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Design of a Strain-Gage Probe

The problem:

Rapid and accurate measurement of long, slender channels by nondestructive means. High performance by a reactor core depends on very close dimensional control of various components and assemblies. For example, a constant flow of coolant through the fuel elements is required to balance the rates of generation and removal of heat, and excessive variations in channel spacings pose serious hydraulic and heat-transfer problems. Thus the imposition of close tolerances for maintenance of channel dimensions requires accurate methods for measurement of these dimensions.

The solution:

A strain-gage spacer probe using the deflection of a leaf spring to measure strain in a long, slender beam nondestructively. Reported accuracies of measurement with two probes of a 0.037-inch channel were ± .0005 and ± .001 inch. With further development, accuracies should exceed ± .0005.

How it's done:

The test probe consists of the strain gage and the required structure to position the gage, fix the relative locations of the components, and provide for movement. One type of probe has been used to measure the spacing between flat simulated fuel plates.

The strain gage is bonded to a 0.003-inch-thick leaf spring that is spot welded to a 0.006-inch-thick, 0.5-inch-wide flat steel strip. A thin cover strip, which protects the strain-gage leads, is spot welded to the steel strip. When this assembly is inserted between the fuel plates, deflection of the leaf spring produces a strain in the spring and strain gage. The changes in strain-gage resistance are a function of the spacing between leaf spring and support strip, and correlate with the channel gap (spacing of the plates).

The strain gage was selected for the smallest size practical: as thin as possible and yet of a standard type. Metal foils gaging 0.003 inch in thickness were selected. The gage is a temperature-compensated type with a 350-Ω resistance. The leaf spring is about 9/16 inch long.

The basic strain-gage instrumentation incorporates a Wheatstone bridge, an amplifier, and a two-channel strip-chart recorder. The gages are placed in two legs of the Wheatstone bridge, and the bridge is null-balanced at the desired nominal dimension. Any change in the resistance of the gage unbalances the system and is detected as a change in voltage.

The output from the probes is also permanently recorded on a strip chart. The speed of chart recorder and probe drive can be adjusted to a 1:1 ratio of chart location to element location.

Notes:

1. This information may interest the aircraft, automobile, and tool industries.
2. Inquiries may be directed to:
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   Argonne National Laboratory
   9700 South Cass Avenue
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   Reference: B69-10343
   Source: V. M. Kolba and D. L. Vetter
   Reactor Engineering Division
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(continued overleaf)

Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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