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30 kG, 8½" BORE SUPERCONDUCTING COIL

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A B S T R A C T

A 30 kG, 8½" bore superconducting coil has been designed using the minimum propagating current data obtained on a short length of composite superconductor. Tests on the coil show complete agreement between predicted and actual performance.

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Using the techniques described in reference (1), a coil was designed to generate a magnetic field of 30 kG at the inner surface of an 8½" bore coil. The cable chosen was made up of a single 0.010" diameter Nb 25% Zr superconductor, copper plated to a diameter of 0.012" and then stranded up with six 0.0113" dia. copper wires. A heat treatment at 650 °C for five minutes was followed by an indium dip and the whole was finally insulated with Terylene (trade name) yarn.

Measurement of the minimum propagating current of a short length of cable to be used in the coil gave the results shown in Fig.1. Values were obtained both with and without the Terylene insulation.

The coil data are as follows:-

Former I.D.	- 8½"
Winding I.D.	- 9"
Winding O.D.	- 12½"
Winding length	- 4"
Overall former length	- 4½"
Total number of turns	- 2815
Inductance	- ≈ 1.8 Hy
Insulation between layers	- nominal 0.01" thick Terylene net.

The cable was broken at one place as the coil was being wound. It was repaired by splaying out the copper wire for 1½" at the ends to be joined, inter-leaving them and finally indium tinning the whole joint.

Helium access to the ends of all the layers was arranged by winding 0.03" diameter Nylon monofilament around the end and centre cheeks. This can be seen in the photograph (Fig.2).

The load line relating field strength at the inner radius of the coil with conductor current is shown in Fig.1.

Since the coil is fully insulated it can be energised from a low voltage supply in 2 - 3 minutes. It has been driven normal a number of times at currents between 150 and 155 amps, corresponding to a maximum field of 29 - 30 kG.

The coil has also been satisfactorily operated in the 'persistent mode with a superconducting short. The coil and switch terminations are made by inserting them together with the main supply leads in a copper tube 0.15"/0.1875" diameter, 1½" long and sweating the whole with indium. This does not give a completely superconducting joint and since there is also a non-superconducting joint in the winding, the shorted coil is slightly resistive. However, the decay time constant is such that after 5-hours' operation at 130 amps, no reduction in field strength was detected, while it is estimated that with the apparatus used a 1% change would have been discernable.

Having energised the coil and closed the superconducting switch while the coil was fully immersed in liquid, the Helium was allowed to boil off. When the temperature of the upper part of the coil had risen to 5 ^{o}K the current was reduced to zero without a propagating quench taking place. This operation suggests that although the better heat transfer properties of liquid helium are required to energise the coil to its full current, the energy released by flux transients as the current decays is insufficient to cause a propagating quench even with the poorer heat transfer properties of Helium gas.

Reference

(1) CORNISH, D.N. Superconducting coils using composite stranded cables. J. Sci. Instruments, (in the press). Culham Laboratory preprint CLM-P 83, July, 1965.

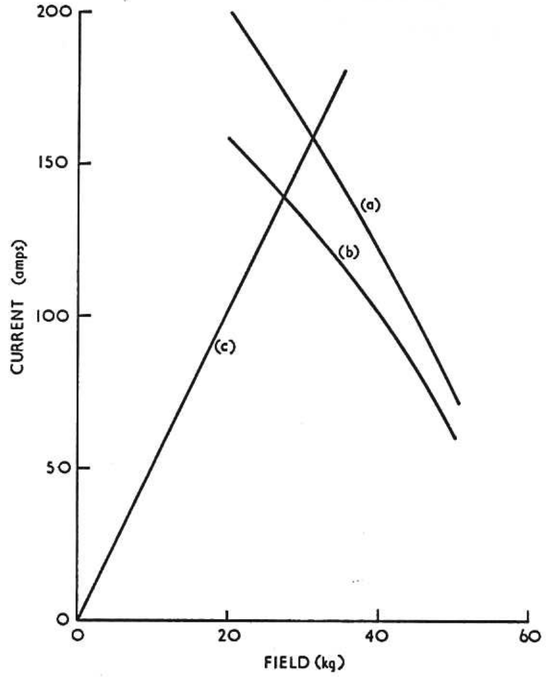

Fig. 1 (CLM-P90)

(a) Minimum propagating current of bare cable

(b) Minimum propagating current of insulated cable

(c) Load line of 8½ inch bore superconducting coil

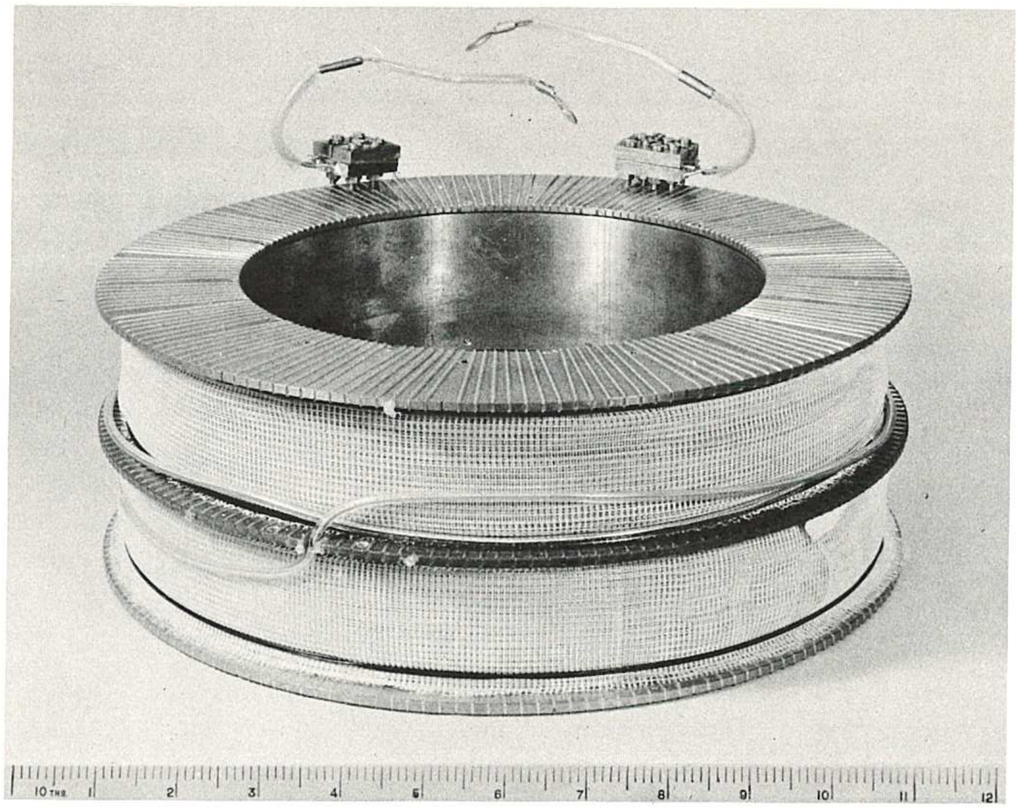

Fig. 2 30 kG 8½ inch bore superconducting coil (CLM-P90)