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O T T A W A May 14th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1222.

(Subsequent to Investigation No.)
(1168, dated February 25th, 1942.)

Second Report on the Misfeldt Processes: Copper-Beryllium Alloy Extrusion Mouldings and Sand Castings.

(Copy No. 10.)

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 May 14th, 1942.

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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1222.

(Subsequent to Investigation No. 1168, dated February 25th, 1942.)

Second Report on the Misfeldt Processes: Copper-Beryllium Alloy Extrusion Mouldings and Sand Castings.

Origin of Problem:

Subsequently to the issuance of Report of Investigation No. 1168, concerning the Misfeldt processes of Pressure Mould Casting and Extrusion Moulding, Mr. Charles Misfeldt, of Glendale, California, submitted personally on April 23rd, 1942, additional test pieces of copper-beryllium alloy for examination.

Description of Samples Received:

For the present investigation seven tensile test specimens were submitted, as follows:

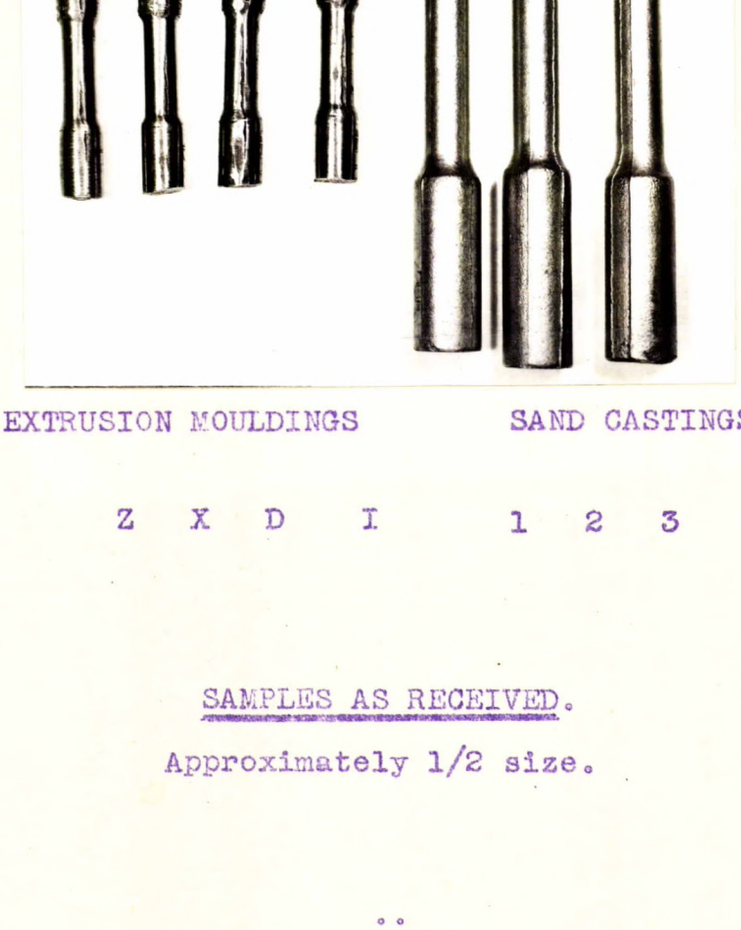
Four (4) test bars made by extrusion moulding, marked "Z", "X", "D", and "I" respectively,

and, for comparison,

three (3) test bars, sand cast, marked "1", "2", and "3".

Figure 1 shows the test bars as received.

Figure 1.



EXTRUSION MOULDINGS SAND CASTINGS

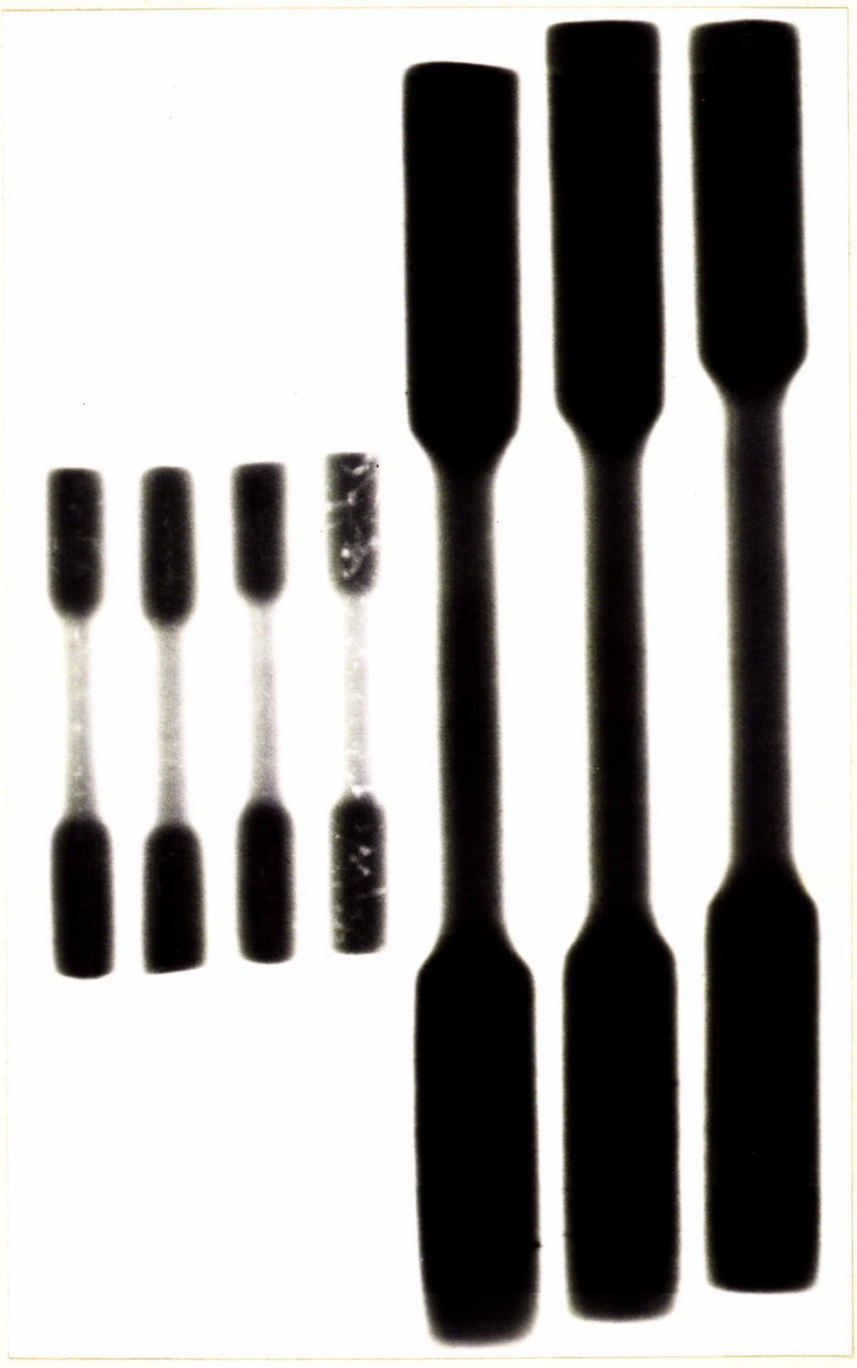
Z X D I 1 2 3

SAMPLES AS RECEIVED.

Approximately 1/2 size.

X-Ray Examination:

X-ray examination, carried out by W. A. Morrison, of the National Research Laboratories, Ottawa, showed considerable porosity, shrinkage cavities and cold-shuts in all four extrusion-moulded test bars, especially in the sample marked "I". The radiograph of the sand-cast test bars shows uniform material with no defects.



Z X D I 1 2 3

Figure 2.

CONTACT PRINT OF THE RADIOGRAPH.

Chemical Analysis:

		Extrusion Mouldings "X" and "D"	Sand Cast No. 1
		(Per cent)	
Copper	=	94.97	94.35
Beryllium	=	1.93	2.55
Aluminium	=	1.48	1.62
Nickel	=	1.24	1.04
Iron	=	0.11	0.18
Silicon	=	0.07	0.07
Phosphorus	=	0.001	0.002
Tin	=	None detected.	None detected.
Lead	=	Nil.	Nil.

Heat Treatment:

The test bars "X" and "Z", made by extrusion moulding, were subjected to the heat treatment specified by the producer:

3 hours at 1475° F., quenched in cold water, then 5 hours at 750° F., cooling in still air.

The sand cast specimens Nos. 1 and 2 were heat-treated as follows (also specified by the producer):

3½ hours at 1475° F., quenched in cold water, then 5½ hours at 750° F., cooling in still air.

Mechanical Properties:

(a) Tensile Tests -

Tensile tests were carried out on all specimens. Of these, the samples marked "D" and "X" were machined to a diameter of 0.28 inch; all others were tested in dimensions as received. Specimens marked "X", "Z", "1", and "2" were tested after heat treatment; all others were tested in the "as received" condition.

The following results were obtained:

(Continued on next page)

(Tensile Tests, cont'd) -

Specimen	Condition	Size of test bar, in.	Yield point,® p.s.i.	0.1% proof stress, p.s.i.	Ultimate tensile strength, p.s.i.	Elongation,®® per cent
a) Extrusion Mouldings -						In 1 inch
I.	As received	0.368 diam.	45,000	-	75,000	20
D.	" "	0.282 "	56,000	-	81,500	18
X.	Heat treated	0.283 "	100,000	-	106,500	2
Z.	" "	0.362	108,000	-	121,000	2
						In 2 inches
b) Sand Castings -						
1.	Heat treated	0.497 diam.	-	115,000	147,000	2
2.	" "	0.492 "	-	110,000	146,500	5.5
3.	As received	0.496 "	-	46,500	89,700	28

® The yield points of the extrusion-moulded samples were determined by the dividers method, as the determination of the exact 0.1 per cent proof stress was impossible because of the small sample size.

®® Elongation of the extrusion mouldings was determined on a gauge length of 1 inch; on sand castings, the gauge length was 2 inches.

The fracture of sample "I" showed considerable porosity and cold-shuts. Sample "D" also showed porosity. Other samples showed "sound" fractures.

(b) Hardness Tests -

Hardness was determined by the Vickers method, using a 10-kilogram load. The following results were obtained:

Extrusion mouldings:	As received	- 180-185 V.H.N.
	Heat treated	- 225-240 V.H.N.
Sand castings:	As received	- 140-150 V.H.N.
	Heat treated	- 315-325 V.H.N.

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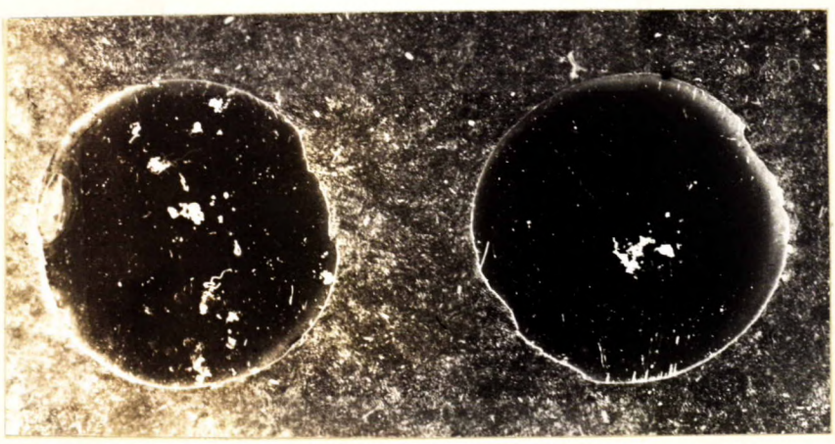
Micro-Examination:

The micro-examination confirms the results of the X-ray and mechanical tests, and shows considerable porosity in the extrusion mouldings. The sand castings reveal a generally "sound" material.

Figure 3 shows the distribution of the porosity and shrinkage cavities in sections taken from the head of the test bar "I".

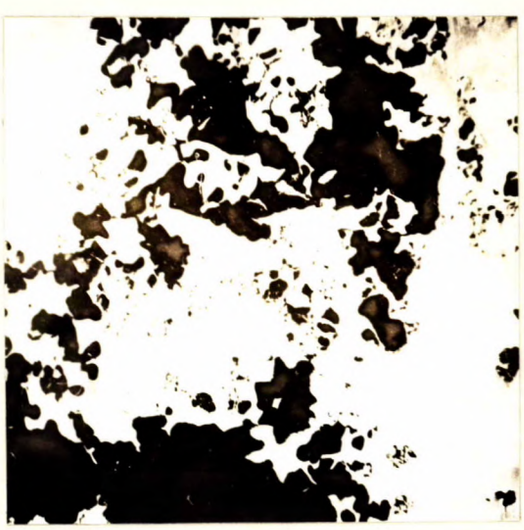
Figure 3.



DISTRIBUTION OF POROSITY IN SECTIONS OF TEST BAR "I".
Approximately X3½ size.

Figure 4 shows the character of the cavities in the extrusion moulding "I".

Figure 4.



X100, unetched.
SHRINKAGE CAVITIES IN EXTRUSION MOULDING "I".

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Discussion of Results:

Chemical analysis shows that the present examined samples contain much more beryllium than did those previously tested.

The X-ray and microscopic examinations of the extrusion mouldings showed considerable porosity, shrinkage cavities and cold-shuts. This was also confirmed by the appearance of the fractures of the test bars. The sand castings showed generally "sound" material.

The difference in the mechanical properties of the sand castings and extrusion mouldings may be partly due to the higher beryllium content and the larger size of the sand-cast bars, but in any event the defective material of the extrusion mouldings caused lower results.

Conclusions:

The present investigation confirms the results obtained previously (Report of Investigation No. 1168, page 31, paragraph 3), as the submitted extrusion mouldings still show considerable defects.

The comparison between the submitted extrusion mouldings and sand castings shows the superiority of the latter. This is rather unexpected, since the principle of the extrusion-moulding process should give definitely better quality products than sand casting.

The results obtained indicate again that the extrusion-moulding process is not yet fully developed and requires possibly more experience in operation and further improvements in the extrusion technique.

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