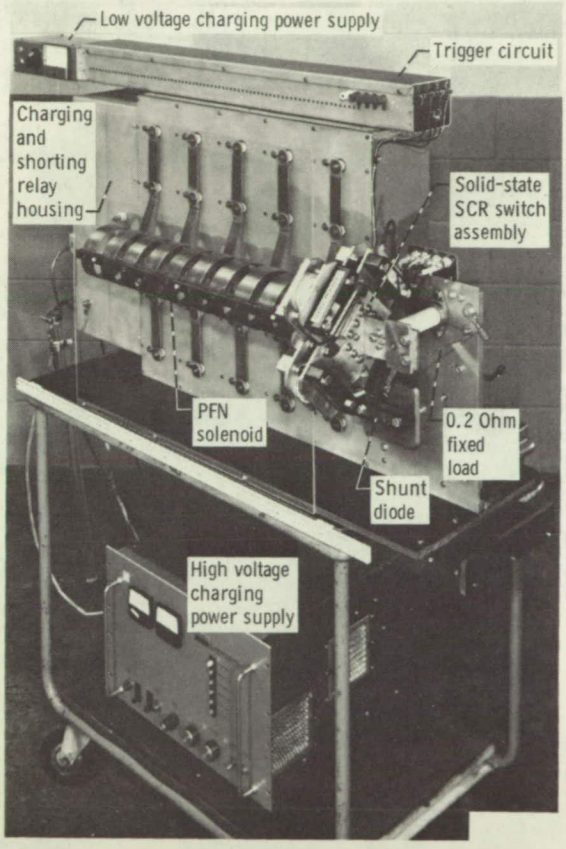
NASA TECH BRIEF

Lewis Research Center

Compact 20-Kiloampere Pulse-Forming-Network Capacitor Bank

A compact high-current pulse-forming-network (PFN) capacitor bank has been developed using commercially available high-energy-density capacitors for energy storage and silicon-controlled rectifiers for switching. A low voltage design employing the solid-state switching is utilized in lieu of the conventional gas discharge switching.



PFN-capacitor bank assembly.

A prototype PFN capacitor bank, shown in the figure, is rated at 1.25 kilojoules and provides rectangular pulse current waveforms for periods of 125 microseconds at a peak current of 20 kiloamperes. The complete assembly is mounted on a 0.91 meter (3 foot) cart. This bank has a capacity of 2500 microfarads distributed equally among five stations. Each station consists of five parallel-connected capacitors rated at 100 microfarads and 2500 volts dc. Inductance is obtained from a 10-turn solenoid consisting of a 3.81 cm (1.5 in) by 0.317 cm (0.125 in) copper strip wound with a 10.2 cm (4 in) inside diameter on a 6.35 cm (2.5 in) pitch. Each two-turn section of the solenoid provides inductance for one capacitor station. Four parallel-connected silicon controlled rectifiers mounted on a common convection-cooled heat sink serve as the switch assembly.

Forward current among the four silicon controlled rectifier (SCR) units is equalized to within 10 percent during both turn-on and conductance by: (1) matching the forward characteristics of each SCR, (2) applying a strong gate trigger to each unit, (3) mounting the SCR's perpendicular to and centered about the axis of the PFN solenoid, and (4) equalizing resistive and inductive paths to each SCR.

The modular design and construction provides capability for extending the length of the rectangular pulse current waveform to any length or multiples of length by adding more stations.

The PFN capacitor bank shown is a prototype of a 10 kilojoule/1 millisecond bank to be built for use in plasma studies. The design is especially suited for powering low-impedance (5 to 25 milliohm) arcs such as those employed in laser and fusion oriented pulsed plasma sources, pulsed solar simulators, and MPD-arc thrusters.

Notes:

1. This PFN capacitor bank design can also be utilized in compact precise pulsed power sources for welding, intense magnetic fields, plasma torches, and arc vacuum deposition of metallic coatings.
2. Documentation may be obtained from:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10171

(continued overleaf)

Patent Status:
NASA has decided not to apply for a patent.

Source: S.J. Posta and C.J. Michels
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(LEW-12009)