

File

FILE COPY

O T T A W A

July 25th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1687.

The Determination of Austenitic Grain Size
in SAE 9255 Steel.



(Copy No. 10.)

O T T A W A

July 25th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1687.

The Determination of Austenitic Grain Size
in SAE 9255 Steel.

Origin of Request and Object of Investigation:

On July 6th, 1944, Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Toronto, Ontario, submitted Requisition No. 831 requesting the determination of austenitic grain size of various samples of track pin steel (A.E.D.B. Lots Nos. 1050, 1106 and 1112, Report R.220, Test 27) and the outlining of a procedure for determining these grain sizes.

Different Methods of Determining the Austenitic Grain Size
on SAE 9255 Steel:

1. - Etching with Vilella's Reagent (1 gr. picric acid,
5 cc. HCl, 95 cc. ethyl alcohol).

The etching can be done on two different structures:

- a) On "as quenched" martensite, the previous austenitic grain boundaries will be outlined by "differential etching of the larger martensite needles along the grain boundaries".
- b) On a tempered martensite structure, the austenite grains will be shown by "imparting different shades or colour to different grains".

Vilella suggests a tempering of $\frac{1}{2}$ hour at 600° F.

However, the tempering can be performed by partially heating the microspecimen during the cutting operation. This technique provides structures, tempered at various temperatures, which after polishing and etching give a good selection for spots of successful etching. A photomicrograph of the result of this technique is shown in Figure 1.

This method, due to its simplicity, is recommended as a check on methods which will be outlined in the following sections.

2. - Isothermal Transformation -

The precipitation of ferrite at the austenite grain boundaries provides another method for the determination of grain size. A successful outlining of the austenite grain boundaries was performed by an isothermal annealing operation ($\frac{1}{2}$ hour at 1250° F.). Figure 2 shows the result. It will be noticed that the ferrite network is not quite complete and is very thin. This is due to the fact that SAE 9255 is close to eutectoid composition.

3. - The Fracture Test -

In Information Memorandum No. 113 (June 21st, 1944), the fracture test was suggested as a simple and reliable procedure

(Different Methods of Determining the Austenitic Grain Size
on SAE 9255 Steel, cont'd) -

for the determination of austenite grain size. Due to the fact that no microscopic examination is needed, this test would seem ideal as a routine inspection procedure.

Recommended Procedure for Fracture Test:

1. Give one pin the same austenizing treatment as in standard production.
2. Notch the pin with a water-cooled friction wheel to a depth of 1/16". The notch radius should not exceed 3/32".
3. Break the martensitic (untempered) pin by transverse impact. The notched side should be exposed to tensional stresses. The drop impact machine can be used for breaking the pins. The usual height (approximately 8 feet) of dropping weight is recommended.
4. The comparison of fractures should be done preferably, with the standards established by Shepherd. Sets of fracture standards can be purchased from The Thermist Company, Phillipsburg, New Jersey. However, where these sets are not available, comparison with fractures obtained on pins of known grain sizes can also be done.

(N.B.: The theoretical background of this recommended practice will be contained in an information memorandum now under preparation.)

Results Obtained on Submitted Pins:

The grain size of the submitted pins has been measured by the isothermal annealing method and checked with Vilella's etching method and the fracture test. The same results were obtained from all methods.

(Continued on next page)

(Results Obtained on Submitted Pins, cont'd)

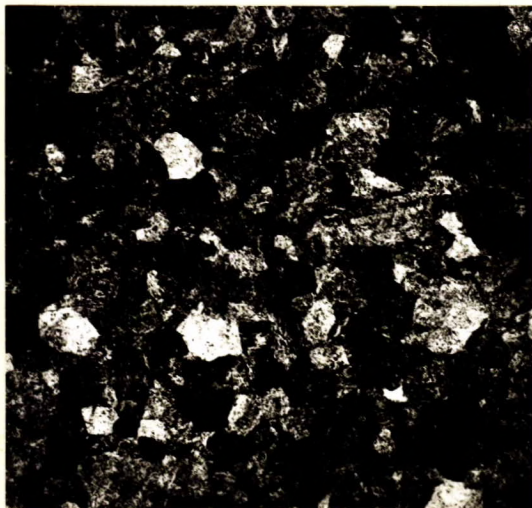
<u>Lot No.</u>	<u>A.S.T.M.</u> <u>Grain Size</u>
1050	5
1106	4
1107	4
1108	4 - 4½
1109	4½
1110	4
1111	4
1112	3½

Note: All the pins were austenitized for $\frac{3}{4}$ hour at 1625° F.

oooooooooooo
oooooo
oo

AD:GHB.

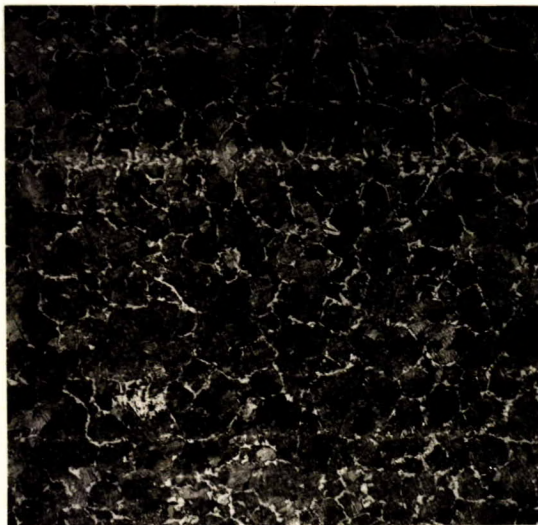
Figure 1.



X100.

VILELLA'S TEMPERED MARTENSITE ETCH,
ON LOT NO. 1108; A.S.T.M. GRAIN
SIZE NO. 4.

Figure 2.



X100, nital etch.

SHOWING THE OUTLINING OF THE
AUSTENITE GRAINS BY THE PRO-
EUTECTOID FERRITE NETWORK.