



B12 QUENCH TEST UPDATE

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Introduction

A facsimile of the proposed quench-protection system has been tested at B12 with four series connected Doubler dipoles (PCA 126, PCA 131, PCA 136, PCA 145). Each magnet was retrofitted with an improved single phase helium venting system to reduce the peak pressure in the cryostat during a quench.

Test Conditions

The magnets were powered by a modified Main-Ring power supply (BB1) located at the B1 service building (Fig. 1). A prototype "energy fountain" dump circuit, also located in the B1 service building, removed the current from the magnet string after a quench or intentional trip.

A microprocessor quench detection system was used to detect the magnet quenches. The number of connected magnets available necessitated that the quench detection voltage gaps be taken across each Doubler dipole.

Due to the short dump time constant, the QBS mode was approximated by delaying the quench trigger to the dump circuit (BB1 supply, shunt SCR, series SCR) up to 3 sec to allow time for the power supply current to switch from the Doubler dipoles to the QBS.

The Main-Ring conventional magnet was inserted in the circuit to serve as a load for the power supply after the current transfer to the QBS was completed. The QBS current was monitored by a calibrated current shunt.

The chronological events of a 4000 A quench are shown in Fig. 2. At time T_1 , the spare heater in PCA 145 was energized. At time T_2 , the microprocessor, set at a 5 V detection threshold, detects the quench in PCA 145 and simultaneously energizes a heater in each dipole and enables the QBS triggers. At time T_3 , the dump is energized and the power supply current decays with a time constant ($T \approx 0.01$ sec) controlled by the Main-Ring magnet inductance and the dump resistance.

Quench-Induced Peak Coil Temperature

The values of the integral

$$\int_{T_2}^{\infty} I^2 dt$$

have been measured at B12 for the 4-magnet string and are plotted in Fig. 3. For comparison, the results obtained on a single magnet measured previously at the Magnet Test Facility (MTF) are also plotted.

Neglecting the propagation delay of the heater energy to the quenched conductor, the three magnets which did not initially quench are subjected to a maximum 4.1 Miits at 4 kA. In the adiabatic approximation, this is equivalent to a peak conductor temperature of approximately 170 K.

As the magnet current is essentially constant during the quench detection delay $T_2 - T_1$, the additional Miits accumulated in the magnet which was quenched at T_1 can be obtained from the relation $I^2 (T_2 - T_1)$. At

a quench current of 4 kA, an additional 1.76 Miits were accumulated for a total of 5.86 Miits. This is equivalent to a peak conductor temperature of approximately 300 K.

Quench Pressure Peak

The single phase helium pressure during a quench was measured (Fig. 5) with a "cold" transducer¹ mounted in the downstream end of the PCA 136 cryostat. A second transducer² was mounted at the magnet string turn-around box. It monitored the single phase helium pressure at this location via a 2-ft long 0.25 in. o.d. stainless steel tube which also contained the electrical leads of a carbon resistor thermometer. Each magnet was fitted with a 1.5 in. Ross and two Circle Seal relief valves which vented into air.

The relief valves used and their connecting geometry were a temporary system intended to demonstrate that the cryostat can survive full current quenches. A more suitable valve³ has recently been tested at the MTF which is extremely compact, eliminates the need for an external trigger and at the same time limits the cryostat pressure to 82 psia.

References

- ¹Bell and Howell Type 4-356-0003.
- ²MKS Type 222HS-x-10000.
- ³Hans Kautzky (H-K) designed valve.

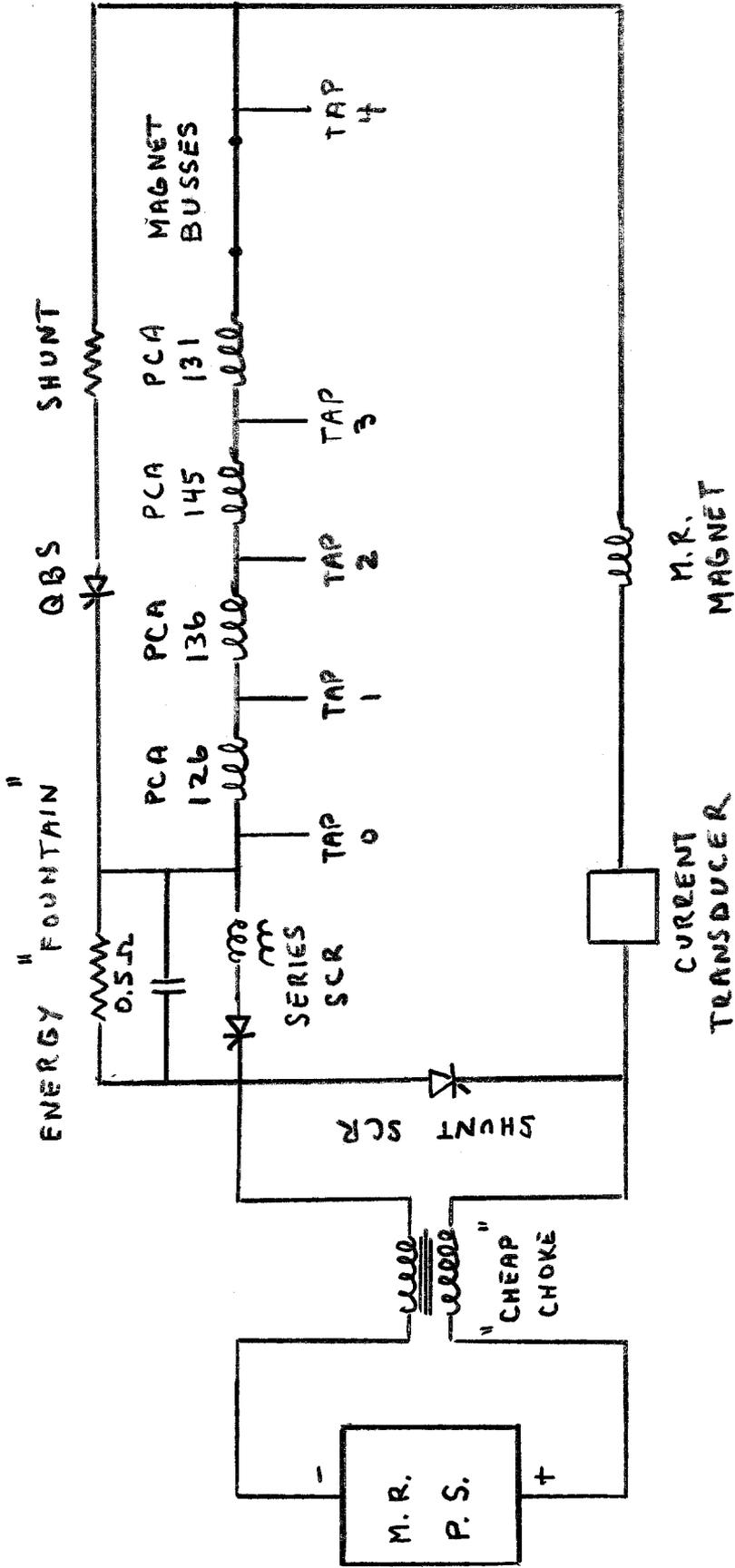


FIG. 1

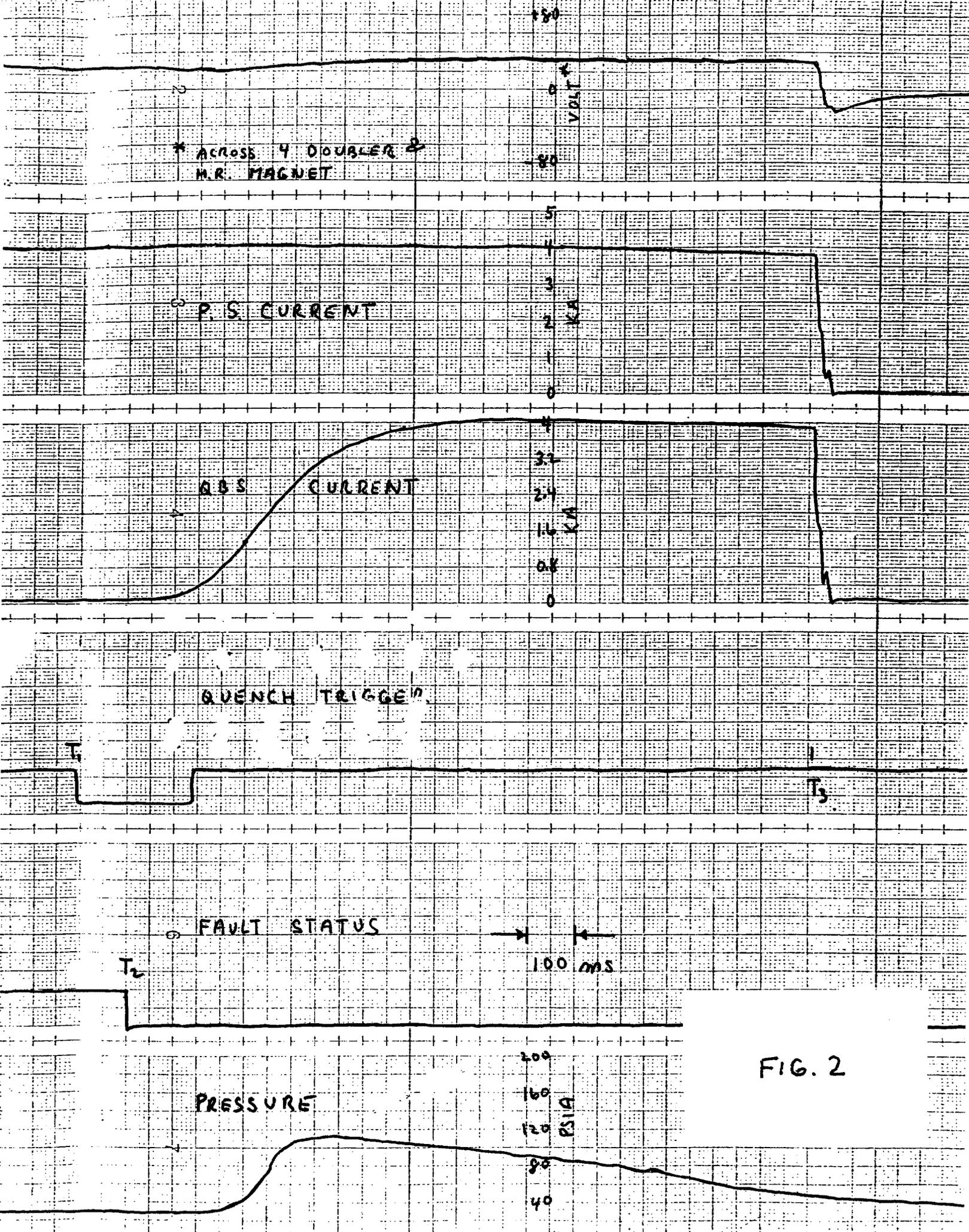


FIG. 2

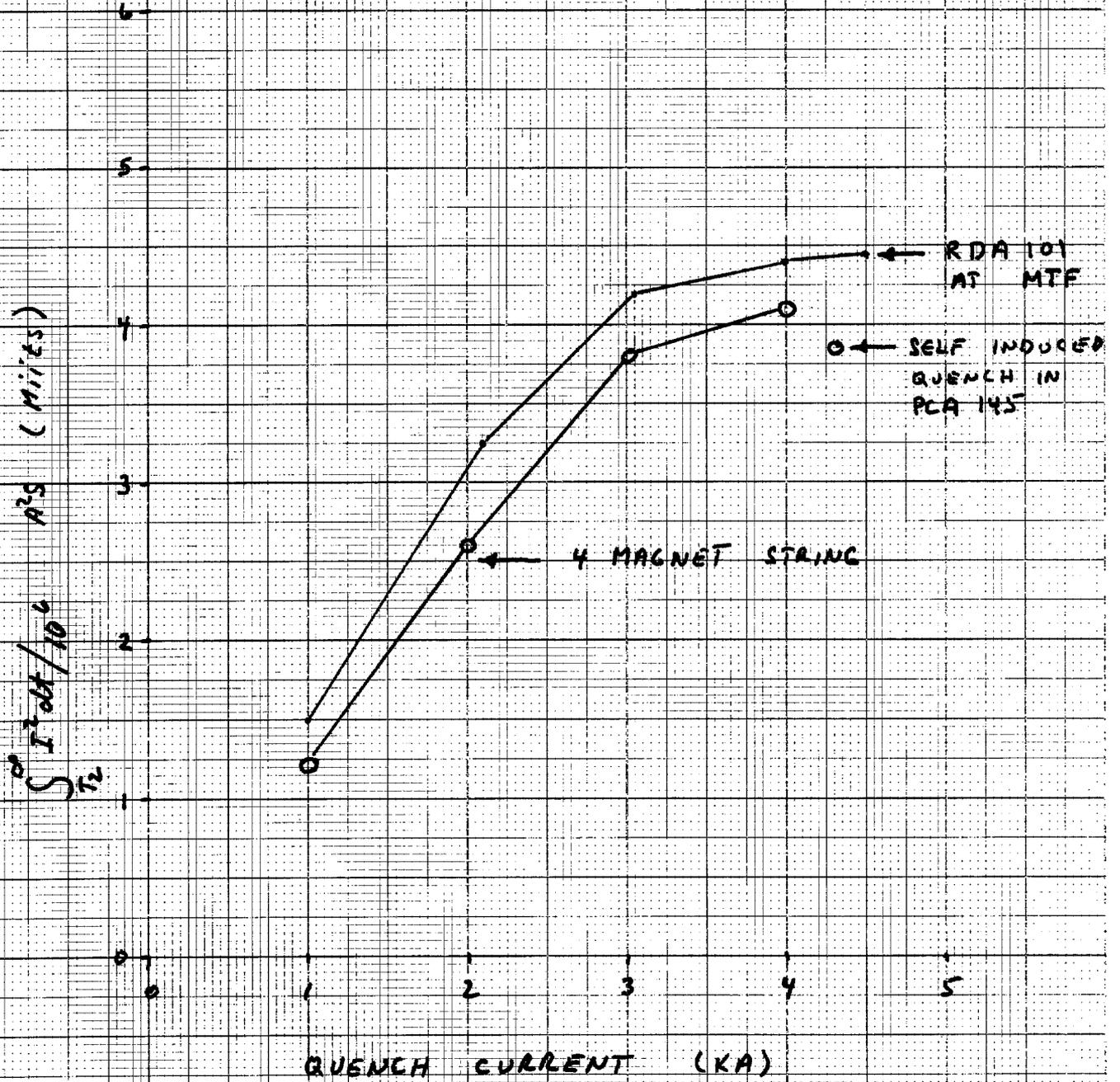


FIG. 3

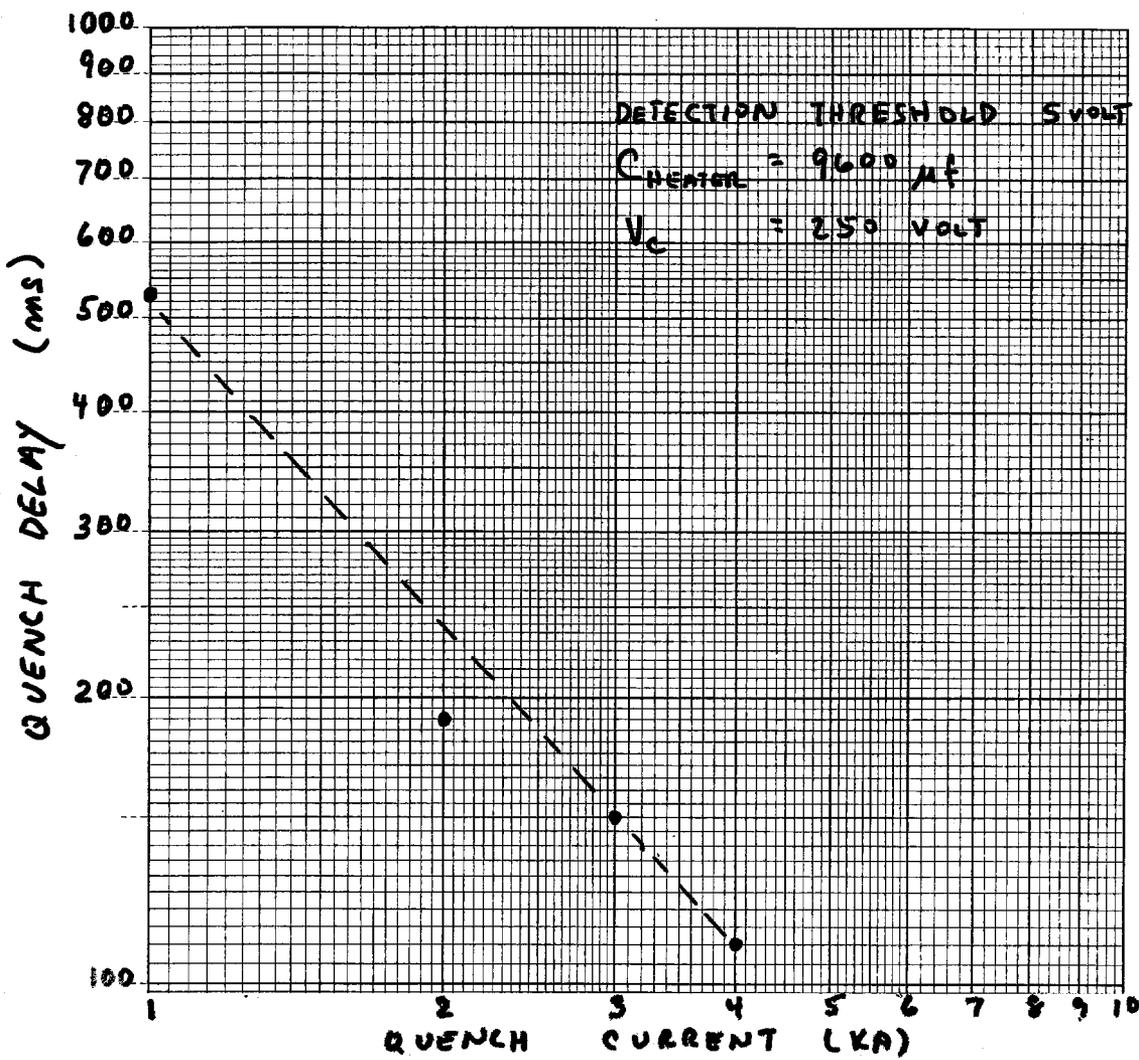


FIG. 4

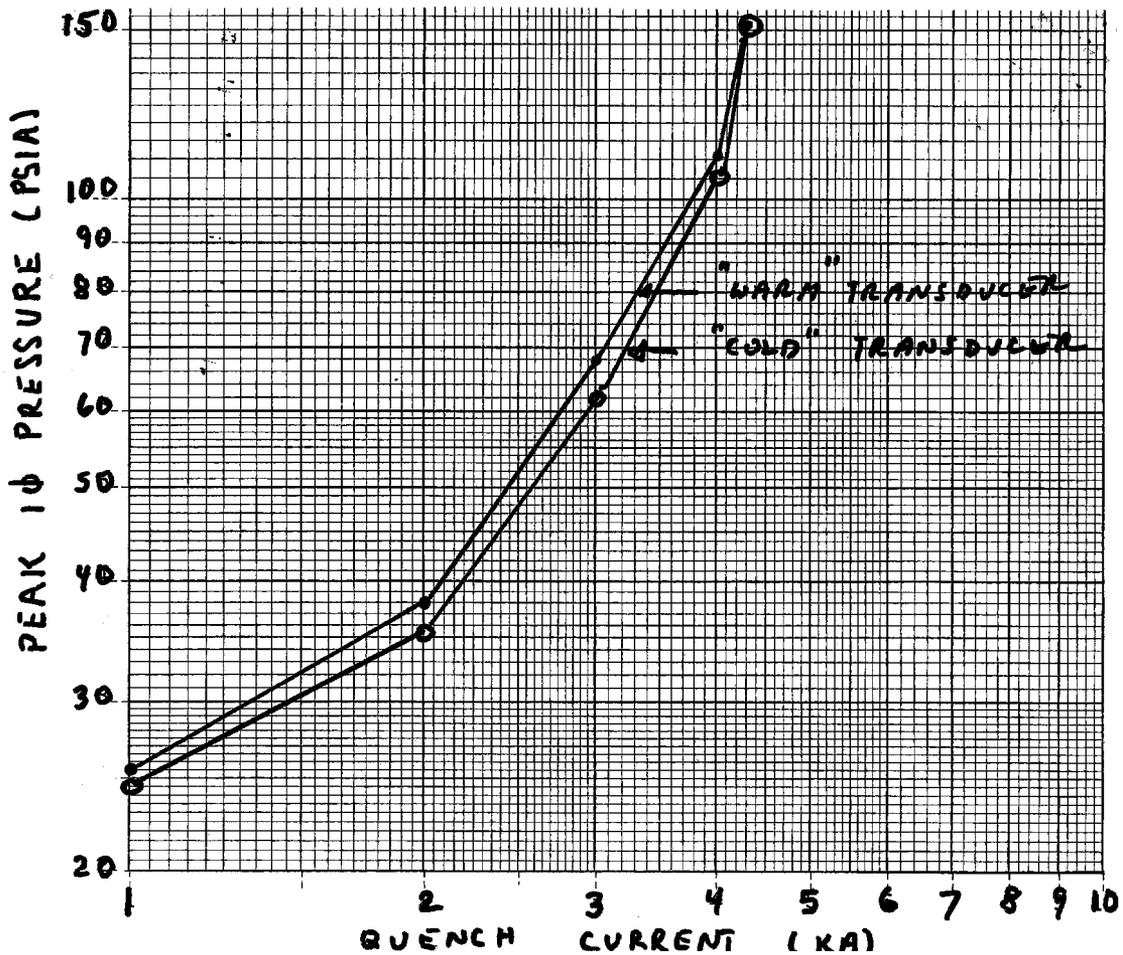


FIG. 5