

CHAPTER VI.

MICROGRAPHIC IDENTIFICATION OF
CONSTITUENTS.

BEING now acquainted with the six constituents of carbon steels and the manner in which each of them behaves when submitted to the various methods of treatment described, we can resume the general course of the analysis in its application to the micrographic separation of these constituents, putting aside the preliminary operations of simple polishing.

1. Polishing in bas-relief on moistened rouged parchment: examining the preparation under the microscope.
2. Using the polish-attack on parchment, with sulphate of lime moistened with infusion of liquorice-root, or a 2 per cent. solution of nitrate of ammonia: examining under the microscope after every 500 passes to and fro if liquorice-root is used, and every 100 if nitrate is used. A certain amount of personal experience is indispensable. Variations in the pressure used in the operation of polishing, have a very marked influence.

The presence or absence of coloration divides the constituents into two groups, intermediate between which is martensite.

- a. CONSTITUENTS NOT COLOURED: Ferrite, Cementite, Martensite, or Austenite.
- b. CONSTITUENTS COLOURED: Martensite, Troostite, or Sorbite.

Martensite, which only takes a yellowish tint, is recognised by its crystalline forms. An inexperienced observer might confound it with pearlite, especially in an oblique light, because it may exhibit the same phenomenon of iridescence, and because its elements of structure may be of the same order of magnitude. The distinction is not, however, difficult. The principal needles of martensite are rectilinear, and frequently cut each other; whereas the layers of pearlite are mostly curvilinear, and never intersect.

Ferrite and cementite are distinguished by their very unequal degrees of hardness: after polishing the former will be recessed, and the latter will be in relief with respect to all the other constituents. The mixtures of hardensite and austenite are only imperfectly resolved by polish-attack; but as the forms of hardenite are very characteristic, the least difference of level is a sufficient indication to a practised eye.

In the second group, troostite colours more slowly and less uniformly than sorbite; but the true criterion is that troostite is the companion of martensite, whilst sorbite accompanies pearlite.

Iodine divides the constituents into two groups:—

- a. CONSTITUENTS WHICH ARE NOT COLOURED: Ferrite or Cementite.
- b. CONSTITUENTS WHICH ARE COLOURED: Sorbite, Troostite, Martensite, or Austenite.

In the first group the ferrite granulates, while the cementite keeps its polish. Ferrite subdivides into

polygonal grains and the cementite often into plates, if these two constituents are not very much subdivided. In the second group sorbite colours more quickly than troostite, and troostite more quickly than martensite or austenite. The tone and intensity of the coloration always vary with the amount of carbon and the quantity of reagent employed. Martensite and austenite colour simultaneously but differently, in such a manner that the structure is well revealed.

This seems to me the best process to follow, and the one which leads most surely to the object in view. I do not wish, however, to induce anyone to believe that the proposed method equals in security and precision those of petrography or chemical analysis. In the first place, the various constituents of steel are not attacked in an absolute manner by the various reagents: neither are they equally attacked *during a given time*. Again, none of these constituents are exactly defined bodies. *Pure* ferrite does not exist, and we are obliged to consider it as nearly pure iron, which is vague. Cementite has indeed a formula, but it may be diluted with, or dissociated in, sorbite. There are not always distinct limits between martensite and troostite, neither are there between troostite and sorbite, nor between sorbite and pearlite in steels of certain hardness; neither is there between martensite and ferrite if the amount of carbon be very low and distributed equally throughout the whole of the mass at the moment of quenching. One has frequently to deal with these transition forms, which are the despair of all who attempt classification. But the classifications are no less necessary, and the divisions which I believe I have been able to establish

will at least, I hope, allow me to show more clearly how the structure of steels varies with their amount of carbon, and how it is transformed under the influence of heat and according to the rate of cooling.