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O T T A W A February 23, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1800.

Metallurgical Examination of Steel Base Plate Blanks for 5.5-inch Shells.

(Copy No. 10.)

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Source of Material and Object of Investigation:

On February 15, 1945, three steel base plate blanks for 5.5-inch shells were received for examination, from Mr. H. H. Scotland, Inspector of Materials, Inspection Board of United Kingdom and Canada, Ottawa, Ontario.

An accompanying analysis requisition, No. O.T. 4330 (File Reference 12/4/1), requested that a full metallurgical examination be carried out on the steel in order to determine its soundness and quality. It was stated that the base plate had been subjected to the same pressure as the shell and it was desired to know whether any observed defects would be detrimental to the functioning of the component part. It was also stated that the base plates submitted were cold stamped from cold-rolled steel, 9/16 in. x 4 in. plates.

Macro-Examination:

A visual examination of the three base plates submitted showed a number of very faint lines across the machined surface of the metal. The plates were then magnafluxed. However, no cracks or flaws were revealed in this test. One of the plates was next given a deep etch in a hot solution of 50 per cent hydrochloric acid in water. Figure 1 shows the structure of the plate after a deep etch.

Figure 1.

STRUCTURE OF PLATE AFTER DEEP ETCH.

(Approximately 2/3 size).

Chemical Analysis:

Drillings were taken from one of the plates for chemical analysis. The results obtained are given in Table I.

TABLE I.

		Per Cent
Carbon	-	0.27
Manganese	-	0.91
Silicon	-	0.03
Phosphorus	-	0.032
Sulphur	-	0.067
Chromium	-	N.d.
Nickel	-	N.d.
Molybdenum	-	N.d.

N.d. = None detected.

(Note: Chemical composition not specified.)

Mechanical Tests:

Tensile and Charpy impact specimens were prepared from samples of the plate in the "as received" and "after quenching and drawing" conditions. The results obtained are given in Table II.

TABLE II.

	"AS RECEIVED"	QUENCHED IN WATER AT 1600° F. AND TEMPERED AT 1200° F.	SPECIFIED
Ultimate stress p.s.i. -	74,200	75,200	62,720
Yield stress(s), p.s.i. -	54,800	61,500	
Elongation, per cent in 1 inch -	34.0*	31.0*	17.0′
Reduction in area, per cent -	59.6	72.6	
Brinell hardness -	143	156	
Charpy impact, ft.-lb. -	16**	29**	

(s.) Determined by the dividers method.
* Longitudinal to direction of rolling.
** Transverse to direction of rolling.
′ Per cent in 4 times square root of area.

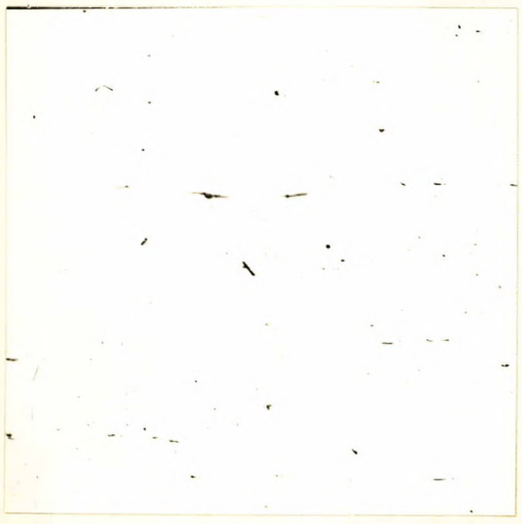
Microscopic Examination:

Specimens of the steel plate were prepared for microscopic examination. Figure 2 is a photomicrograph, at X100 magnification, showing the elongated sulphide inclusions observed in the steel.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 2.



X100, unetched.

Note elongated sulphide inclusions.

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The nital-etched structure of the steel is shown in Figure 3. The structure consists of pearlite, the iron-iron carbide constituent, the dark etching material, and ferrite, the iron constituent, the light etching material. The steel has a slightly banded structure. Elongated sulphide inclusions can be seen in the ferrite bands.

Figure 3.

X100, etched in 2 per cent nital.

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Discussion of Results:

The steel was found to have a chemical composition similar to that of an SAE 1025 steel except for the sulphur content which was above the upper limit. The surface markings observed in the steel are associated with banding, banding being caused by the precipitation of ferrite around inclusions. The ferrite of these bands will have a distinctly higher phosphorus content than that of the steel as a whole. This local concentration of phosphorus is one of the reasons for the transverse weakening produced by the banded structure. Charpy impact tests carried out on a transverse specimen cut from one of the plates in the "as received" condition showed that its impact strength was fairly low. A quench from 1600° F. and a 1200° F. draw heat treatment carried out in these Laboratories on a sample of this steel did not remove the banded structure, but the impact and yield strength were improved considerably without any appreciable sacrifice of ductility.

The results of this investigation show that:

1. The steel has a high sulphur content.

2. Its impact strength, while not specified, is low.

3. The steel has the specified tensile strength and elongation.

4. Experimental tests showed that all these properties could be improved by a quench-and-draw heat treatment.

5. The steel, although in none too good condition, should prove satisfactory for the intended application.

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