



FIG. 5. An example of diamond growth from an iron-carbon system. Note the octahedron protruding from the top left. The crystal edge showing is approximately 2.7 mm long.

Since carbides of nickel and cobalt can be formed, perhaps some clarification is in order.

The reactions generally required for their formation are of a metal-gas type carried out at relatively low pressures and temperatures for extended periods (Hofer and Peebles, 1947, and Hansen, 1958). The respective carbides reported (Ni_3C , Co_3C and Co_2C) are of powder form, of poor crystallinity and reactive. They frequently find use as catalytic

reagents. They are classed as metastable (Hansen, 1958). The carbide of nickel, Ni_3C , also has been formed by solution of carbon in nickel. Temperatures over 2000°C . at normal pressure are required, followed by rapid thermal quench to below 1000°C .

Thus far, neither a recoverable nickel carbide nor microstructural evidence of the existence of such a compound has been observed in the diamond making range of pressure and temperature. Evidence has been noted, however, of a free nickel carbide in high pressure reactions carried to temperatures far in excess of the limit for diamond growth, followed by rapid thermal quench. The latter occurrence corresponds to the carbon solution in nickel at high temperature and normal pressure described above. The carbide is similarly considered unstable.

Residual microstructures observed from successful diamond experiments with the cobalt-carbon system indicate the probable occurrence of a series of cobalt carbides at high pressures. The latter is in accord with the fact that cobalt carbide(s) formed at normal pressure are considered slightly more stable than those of nickel (Hansen, 1958). Figure 6 shows three different structural patterns most frequently observed. X-ray diffraction studies, however, have determined the presence of only elemental cobalt and graphite. Such carbides of cobalt that the microstructures might indicate, therefore, are normally unstable. Decomposition is complete. Note the sharp segregation of constituents. No evidence of a platinum carbide has been observed in work on the platinum-carbon system.

On the basis of diagnostic evidence from residual products, the mechanism of diamond synthesis in the case of non-carbide forming solvents such as nickel or platinum, or alloys thereof, apparently is that of simple binary (or ternary, etc.) solution carried to supersaturation. That the latter prevails is evidenced by the fact that diamond growth is spontaneous.

An idea of the degree of carbon solubility in nickel is given in Figure 7. The latter, 7(a), shows a cross section of a nickel plug heated to a "normal" diamond growth temperature (1475°C .) but maintained at a slightly deficient pressure (45-50 kilobars) for a period of 2 minutes. The white area is nickel and the gray is dissolved carbon. The content of dissolved carbon in the reaction zone is approximately 36% by weight. On an atomic weight per cent basis, the latter would provide an approximate NiC_2 compositional formula. A similar degree of solubility has been observed for iron.

That the carbon was truly in solution is illustrated by Fig. 7(b) and 7(c). Again the white areas are nickel and the gray to black recrystallized graphite (photographed in crossed polarized light). The coarse and