

Title

O T T A W A December 13th, 1943.

R E P O R T
of the
ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1553.

Examination of Six Macro-Etched Samples
of Steel Bars for 17-Pdr. A/P Shot.

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Origin of Samples and Object of Investigation:

On December 8th, 1943, under Analysis Requisition No. O.T. 4112, Mr. H. H. Scotland, for the Inspector General, Inspection Board of the United Kingdom and Canada, Ottawa, Ontario, submitted (with letter, File No. 4/4/4) six samples of $3\frac{1}{4}$ -inch-diameter A/P shot steel received by him from Mr. J. O. Swan, Inspector of Materials, I.B.U.K. & C., New York. It was said that rounds were taken from six ingots of three heats.

These pieces had been macro-etched by the Crucible Steel Company, of Midland, Pa., which, it is reported, made the steel. The pieces were marked as follows: 33384, AA4; 33384, AA16; 33385, AA3; 33385, XA36; 73365, AA2; and 73365, AA18. Evidently the first set of numbers indicates the heat, the letters indicate the cut in bloom stage and bar stage respectively, and the last number indicates the ingot.

It was thought, from the appearance of the etches, that the steel might be porous or burnt. For this reason the above samples, said to be typical, were submitted with the request that the nature of the condition seen in the etches be investigated.

Macro-Examination:

The etches evidently had been made some time ago and the steel surface had rusted. Therefore, Samples 33385-AA3, 33385-XA36, and 73365-AA2 were reground and re-etched. A centre condition typical of several of the samples was noticed in 73365-AA2 (shown in Figure 1). A rather widespread rough appearance was found in 33385-XA36. This latter sample was then normalized for one hour at 1550° F. and re-etched, but no change in appearance was noticed.

Figure 1.



SECTION FROM 73365-AA2.

(Approximately to size).

Representative sections were sulphur-printed but no evidence of sulphur segregation was found.

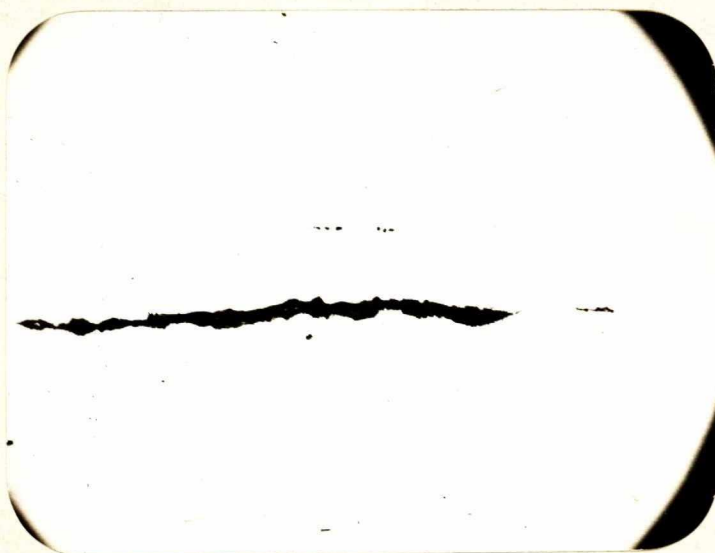
Micro-Examination:

Samples for microscopic examination were removed from 33384-AA16, 33385-AA3, 33385-XA36 at the points of greatest apparent deep-etch attack. No indications of overheating or

(Micro-Examination, cont'd) -

porosity were found. The inclusion content of the steel as a whole was higher than usual, with the inclusion content of 33385-XA36 noticeably the highest. Figure 2 is a photomicrograph of the largest inclusion found in 33385-XA36. Figure 3, from the central portion of 33384-AA16, shows an inclusion content typical of the other samples examined.

Figure 2.



X100, unetched.

SAMPLE FROM 33385-XA36.

Figure 3.



X100, unetched.

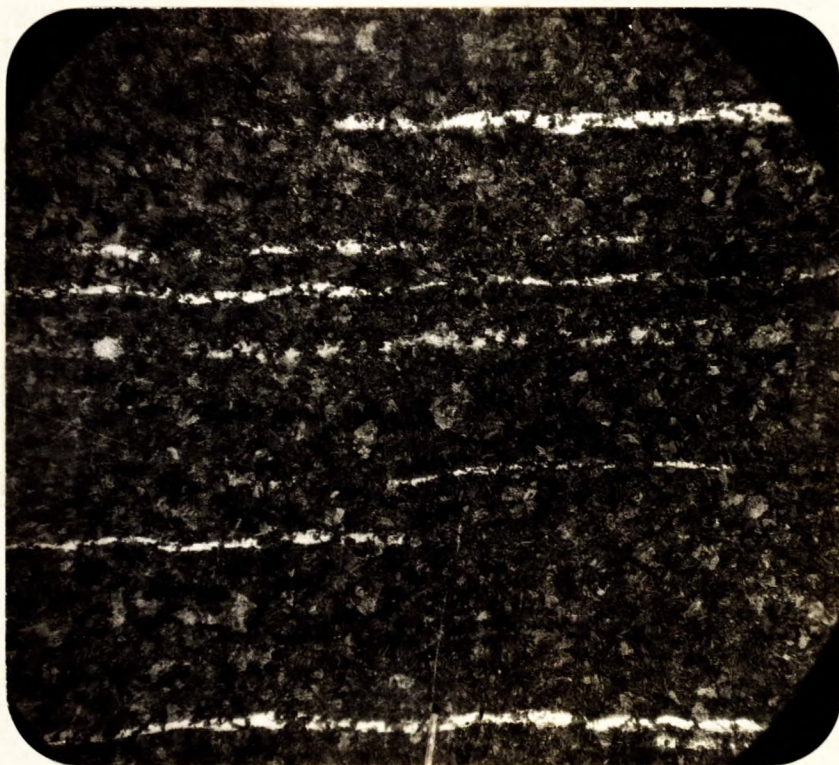
SAMPLE FROM 33384-AA16.

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(Micro-Examination, cont'd) -

Etching the samples showed some banding to be present. This is shown, at 30 diameters, in Figure 4.

Figure 4.



X30, nital etch.
SAMPLE FROM 33384-AA16.

Discussion of Results:

The centre condition (particularly noticeable, after etching, in 33384-AA16 and 73365-AA2) was evidently caused by central segregation or inhomogeneity. This is frequently found in ingots well below the normal crop. Incidentally, ingots that showed the worst condition were from upper cuts. Also, it might be noted that Canadian steel made for the same application had fairly similar deep-etching properties. In the rolled samples examined this centre condition did not indicate overheating or porosity.

The general roughness of 33385-XA36 after etching

(Discussion of Results, cont'd) -

is believed to have been caused by the rather large inclusions present in it. According to designation, this sample came from an ingot poured later in the heat than 33385-AA3 and this probably accounts for the large amount of inclusions.

The bandings noticed (apparently ferrite) will undoubtedly largely disappear in the heat treatment of the shot.

Summary:

With the possible exception of one sample high in inclusions, the steel appeared satisfactory.

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