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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1905.

Metallurgical Examination of an Experimental Jungle Track Shoe Steel Casting.

(Copy No. 14.)

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Source of Material and Object of Investigation:

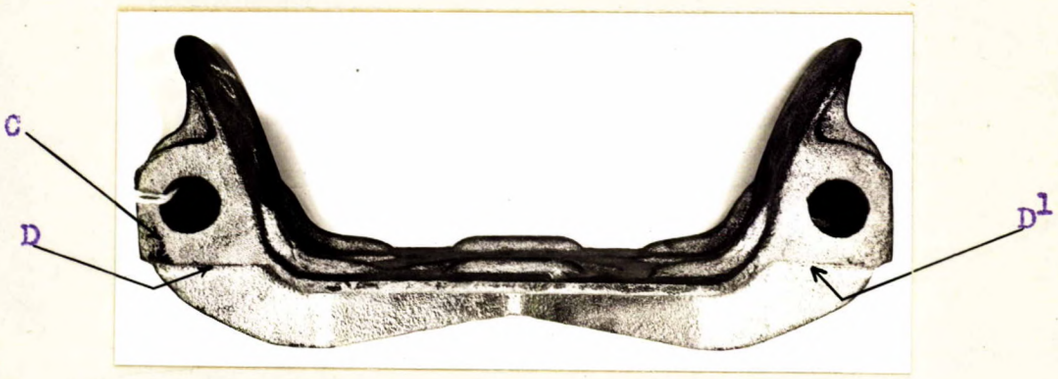
On July 5, 1945, the Directorate of Metallurgy of the Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted for examination a sample experimental jungle track shoe casting, DVSA-B-25. A complete metallurgical examination was requested in order to determine the quality of the material. The request for this work was covered in Requisition No. 1000, A.E.D.B. Lot No. 593, Report No. 13, Test No. 77.

Macro and X-Ray Examinations:

Figures 1 and 2 are photographs showing two views of the track. Figure 3 is a photograph showing a shrinkage cavity in a section cut through the web of the casting at A in Figure 2. Small shrinkage cavities were also observed in the X-ray film at points D and D^1 in Figure 1.

The radiography of the casting was done by the National Research Council, and the film is attached to one copy of this report.

Figure 1.



SIDE AND TOP VIEW OF TRACK.

(Approximately 1/3 actual size).

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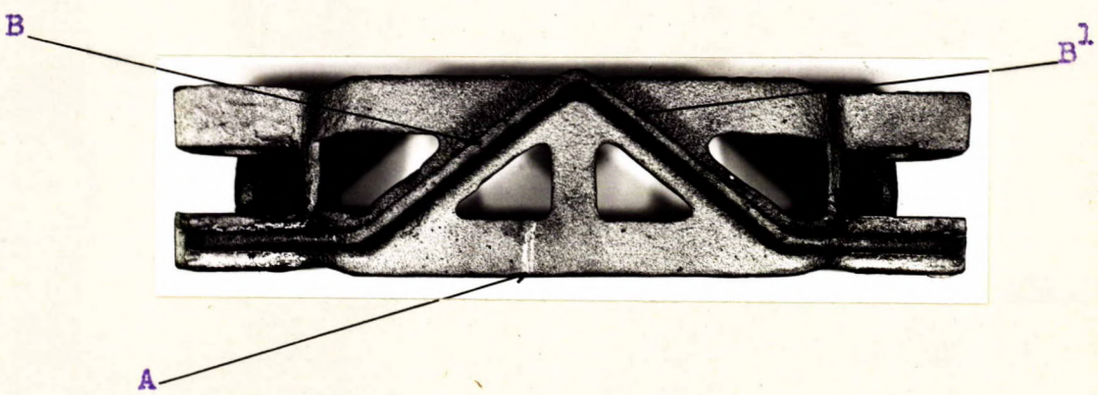
Figure 2.



BOTTOM VIEW OF TRACK.

(Approximately 1/3 actual size).

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(Macro and X-Ray Examinations, cont'd) -

Figure 3.

SHRINKAGE CAVITY AT A, FIGURE 2.

(Approximately twice actual size).

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Chemical Analysis:

Drillings taken from the casting had the following chemical composition:

		Per Cent
Carbon	-	0.36
Manganese	-	0.80
Silicon	-	0.19
Phosphorus	-	0.063
Sulphur	-	0.040
Chromium	-	0.09
Nickel	-	0.15
Molybdenum	-	0.05
Vanadium	-	Nil.
Copper	-	0.11

Mechanical Properties:

Two tensile and one Izod impact specimens machined from the casting had the following mechanical properties:

(Continued on next page)

(Mechanical Properties, cont'd) -

Location of Sample	Size of Test Piece, inch	Ultimate Stress, p.s.i.	0.2 Per Cent Proof Stress, p.s.i.	Elongation per cent 4 area	Reduction in area, per cent	Brinell Hardness Number
B, Fig. 2.	0.498 X 0.209	143,200	133,600	5.5*	7.7	285
B, Fig. 2.	0.498 X 0.178	142,000	128,100	5.8	7.9	285
Specified***	--	115,000	90,000	17.0	-	250 -290

	Izod, ft-lb.	
C. Fig. 1.	17.0**	277
Specified***	20.0	

* Per cent in 1 inch.

** Sampled adjacent to eye hole.

*** Specified by Otis Fensom but not necessarily present in the casting submitted.

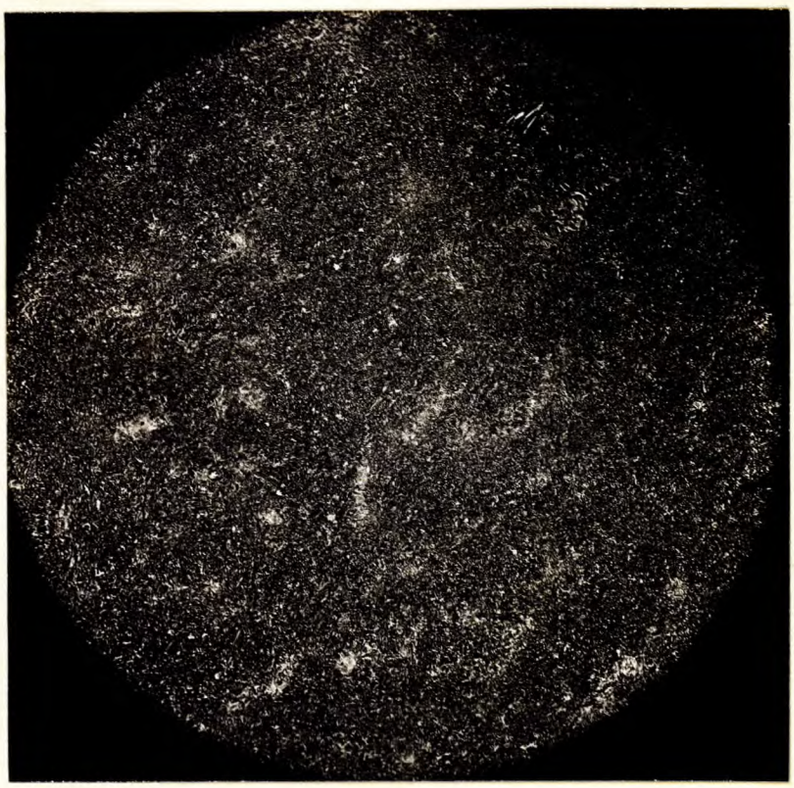
Microscopic Examination:

A specimen cut from the casting was given a metallographic polish and examined under the microscope in the unetched condition. The steel was found to be fairly clean. After etching in a solution of 2 per cent nitric acid in alcohol, the steel was re-examined. Figures 4 and 5 are photomicrographs showing the nital-etched structure of the steel at X100 and X500 magnifications respectively. The structure consists of tempered martensite with small amounts of free ferrite. It will be noted in Figure 4 that the dendritic structure has not been completely eliminated in the quench-and-draw heat treatment of the casting.

(Continued on next page)

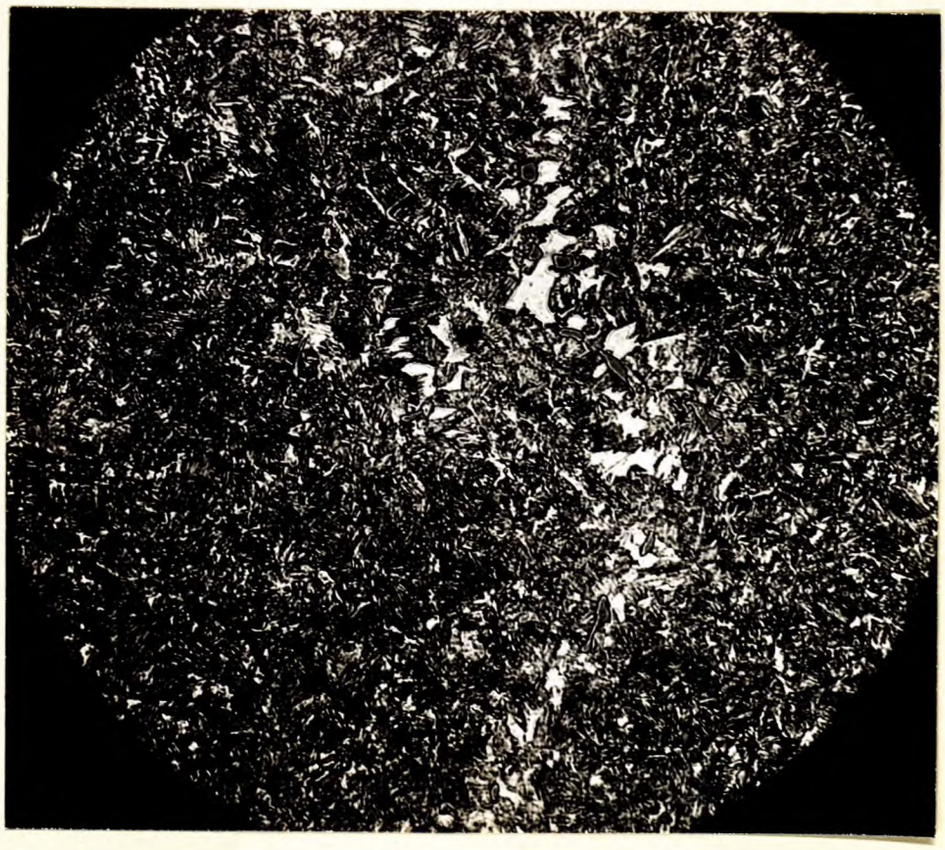
(Microscopic Examination, cont'd) -

Figure 4.



X100, etched in
2 per cent nital.

Figure 5.



X500, etched in
2 per cent nital.

Discussion of Results:

The casting submitted was found to have a chemical composition similar to that of a medium carbon cast steel. The steel was fairly high in phosphorus. Low sulphur and phosphorus are desirable in steel castings in order to safeguard against brittleness. The phosphorus and sulphur should be held by specification to a maximum of 0.05 and 0.060 per cent respectively. The chromium, nickel, molybdenum and copper contents are considered as residuals and probably originated in the scrap.

The macro and X-ray examinations showed the casting to contain several shrinkage cavities. The elimination of these defects is a foundry problem and can be corrected by the use of suitable chills and risers.

The hardness of the steel was within the range specified. The tensile and yield strengths also meet the specification. However, its elongation was considerably lower than the value specified. The impact strength was only slightly less than required.

The microscopic examination showed that the steel was fairly clean. The structure of the steel indicated that the casting had received a quench-and-draw heat treatment. The presence of free ferrite indicates a poor quench. A more rapid quench would prevent the precipitation of ferrite in the quenching operation. The ductility could be improved by tempering at a higher temperature, without lowering the tensile and yield strength below the values specified.

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