DISCUSSION

N. W. Hung[2] (*written discussion*)—Dr. Cina brought up an important issue of reducing the residual stress by coldworking. I understand that your main concern was the dimensional stability rather than the benefit of the compressive surface stress. Your data as the result of the uniaxial tension or compression on the simple geometry specimen, is very beneficial to help us understand the technical aspect of this complicated subject; nevertheless, I am a little concerned about the general practicality of this method. For very complex geometry, high precision (tolerance $< \pm 0.0005$ in.), or smaller size parts, the technique of cold working to reduce the residual stresses can become very expensive, if not impossible. I think the alternative technique that is worth considering is the thermal-mechanical, uphill quenching technique which can help reduce the stress due to solution heat treat quenching.

Y. Altschuler, T. Kaatz, and B. Cina (*authors' closure*)—The results of the work were intended to be applied primarily to forgings and specifically thick forgings subsequently to be heavily machined to parts for structural purposes. Such parts, even those of complex geometry, are routinely cold worked to reduce their residual stresses. We would agree that if special cold-working dies have to be designed and manufactured because of the complexity of the part, this entails a considerable expense, however even this is done if uniform and maximum dimensional stability on subsequent machining is essential. Uphill quenching is indeed one alternative method for reducing residual stresses resulting from quenching from an elevated temperature. The process has not yet been generally accepted nor standardized although it is now being more thoroughly evaluated.

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