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O T T A W A

September 26th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1101.

Examination of a Gun Metal Coupling.

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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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Origin of Material and Purpose of Investigation:

On September 20th, 1941, a gun metal coupling, Reg'd. No. 1930, was received for examination, accompanied by a letter (File - N.S. 835-7-1) dated September 20th, 1941, from A. B. Coulter, Acting Director of Naval Stores, Department of National Defence, Naval Service, Ottawa, Ontario.

(Origin of Material and Purpose of Investigation, cont'd) -

The following information was given in the accompanying letter:

The gun metal coupling, Reg'd. No. 1930, is a sample of material supplied by sub-contractors to contractors building small boats for the Department of National Defence (Naval Services). It was stated that in the opinion of the technical officers of the Department the metal was not up to standard.

An examination of this sample and a determination of chemical composition were requested.

Macro-Examination:

The appearance of the surface of the sample casting is shown in Figure 1.

Figure 1.



Approximately 7/8 size.

Chemical Analysis:

| | <u>Per cent</u> | |
|------------|-----------------|-----|
| Copper | - 77.94 | (5) |
| Tin | - 2.40 | (3) |
| Lead | - 10.05 | (5) |
| Zinc | - 8.01 | (3) |
| Nickel | - 0.16 | (2) |
| Antimony | - 0.22 | (2) |
| Iron | - 0.83 | (2) |
| Phosphorus | - 0.034 | (2) |

(Continued on next page)

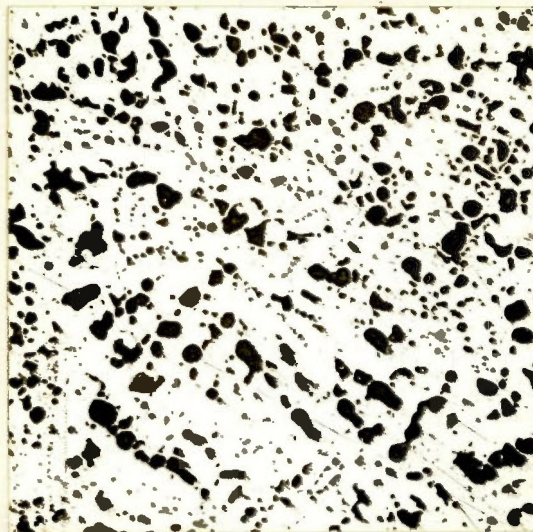
(Chemical Analysis, cont'd) -

Sample was badly segregated.

Results reported are average of determinations shown above.

Microstructure:

Figure 2.



X100, unetched.

The lead (black) is well dispersed throughout the structure. This is satisfactory for metals to be used as bearings. It is, however, not desirable in any article proposed for use in tension.

DISCUSSION OF RESULTS:

The surface of the casting as received is severely pitted, due to slag inclusions. It is possible, also, that some sand from the mould was carried by the slag in the metal from around the sprue and gate into the body of the casting when the mould was being filled with metal. The inclusions also appear on the surface of the threaded section. That the inclusions extend to some depth in the body of the casting is shown at the point of fracture, where they occupy approximately

(Discussion of Results, cont'd) -

25 per cent of the total cross-sectional area. There is also evidence of blow-holes or gas pockets in the body of the casting.

Gun Metal Specifications -

The chemical composition for Admiralty Gun Bronze Castings (commonly known as 88-8-4 Copper-Tin-Zinc) is given in A.S.T.M. Specification B 60-36, as follows:

| Element | P e r c e n t | | |
|------------|---------------|---------|---------|
| | Minimum | Desired | Maximum |
| Copper | 86.0 | 88.0 | 89.00 |
| Tin | 7.5 | 8.0 | 11.00 |
| Zinc | 1.5 | 4.0 | 4.50 |
| Iron | - | - | 0.25 |
| Nickel | - | - | 1.00 |
| Phosphorus | - | - | 0.05 |
| Lead | - | - | 0.30 |

The physical properties are also given:

| | | |
|--------------------------------|---|--------------|
| Tensile strength, min., p.s.i. | - | 38,000 |
| Yield point, min., p.s.i. | - | 16,000 |
| Elongation in 2 in., min., | - | 22 per cent. |

This alloy is used primarily for structural purposes where resistance to corrosion, particularly of sea water, is essential. A small amount of lead is added to improve the machineability.

Chemical Composition of Casting Submitted -

The chemical composition of the submitted casting was difficult to determine due to the numerous inclusions present. For this reason, two analyses were made for four elements, three analyses for two elements, and the copper and lead were checked five times.

The chemical composition shows that this casting was made from a semi-red brass or medium red foundry brass.

(Continued on next page)

(Chemical Composition of Casting Submitted, cont'd) -

The chemical analyses conform somewhat to those given in A.S.T.M. Tentative Specification B 119-40T for Leaded Semi-Red Brass, which specifies in addition to the copper, "Zinc 8 to 17 per cent, Tin less than 6 per cent, Lead over 0.5 per cent."

The chemical composition given in A.S.T.M. Tentative Specification B 30-40T, No. 5A, is:

| | | <u>Per cent</u> |
|------------|---|-----------------|
| Copper | - | 79.50 - 81.50 |
| Tin | - | 2.75 - 3.25 |
| Lead | - | 6.50 - 7.50 |
| Zinc | - | 8.50 - 10.00 |
| Nickel | - | 0.50 maximum |
| Iron | - | 0.35 " |
| Antimony | - | 0.20 " |
| Phosphorus | - | 0.01 " |

The physical properties for an alloy of the above type, as given in the Cast Metals Handbook, 1940 edition, page 270, are as follows:

| | | |
|--------------------------|---|-------------------|
| Tensile strength, p.s.i. | - | 30,000 - 36,000 |
| Yield point, p.s.i. | - | 15,000 - 20,000 |
| Elongation in 2 in. | - | 15 - 25 per cent. |

This material is used for general hardware fittings, low pressure valves, and plumbing supplies and fixtures.

The physical properties of this material are considerably lower than those of gun metal. In the case of this particular casting, the properties will be lowered further by the higher lead content.

Conclusion:

Specifications for castings usually include a clause which states in part: "The castings shall be free from blow-holes, porosity, hard spots, shrinkage defects, or cracks or

(Conclusion, cont'd) -

other injurious defects." On the basis of this clause alone there is good and sufficient reason for the rejection of all or any castings similar to the sample submitted, regardless of whether or not the chemical specifications and physical requirements have been fulfilled.

The chemical composition used for the sample submitted is not the most suitable that could be employed and does not meet either specification that possibly was desired.

The melting, especially, and the moulding practice of gun metal must be carried out under close control in order to avoid foundry defects and meet the required specifications.

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