In summary, austenitizing under pressure has apparently raised the grain growth threshold at least 100°F. Furthermore, it appears that pressure has resulted in more positive control of particle size and distribution of complex carbides up to the grain growth temperature. Tempering under pressure has probably affected the rate of nucleation and precipitation from martensite, and the precipitate formed could be of a different nature. Pressure treatments seem to have little effect on hardness. The pressure treated samples do tend to be a little lower in hardness, however, and this may be an indication that the rate of solution of the alloy carbides has been adversely affected by pressure.

The more important variables governing the properties of tool steels include austenitic grain size and carbide distribution. In view of the effects of pressure on these variables as noted above it may be concluded that pressure treatment should have a beneficial effect on the properties of tool steel. Unfortunately, due to limitations imposed by the specimen size employed, these probable improvements could not be directly measured.

IV. DISCUSSION OF RESULTS

The large volume change occurring in the transformation from graphite to diamond is extremely rare, if not unique, in metal as well as in nonmetal systems. The results of this exploratory project indicate that metal systems in general are not likely to reveal highly sensational irreversible changes as a result of the application of pressure. This is in agreement with that expected in view of the elastic nature of the metallic bond and of the fact that metallic systems generally already exist as closely packed structures because of the nondirectional nature of the bond.

However, reversible, more moderate structural changes such as the transformation from body-centered cubic to the denser face-centered cubic structure, can be expected to occur as a result of the application of pressure, since these transformations occur rather readily in metal systems with moderate changes in conditions even without the application of pressure. Thus, strong evidence was found in the iron-chromium and iron-aluminum systems to indicate that the face-centered cubic (gamma) region was extended to higher alloy contents by the application of pressure. The fact that a similar reversible transformation was not detected in pure chromium or chromium-nickel alloys does not indicate, of course, that it has not occurred, since in these cases transformation products indicative of a reversible change may not have been produced or retained. The effects of pressure noted on high-speed steel may have been due more to the effects of pressure on the kinetics of the system rather than on phase transformations directly.

Although these transformations may not involve vastly different structures, it should be recognized that they may be the basis for significant property improvements. Unfortunately, interest in the practical aspects of these findings may be somewhat dampened by the inability to produce sufficiently large quantities of the alloys for more extended testing or for actual structural application. However, a continued, more careful, and more theoretical study of pressure effects may contribute significantly to our understanding of the fundamental nature of metal systems and may indirectly lead to improvements in alloys made by more conventional techniques.

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