Fig. 9—Typical notch-tensile failures of arc-cast and powder metallurgy molybdenum specimens. A is powder metallurgy molybdenum, static failure; B, powder metallurgy molybdenum, fatigue failure; C, arc-cast molybdenum, static failure; and D, arc-cast molybdenum, fatigue failure.

specimens tested in fatigue and in static tension. Typical failures of notched specimens of the two types of fabrication are shown in Fig. 9. Regardless of the differences in appearance of the failures, the two types of molybdenum behaved in a nearly similar manner both in static tension tests and in fatigue.

This study has revealed that molybdenum has unusually good unnotched and notched fatigue behavior. The endurance ratios in the range 0.65 to 0.81 for the two types of molybdenum compare favorably with the endurance ratios of steel (0.4 to 0.6)

and aluminum (0.2 to 0.4). Fatigue notch factors of $K_t = 2.05$ and 1.36 for the arc-cast and powder metallurgy materials, respectively, appear low for the notch severity studied, $K_t = 3.1$. This is particularly the case for powder metallurgy molybdenum.

In both types of molybdenum, the applied stress was in the direction of the fibrous structure (working direction). This may be an influencing factor on the observed fatigue behavior. Some additional fatigue studies of specimens from recrystallized material or of specimens from worked material at orientations other than the working direction would provide helpful information to better categorize the fatigue behavior of these products.

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Technical Note

Allotropic Transformation at High Temperatures—A Discussion

by Arthur G. Metcalfe

(Reply by James O. McCaldin and Pol Duwez¹)

THE failure to detect any change in the thermal properties of cobalt at the Curie point would appear to indicate that the apparatus may have a limited sensitivity. The Curie temperature has been determined by direct methods to be $1121 \pm 3^\circ\text{C}^2$ and 1131°C^3 . The specific heat has been determined many times⁴⁻⁷ and weighted values are given in Table I.

The allotropic transformations in iron and titanium, used by the authors to test the experiment method, involved a volume change of the order of 3 pct on going from the close-packed to the body-centered-cubic lattice. These energy changes are likely to be much larger than those involved in a diffusionless transformation from a hexagonal to a cubic-close-packed lattice. However, it has been pointed out that thermal observations are unreliable in the detection of phase changes when these are near a Curie point.⁸

James O. McCaldin and Pol Duwez (authors' reply)—The sensitivity of the present technique is limited to first-order transformations, so that gradual changes in specific heat, e.g., in the vicinity of Curie

Table I. Weighted Values for Cobalt

Temperature, °C	500	600	700	800	900	1000	1100	1200	1300	1400
True specific heat	0.126	0.136	0.147	0.159	0.172	0.187	0.204	0.166	0.167	0.168

points, are not detected. Furthermore, the existence of first-order transformations with latent heats much smaller than those occurring in the known allotropic transformations of iron and titanium is, we agree, still pending.

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