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### 8. The Quasi-Hollow Conductor Magnet as a Space Shield Against Electrons, S. H. Levine, R. Lepper (Northrop)

The shielding mass required to protect manned space vehicles against trapped electrons can be reduced by using active shields in lieu of material shielding<sup>1</sup>. Trapped electrons in the inner Van Allen belt are principally artificially injected electrons. The steep energy spectrum of these electrons makes negligible their hazard above 7 MeV. For the Outer Belt, the maximum energy necessary to consider is approximately 2 MeV.

An active shield design that shows promise for protecting a toroidal-shaped vehicle is the quasi-hollow conductor magnet<sup>2</sup>. In this design, individual coils are placed around the vehicle as shown in Fig. 1. This shield has the advantage of reducing the superconductor cooling area and provides flexibility in shaping the protected region.

The magnetic shield simulator (MAGSIM)<sup>3</sup> has been employed to study the current distributions in a seven-coil quasi-hollow conductor magnet which will provide a correctly shaped protective region. The MAGSIM is an analog instrument employing an electron gun, phosphor-coated grid, support assembly for the magnet and grid, power supplies, vacuum chamber, and photographic equipment for taking the data. The operation of this instrument utilizes the fact that electrons will illuminate the grids in the allowed regions, but will not penetrate the forbidden region.

The magnet model used in these experiments had seven coils equally spaced about the toroid. Its radius,  $a$ , was 4.22 in. and the radius of the region to be protected,  $r_v$ , was 0.8 in. Two nondimensional parameters<sup>4</sup>,  $\Delta S = 2 r_v/a$  and  $\lambda = a/C_{st}$ , are used to scale the MAGSIM data to both large vehicles and high electron energies;  $C_{st}$  is the Stormer radius. A shield having a  $\Delta S$  of 0.1 or greater will produce a protective region whose center is displaced outward, and this displacement increases with increase in  $\Delta S$ . This effect can be nullified (i.e.,  $\delta = 0$ , or  $r_v = r_0$ ) by redistributing the current about the seven-coil model having a  $\Delta S$  of 0.38 as shown with MAGSIM data. This condition occurs with 188 amp turns in each of the inner three coils, 275 amp turns in the two adjacent coils,

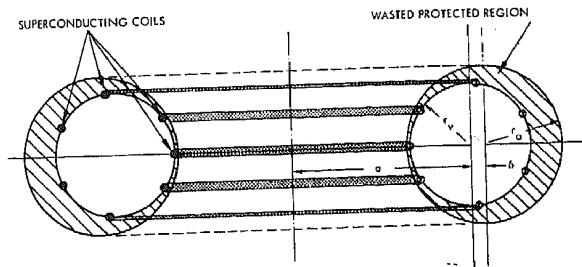


Fig. 1. Cutaway view of quasi-hollow conductor configuration showing forbidden region displaced.

and zero amp turns in the outer coils. For a space vehicle scaled<sup>5</sup> to  $r_0 = 1.6$  m ( $a = 8.4$  m;  $V = 530$  m), a total of  $3.8 \times 10^5$  A-turns is required for protection against 7-MeV electrons. Assuming a practical current density of  $2.5 \times 10^5$  A/cm<sup>2</sup>, the mass of the superconductor is 64.3 kg. For 2-MeV electrons, this mass is approximately 20 kg.

Other factors of importance, such as mass of cryogenic system and its power supply, and magnetic field, are of nominal magnitudes. Design values show this type magnetic shield to be near state-of-the-art.

1. A. BHATTACHARJIE and I. MICHAEL, "Mass and Magnetic Dipole Shielding Against Electrons of the Artificial Radiation Belt," *ALAA Journal*, 2, 12, 2198 (December 1964).
2. S. H. LEVINE and R. LEPPER, "Analogue Studies of Magnetic Shields," presented at AIAA 4th Aerospace Sciences Meeting (June 27-29, 1966).
3. S. H. LEVINE and R. LEPPER, "Magnetic Shield Simulator," Institute of Environmental Sciences' Annual Technical Meeting Proceedings (1965).
4. R. H. LEVY, "Radiation Shielding of Space Vehicles by Means of Superconducting Coils," *ARS Journal*, 31, 1568 (1961).