

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 945

DESIGNATION OF THE MICROSTRUCTURE
OF GRAPHITE IN CAST IRON

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 945, *Designation of the microstructure of graphite in cast iron*, was drawn up by Technical Committee ISO/TC 25, *Cast iron*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question by the Technical Committee began in 1962 and led, in 1964, to the adoption of a Draft ISO Recommendation.

In April 1967, this Draft ISO Recommendation (No. 1196) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Belgium	India	Romania
Brazil	Ireland	South Africa, Rep. of
Canada	Israel	Sweden
Chile	Italy	Switzerland
Czechoslovakia	Korea, Rep. of	Thailand
Finland	Netherlands	Turkey
France	Norway	U.A.R.
Germany	Poland	United Kingdom
Greece	Portugal	Yugoslavia

No Member Body opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in January 1969, to accept it as an ISO RECOMMENDATION.

DESIGNATION OF THE MICROSTRUCTURE OF GRAPHITE IN CAST IRON

1. SCOPE

This ISO Recommendation gives an international designation of the microstructure of graphite in cast iron. It is not intended as a basis for acceptance specifications.

2. GENERAL

- 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),
 - (c) its size (designated by Arabic numerals, see Figures 3 to 6).
- 2.2 The three series of reference diagrams included in this ISO Recommendation, for evaluating the type of graphite, form a 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. This method permits quick identification of the graphite, promotes mutual understanding between technicians in this field, permits clear representation of the findings, facilitates statistical analysis and saves a vast amount of photographic work.
- 2.3 The comparison of the graphite observed with the three series of reference diagrams in Figures 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 When taking specimens from the casting, attention must 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 should be carefully recorded in any report.
- 3.2 The area of polished surface should be sufficient to give a true representation of the graphite distribution. 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 usually 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.

4. MICROSCOPIC EXAMINATION

- 4.1 The polished specimens should be viewed under a microscope so that the entire polished area may be examined. A comparison should first be made with the reference diagrams for the graphite form and distribution (see Figures 1 and 2) and the microstructures observed should then be identified from the corresponding reference diagrams. Following this, the size of the graphite particles is determined at a magnification of 100 diameters, by reference to Figures 3 to 6 inclusive and/or 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. The field of view should have approximately the same size as the reference diagrams (about 80 mm diameter).
- 4.3 The measurement of the graphite particles can be facilitated by the use of suitable calibrated eye-pieces.
- 4.4 The method described above gives good results, but any other method of examination which gives good results may be used.

5. REFERENCE DIAGRAMMS

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, thus avoiding the minor effects which might interfere with the results of the observation.

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 principle types of graphite found in cast iron. However, other forms are also known occasionally to occur.

5.2 Reference diagrams for graphite distribution

The reference diagrams for the graphite distribution (Fig. 2) show five examples designated by the letters A to E.

The diagrams in Figure 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 diameter reproduction scale, sizes are indicated ranging from a maximum dimension of the particle of $> 100 \mu\text{m}$ (size 1) down to $< 1.5 \mu\text{m}$ (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 Figure 1 are used for the form, the capital letters of Figure 2 for the distribution and the Arabic numerals of Figure 3 and Table 1 for the size, in that order. Thus, for example, Type I A 4 means that, with a 100 mm diameter magnification, graphite particles, form I, distribution A, having a maximum dimension of 12 to 25 mm, have been observed.

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

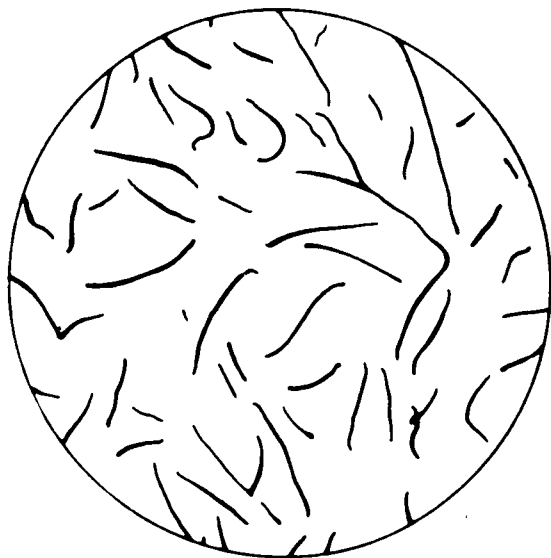
- 6.3 Mixed structures with different types of graphite may be defined by estimating the percentage proportion of the different types of graphite : for example,

$$60 \% \text{ I A } 4 + 40 \% \text{ I D } 7$$

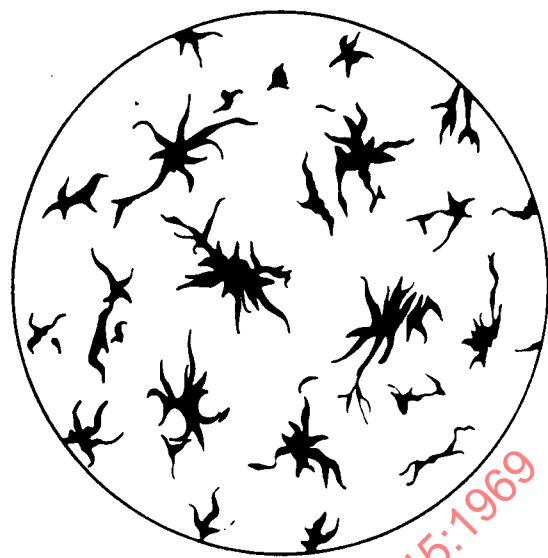
means 60 % graphite of the form I, distribution A and size 4, and 40 % graphite of the form I, distribution D and size 7.

TABLE 1 – Dimension of the graphite particles forms I to VI

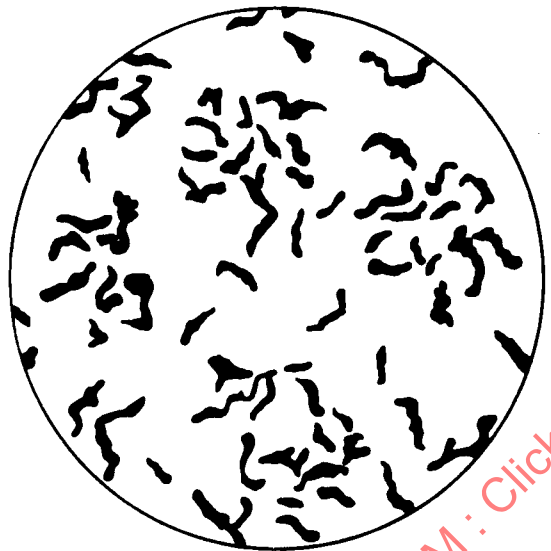
Reference number	Dimension of the particles observed at $\times 100$ magnifications	True dimension
	mm	mm
1	> 100	> 1
2	50 to 100	0.5 to 1
3	25 to 50	0.25 to 0.5
4	12 to 25	0.12 to 0.25
5	6 to 12	0.06 to 0.12
6	3 to 6	0.03 to 0.06
7	1.5 to 3	0.015 to 0.03
8	< 1.5	< 0.015



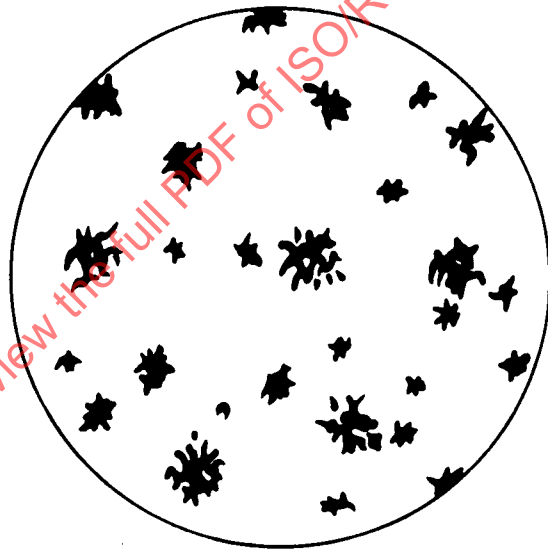
Form : I



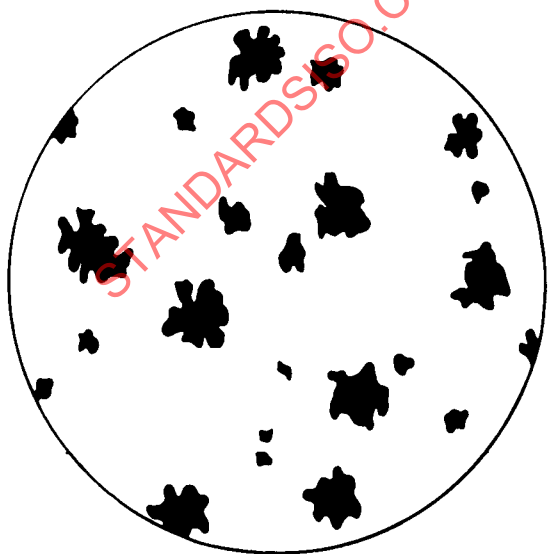
II



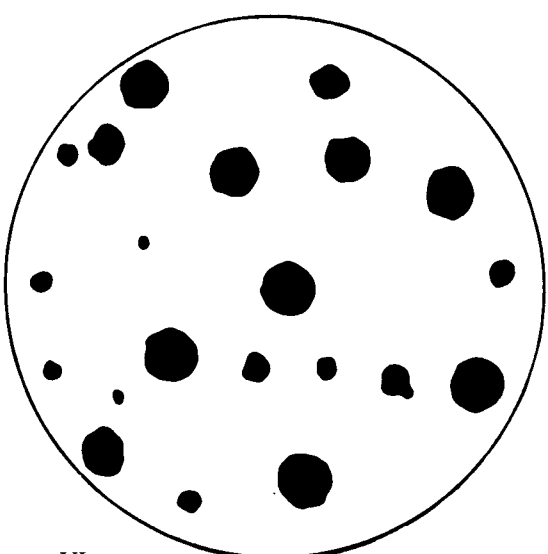
III



IV



V



VI

FIG. 1 – Reference diagram* for the graphite form (Distribution A)

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

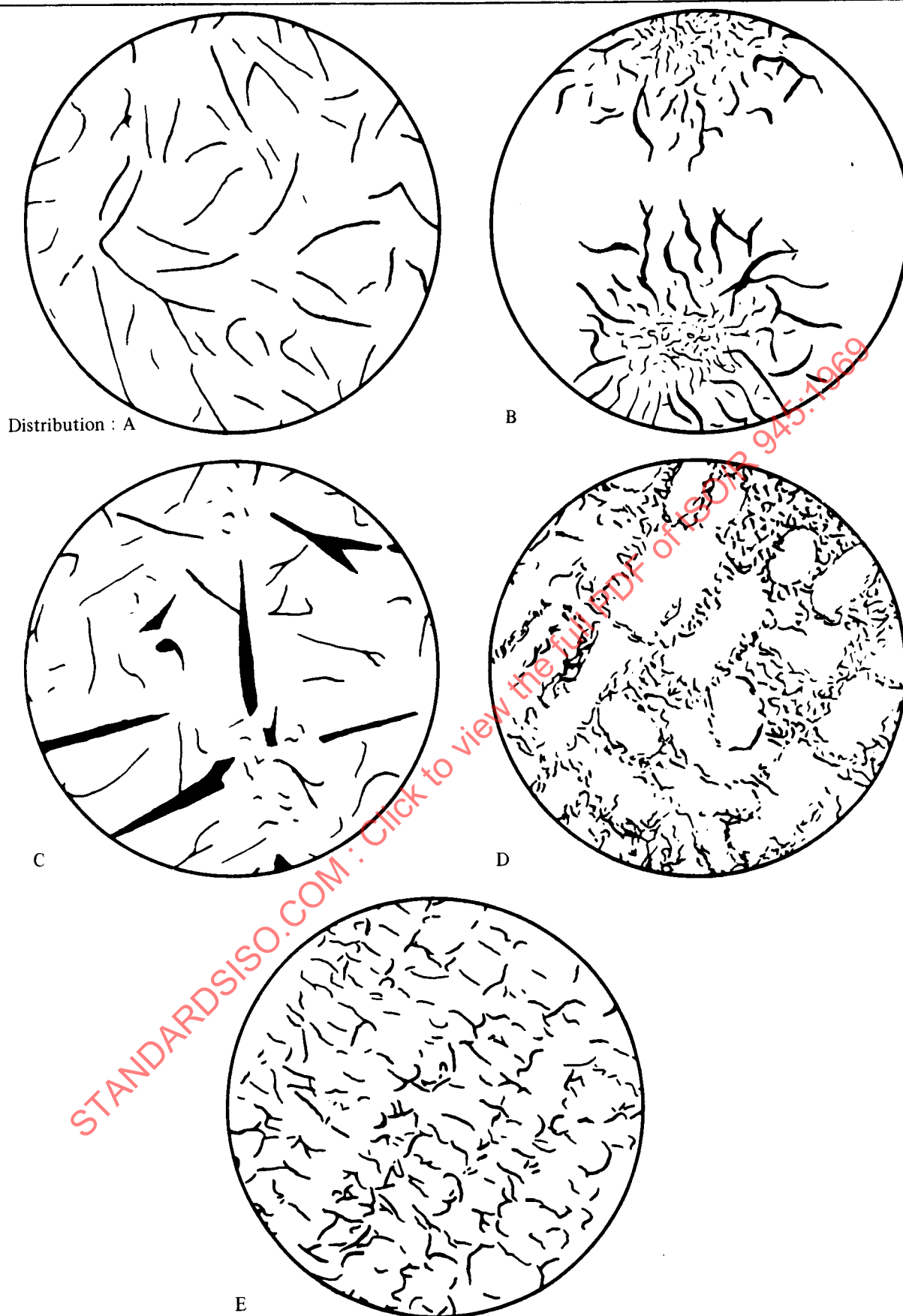


FIG. 2 – Reference diagram* for the distribution of graphite (Form I)

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

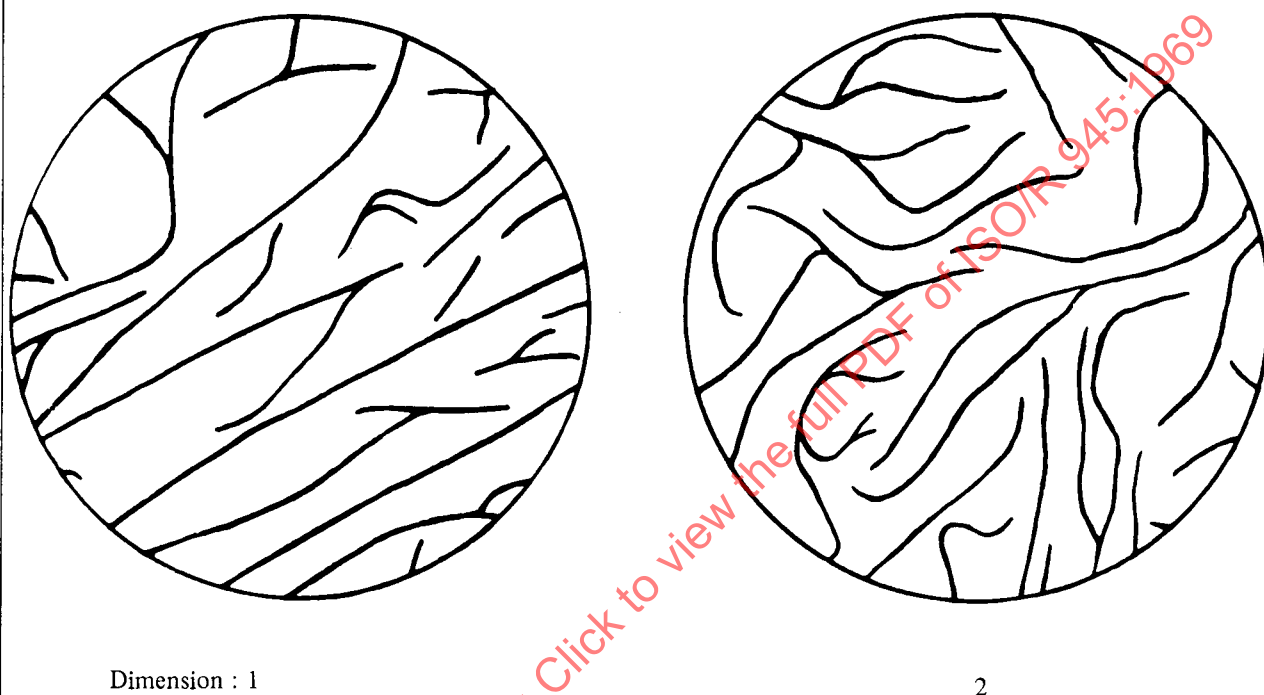


FIG. 3 – Reference diagram* for the dimension of graphite form I and distribution A
($\times 100$ magnifications) – Reference Nos. 1 and 2

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

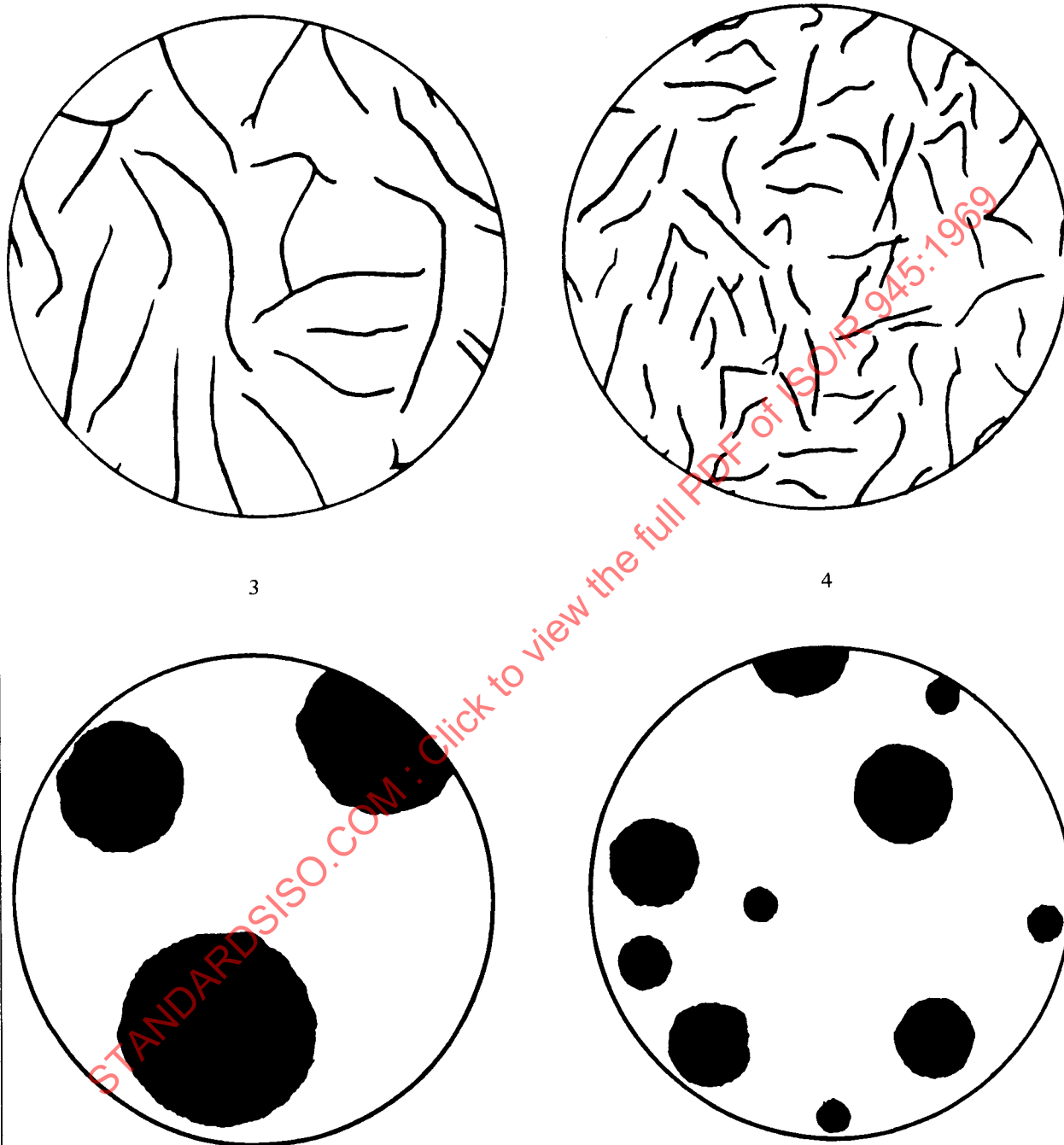


FIG. 4 – Reference diagram* for the dimension of graphite forms I and VI and distribution A
(X 100 magnifications) – Reference Nos. 3 and 4

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