national accelerator laboratory

TM-679
1600.000

MEASUREMENT OF RESISTANCE VS TEMPERATURE OF 23 STRAND SUPERCONDUCTING CABLE

M. Kuchnir and J. L. Tague

August 2, 1976

The resistance vs temperature of several samples of superconducting cable being used in the manufacture of Energy Doubler/Saver magnets have been measured under zero field condition. This data is to be used in the determination of safety limits and quench propagation characteristics for these magnets. Previous determination of safety limits were based on wire parameters. The critical dependence of those determinations on the resistance as a function of temperature required actual measurements for a comfortable confidence index. A side benefit of these measurements is an easy way to monitor coil cooldown progress.

The measurements were carried out in a vacuum environment immersed in liquid helium. The uninsulated 12 cm long sample, with its current and voltage probes, was sandwiched between two copper blocks. Two layers of .001 inch thick paper varnished with GE-7031 insulated electrically the sample from the copper blocks while providing good thermal contact. An electrical heater established the temperature of the copper blocks, which was measured by a calibrated glassy carbon thermometer. Data points were obtained under equilibrium conditions, using four lead thermal emf compensated dc techniques.

The samples are characterized[1] in Table I and the data presented in Fig. 1. The ratio of the resistance with respect to its value at 273K is what is plotted since in this form it is more readily usable in monitoring cooldown progress. It was satisfying to observe the independence of the plotted ratio on the manufacturer, indicating the uniformity of the material used. For further characterization, the cross sections of these samples were microphotographed.[2] The results are presented in Fig. 2.

References

[1]M.E.Price provided us with the data on short sample quench current and cable dimensions; R.H.Flora with the list of coils made with these cables up to July 1976.

[2]A simple facility for producing photomicrographs of superconducting wire has been operational at 36 Neuqua. When a few scratches can be tolerated its turn around time is overnight.

TABLE I

CHARACTERIZATION OF SUPERCONDUCTOR CABLE† SAMPLES

Reel No.	Manufacturer	Short Sample Quench Current at 50 kG	Resistance of 12 cm at 273 K	Cable Dimensions	Coils Built With This Cable
92	MCA	5.17kA	.3735mΩ	*	E1-24, E1-28
84	Airco	5.04	.3072	.051"x.303"	E1-20, E1-21, E1-22, E1-23, E1-27, E5-2
80	IGC	5.57	.3256	.051"x.308"	E10-4, E1-19
94	MCA	5.28	.3092	**	

†All cables had 23 strands of .027" diameter with ~2100 filaments of NbTi (53.5% Nb) of 9μ diameter Cu:SC ratio 1.8/1

*Keystone shaped .056", .046" x .310"

**Keystone shaped .054", .046" x .304"

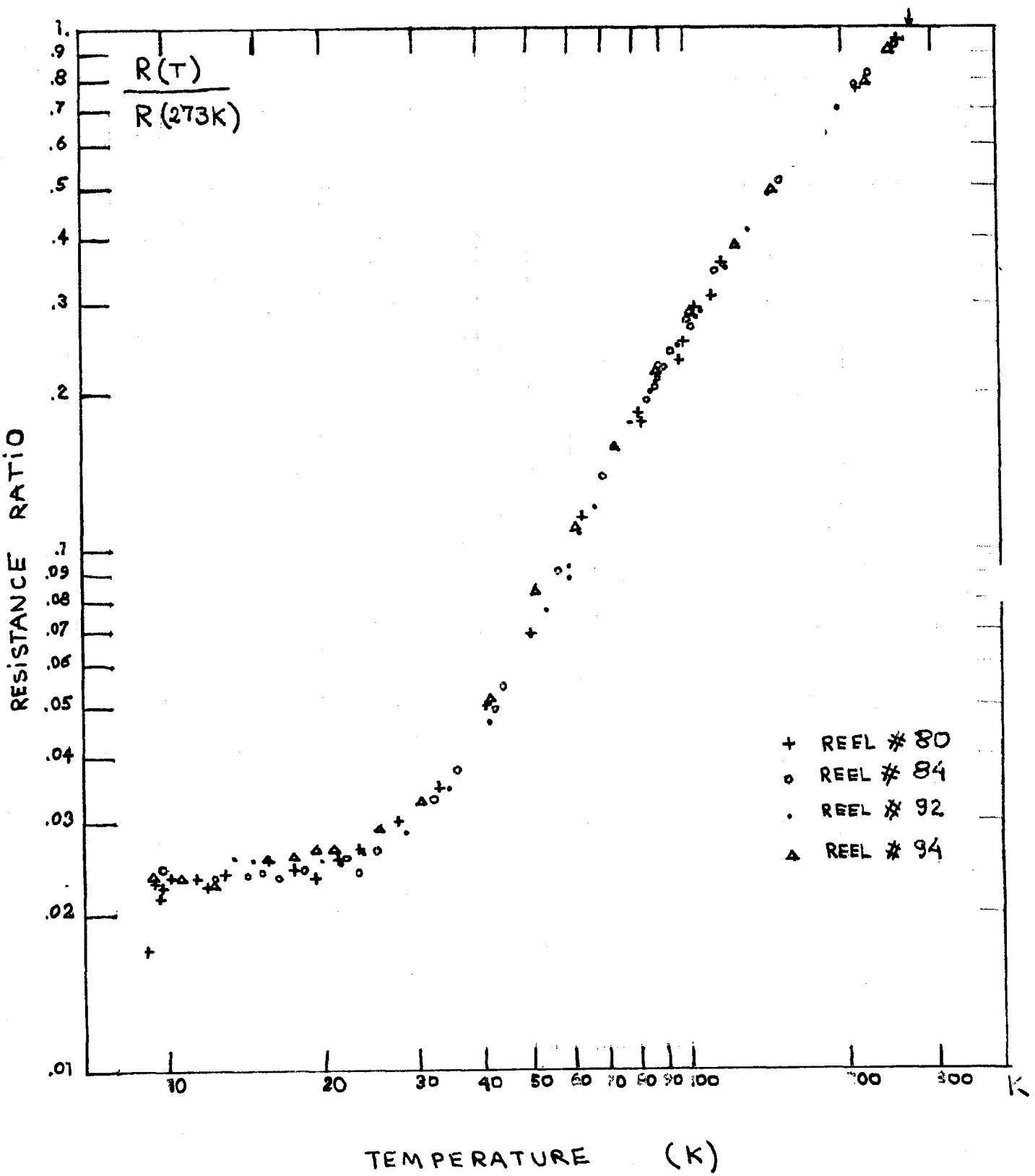
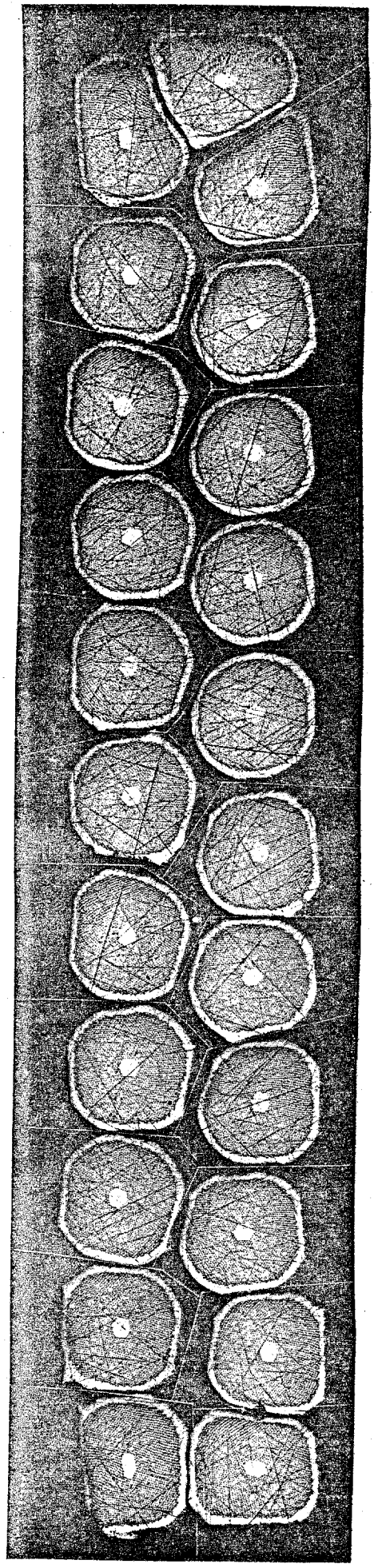
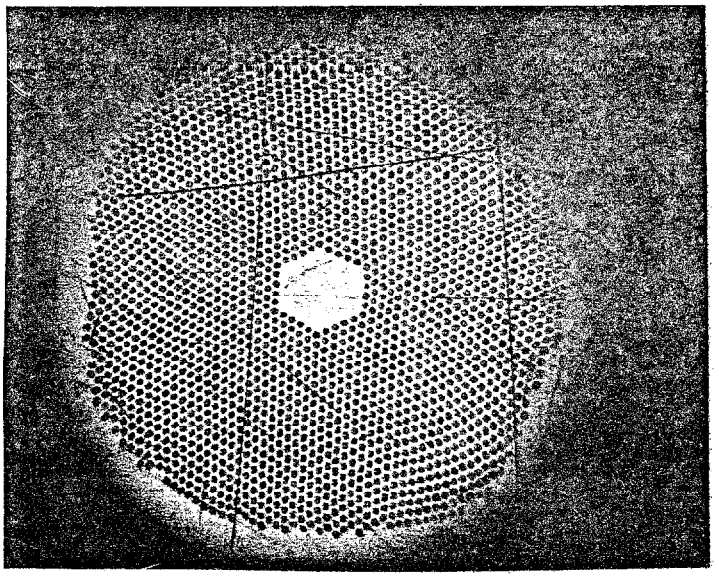
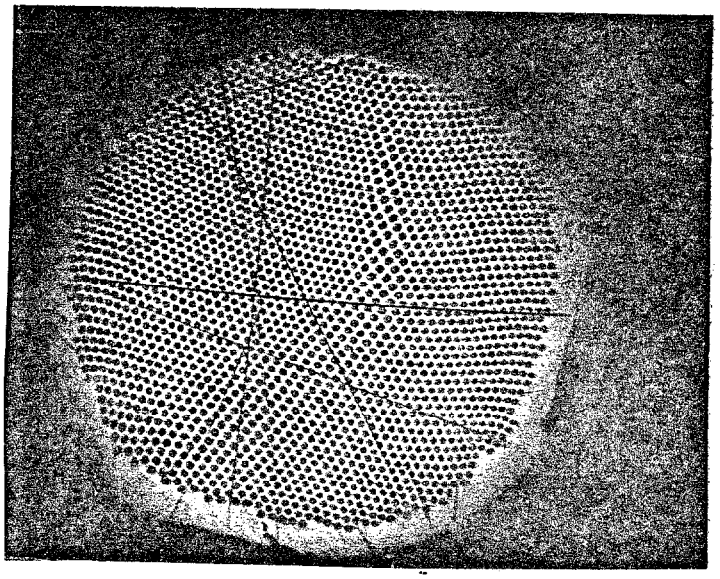

TM-679
1600.000
R(T)
R(273K)
RESISTANCE RATIO
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
.09
.08
.07
.06
.05
.04
.03
.02
.01
10
20
30
40
50
60
70
80
90
100
K
REEL # 80
REEL # 84
REEL # 92
REEL # 94
TEMPERATURE (K)

FIGURE 1

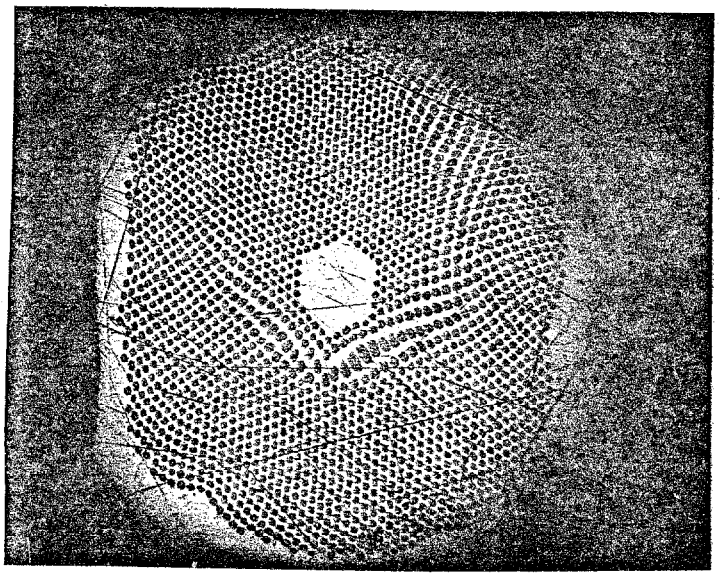




Typical Strand From Reel #80 (100×)



Typical Strand From Reel #34 (100×)



Typical Strand From Reels #92 and #94 (100×)

Fig. 2. Cross Section of Cable From Reel #80 (25×) and Typical Strands