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AN IMPROVED COPPER SEPTUM MAGNET DESIGN*

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A copper septum magnet of improved design has been developed to replace the existing F5 septum deflector in the slow-extraction channel at the Brookhaven National Laboratory AGS. The new magnet has several novel design features such as a solid rather than laminated core, a ball bearing suspended septum and a radiation resistant quick disconnect system.

The application calls for an 0.6 meter long magnet with a 17 mm gap operating at 0.15 Tesla. The magnet is pulsed with a 50% duty factor every 2.5 seconds. It must reach 99.5% of full field in less than 100 msec. The septum is .75 mm thick and operates at 170 amps/mm^2. Edge cooling is employed with monel tubes carrying 8 liters per minute of water to handle the 2000 watts average septum power. Because of the relatively high current density, the septum expands and contracts .5 mm with each pulse or some 38 million times over three years of continuous operation. This thermally induced stress cycling along with the high radiation and high vacuum environment have been causes of frequent breakdowns in the past.

For such a magnet, complexity and construction time can be reduced and reliabiity correspondingly improved if a solid rather than laminated core can be used. Simple eddy current considerations suggest that a lamination thickness of the order of 1 cm is needed. Since the required field, 0.15 T, is small compared to the saturation induction of the 1006 steel core, a solid core with the cross-section shown in Fig. 1 was used. Here the effective lamination thickness is 1.2 cm. Measurements showed that the rise and fall time of such a core are quite good, as shown also in Fig. 1. Within the accuracy of the field measurements, the magnet in fact turned out to be just as fast as the laminated model it replaced.

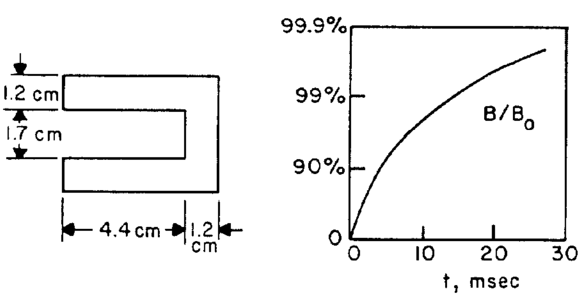

Fig. 1. Magnet core cross section (dimensions in cm), and measured risetime.

The cyclic expansion and contraction had caused leaks due to fatigue at the brazed joint between the water passage tubes and their manifolds. The stresses at these locations were greatly reduced by making the leads long and flexible.

Rubbing friction at the septum insulation was eliminated by "floating" the septum on ball bearings of 1/16 in. diameter ruby balls. This arrangement is shown in Fig. 2. The balls cost 20¢ each. Approximately 300 are required per magnet.

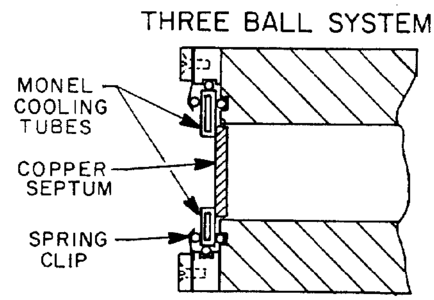

Fig. 2. Septum support scheme.

The third unique feature of the design is a radiation resistant quick disconnect system for feeding power and water into the evacuated magnet enclosure (see Fig. 3). Previously power and water entered the enclosure via a metalized ceramic bushing which provided the vacuum seal and insulation. This bushing was soft soldered in place, and each time a magnet was removed, the solder joint which was inside the module had to be melted and later rejoined. This job took 2 to 3 minutes and required that the person doing the work be exposed to 10 to 20 Rem/hr. As a consequence, the work was sometimes hastily done, and leaks resulted. The new septum makes use of an indium coated "C" ring compressed against a smooth ceramic surface to give electrical insulation and a vacuum seal. The seal can be connected and disconnected from outside the module in about 30 seconds.

To date the new magnet has operated in the AGS for approximately one year without failures.

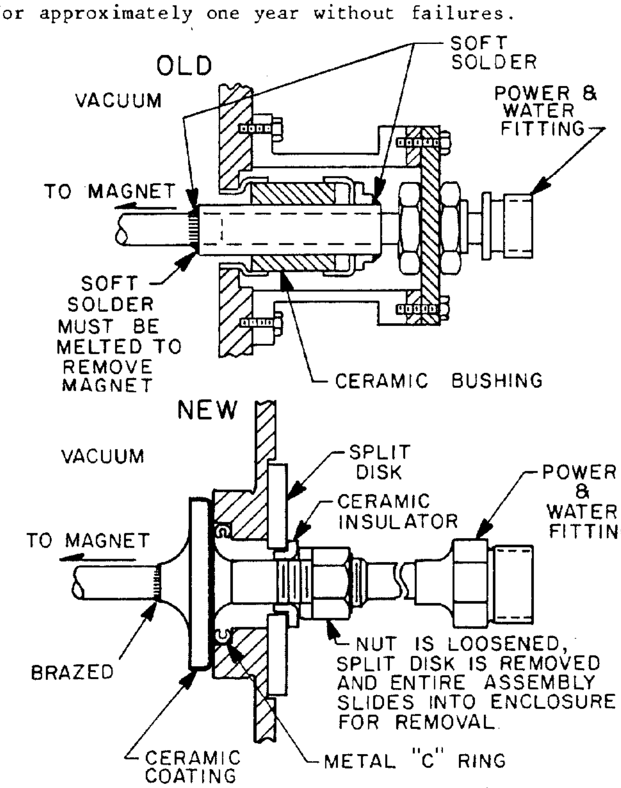

Fig. 3. Quick-disconnect feedthru.

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