AEC-NASA TECH BRIEF

Method for Making Small Pointed Thermocouples

The problem:

To devise a method for making single-ended 1 mil or smaller thermocouples that have the fast response time necessary to measure rapid temperature changes accurately and that will not significantly alter the environment being measured.

The solution:

A constantan wire is worked to a needle point and covered with a copper coating to produce a small, concentric, fast-reaction thermocouple that alters the environment only slightly because of the small mass involved.

How it's done:

A straight piece of 0.032 inch diameter constantan wire, 1½ inches long, is mounted in a pin vise so that approximately 1 inch of wire extends from the vise. A tip is formed by rotating the wire against an aluminum block and shaping it with a fine file down to 0.005 inch or less. The filing motion must be parallel with the wire and in a direction away from the pin vise. After as much work as possible is done with the file, the tip is worked with successively smaller emery cloths, and finished with crocus cloth. All shredding caused by the file must be removed. After the tip is formed, the space ¼ to ½ inch from the butt end is knurled by rolling a file over the constantan while it is lying on a piece of hardwood; this will help hold the sleeve in place. The wire is then lightly oxidized to free the surface of grease and oil.

A refractory cement is used to attach a sleeve of ⅛ inch copper pipe, ¼ inch long, to the butt end of the wire. After the cement has been cured by heat, a thin, uniform coating of a clear glaze ceramic paint is applied to about ⅜ inch of the tip and fused by heating to 1700° F. in an oven. An insulating cement is applied from the base of the sleeve to within ¼ inch of the tip, the refractory cement being covered. The copper sleeve is then cleaned of all oxide caused by the heating, and the assembly is mounted vertically and rotated in a vacuum chamber for copper coating. After 2×10^{-6} to 20×10^{-6} inch of copper is deposited on the assembly, it is removed from the vacuum chamber, and about 1/32 of an inch of the tip is cut off with jewelers' end cutters. The thermocouple is then given another vacuum coating of copper which completes the contact to the constantan tip.

After a continuity check with a low voltage ohmmeter, the thermocouple is given a final electroplating with copper. The base is covered with wax, and the assembly is placed in a copper electroplating bath with 1/16 inch of the tip not immersed. The tip is gradually moved further above the level of the plating solution so that the copper plating is heavy on the base to ensure a good contact and thin near the tip to keep the mass small near the thermocouple junction.

Notes:

1. The average decay response time on a small tip is about ¼ second in slow moving air, although several thermocouples had much better response times.
2. A needle point thermocouple can be used to measure the internal temperature of animal tissue. Its rapid response time makes it useful for control purposes.

(continued overleaf)

3. Inquiries concerning this innovation may be directed to:

Sandia Office of Industrial Cooperation,
Org. 3416
Sandia Laboratories
Post Office Box 5800
Albuquerque, New Mexico 87115
Reference: B68-10389

Patent status:

No patent action is contemplated by AEC or NASA.

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