INTERMITTENT THERMOMETER *for High-Temperature Measurement*

Development of a 16-megawatt magnetically-rotated plasma arc for use as a heater for a high-altitude, Mach 7 to 10 wind tunnel is under way at APL (see *Digest,* Nov. Dec. 1961, for a discussion of plasma arc development). Concurrently, S. D. Raezer has sought a simple yet accurate and reproducible means of measuring temperature in the hot gas stream, expected to be approximately 7000°R in the test section of the tunnel. It is believed that he has found it in the intermittent thermometer.

Still in the early stages of investigation, the intermittent thermometer technique is, basically, one by which the range of a thermometer may be extended above its own melting point. The principle of the cycling technique was first used by H. L. Olsen, E. L. Gayhart, and L. W. Bennett of APL to measure the average temperature of flame kernels that were ignited and carried by the gas stream past a stationary thermocouple. In the present study the measuring device is a chromel-alumel thermocouple probe driven in and out of a cylindrical, water-cooled sheath by a double-acting solenoid. The timing cycle is obtained by using a light beam interrupted by a motor-driven chopper wheel and monitored by a photocell. In the present case, the frequency used was 40 to 200 cycles per minute. Two or more ratios of time spent in the water jacket to time spent in the hot gas are used; from the cycling ratios and the average equilibrium probe temperature corresponding to each ratio, the gas temperature is obtained. In the investigations three cycling ratios were used in the determinations of temperature as this allowed a check on the assumption that the heat transfer is linear in the temperature differences (which relationship was verified for all data taken). Probe tip (or thermocouple bead) sizes ranged in diameter from 0.05 to just under 0.09 in., the inside diameter of the water jacket sheath. Results indicated that the measured gas temperature is independent of probe tip size, as was expected.

To date, temperatures up to 3500°K have been measured in a Mach 0.7 plasma flame, and they are found to agree with those obtained by direct thermocouple measurement up to 1800°K using a platinum, platinum-rhodium thermocouple. Variation in the measurement was of the order of ±5%, which can easily be explained by fluctuations in the temperature of the plasma and minor variations in the cycling ratio resulting from the use of relays in the driving circuit.

Such results demonstrate that the intermittent thermometer has promise. It has the advantage of high spatial resolution compared with optical techniques; furthermore, point-to-point temperature traverses can be taken through the hot gas in the tunnel. In the case of a non-equilibrium gas, it is hoped that this approach may provide a means of specifying temperatures.

Attempts will be made to extend the range of the instrument by increasing the cycling ratio and the heat transfer in the water-cooled jacket. Also, measured temperatures will be compared with those obtained by optical methods.

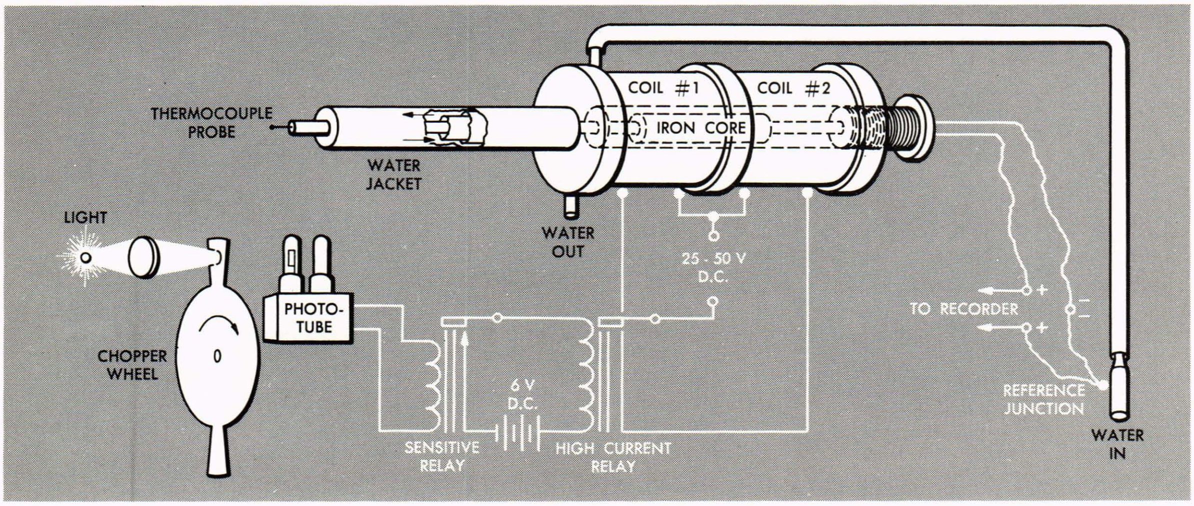

Diagram of the intermittent thermometer and its timing cycle circuitry.