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Technique for Predicting the Thermal Expansion Coefficients of Cryogenic Metallic Alloys

The problem:

The widespread use of many new cryogenic metallic alloys led to a need for their low-temperature thermal expansion coefficients. A requirement also existed to establish relationships between related alloys that would aid in predicting their thermal expansion reliably. In addition, thermal expansion data were necessary for the reduction of electrical resistivity measurements of some of the same materials.

The solution:

A series of measurements on the thermal expansion coefficients of several aerospace alloys and standard materials from liquid hydrogen temperature (20°K) to room temperature (293°K).

How it's done:

The following materials were measured and compared with literature data of similar alloys:

Al 2024	Inconel 625	Aluminum bronze D
Al 5083	Inconel 718	AISI 633 (AM 350)
Al 7039	Waspaloy	AISI 430 F
Al 7075	Udimet 630	Fe-29% Ni
Hastelloy C	Udimet 700	Invar 36
Hastelloy N	TD Nickel	LR 35
Hastelloy X	Phosphor bronze A	Fe-50% Ni

Both the thermal contraction from room temperature, $(L_{293}-L_T)/L_{293}$, and the thermal expansion coefficient, $(1/L_{293})\,(dL/dT)$, were tabulated as a function of temperature. A comparison of similar alloys and alloy conditions led to the general conclusions that: (a) relatively large changes in composition are required to produce significant changes in the thermal expansion, (b) thermal treatment or condition has little effect except when it produces a basic structure change, and (c) the thermal expansion coefficient at room temperature is a good indicator of the total length change to a low temperature. These three generalizations now provide a good guide in making engineering estimates of thermal expansion coefficients of unmeasured materials.

Notes:

1. This data should be of interest to those companies that fabricate structures of cryogenic materials.
2. Additional information is contained in *Cryogenics*, Volume 8, No. 5, 1968. Reprints of the measurement program discussed in this volume may be obtained from:

   Technology Utilization Officer
   AEC-NASA Space Nuclear Propulsion Office
   U.S. Atomic Energy Commission
   Washington, D.C. 20545
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No patent action is contemplated by the AEC or NASA.

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