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O T T A W A October 20th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1317.

Examination of Nickel-Bronze Test Bars.

(Copy No. 13.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS
ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Source of Material and Object of Investigation:

On October 5th, 1942, two samples of nickel bronze were submitted for examination by the Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario. This shipment was designated AEDB Lot No. 102. It was stated that difficulty was being encountered in obtaining the desired hardness on this material in gear blanks. The samples consisted of one square test piece marked "O", obtained from a cast keel

(Source of Material and Object of Investigation, cont'd) -

block, and one tensile test piece marked "AO," cast to size.

Chemical analysis, micro-examination and physical tests were requested.

Chemical Analysis:

	Casting Mixture - Per cent -	Found - Per cent -
Copper	88.0	88.37
Nickel	5.0	4.65
Tin	5.0	5.11
Zinc	2.0	1.68
Lead	-	0.04
Phosphorus	0.05	Trace.
Iron	-	0.07
Manganese	-	None detected.

Physical Properties:

Property	A. F. A.		AS FOUND	
	As Cast	Heat Treated(3)	"Q"(1)	"AO"(2)
Tensile strength, p.s.i.	47,000	75,000	38,000	41,000
Yield point, p.s.i.	22,000	55,000	-	-
Proof stress, p.s.i.	15,000	35,000	22,750	18,800
Reduction in area, per cent	45.0	20.0	N.D.	25.4
Elongation in 2 in., per cent	40.0	20.0	12.0*	21.0
Size of test bar, inches	-	-	.505	.578
Brinell hardness (1,000-kg. load)	85	148	89.4	75
Izod impact, ft.lb.	-	-	30.0	N.D.

(N.D. - Not determined.)

* Broke outside gauge marks.

(1) Machined 0.505 in. test bar.

(2) Cast test bar.

(3) Recommended heat treatment:- 5 hrs. at 1400° F., oil quench; 5 hrs. at 500° F., air cool. Modification of properties may be secured by adjustment of heat treatment. Lead must be absent when castings are to be heat treated, for as little as 0.01 per cent lead will retard age-hardening.**

** CAST METALS HANDBOOK, 1940 Ed., p. 279, Amer. Foundrymen's Assoc.

Microscopic Examination:

A sample was cut from the cast keel block and given a metallographic polish. The specimen was then etched in a solution of ferric chloride in hydrochloric acid and water. Figure 1 shows, at X100 magnification, the grain structure of the material. Figure 2 shows, at X100 magnification, the presence of intercrystalline shrinkage cavities. Figure 3 shows, at X1000 magnification, one of the discoloured grain fractures adjacent to the shrinkage cavities shown in Figure 2.

Discussion of Results:

The material was found to have the approximate composition specified by the A.S.T.M. for five per cent nickel bronze. The percentage of lead present, however, would retard age-hardening[1] if these castings are to be heat treated. The tensile strength and per cent elongation are considerably under those given in the 1940 edition of Cast Metals Handbook of the American Foundrymen's Association. The presence of intergranular shrinkage cavities and grain fractures, shown in Figures 2 and 3, would account for these low physical properties. These shrinkage cavities can be avoided by improving the foundry practice, such as by the use of proper deoxidizer, of adequate gates and risers, and by pouring the metal at the optimum pouring temperature.

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(1) CAST METALS HANDBOOK, 1940 Ed., p. 279, Amer. Foundrymen's Assoc.

CONCLUSIONS:

The chemical composition and the hardness of the cast metal conforms very closely to values given in the literature for five per cent nickel-bronze castings.

The tensile strength and elongation do not meet the specification.

The presence of intercrystalline shrinkage cavities is apparently due to poor foundry practice.

It is recommended that the melting procedure that is given on Pages 8-9 of Section II of Bulletin No. 405 issued by the Canadian International Nickel Products Limited, 25 King Street West, Toronto, Ontario, be followed in making castings from this mixture.

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Figure 1.

X100, etched in $FeCl_3$ solution.

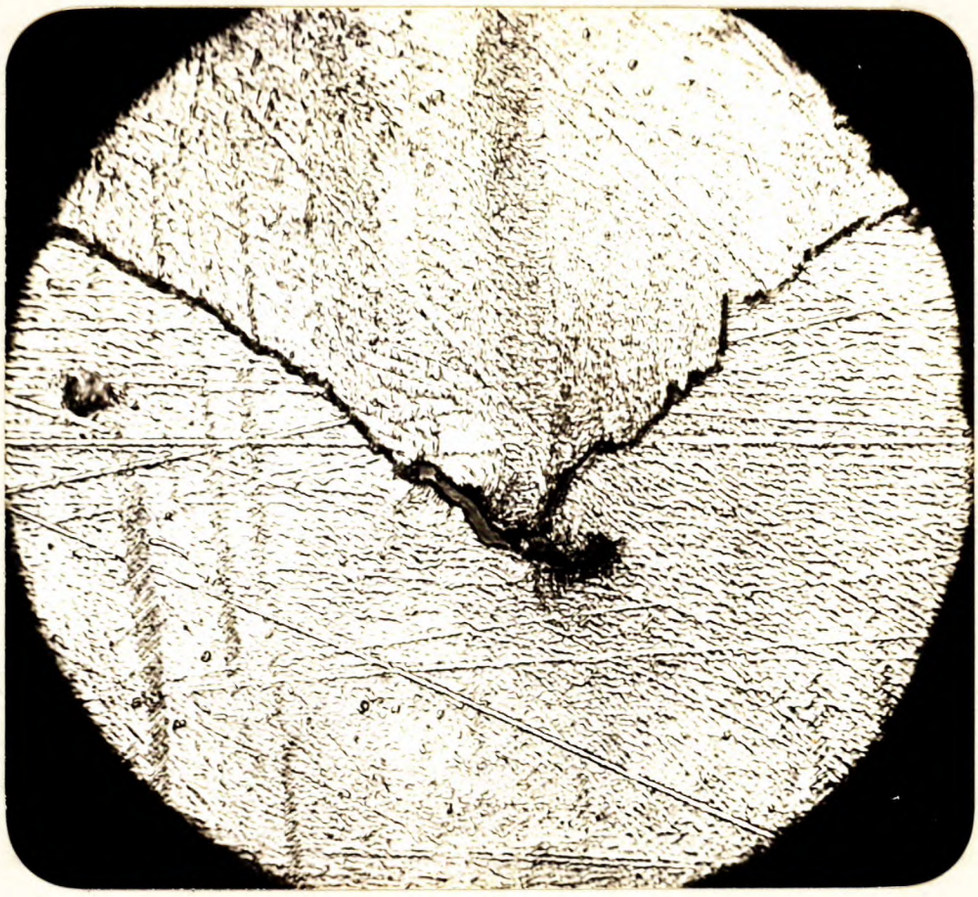
GRAIN STRUCTURE.

Figure 2.

X100, etched in $FeCl_3$ solution.

SHRINKAGE CAVITIES.

Figure 3.



X1000, etched in $FeCl_3$ solution.

DISCOLOURED GRAIN FRACTURE
ADJACENT TO SHRINKAGE CAVITIES.

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