High-Field Superconducting Nested Coil Magnet

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)
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

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

**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.
4. Inquiries may be directed to:
   - Office of Industrial Cooperation
   - Argonne National Laboratory

9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B70-10061

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**Patent status:**
Inquiries concerning rights for commercial use of this innovation may be made to:
- Mr. George H. Lee, Chief
- Chicago Patent Group
- U.S. Atomic Energy Commission
- Chicago Operations Office
- 9800 South Cass Avenue
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