DISCUSSION

A. L. Bement[1]—There are important distinctions between the occlusion of hydrogen in cold-worked as compared with irradiated steel. Microtears developed by the cold working of steel create internal surfaces which can trap hydrogen in an absorbed state. This hydrogen would be released at relatively high temperatures. Irradiation induced defects, however, might also trap hydrogen by chemical binding forces, but the hydrogen should be released when the binding energy is overcome by thermal activation or when the defect is annihilated by thermal recovery. Therefore, there could be significant departures from a single hydrogen sensitivity versus ultimate strength correlation for steels representing mixed structural states.

C. R. Brinkman (authors' closure)—Trapping of hydrogen in steel is a complex phenomenon. Indeed, besides microvoids or cracks it is believed that dislocations, grain boundaries, precipitates (interfaces), twins, voids, interstitials, etc., also can be effective in trapping hydrogen. The trapping mechanism is by no means the same and its effectiveness is dependent on the size, density, and binding energy associated with the traps. Thus, microcavities can adsorb monatomic hydrogen at the lattice defect interface or they can absorb hydrogen acting as sites for recombination and collection of molecular hydrogen, or even methane if the temperature is high enough. Similarly, strain fields set up around line or point defects result in atmospheres of atomic hydrogen which can diffuse to the defect cores. Certainly the nature and extent of the structural imperfections introduced by cold working[2] or irradiation damage will result in differences in the types of traps operative at a given temperature; however, the two conditions could show similar anomalous behavior, as was indicated in this paper, with respect to an apparent increase in hydrogen solubility over that of the unirradiated and strain-free material.

Departure from a simple hydrogen sensitivity versus ultimate strength correlation is indeed a possibility in irradiated materials and it has been shown that this can be accomplished in unirradiated steels by microstructural variations at a given strength level. Additional work needs to be accomplished in order to more closely define the nature of the hydrogen-irradiation induced defect interaction intimated by this work.

[1] Battelle-Northwest, Richland, Wash. 99352.
[2] Oriani, R. A., *Acta Metallurgica*, AMETA, Vol. 18, Jan. 1970, p. 147.