



The University of Texas at Austin

Center for Electromechanics

HOMOPOLAR GENERATOR (HPG)

-- REDUCED COST DESIGN --

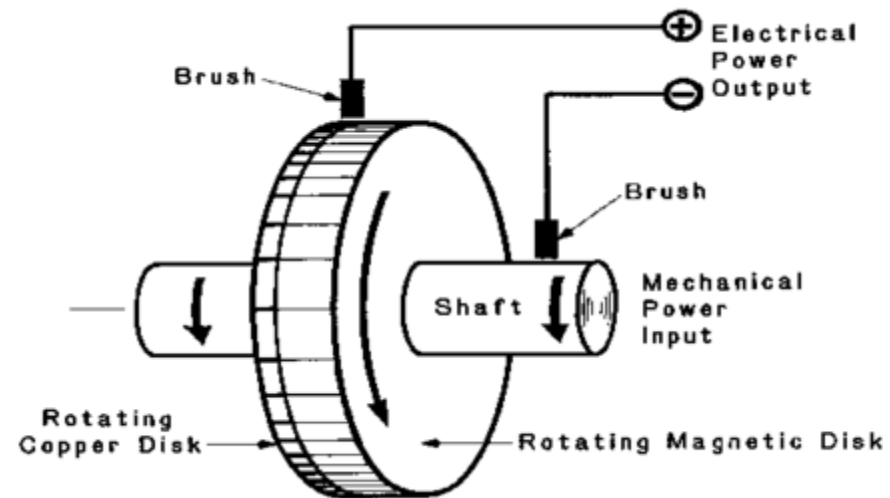
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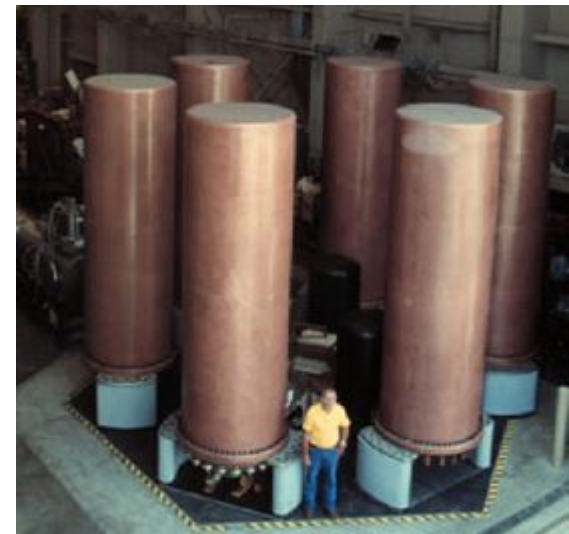
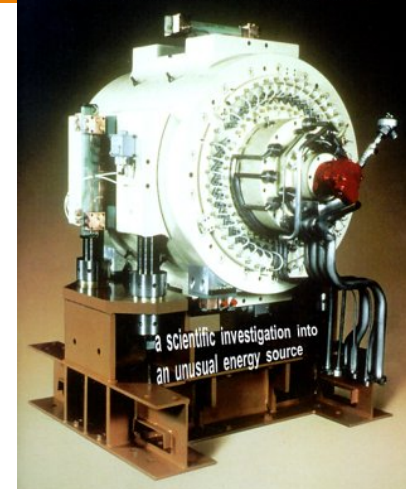
What is an HPG

- “Faraday disk or wheel”
- Simple DC Electrical Generator
- Operational Basics:
 - Solid metal conducting rotor is spun to speed
 - Once at speed, field coils are energized
 - Induces a voltage potential across surface of rotor
 - Conductive brushes actuate onto rotor to complete circuit
 - Electromechanical conversion – kinetic to electric energy
- Generates low voltage – typically tens of volts
- Designed with very low internal impedance
- Result: capable of very high current output



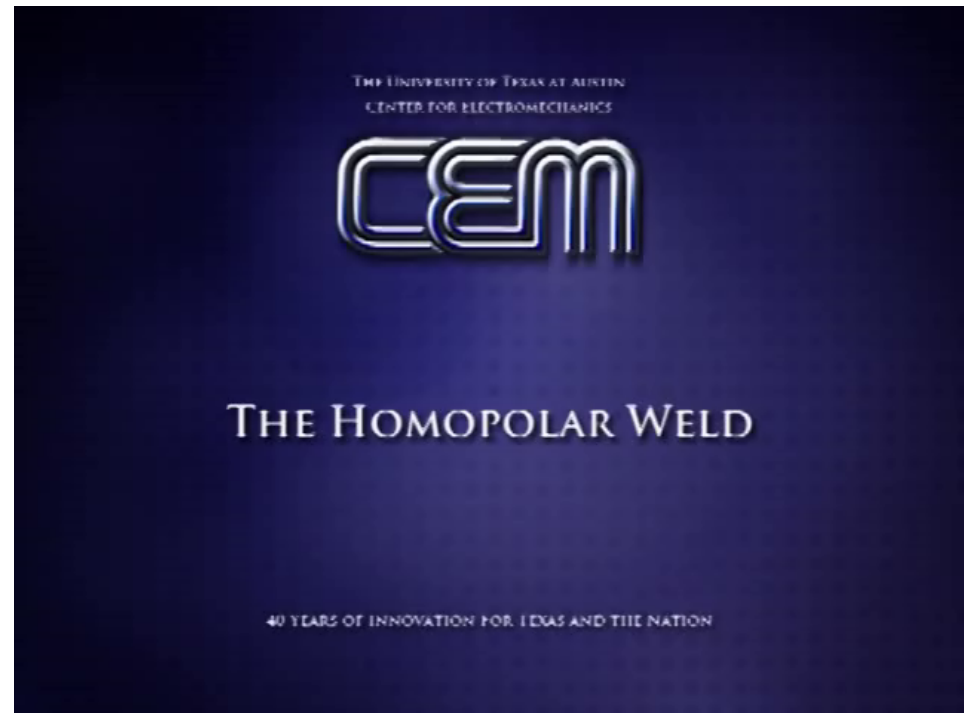
CEM HPG Research

- EM launchers (railguns)
- Fusion research (magnetic plasma confinement)
- Industrial Applications
 - Pulsed resistance welding
 - Sintering
 - Billet heating



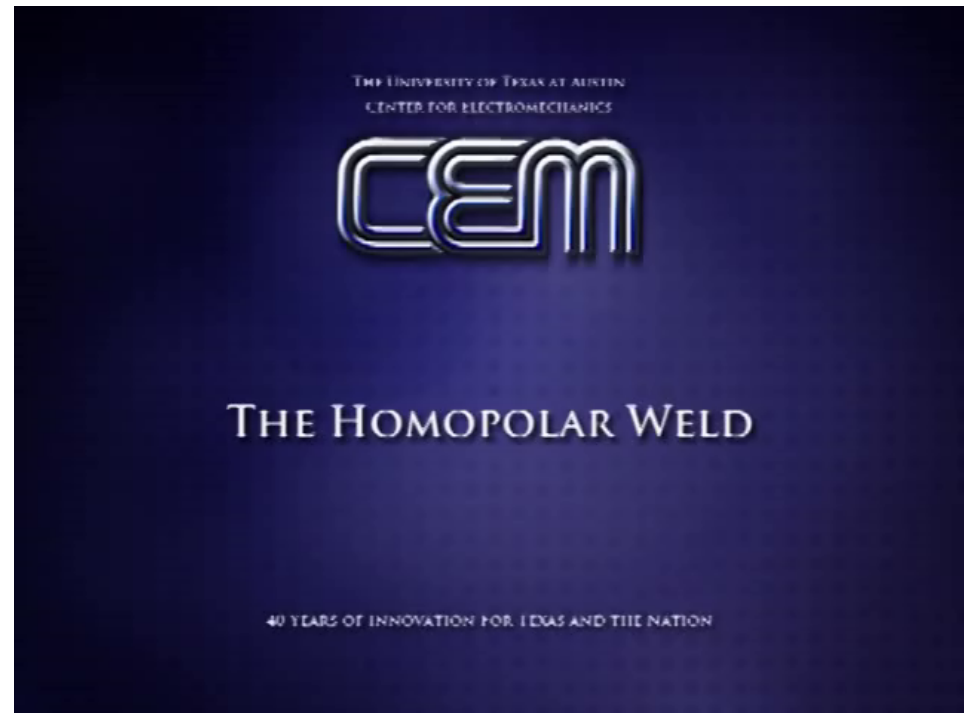
HPG Pulsed Resistance Welding

- Process developed at UT-CEM in early 80s
 - Weld articles prepped and loaded in press fixture connected to HPG
 - Compressive load (20,000 psi) applied and HPG spun to speed
 - HPG discharged into weld article
 - Energy dissipated at weld interface – rapid rise to forging temperature
 - Compressive load upsets weld and forges joint
 - Rapid quenching of weld zone – no heat effected zone
- Similar process utilized for pulsed sintering and billet heating



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- Technology commercialization pursued
- Cost of HPG system prohibitive



U.S. D.O.T. HPG Welding Program

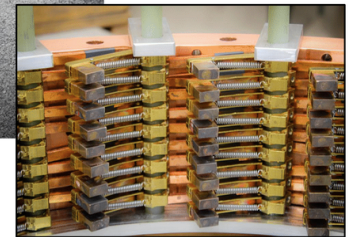
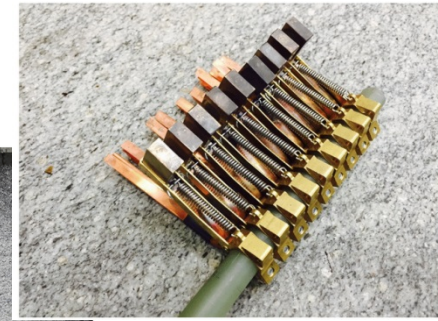
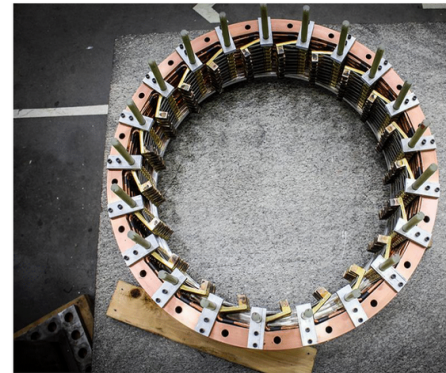
- SBIR Initiative --
 - Weld high performance bridge steel with a pulsed energy source for the D.O.T.
 - Design a system that welds 3" x 30" steel bridge girder plates faster than existing submerged arc welding (SAW) method
- Secondary goal: Utilize new technologies to design a lower cost HPG
- SBIR program:
 - Phase I- Concept design of subscale HPG*
 - Phase II – Manufacture prototype HPG*
 - Phase IIB – Design & build weld fixture and produce 1" x 12" weld samples*



S.A.W. weld system

Target Cost Reduction Items

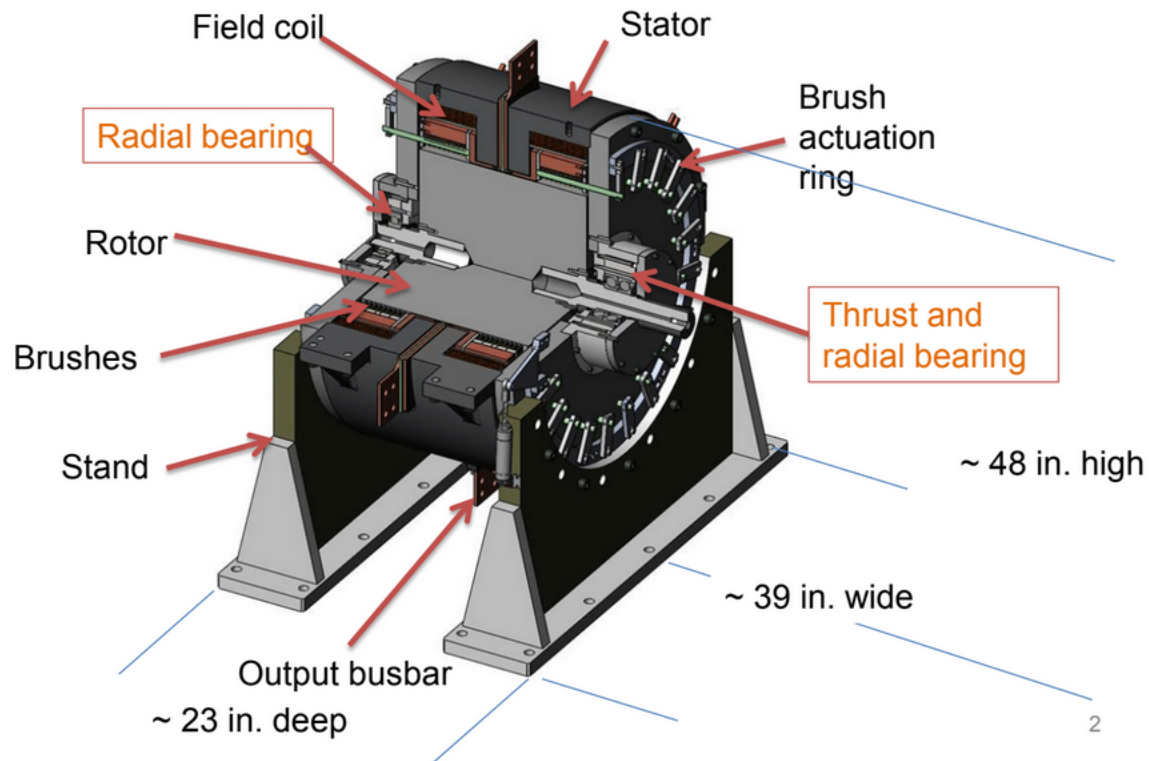
- HPG Design
 - Simpler design to reduce material and manufacturing costs
- Brushes
 - (OLD) Pneumatic bladder actuators
 - (NEW) OTS brush actuation arms. External mechanical actuation.
- Bearings
 - (OLD) Hydrostatic bearings
 - (NEW) Ceramic rolling element bearings
- Drive Motor
 - (OLD) Hydraulic motor
 - (NEW) High speed induction motor
- **Result: Previous HPG system > \$1M/unit**
New HPG design approx. \$400K/unit



D.O.T. HPG Design

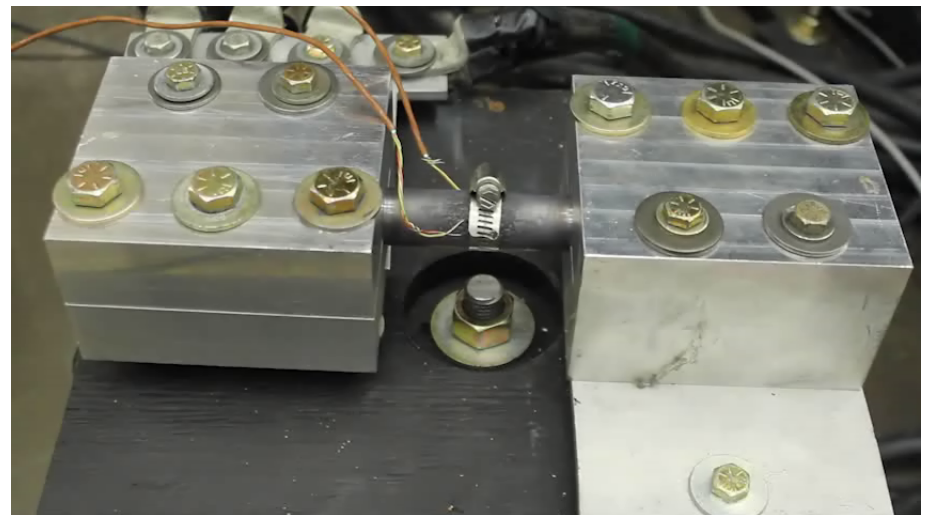
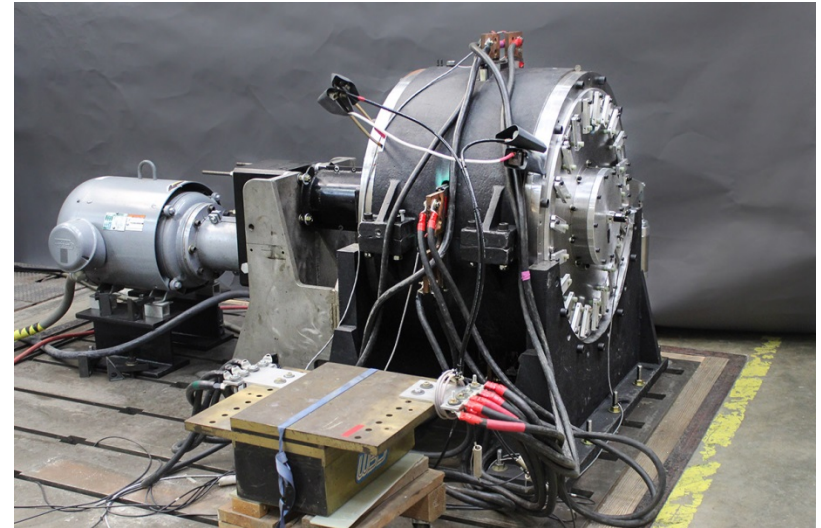
- Drum-type HPG
- 4200 rpm peak speed
- 12 volt peak voltage
- 20,000 ft-lb output torque
- 4 pair of output terminals
- Design output current > 1 MA with low resistance load
- External brush actuation ring mechanism

Subscale HPG Machine Components



HPG Testing to Date

- Full design speed
- Full field current
- 12 V output voltage
- ~200 KA output current
 - High resistance temporary load
- Brushes (spin test validation)
 - Full brush current
 - 150% brush action
- Parameters Characterized
 - Brush voltage drop
 - Internal HPG impedance
- **New HPG design has met required parameters and performance to date**



Future work-plans

- Complete design and manufacture of electrical buss and weld fixture hardware
- Conduct test welds of bridge steel for independent testing
- **Promote new reduced cost technology to industry again**
 - Deep sea welding application
 - Industrial billet heating interest
 - D.o.D project for sintering advanced materials
- **Utilize HPG and press/weld fixture assembly for process development and tech transfer outreach**

