GENERAL ELECTRIC

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MATERIALS UTILIZATION IN THE GENERAL ELECTRIC COIL FOR THE LARGE COIL PROGRAM

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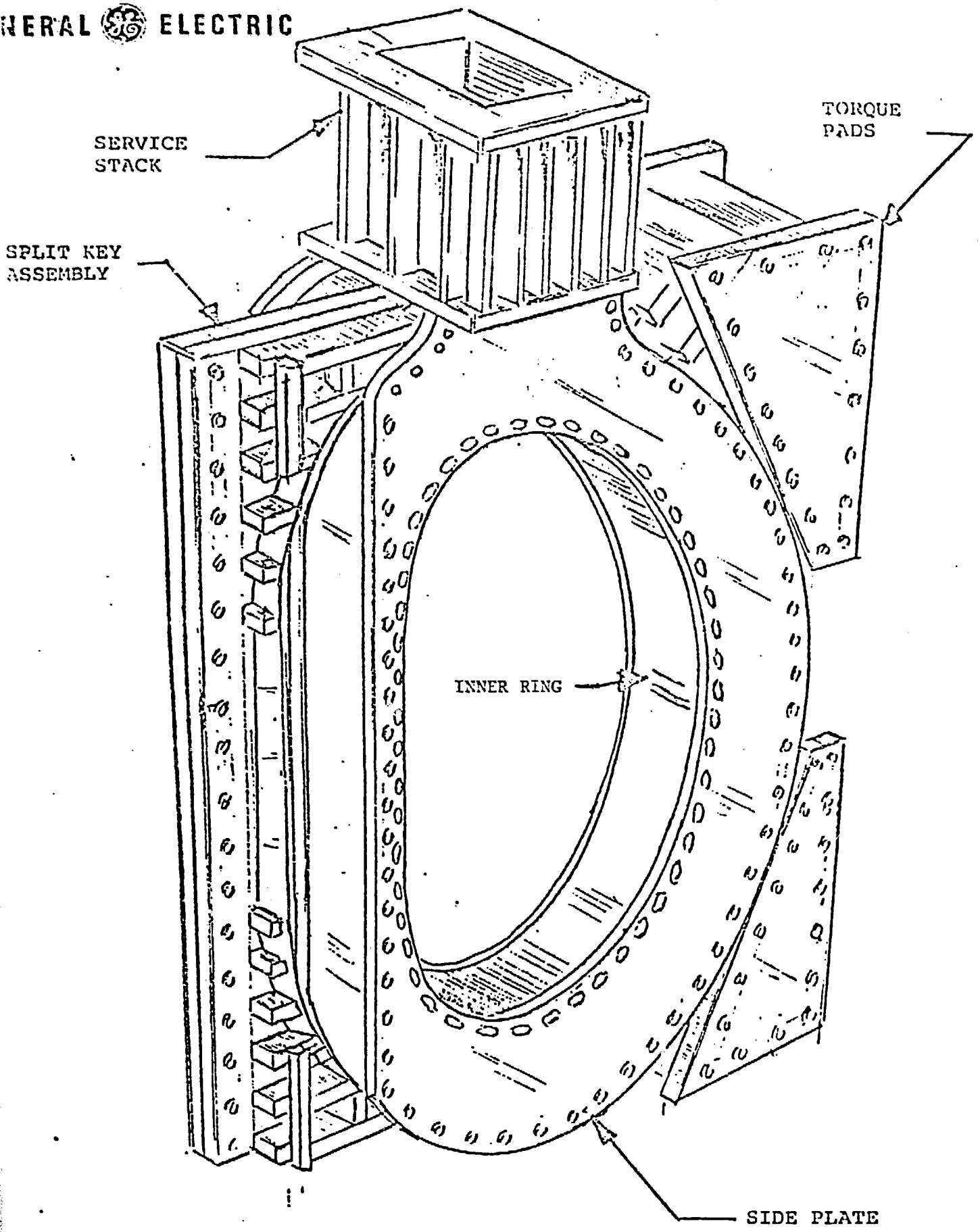
The General Electric Company is under subcontract from the Union Carbide Corporation to design, develop and manufacture an 8-Tesla superconducting coil in support of the Large Coil Program (LCP). The coil is to be tested at the Oak Ridge National Laboratory as part of the DOE-funded effort to develop toroidal field coils for magnetic fusion energy production. The GE coil is designed for a maximum field of 8 Tesla at the operating current of 10.45 KA. It uses a fully cryostable, graded and pankcake wound NbTi/Cu superconductor which is cooled by pool-boiling helium.

The coil structure is shown in Figure 1. The assembled coil (structure and winding) weighs approximately 392 kN (∿ 44 tons), with an oval-shaped bore measuring 2.35 meters horizontally and 3.35 meters vertically. The coil structure fabrication utilizes welding to produce the two side plates, the two rings (inner and outer), the torque pads, the service stack and the splitkey assembly. Following conductor winding, the coil will be assembled by bolting the side plates to the inner and outer rings, followed by sealwelding to provide a leak-tight structure.

Table1 summarizes the materials selected for the GE coil. AISI 316LN is extensively used as a structural material in the coil in heavy sections (typically 5 cm thick) with extensive structural welds. The selection of AISI 316LN was primarily based on its excellent cryogenic mechanical properties coupled with good weldability and microstructural stability at minimum cost. At 4 K, AISI 316LN offers a yield strength typically in excess of 140 ksi, an ultimate strength of about 200 ksi, an elongation

of 30-35%, a reduction of area of 45-55%, and K_{IC} (J_{IC}) value of 170-190 ksi$\sqrt{in.}$ These material properties exceed the design requirements of the GE LCP Coil and offer an excellent potential for the application of the material in future larger coils; such as TNS and EPR.

A cooperative GE/NBS-Boulder test program is underway to verify the performance of AISI 316LN. The program consists of measuring base-metal properties and weld metal properties using various welding processes and weld wire chemistries. The primary objective of the welding studies is to select the most economical welding procedure consistent with the engineering requirements of the design. Details of the test program, as well as the progress made to date will be presented at the Workshop.



FIGUPE 1 SKETCH OF THE GE ASSEMBLED COIL STRUCTURE

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TABLE 1

SUMMARY OF GE COIL MATERIALS

Coil Component	Selected Material
Helium container/structure	AISI 316LN (.03 Max C, 0.10-0.16 N)
Structural Bolts	Cold-worked AISI 310S
Superconductor core (reinforcement)	Cold-worked copper - 1/4 hard
Inter-turn insulation	Nomex (an aromatic polyamide)
Inter-pie insulation	Fiberglass/epoxy laminate (G-10)