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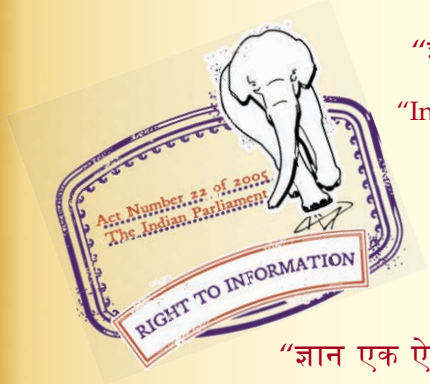
IS 7754 (1975): Method for designation of microstructure of graphite in cast iron [MTD 22: Metallography and Heat Treatment]



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IS : 7754 - 1975
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Indian Standard

METHOD FOR DESIGNATION OF THE MICROSTRUCTURE OF GRAPHITE IN CAST IRON

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NEW DELHI 110002

Gr 5

January 1976

Indian Standard

METHOD FOR DESIGNATION OF THE MICROSTRUCTURE OF GRAPHITE IN CAST IRON

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Indian Standard

METHOD FOR DESIGNATION OF THE MICROSTRUCTURE OF GRAPHITE IN CAST IRON

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 31 July 1975, after the draft finalized by the Metallography and Heat Treatment Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard has been prepared in order to establish a uniform practice for evaluation and classification of graphite in cast iron.

0.3 In the preparation of this standard assistance has been derived from the following:

ISO/R 945-1969 Designation of the microstructure of graphite in cast iron. International Organization for Standardization.

ASTM A 247-67 Evaluating the microstructure of graphite in iron castings. American Society for Testing and Materials.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers the evaluation and classification of graphite in cast iron in terms of its form, distribution and size. This standard is applicable for all iron-carbon alloys containing graphite particles, and may be applied to grey iron, malleable iron and spheroidal graphite or ductile iron.

2. CLASSIFICATION

2.1 When examining iron-carbon alloys under a microscope, the graphite occurring in these alloys can be classified by:

a) its form (designated by Roman numerals, *see* Fig. 1),

b) its distribution (designated by capital letters, *see* Fig. 2), and

c) its size (designated by Hindu-Arabic numerals, *see* Fig. 3 to 6).

2.2 The three series of reference diagrams included in this standard for evaluating the type of graphite form the basis for such a classification. The characteristic features of the graphite which occur are designated by letters and numerals. For this purpose, microstructures of graphite are arranged side by side in the series. Form, distribution and size of the graphite observed are determined by comparison with the diagrams and the allocation of the same classification as the diagrams that resemble them most closely.

2.3 The comparison of the graphite observed with the three series of reference diagrams in Fig. 1 to 6 does not give any information on the suitability of the iron-carbon alloys for any particular service.

3. SAMPLING AND PREPARATION OF SPECIMENS

3.1 While taking specimens from the casting, attention shall be paid to the location, to the wall thickness, to the distance from the surface and to the presence of chills and the like. The location of the surface examined shall be mutually agreed upon between the purchaser and the manufacturer.

3.2 The area of polished surface should be sufficient to give a true representation of the graphite distribution. The area of the specimen shall not be less than 100 mm^2. Attention should be paid to the careful grinding and polishing of the specimens in order that the graphite particles appear in their true form and size. The examination of the graphite under the microscope is normally carried out on the unetched polished section, though final etching is recommended in the case of some special alloy cast irons, for example, those containing high silicon.

NOTE — An Indian Standard code of practice for preparation of metallographic specimens of cast iron is under preparation. Until this code is published the method of preparation of samples may be as agreed to between the contracting parties.

4. MICROSCOPIC EXAMINATION

4.1 The polished specimens shall be viewed under a microscope at any convenient magnification below 100 × to facilitate examination of the entire polished area. A comparison shall first be made with the reference diagrams to determine the percentage of graphite both formwise and distributionwise

(*see* Fig. 1 and 2). Following this, the size of the graphite particles is determined at a magnification of 100×, by reference to Fig. 3 to 6 inclusive and Table 1.

4.2 Examination under the microscope can be carried out by direct observation or by projection on the ground glass of the microscope. A field of view approximately of the same size as the reference diagrams (about 80 mm diameter) facilitates comparison.

4.3 The measurement of the size of graphite particles is also facilitated by the use of suitably calibrated eye-pieces.

4.4 It is a common practice in malleable iron to use nodule count per unit area instead of a comparison chart. Nodule count with known free carbon content is a measure of calculated nodule area.

4.5 The measurement of size of Form II graphite shall be as agreed to between the contracting parties.

5. REFERENCE DIAGRAMS

5.0 A series of reference diagrams is provided for form, distribution and size of graphite. The reference diagrams show microstructures of an ideal character instead of actual photomicrographs.

5.1 Reference Diagrams for Graphite Form — The reference diagrams for graphite form (Fig. 1) show six characteristic forms which are designated by the Roman numerals I to VI. These represent the principal types of graphite found in cast iron. However, other forms are also known to occur occasionally.

5.2 Reference Diagrams for Graphite Distribution — The reference diagrams for graphite distribution (Fig. 2) show five examples designated by the letters A to E. The diagrams in Fig. 2 apply to Form I graphite. The other forms generally occur in Distribution A, but other distributions may sometimes be found.

5.3 Reference Diagrams for Graphite Size — Figures 3 to 6 and Table 1 serve to determine the graphite size. For the '100×' magnification reproduction scale, sizes are indicated ranging from a maximum dimension of the particle of over 100 mm (size 1) down to less than 1·5 mm (size 8). The size ranges covered by the size reference numbers 3 to 7 inclusive are based on an average particle size which is half that of the larger size range.

6. DESIGNATION OF GRAPHITE BY FORM, DISTRIBUTION AND SIZE

6.1 To characterize the graphite observed, indications are generally necessary on the form, distribution and size of the graphite particles. To this purpose, the Roman numerals of Fig. 1 are used for the form, the capital letters of Fig. 2 for the distribution and the Hindu-Arabic numerals of Fig. 3 and Table 1 for the size, in that order. Thus, for example, Type I A4 denotes graphite particles, Form 1 (Fig. 1), Distribution A (Fig. 2), having linear dimensions in the range of 12 to 25 mm at 100× magnification (Fig. 3 to 6 and Table 1).

6.2 If the graphite observed lies between two sizes, reference to both is possible (for example, 3/4). In a given case the predominating size may be emphasized by underlining (for example, $\underline{3}/4$). This method can be extended to cover structures where more than two sizes are present.

6.3 Mixed structures with different types of graphite may be defined by estimating the percentage proportion of the different types of graphite. For example:

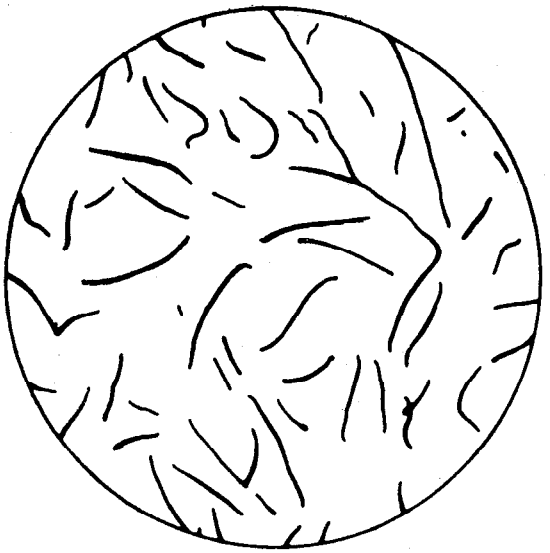
60 percent I A4+40 percent I D7

means 60 percent graphite of the Form I, Distribution A and size 4, and 40 percent graphite of the Form I, Distribution D and size 7.

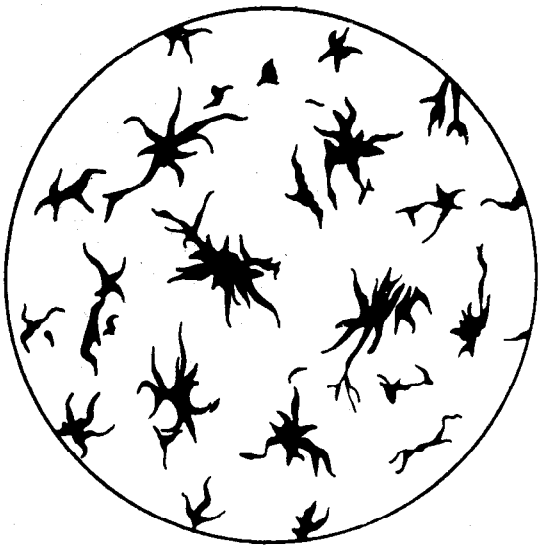
TABLE 1 DIMENSIONS OF THE GRAPHITE PARTICLES — FORMS I TO VI

(*Clauses* 4.1, 5.1 *and* 6.1)

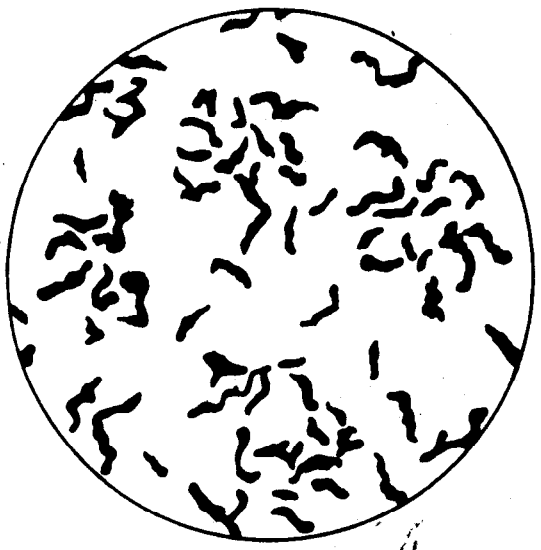
Ref No.	Dimension of the Particles Observed at 100× Magnification	True Dimension
(1)	(2)	(3)
	mm	mm
1	Over 100	Over 1
2	50 to 100	0·5 to 1
3	25 „ 50	0·25 „ 0·5
4	12 „ 25	0·12 „ 0·25
5	6 „ 12	0·06 „ 0·12
6	3 „ 6	0·03 „ 0·06
7	1·5 „ 3	0·015 „ 0·03
8	Less than 1·5	Less than 0·015



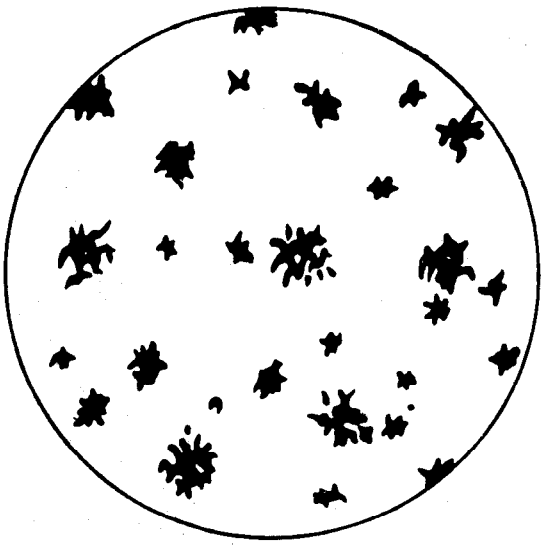
Form I Flake



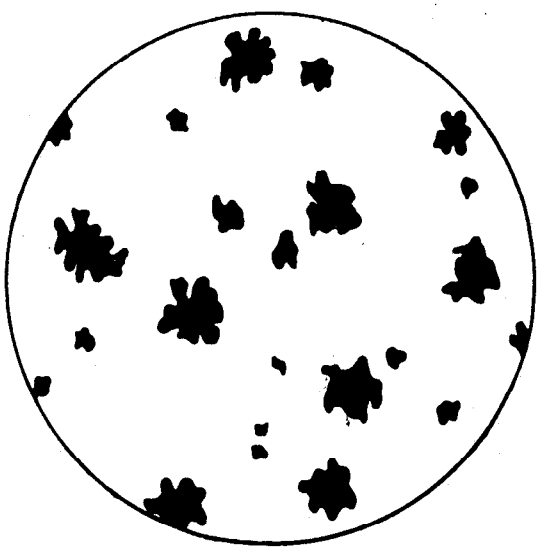
Form II Star



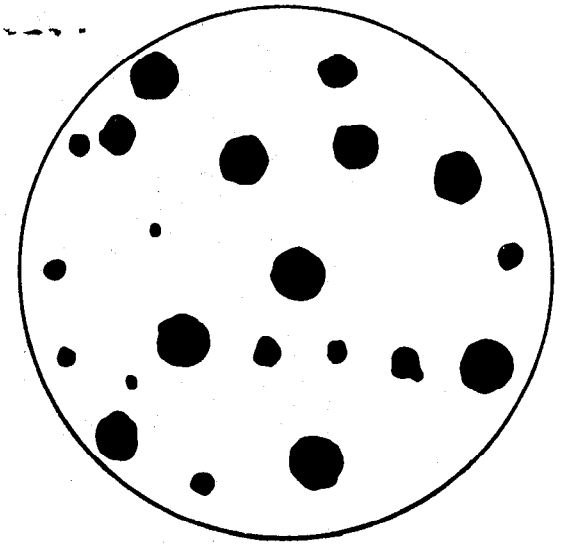
Form III Worm



Form IV Chinese Script



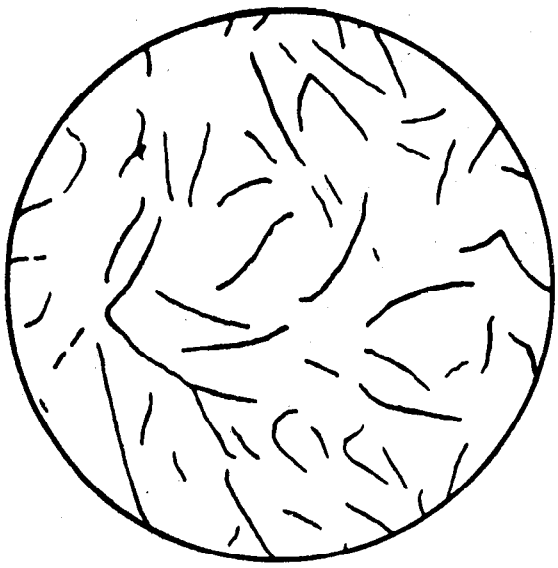
Form V Amœba



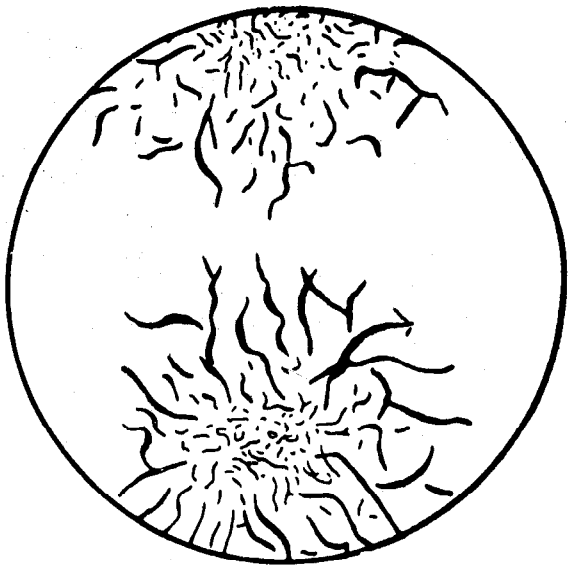
Form VI Round

FIG. 1 REFERENCE DIAGRAM* FOR THE GRAPHITE FORM (DISTRIBUTION A)

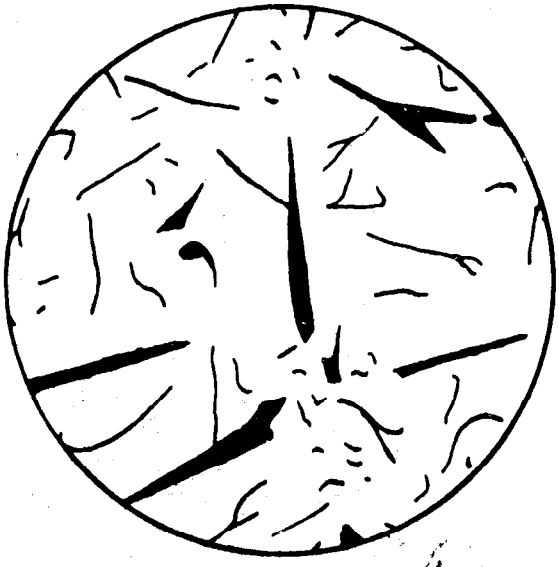
*The diagrams show only the outline and not the structure of the graphite.



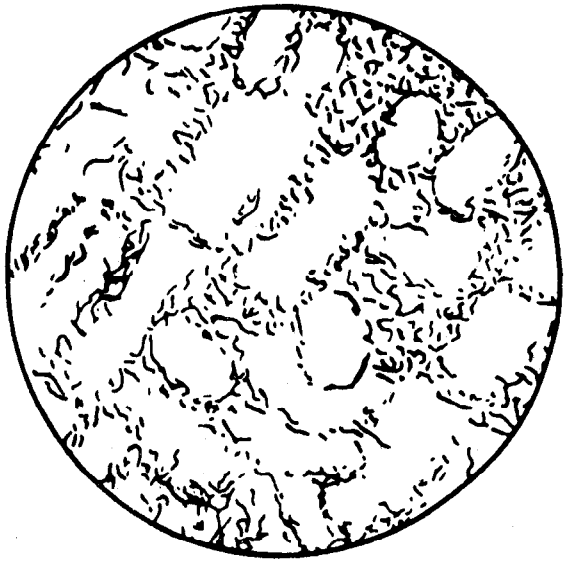
Distribution A Uniformly Distributed Random Flakes



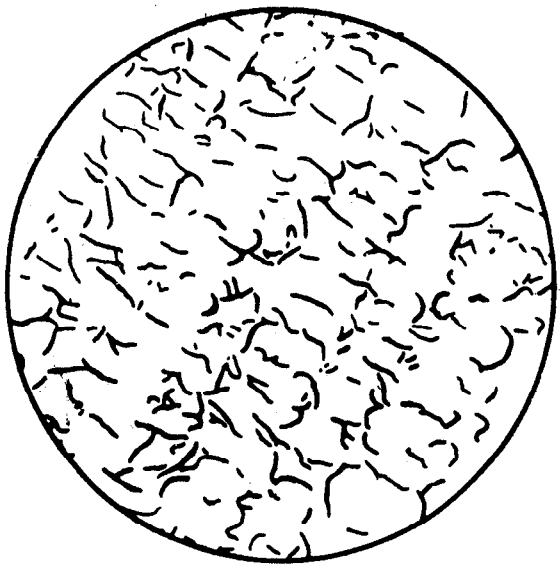
Distribution B Rosset Grouping, Random Orientation



Distribution C Superimposed Flakes, Random Orientation



Distribution D Interdendritic Segregation, Random Orientation



Distribution E Interdendritic Segregation, Preferred Orientation

FIG. 2 REFERENCE DIAGRAM* FOR THE DISTRIBUTION OF GRAPHITE (FORM 1)

*The diagrams show only the outline and not the structure of the graphite.

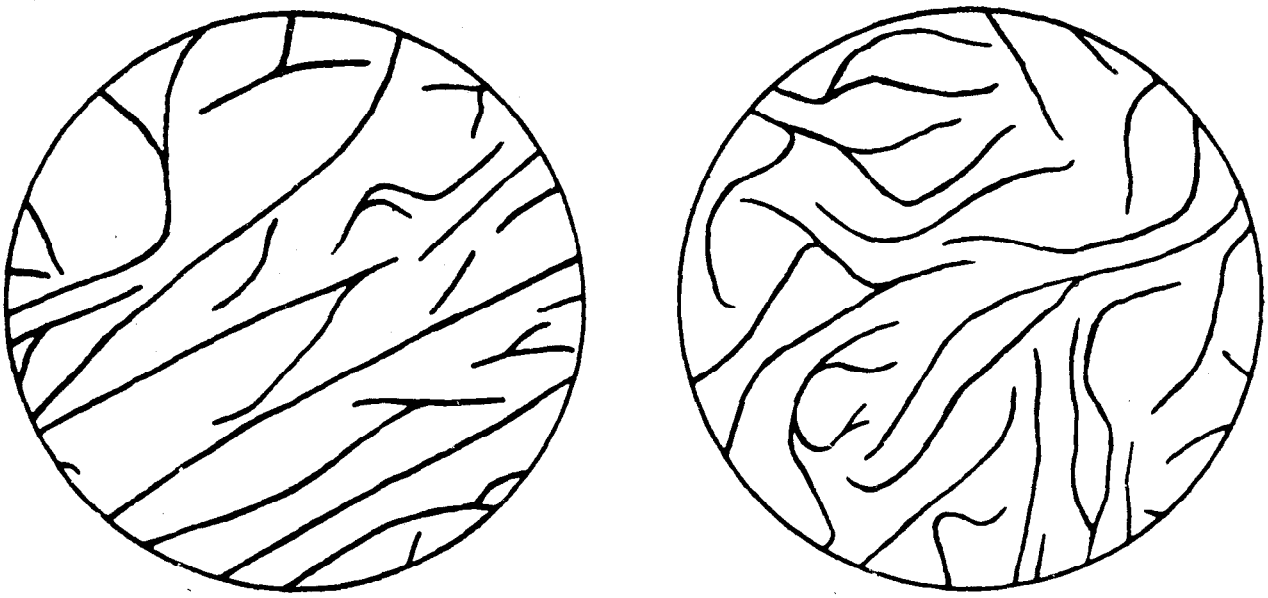


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FIG. 3 REFERENCE DIAGRAM* FOR THE DIMENSION OF GRAPHITE FORM I AND DISTRIBUTION A (100× MAGNIFICATION) — REFERENCE NO. 1 AND 2

*The diagrams show only the outline and not the structure of the graphite.

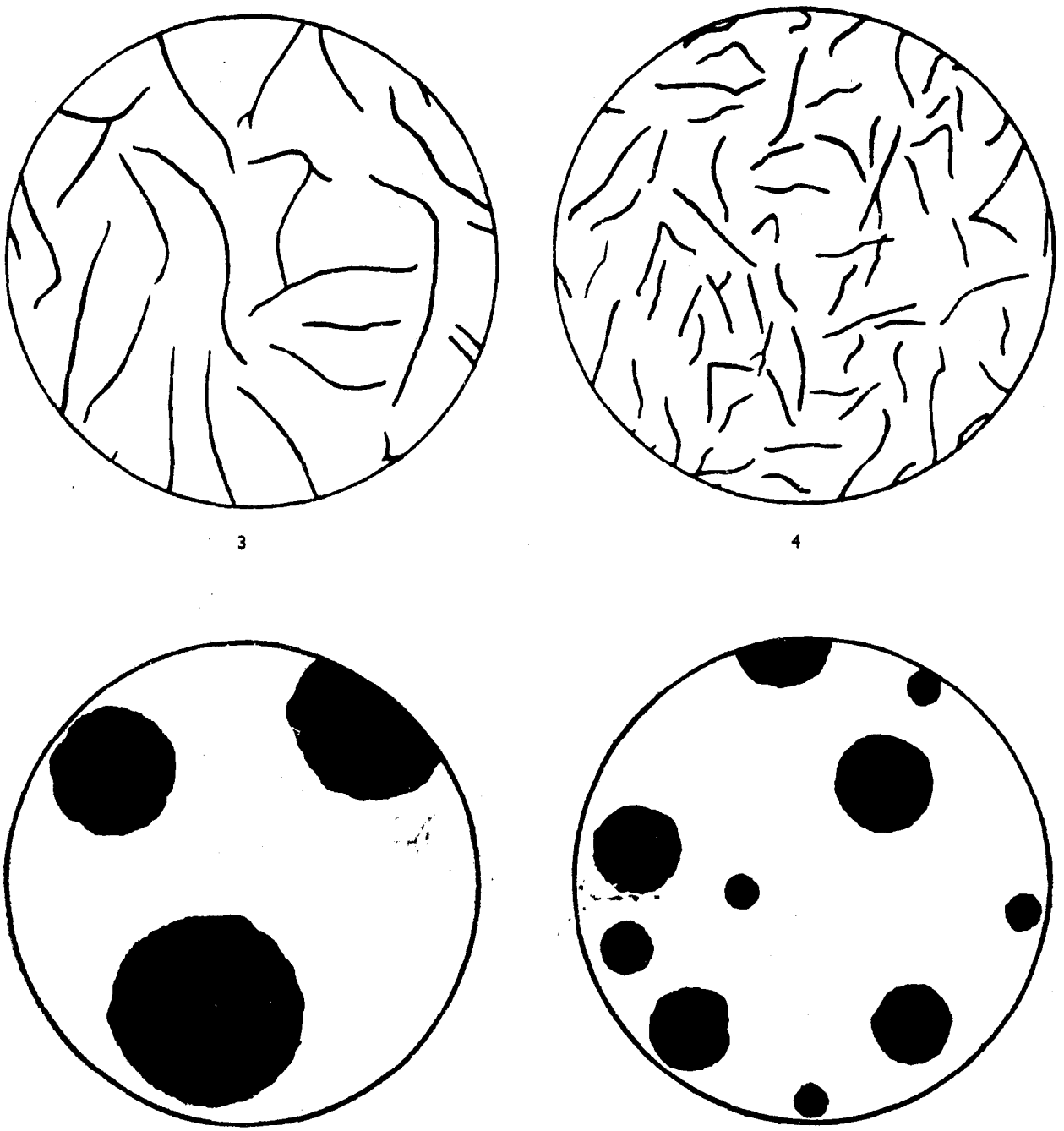
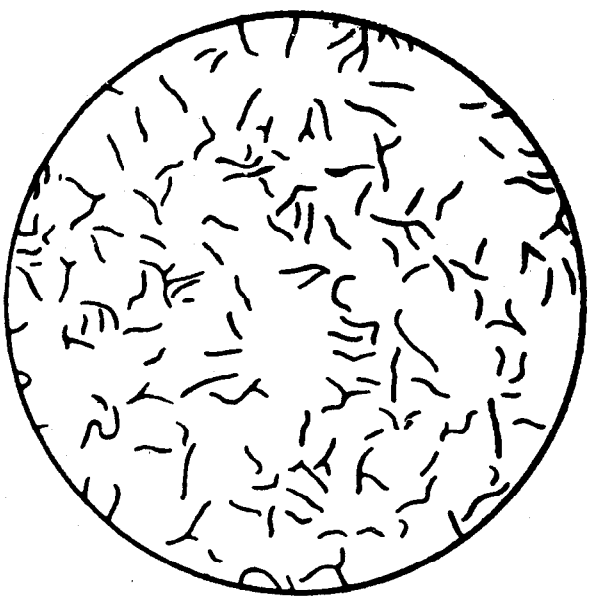


FIG. 4 REFERENCE DIAGRAM* FOR THE DIMENSION OF GRAPHITE FORMS I AND VI AND DISTRIBUTION A (100 × MAGNIFICATION) — REFERENCE NO. 3 AND 4

*The diagrams show only the outline and not the structure of the graphite.



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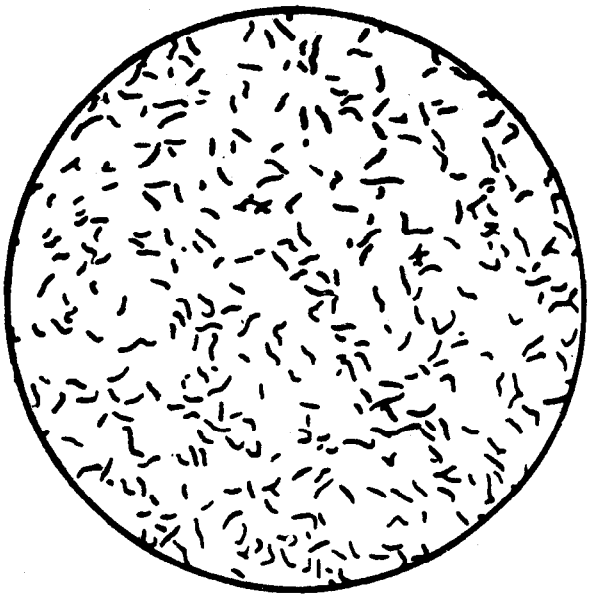

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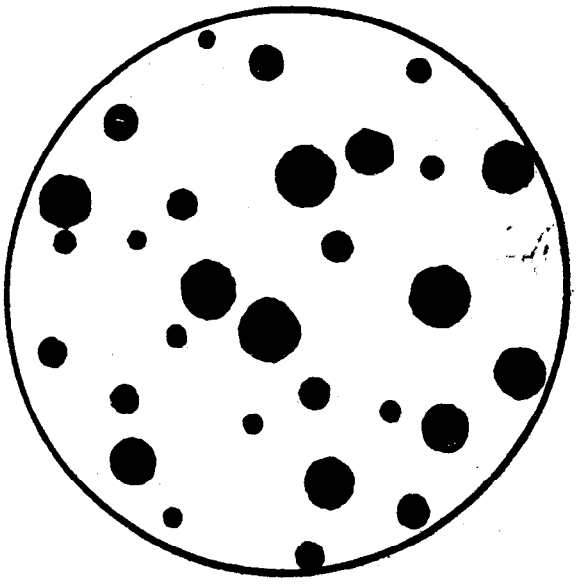


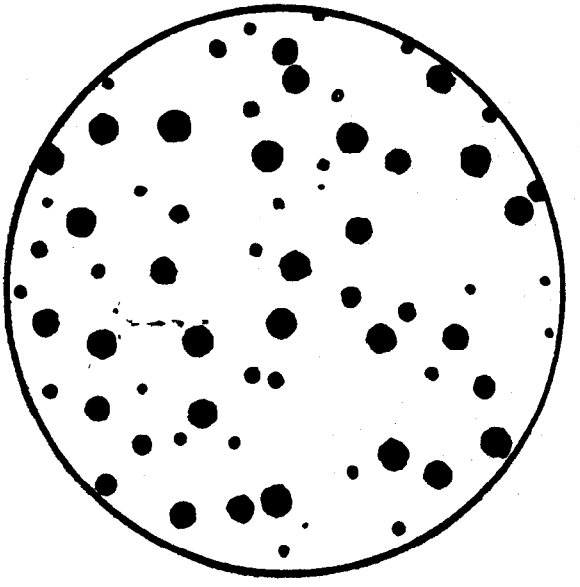
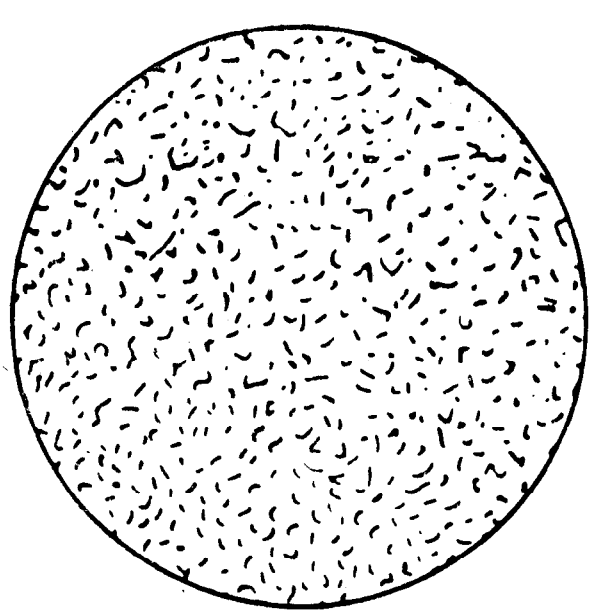


FIG. 5 REFERENCE DIAGRAM* FOR THE DIMENSION OF GRAPHITE FORMS I AND VI AND DISTRIBUTION A (100× MAGNIFICATION) — REFERENCE NO. 5 AND 6

*The diagrams show only the outline and not the structure of the graphite.



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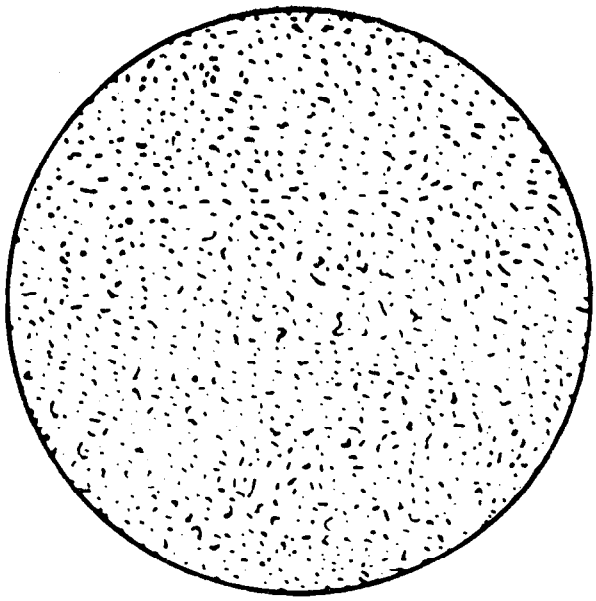

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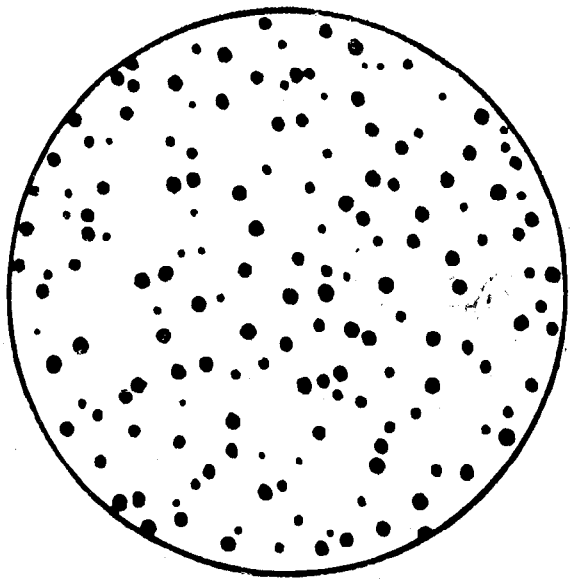

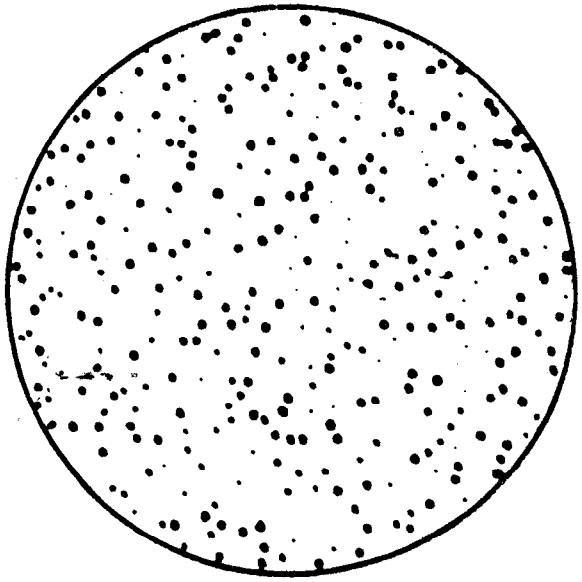

FIG. 6 REFERENCE DIAGRAM* FOR THE DIMENSION OF GRAPHITE FORMS I AND VI AND DISTRIBUTION A (100× MAGNIFICATION) — REFERENCE NO. 7 AND 8

*The diagrams show only the outline and not the structure of the graphite.

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