O T T A W A November 29th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1126.

Examination of a Defective Valentine Tank Manganese Steel Track Link.

(Copy No. 5.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A November 29th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1126.

Examination of a Defective Valentine Tank Manganese Steel Track Link.

Origin of Material:

On November 15th, 1941, under I.B.U.K. Analysis Requisition No. J.M.G.1190, Mr. R. Boult, of the Inspection Board of the United Kingdom and Canada, 58 Lyon Street, Ottawa, Ontario, sent in a Valentine No. 7 Tank track link for examination as to cause of failures.

Macro-Examination:

Two identification marks appeared on the link: the letter H and the pattern number 2(?)2646T. Figure 1 shows the link as received. One of the end bearing holes is torn open while the other is partially broken. As seen in Figure 2 (natural size), failure has started on this latter bearing. A longitudinal flaw extending along the entire length of the bearing reveals two surfaces (one curved outside, the other inside) which were adhering only at one spot. A similar discontinuity in the material is also found extending approximately one inch from the inner portion of the other bearing (Figure 3, natural size). The surface of the track link appeared bright and polished, indicating that the casting had been in service for some time.

Chemical Analysis:

The steel analysed as follows:

		Per cent
Carbon	-	1.21
Manganese	-	8.88 (average of 4 determinations)
Silicon	-	0.24
Sulphur	-	0.008
Phosphorus	-	0.040

PHYSICAL TESTS:

Hardness Test.

The hardness of the steel (by the Vickers method, with a 30-kilogram load) averaged 183 on various core sections.

Bend Test.

No bend test was made, since the link had been partially broken in service.

..

Microscopic Examination:

A sample, cut from the bearing which had been torn open, was given a metallographic polish and etched in a solution of 2 per cent nitric acid in alcohol. Figure 4 (magnification X100) shows the steel structure on the section near the rounded-off edge of the flaw. It consists of grains of austenite (a solid solution of iron and carbon) which are large in size. The small dark particles are inclusions. No free cementite appears in this microphotograph.

Discussion of Results:

Macro-examination of the casting reveals the presence of "cold shut". This flaw would originate while pouring and would be due to the freezing of one surface before the other metal flows over it, thus causing a lack of continuity in the structure of the material.

The composition of austenitic manganese steel that is sufficiently strong and tough for the severe service required lies within the following limits:

		Per cent
Carbon	-	1.00 to 1.40
Manganese	-	10 per cent minimum (recommended, 12.5 to 13.0).
Silicon	-	0.30 to 1.00
Sulphur	-	0.05 (max.)
Phosphorus	-	0.10 (max.)

The manganese content of the material is too low. Such a steel, having 1.2 per cent carbon and 8.8 per cent

(Discussion of Results, cont'd) -

manganese, will exhibit, in a quenched condition, poor strength, poor toughness, and poor wearing quality. Furthermore, for such a steel a higher quenching temperature is required to put the carbide into solution in the austenite in order to form a uniform austenitic structure.

Summary and Conclusions:

1. The metal is too low in manganese. This condition will reduce its strength and toughness. It is possible that the manganese content of the metal is dropping at the end of the pour, due to manganese passing into the slag.

2. The casting under examination reveals a defect, known as "cold shut", which caused its failure in service. Such a defect is due to a lack of fluidity, most likely resulting from pouring the metal too cold.

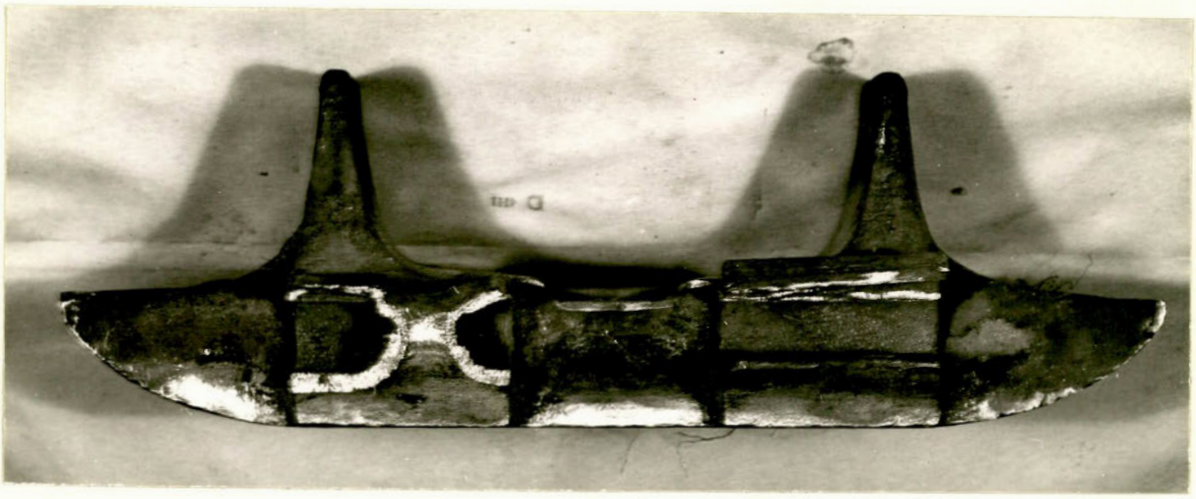
Recommendation:

It is recommended that a test such as the stethoscopic test be developed in order to readily identify by the sound the defective castings before use. In doubtful cases more expensive tests, such as X-ray or gamma ray examination, might also be used.

oooooooooooo
ooooooo
o

RP:PES.

Figure 1.

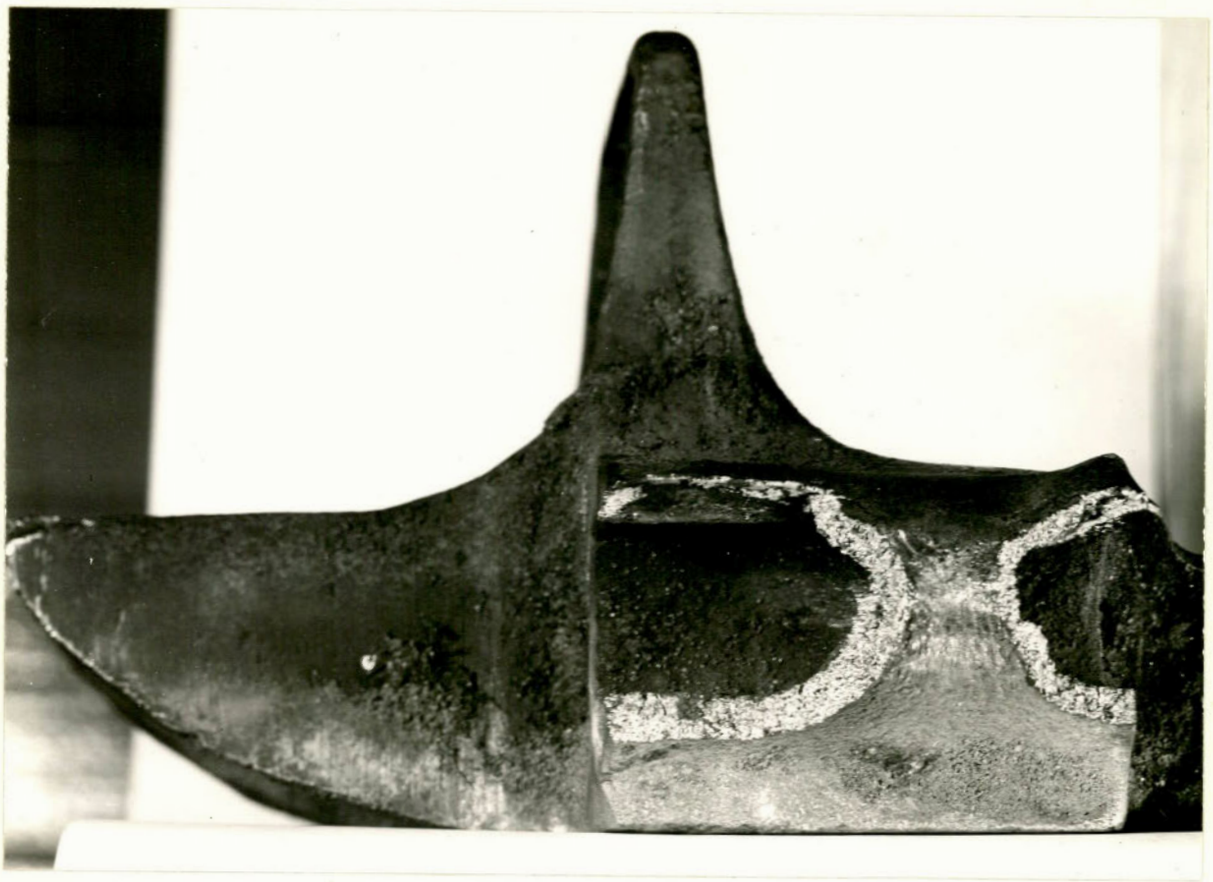


Track Link As Received.
(Approximately 1/6 size)

Figure 2.

Bearing Hole Torn Open Due to Cold Shut.
(Natural size)

Figure 3.



Bearing Hole Partially Broken Due to Cold Shut.
(Natural size)

Figure 4.

X100, nital etch.

Section taken from bearing.

RP:PES.