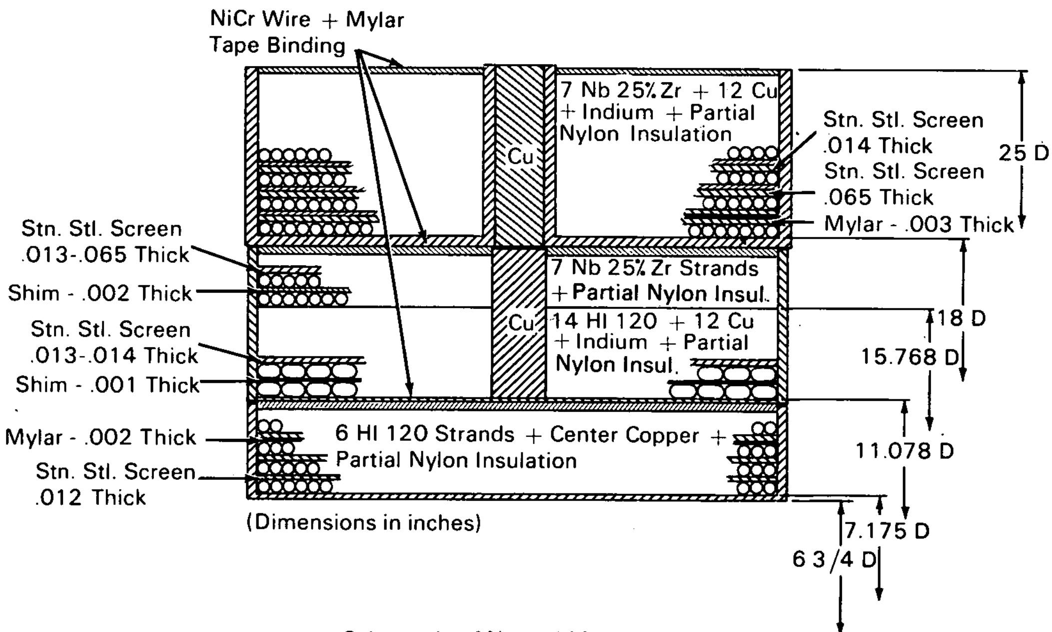
AEC-NASA TECH BRIEF

High-Field Superconducting Nested Coil Magnet



Schematic of Nested Magnet System

The problem:

To design and test an experimental, high-field superconducting magnet to obtain information for the design of future magnets and also information on the properties of the superconducting material utilized.

The solution:

A superconducting magnet is employed in conjunction with five types of superconducting cables in a nested solenoid configuration. Three separate, and easily removed, nested solenoids are capable of producing total central magnetic field strengths approaching 70 kG. The multiple coils permit maximum information on cable characteristics to be gathered from one test.

How it's done:

The magnet consists of four concentric windings in a configuration of three nested solenoids with inner diameters of 7.175, 11.08, and 18 inches, respectively. The inner nest cable is wound as a single length on a titanium form. The center nest contains two coils, an inner coil (11.08-inch ID) and an outer coil (15.77-inch ID). The outer nest is a split-coil solenoid using uncoated and copper/indium-coated cables. Table I summarizes coil-configuration and magnet-performance data.

The use of stainless steel mesh as layer-to-layer insulation, together with a partial nylon wrap, provides automatic shunting when superconducting-to-normal

(continued overleaf)

Table I

Winding Designation	Winding ID, in.	Winding OD, in.	Winding Length, in.	No. of Turns, N	Field Constant, Gauss/A	Max. Current, A	Packing Factor λ, %	Average Current Density, A/cm^2
Inside (7-in.-ID)	7.175	10.675	10.875	6225	216	119	15.4	6037
Inner (11-in.-ID) Intermediate	11.08	15.62	4.875	1363	76	283	13.5	5404
Outer (15-in.-ID) Intermediate	15.77	17.44	4.875	1800	88	134	24.26	9188
Outside (18-in.-ID) Uncoated	18	24.125	4.6	1952	40	211	7.6	4532
Outside (18-in.-ID) Coated	18	24.5	4.625	1846	38	245	7.0	4851

transitions occur; it also eliminates the need for elaborate protection schemes. Compressive loads in excess of 100 tons are exerted axially on the inside flanges of the split-coil system and are transmitted through the windings, eliminating space-consuming support structures. The outside of each coil is wound with Mylar tape and nichrome wire to prevent movement of the outside layers.

The test results in Table II indicate that central fields greater than 67 kG should be obtainable.

Table II

Test No.	Central Field, kG	Separate Winding Currents, Amp				Reason for Transition	Object of Test
		7-in.-ID	11-in.-ID	15-in.-ID	18-in.-ID		
1	58	100	241	100	193	Charge rate on 11-in. winding increased too quickly	General check of system and of technique for charging with inadequate power supplies
2	31	Not energized	134	134	134	15-in. winding driven to transition	Check for operating range of 15-in. winding
3	42	Not energized	284	92	154	11-in. winding driven to transition	Check for operating range of 11-in. winding
4	40	Not energized	205	119	179	Increased charge rate in 11-in. winding	Attempt to set windings at reasonable operating currents
5	67	119	256	97.5	198.5	Changed to high charge rate in 7-in. winding	Check for operating range of 7-in. winding at high field

Notes:

1. The use of multistrand conductors insures low inductance, high mechanical stability, and good current-carrying capacity in each strand. Coil windings can withstand compressive loads of 100 tons, eliminating the need for separate load-bearing material in the coil.
2. Information achieved in studies of small coils can be used as a basis for large coil design.
3. Additional details are given in ANL-7002, "A Large, High-Field Superconducting Magnet System," C. Laverick and G. M. Lobell, Argonne National Laboratory.
4. Inquiries may be directed to:
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Source: C. Laverick
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Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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