MONOLITHIC COIL TOKAMAK

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In Progress Report #38, we reported on two activities concerned with applying inertial energy storage and homopolar generators to simplified toroidal field-coil structures for tokamaks to either reduce the cost, increase the achievable field strength, or both.

In the first activity, work has continued on the evaluation of the performance of a monolithic tokamak field coil of a geometry and size suggested by Dr. Marshall Rosenbluth as having a good chance of ohmically heating to ignition. The configuration being used in the analysis is illustrated in Figure 1.

A finite-element computer analysis is being made in the following way. An inner radius R_i is chosen and the bore is assumed to either be empty or filled with steel. The conductor material is selected and its electrical conductivity and mechanical properties as functions of temperature are provided. The initial temperature is set to either ambient or liquid nitrogen (LN_2) and the current necessary to produce the desired magnetic field strength is established rapidly. The finite element computer code determines the current distribution and calculates how it evolves over time as the conductor heats unevenly. In addition, the computer code provides the temperature and stress distributions as they evolve over time. The hot spot temperature and the mechanical strength of the conductor determine how long the coil can operate at a selected magnetic field strength. Clearly, the higher the desired field strength, the shorter time the coil will be able to operate before it must be de-energized and cooled down for the next pulse.

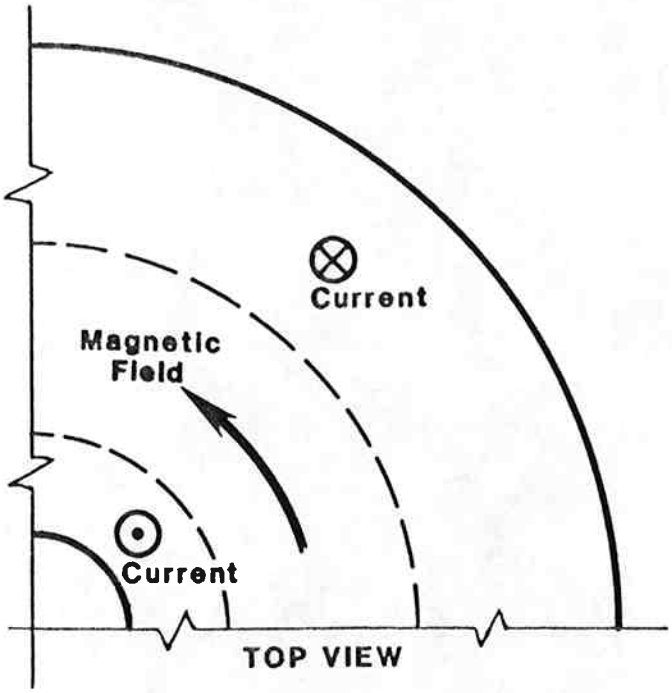
Initial results are promising in that they show that a copper coil can operate for the order of 10 seconds at about 20 Tesla if started from LN_2 temperature.

This work is continuing and will be reported on more fully in the next progress report.

In the second activity reported on under this topic in Progress Report #38, which was the work with staff members of the Plasma Fusion Center at MIT on the SO-LITE configuration for a proposed tokamak ignition experiment, some initial calculations were made on a modular coil configuration of 60, single-turn coils, each excited by its own homopolar generator. These initial results were presented to a meeting of Plasma Fusion Center staff at MIT; and, after some further study, their conclusion was that, whereas the homopolar generator technology provides opportunities for possibly reducing the costs of tokamak toroidal field coils and power supplies, those opportunities can e realized only after a thorough and detailed study. Such a study was deemed to be beyond the scope of their current task; and, as a consequence, they have subsequently pursued the LITE design with conventional toroidal field power supplies. Because of this decision, our consideration of homopolar generators for parallel operation of tokamak field coils has been dropped for the time being.

Figure Caption

1. Monolithic coil geometry for analysis.


Current
Magnetic
Field
Current
TOP VIEW

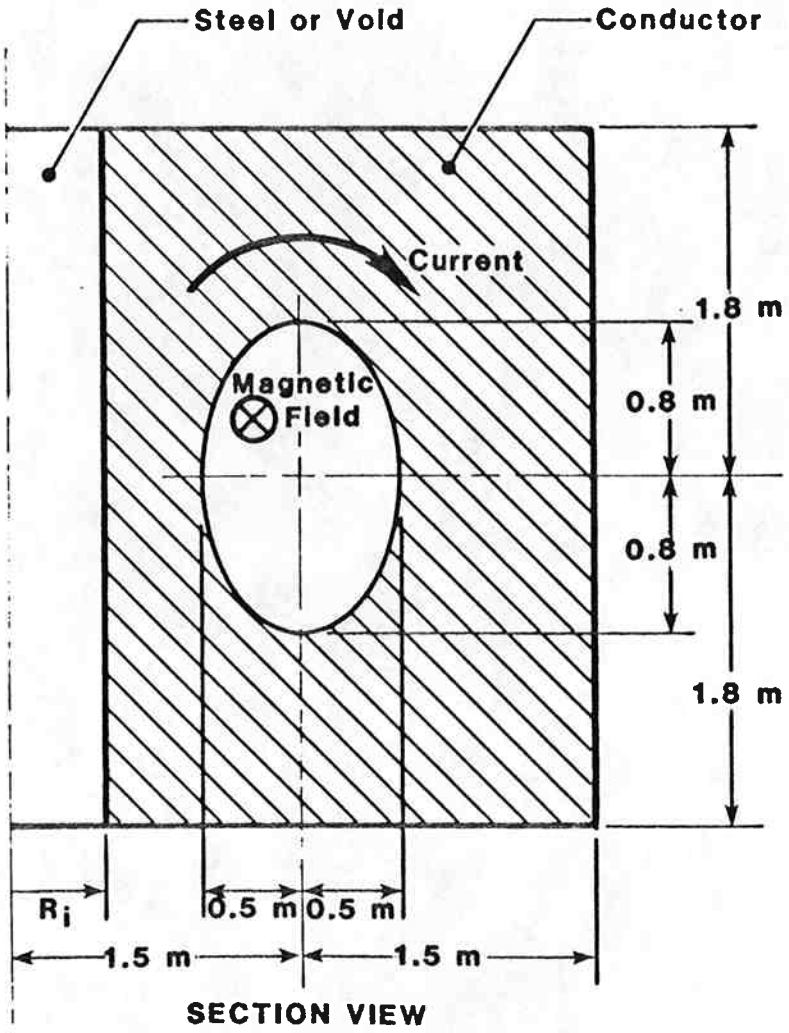

Steel or Void
Conductor
Current
1.8 m
Magnetic
Field
0.8 m
0.8 m
1.8 m
R_i
0.5 m
0.5 m
1.5 m
1.5 m
SECTION VIEW

FIGURE 1