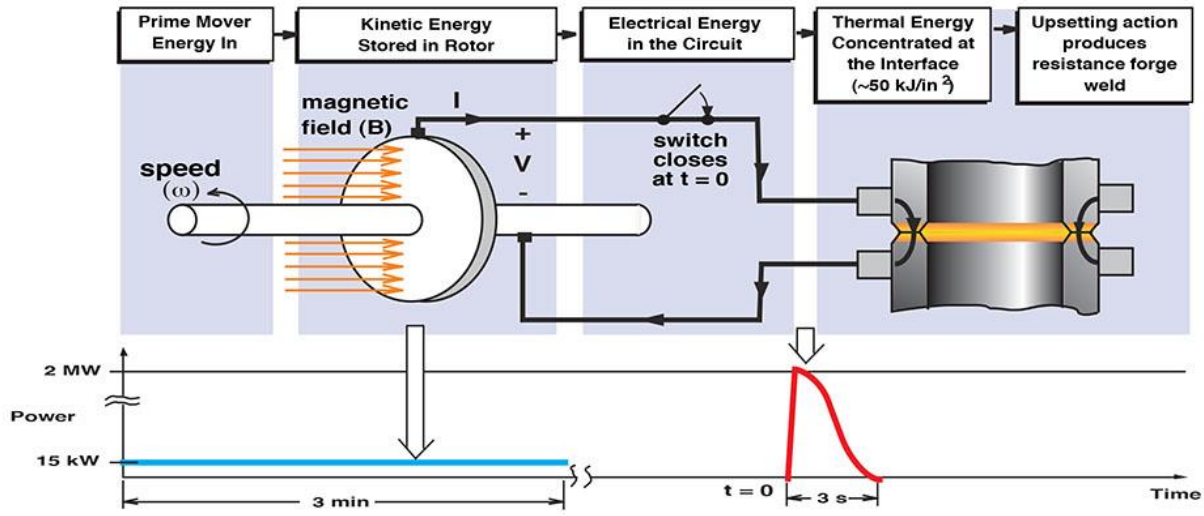
A New SBIR DOT Contract in Bridge Steel Welding

The team of KAI Inc. and UT-CEM has been awarded a contract by the Department of Transportation in the area 13.2- FH1, Development of Innovative Welding for High Performance Bridge Steel. It is proposed to use Homopolar Generator (HPG) Welding to join the high performance bridge steel in the 3" by 30" cross sections mentioned in the announcement in under 1 second. All of the energy required to perform the weld is stored in the spinning rotor of the pulsed power supply. Through electromechanical conversion the rotational energy is converted to a high discharge current that passes directly through the weld interface. Electrodes are clamped to the workpiece either side of the weldment and high current is passed through the plates to bring them to forge temperature. At this time an upset pressure is applied and the weld is created by resistance - forge welding process.

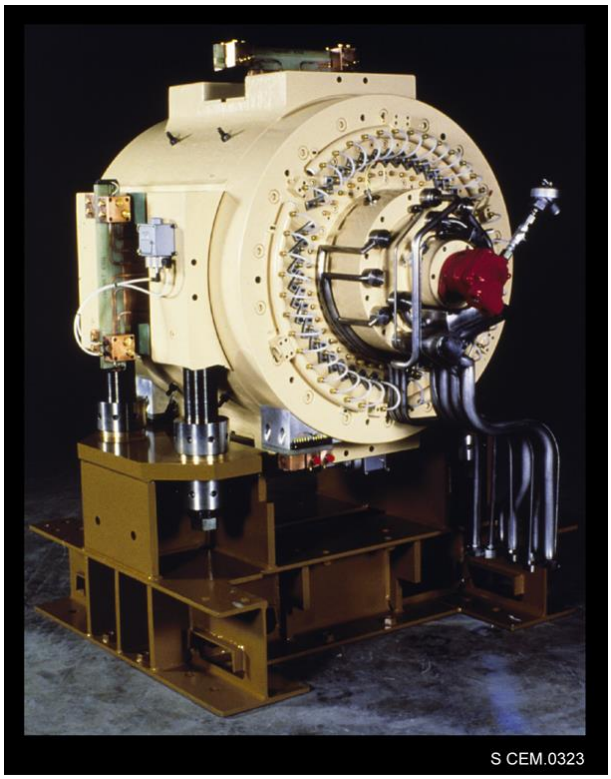


Energy is stored in the rotating inertia of the Homopolar generator at low power over several minutes using a low power prime mover. At the time of welding a field is turned on in the generator to produce voltage and a switch is closed to direct current into the weldment. In a matter of seconds the Megajoules of energy that were stored kinetically in the rotor is converted to electrical energy which is deposited in the highest resistance in the circuit which is the weld interface. An upset pressure is applied to the weld specimen at the same time and a resistance forge weld is created.

This process has been used to weld High Performance Steel pipe, 12" in diameter, with a 9/16" wall thickness. The pipes show good strength and toughness in the in both the weld metal and the heat –affected zone. These welds were accomplished with 3, 10 Megajoule, generators operating in parallel and the larger cross sections can be welded by adding generator units in parallel.

Welded 12 in. gas pipeline. Just over 1.3 million amps of current was used to weld this cross section.

The capability of a game changing innovative welding process will be demonstrated. The final goal of the program will be to connect pulsed generators in parallel to weld large cross sections of High Performance Bridge Steel. The process has already been demonstrated for API-5L steel pipe with generators designed and built in 1985.



10 MJ Homopolar Generator constructed in 1985. One goal of this program will be to apply advancements in rotating machine design realized over the last 28 years to substantially reduce the cost of the generator unit.

Since that time the machine design technology has advanced to allow the design of cost competitive generators. In Phase I a scale prototype will be designed to quantify the cost savings and in Phase II this generator will be fabricated and used to produce the specimens required to qualify the process for bridge steel welding. Once the ability to produce cost acceptable generator is proven there will be a multitude a commercial applications many of which have already been demonstrated with the earlier generators. The applications obviously include welding bridge steel, pipe, tubing, and railroad rail. In addition the generators have been used to sinter alloys such as molybdenum, tungsten, metal matrix composites and amorphous materials. Billet heating is also a strong attribute of this process whereby the entire billet is heated to forge temperature in the matter of seconds preventing the mill scale build-up. Another strength of the process is to weld alloy steel in under a second thus inhibiting any thermal diffusion from the weld zone that may alter the alloy chemistry.