MONOLITHIC COIL TOKAMAK

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By operating tokamaks, at higher toroidal magnetic fields, substantial benefits may be realized. Higher plasma currents can be supported increasing the likelihood of ohmic heating to ignition. In the event that ignition is realized by this approach, such high field tokamaks would operate at higher power densities, potentially reducing the size and cost of fusion reactor based power plants.

Operating tokamak field coils at higher magnetic field levels necessarily increases the stresses imposed on magnet materials -- especially the insulating materials used to separate the copper conductors. In addition, the insulation occupies critical volume within the magnet without contributing to the ampere turns or magnetomotive force which creates the desired magnetic field. With these limitations in mind, CFE has been investigating a "monolithic magnet" concept involving low impedance, single turn copper magnets driven by the homopolar generators (HPG) supported by TAERF and developed by the Center for Electromechanics.

The original monolithic magnet concept involved a cylindrical copper annulus containing a toroial cavity for plasma confinement (Fig. 1). Such a magnet might be divided by radial flanges, allowing additional HPG's to be used to drive poloidal field currents in the same material. The entire magnet assembly might be immersed in liquid nitrogen (LN_2) to reduce its initial resistance. The magnet

temperature would be allowed to rise during a pulse of some ten seconds and then be cooled back down between pulses by the LN_2 bath.

Recent investigations have been concentrated on two designs. The first is a small, extremely high field monolithic coil tokamak proposed by Dr. Marshall Rosenbluth to have the best chance of ohmically heating to ignition. This machine concept with a major radius of 1.5 m and minor radius of 0.5 to 0.8 m is being explored for operation at toroidal field levels around 20 T.

The second design under consideration is a monolithic coil version of the Long pulse Ignited Tokamak Experiment (LITE) proposed by MIT as the next major fusion experiment in this country. The monolithic coil concept offers the possibility to substantially reduce the cost of the LITE device. However, the original monolithic coil concept does not lend itself directly to a device as large as LITE (major radius 2.3 m, minor radius 0.8 m) because of the difficulty in fabricating such a large copper monolith ($\sim$ 400 tons). This difficulty led to a modification of the monolithic coil concept shown in Fig. 2. The monolithic toroidal magnet is divided into 60 coil modules, each with its own HPG. Since these modules are operated electrically in parallel, isulation between the modules is not a problem. This concept, which has come to be known as Son Of LITE (SO-LITE), is presently being explored in cooperation with engineers and scientists at MIT.

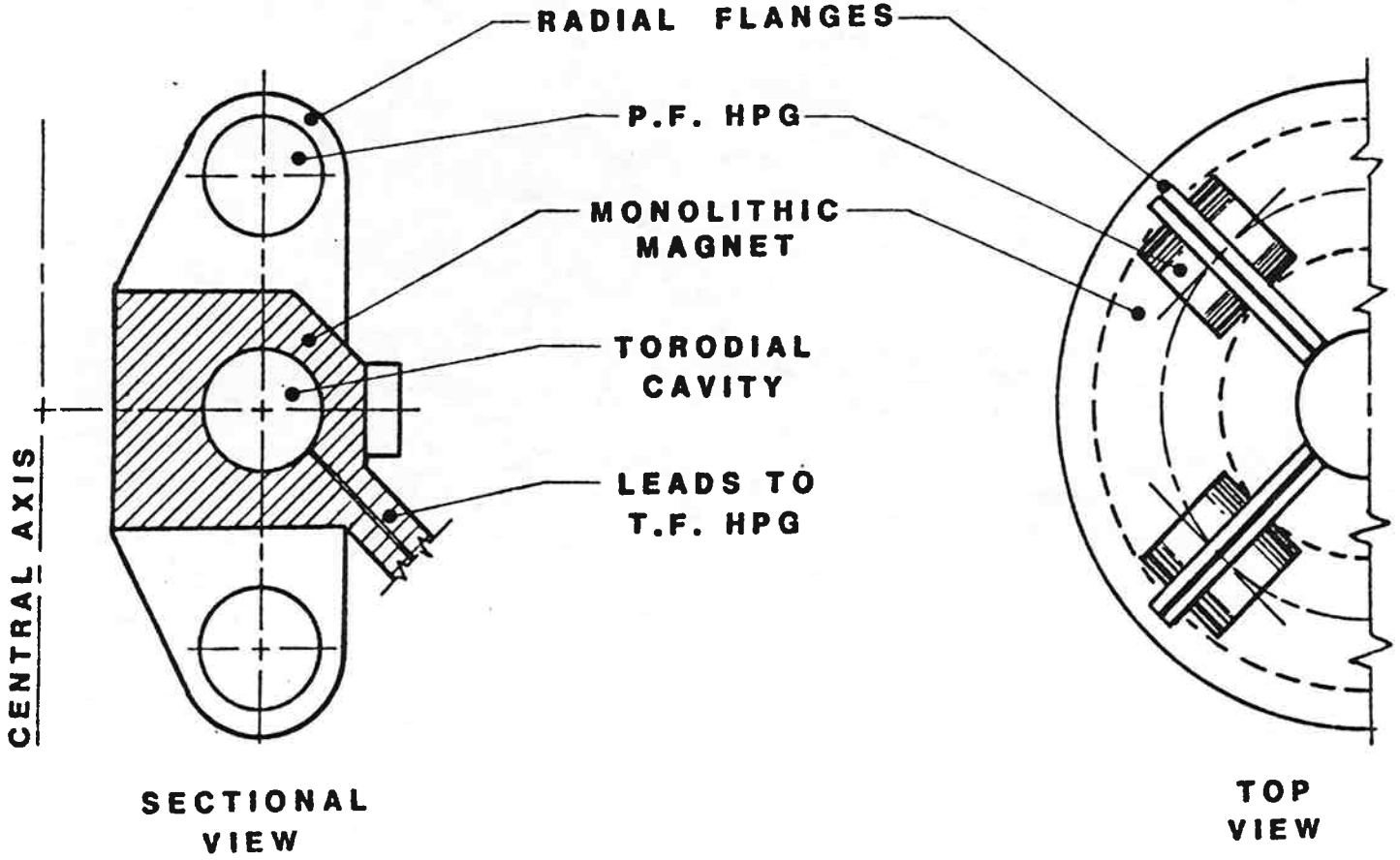

FIG. 1.
MONOLITHIC COIL
TOKAMAK

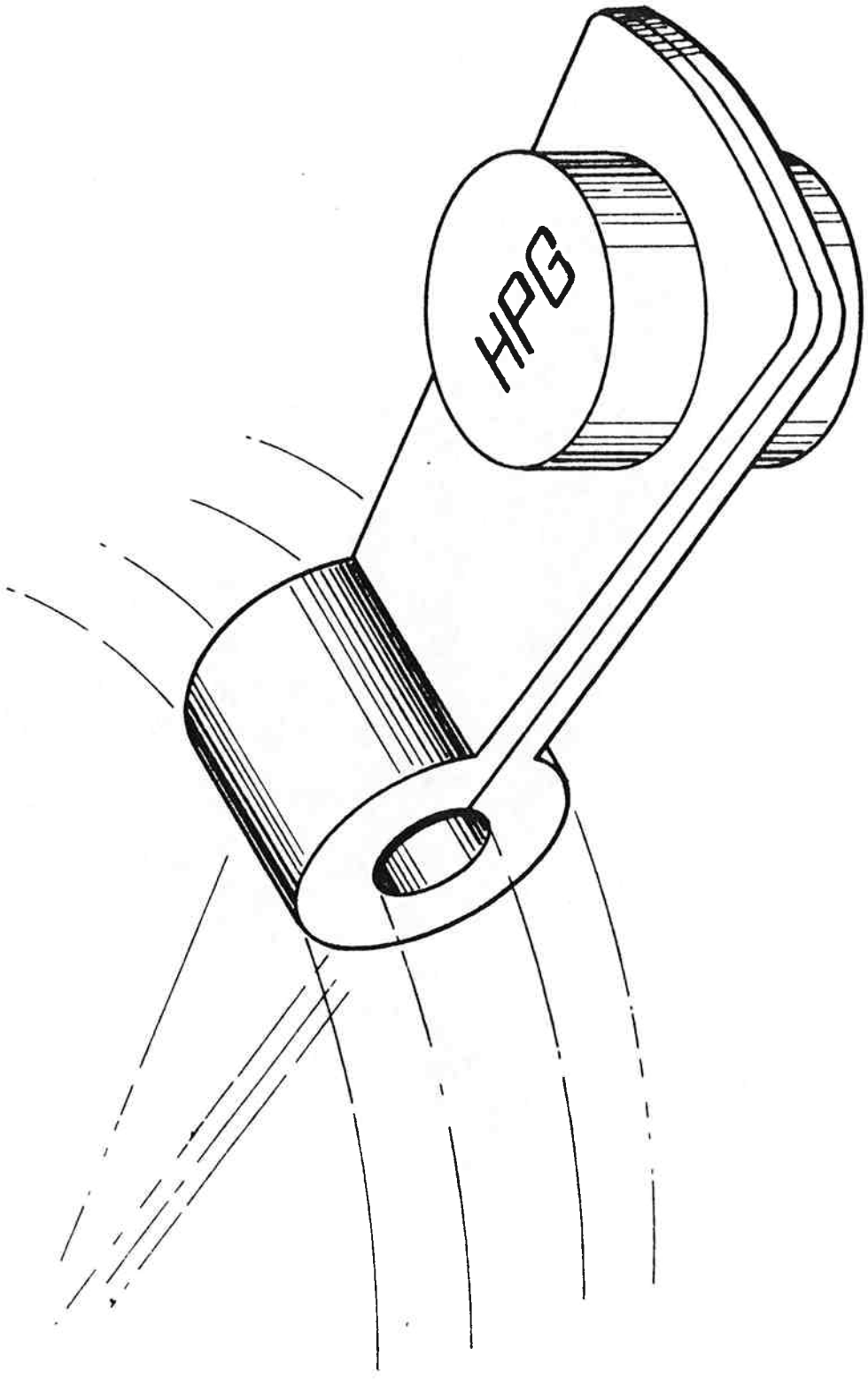

FIG. 2
MODULAR MONOLITHIC
COIL FOR SO-LITE