ON THE OCCURRENCE OF WIDMANNSTATTEN'S FIGURES IN STEEL CASTINGS.

SOME little time ago, during his inspection of the metallurgical laboratories at the University College of Sheffield, Sir Norman Lockyer exhibited considerable interest in the fact then communicated to him that almost invariably small steel castings exhibited in the first stage of their manufacture the Widmannstätten figures, provided that the carbon was near the semi-saturation point of steel, namely, 0·45 per cent. The authors communicated the following brief note in the hope that it would be interesting to mineralogists and astronomers.

For many years an exhaustive research into the properties of steel castings has been proceeding at the Sheffield College. This research necessarily involves a close investigation of the influence of mass; hence the weight of the experimental castings varies from about 28 lb. to 2 tons. In such heavy castings as those last named the Widmannstätten figures are seldom found, the slow cooling of the mass exerting an influence similar to that of annealing, an operation which, as will presently be seen, causes a change in structure so profound as almost always to destroy the figures. The authors therefore selected for purposes of demonstration research casting No. 541, weighing about 30 lb. The mean analysis of drillings from this metal, taken from a portion of the casting $1\frac{3}{8}$ inches in diameter, registered the following figures:—

	Per cent.
Carbon	0·39
Silicon	0·08
Manganese	0·03
Sulphur	0·03
Phosphorus	0·02
Aluminium	0·03
Iron by difference	99·42

The structure of the metal as cast is shown in the upper half-section of Fig. 1. As usual, it exhibits two

FIG. 1.—Research casting 541. Reduced from micrograph. Magnified 22 diameters.

constituents, the magnification being too low to reveal its third and fourth constituents, namely, the sulphides of manganese and iron also present in minute quantities. The dark etching constituent is pearlite ($21Fe+Fe_3C$), its colour being due to the liberation during etching of an automatic stain composed of that dark, carbonaceous colouring matter upon which the well-known carbon colour test depends. The pale constituent is, of course, ferrite, in this case nearly pure iron, and has obviously assumed that crystalline structure characteristic of the Widmannstätten figures.

The lower half-section of Fig. 1 delineates the structure of the metal after the operation of annealing. The two stages of annealing were carried out as follows:—first, the steel, protected so far as possible

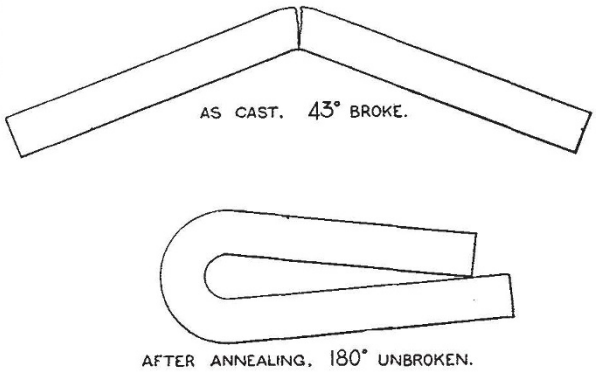

FIG. 2.—Dimensions of test-pieces:—10″ × $\frac{3}{4}$″ diam.; bending radius, $\frac{3}{8}$″.

from the air, was maintained for about seventy hours at a temperature of about 950° C.; secondly, it was allowed to cool very slowly, occupying, perhaps, another seventy hours in falling to a temperature at which it could be comfortably handled. The result was a total re-arrangement of the pattern presented by the ferrite and pearlite, and a consequent elimination of the figures. This change in structure was accompanied by a profound change also in the mechanical properties of the steel.

Fig. 2 reproduces, before and after annealing, bending tests made on bars 10 inches long and $\frac{3}{4}$ inch in diameter. The metal as cast snapped sharply after bending through an angle of 43° over a radius of $\frac{3}{8}$ inch. The annealed steel bent through an angle of 180° without exhibiting any signs of fracture. At the request of Prof. Lewis, of Cambridge University, the authors have submitted to him duplicate sections of the steels figured in this paper. Prof. Lewis considers that an interesting point raised is as to whether the occurrence of the Widmannstätten figures in pieces of metallic iron dug out of the earth necessarily proves them to be of meteoric origin.

The authors have to thank their colleague Mr. J. H. Wreaks, demonstrator of metallography at the Sheffield College, for his patient and precise reproduction of the structures figured in this note.

J. O. ARNOLD.
A. MCWILLIAM.

FORESTRY IN THE UNITED STATES.

AMONG the professional papers of the United States Geological Survey we have already noticed the first six reports dealing with the various forest reserves in the States of Oregon, Washington, and California. The two latest reports, Nos. 7 and 8, now to hand, deal with the forest conditions in the San Francisco Mountains Forest Reserve and the Black Mesa Forest Reserve in the State of Arizona. The former report is by John B. Leiberg, Theodore F. Rickson, and Arthur Dodwell, with an introduction by F. G. Plummer; while the latter report was prepared by F. G. Plummer from notes by Theodore F. Rickson and Arthur Dodwell. Both forest reserves were first created by proclamation of President M'Kinley, dated August 17, 1898. The region in which the San Francisco Mountains Forest Reserve