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# NASA TECH BRIEF

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## Study of Fast Response Thermocouple Measurement of Temperatures in Cryogenic Gases

To obtain a fast response from a temperature sensor, the heat capacity of the sensing element must be small in relation to the heat transfer to the element. Also, the element must be thermally isolated from its supports. The first of these requirements is met by a small diameter thermocouple wire. The second requirement can be met by making the leads of sufficient length so that the heat conduction down the leads is small and assuming that the leads adjacent to to the junction are subjected to the same thermal conditions. On other sensors that were considered, the mountings were generally large and thermally too close to be considered acceptable. Platinum wire resistance probes were considered but they required a four-wire lead system to eliminate the error due to lead resistance changes. Also the sensor element "averages" the temperature between the sensor wire supports and is affected to a considerable degree by heat transfer to the supports. Although the smallest thermocouple wire used will give the fastest response time, this program was restricted at the onset to a wire size considered large enough to withstand gas velocities up to 30 feet per second.

The basic configuration tested is known as the slingshot type and consists of a Y-shaped frame supporting the thermocouple and its leads. The following is a list of variables which were investigated for their effects on response time.

1. The thickness of a teflon slingshot frame.
2. A slingshot frame made of 18 gage thermocouple wire.
3. Dimensions of the slingshot frame.
4. Thermocouple junction weld.
5. Welds on lead wires in relation to the frame.
6. Angles formed by the thermocouple junction.
7. Relation of the thermocouple to the horizontal during testing.
8. Effect of insulation and varnish.
9. Cleaning of the thermocouple wire at the junction.
10. Speed of probe being removed from liquid.

The results indicate that durable thermocouples can be made in quantity and have fast reproducible response times. Such thermocouples should be fabricated from uninsulated small diameter wire. The thermocouple should be mounted in a lightweight wire slingshot frame with support distance 3 inches or more. The thermocouple leads should form an included angle of about 75° (the bead about 2 inches beyond the ends of the frame arms). The frame should be mounted so the plane of the supports is about 30° above horizontal. The thermocouple junction should be made by welding with excess wire carefully trimmed away.

### Note:

Additional details are contained in the Beech Aircraft Corporation report, "Fast Response Thermocouple for Measurement of Temperatures in Cryogenic Gases," by C. C. Robinson, et al, October 12, 1964, which is available from:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
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**Patent status:**

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: C. C. Robinson, A. R. Lowrie, and T. Bielawski
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