Head, Non-Ferrous Met Sect
(J O Edwards)

[redacted]

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 58-103

METALLURGICAL INVESTIGATION OF CASTING CHARACTERISTICS AND CHEMICAL ANALYSES OF ALUMINIUM BRONZE BOBBINS

by

G. W. TOOP

PHYSICAL METALLURGY DIVISION

Copy No 19

JUNE 12, 1958

Industrial Confidential

Mines Branch Investigation Report IR 58-103

METALLURGICAL INVESTIGATION OF CASTING CHARACTERISTICS AND CHEMICAL ANALYSES OF ALUMINIUM BRONZE BOBBINS

by

G. W. Toop*

SUMMARY OF RESULTS

Failure of a sand-cast aluminium bronze bobbin was attributed to shrinkage porosity at a critical point in the casting where a U-shaped notch had been machined in the part.

X-ray and chemical analyses of a batch of cast blanks indicated that closer chemical control and changes to moulding pattern design were necessary.

A modified mould was developed. Subsequently, the use of aluminium bronze in the bobbins was abandoned in favour of high-strength manganese bronze because of the latter's superior foundry characteristics.

---

*Scientific Officer, Physical Metallurgy Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

CONTENTS

(1 table, 0 illus.)

INTRODUCTION

On November 27, 1957, Mr. C. W. Pidgeon, Production Manager of the Capital Wire Cloth & Mfg. Co. Ltd., Ottawa, Ontario, submitted personally a broken sand-cast aluminium bronze bobbin for examination, and stated that the bobbin was one of several that had failed in service, causing damage to the fourdrinier wire cloth being woven.

In a letter dated November 29, 1957, Mr. Pidgeon requested that a batch of about 300 cast aluminium bronze bobbins be X-rayed before the castings were machined and put into use.

In conjunction with the X-ray work, the Non-ferrous Metals Section of the Physical Metallurgy Division undertook a study of the pattern design and chemical analysis of the castings, as a general program to improve the quality of the bobbins.

EXAMINATION OF THE FRACTURED BOBBIN AND CHEMICAL ANALYSIS OF THE CAST BLANKS

The bobbin fracture, exhibiting extensive porosity, had occurred at a critical point in the bobbin where a U-shaped notch had been machined in the part. The fractured bobbin was compared with one of the sand-cast blanks and it was found that the ingate, in the butt end of the casting, coincided with the fracture and the machined area of the bobbin.

X-ray examination of the cast blanks showed shrinkage porosity at the ingates of approximately 90% of the castings.

A sample of the aluminium bronze was submitted to the Chemical Laboratory of the Mines Branch. The chemical analysis reported showed an unusually high zinc content (see Table 1, column 1).

MODIFICATION OF PATTERN DESIGN

With the results on the initial batch of bobbins, it was apparent that closer chemical control of the aluminium bronze melts and a modified pattern design were necessary.

Subsequently, several batches of six to twelve bobbins, poured with various trial moulds, were received. X-ray examination of the castings indicated that although the percentage of sound castings increased, some of the bobbins showed shrinkage porosity and inclusions. Chemical analysis of one of the batches showed a zinc content in excess of the specified maximum (see Table 1, column 2).

The Non-Ferrous Metals Section of the Physical Metallurgy Division then proposed a modified pattern, with a skimmer-bar and riser system designed to provide better feeding of cleaner metal to the mould cavity. An experimental batch of sound bobbins was produced with this pattern, but a subsequent production run was not 100% sound, mainly because of the presence of small oxide inclusions and porosity. Chemical analysis of the production run indicated a high zinc content in the metal (see Table 1, column 3).

At this point, Bond Brass Limited, Ottawa, Ontario, using the proposed pattern, produced an experimental batch of sound aluminium bronze bobbins but found that moulding time could be shortened by placing the ingates of the castings at the pointed end of the bobbin rather than at the butt end.

A production run followed which showed no porosity, but some of the pieces contained inclusions and the castings were very brittle. A chemical analysis of the castings indicated the presence of zinc, lead, tin and silicon in the metal (see Table 1, column 4).

TRIAL RUN OF MANGANESE BRONZE BOBBINS

In an attempt to obtain improved ductility and freedom from inclusions, Bond Brass Limited poured a batch of high-strength manganese bronze bobbins (for specifications, see Table 1). The batch was produced by gating the mould through the pointed end of the bobbin.

The castings were X-rayed and the critical areas of the bobbins were found to be free of porosity and inclusions. With these results, Capital Wire Cloth & Mfg. Co. Ltd. favoured manganese bronze, and it is expected that subsequent production runs will be of this material.

DISCUSSION

Aluminium bronze, having a short freezing range, is commonly described as a high-shrinkage alloy. The need for generous feeding is one of two outstanding foundry characteristics of the material; the other is the need for non-turbulent pouring, necessitated by the nature of the

aluminium oxide films which form on the exposed surfaces of the molten metal. The tenacious alumina films are apt to fold and crumple during pouring, and, when trapped in the casting, can constitute harmful discontinuities.

The presence of zinc in aluminium bronze is believed to impair corrosion resistance, and certain specifications (see Table 1) require that zinc shall not exceed 0.2%. Since the bobbins are used in a non-corrosive environment, up to 1% zinc attributable to scrap contamination might be tolerated. However, the presence of zinc in quantities, as shown in Table 1, may alter the structural balance of the aluminium bronze and is therefore undesirable. The presence of lead with silicon in bronzes is generally considered to be deleterious.

With respect to foundry characteristics, manganese bronze is less challenging than aluminium bronze, and the use of manganese bronze bobbins seems to be substantiated by the X-ray results of the trial batch.

However, it has been shown that by using reasonable care in the foundry it is entirely feasible to cast sound, clean, aluminium bronze bobbins, using the mould design suggested.

GWT/KW

TABLE 1

Chemical Analyses* and Specifications

Product	1 Initial batch of aluminium bronze bobbins, %	2 Batch after initial pattern modification, %	3 Batch with pattern proposed by Non-Ferrous Metals Section, Mines Branch, %	4 Batch produced with ingate at the pointed end of the mould, %	Aluminium Bronze A.S.T.M. B 148-52 Alloy 9 D Specification, %	Aluminium Bronze specification quoted by Capital Wire Cloth & Mfg. Co. Ltd., %	Manganese Bronze A.S.T.M. B 147-52 Alloy 8 C Specification, %
Cu	75.36	80.58	80.32	79.05	78 min.	78 min.	60.0-68.0
Al	7.80	8.48	5.90	8.33	10.0-11.5	8.5-10.5	3.0- 7.5
Fe	4.26	4.16	3.70	3.85	3.0- 5.0	3.5- 5.5	2.0- 4.0
Mn	1.28	1.69	1.46	1.52	3.5 max.	1.5- 3.0	2.5- 5.0
Ni	4.10	3.99	4.45	4.24	3.0- 5.5	4.5- 6.5	-
Zn	6.21	0.73	3.69	1.50	-	0.2 max.	Remainder
Sn	0.18	0.03	0.05	0.35	-	-	0.20 max.
Si	0.05	0.03	-	0.15	-	-	-
Pb	-	-	-	0.75	-	-	0.20 max.
Sb	-	-	-	0.08	-	-	-

*Batches 1 to 4 were analyzed in the Analytical Chemistry Laboratory, Mineral Dressing and Process Metallurgy Division, Mines Branch, Ottawa.