SUBJECT
Low Current Superconducting Coil
Test No. 2 (Pancake Coil)

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DATE 12/13/76

REVISION DATE

We build and tested our second small coil with insulated strand cable. This coil, however, has all the mechanical characteristics that a full size coil has. Flat pancakes were wound around a stainless steel bore tube. The coil was cured and clamped with an aluminum pipe over G-10 spacers. Nine strand cable was used to wind the coil. After the coil was clamped, the strands were electrically connected in series.

Test Results

We powered the coil and after 4 quenches we reached 335 Amps, the lower value of the wire critical current. The coil was warmed up and additional heaters were installed. In the second cooling, the coil did not train and reached a current of 363 amps in the first quench. Voltage taps were installed at different places in the coil to study the quench propagation. Heaters were used to quench the coil with and without the power supply on. Without the power supply driving the current, we did not see all the voltage taps turn to normal when the heaters quenched the coil. With the power supply turned off the current decays and makes it harder to propagate the quench. However, with the power supply on the quench did propagate well; all the voltage taps became normal. Both methods of quenching were recorded at about the same current level. The coil was wound intentionally to give the worst quench propagation. Each pancake was completely wound before going to the next pancake and .125 G-10 spacer was insulating between pancakes. The porous coil design gives a good thermal stability especially at the joints of the strands where they are away from the high field region.

Coil Fabrication

Insulated strands cable was used to wind the flat pancakes around a stainless steel bore tube. After the coil was completely wound, the B-stage glass tape wrapped around the cables was cured under clamping pressure. This resulted in a porous coil with spacers between cables for the liquid helium to flow through. G-10 spacers were clamped on the outside of the coil to form a round configuration. The coil assembly was then turned around on a lathe. Scotch Ply Glass tape was then wrapped around the G-10 spacers. The glass tape was cured and later machined round to an interference fit of .012 with the aluminum pipe which applied the overall coil clamping. Cooling the coil, the aluminum contracted more than the stainless steel bore tube and kept the coil under compression forces. This force was calculated to exceed the electromotive forces produced by the coil field.

First Cooling

Test Run No.	Quench Current	Test Run No.	Quench Current
1	No Quench	9	348 Amp
2	311 Amp - First Quench	10	355 Amp
3	317 Amp	11	359 Amp
4	322 Amp	12	362 Amp
5	335 Amp - Low Critical Current	13	368 Amp
6	339 Amp	14	370 Amp
7	346 Amp	15	365 Amp
8	352 Amp		

Test Run No. 2
16 to 27

Difficulty in quenching magnet with heater on top of coil. We raised the current in the heaters to 5 Amps and we burned up the heaters.

Second Cooling

Two new heaters were installed closer to the bottom of the coil:

Test Run	Quench Current
1	363 Amp First Quench
2	359 Amp
3	354 Amp
4	366 Amp
5	366 Amp
6	376 Amp
7 to 31	Tried different quench modes with heaters.
32	379 Amp Last quench no heater.

Comments

We learned that to achieve good quench propagation, the series strand connections have to alternate from the top to the bottom half of the coil pancakes. G-10 spacers should be replaced with aluminum strips to improve the heat transfer quality. The joints of the strands away from the high field region are relatively stable. A back up copper strip is not required.

NATIONAL ACCELERATOR LABORATORY

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
PROTON	SUPERC. MAGNET	76-0402	3/3

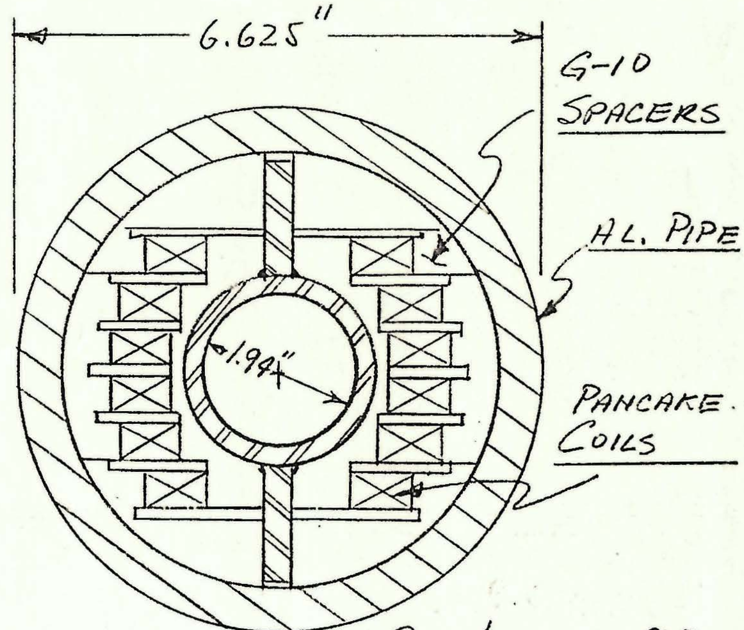
SUBJECT	NAME	DATE	REVISION DATE
LOW CURRENT SUPERCONDUCTING COIL TEST NO. 2 (PANCAKE COIL)	JOHN SATTI	13-DEC '76	

PANCAKES COIL

.040" SUPERCONDUCTOR WIRE
4:1 Cu-NbTi RATIO
9 STRANDS INSUL. CABLE
$I = 360$ AMP
$B = 44$ KG (CALCULATED)
$N = 864$ TURNS
$L = .165$ HENRY

WIRE CRITICAL CURRENT

$I_c = 335 - 360$ Amp AT 40 KG



COIL LENGTH = 9.5 IN.