O T T A W A May 9th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1217.

Examination of Magnesium Alloy Castings (Control Handles A.H. 2040).

(Copy No. 14.)

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 Problem:

In a letter dated April 10th, 1942, (File No. CANAID/M.244/10360), Mr. E. E. Turner, for Inspector-in-Charge, B.A.C., Canadian Aircraft Group, Montreal, Quebec, requested the X-ray examination of six submitted control handles cast by a Canadian manufacturer from magnesium alloy covered by British Aircraft Specification D.T.D. 289.

After completing and reporting the results obtained from the radiographic examination of the six Canadian castings,

(Origin of Problem, cont'd) -

it was decided to check these results by further tests (mechanical, chemical, and microscopic) and also, for comparison, to examine a similar casting of American origin.

Description of Samples:

The castings were marked as follows:

Canadian:	MG 206 x 67	MG 207 x 83
	MG 207 x 129	MG 207 x 134
	MG 208 x 94	MG 208 x 97
American:	N 433 HS.	

For the complete investigation, one Canadian casting, MG 208 x 97, which showed the poorest structure in the radiograph, and the American casting were chosen.

Figure 1 shows Casting MG 208 x 97 after cutting out a specimen for micro-examination.

Figure 1.

Casting MG 208 x 97.

(Approx. ½ size).

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X-Ray Examination:

X-ray examination, carried out by W. A. Morrison of the National Research Laboratories, Ottawa, showed that the castings are of homogeneous metal with no signs of any discontinuity. However, cloudiness was observed in certain sections.

Figures 2 and 3 show contact prints of the radiographs* taken respectively from the Canadian casting MG 208 x 97 and the American casting N 433 HS.

Considerable cloudiness (shown by the light area "a") in the radiograph of the Canadian casting (Figure 2), and similar, but not so pronounced, cloudiness in the American casting (Figure 3) were believed to constitute evidence of microporosity in these areas.

In all castings examined the most pronounced cloudiness appears in location "a" (Figures 1 to 3), the most uniform area in location "b".

Of the six originally submitted Canadian castings, this cloudiness was most clearly defined in Castings MG 208 x 94 and MG 208 x 97. The American casting showed the same condition and in the same location but not so noticeably.

(Figures 2 and 3 appear on Pages 4 and 5)

* All seven original radiographs were sent to the Inspector-in- Charge, B.A.C., Canadian Aircraft Group, Montreal, Quebec.

(X-Ray Examination, cont'd) -

Figure 2.

RADIOGRAPH OF CASTING MG 208 x 97.

(X-Ray Examination, cont'd) -

Figure 3.

RADIOGRAPH OF CASTING N 433 HS.

Chemical Analysis:

	- PER CENT - Casting MG 208 x 97 (Canadian)	Casting N 433 HS (American)	Specification D.T.D. 289
Aluminium -	5.97	5.97	max. 8.5
Zinc -	3.08	3.09	max. 3.5
Manganese -	0.28	0.20	max. 0.5
Silicon -	0.07	0.09	-
Copper -	0.035	0.10	-
Iron -	0.017	0.018	-
Nickel -	Nil	Nil	-
			Total impurities: max. 1.0

Mechanical Properties:

(a) Tensile Tests.

Tensile tests were carried out on a Hounsfield tensometer, which permits the testing of very small-sized test specimens obtained from castings, forgings, etc.

The specimens were cut out from each of the two examined castings, from two locations ("a" and "b" in Figure 1). From each location two specimens were obtained.

The dimensions of the machined test specimens were:

Diameter - 0.158 inch
Gauge length - 0.586 "

The results of the tensile tests are shown in the following table:

Specimen No.	Location of the specimen in the casting	Ultimate tensile strength, p.s.i. Casting MG 208 x 97 (Canadian)	Casting N 433 HS (American)
1	"a"	27,000	32,000
2		24,000	29,500
Average		25,500	30,750
3	"b"	23,000	28,000
4		26,000	27,500
Average		24,500	27,750

(Continued on next page)

(Mechanical Properties, cont'd) -

(Tensile Tests, cont'd) -

The British Aircraft Specification D.T.D. 289 requires, for sand castings on standard-size test bars (cast separately), an ultimate tensile strength of 29,000 p.s.i.

(b) Hardness Tests.

Hardness was determined by the Vickers method, using a 10-kilogram load, with the following results:

Canadian Casting MG 208 x 97 - 55-57 V.H.N.

American Casting N 433 HS - 60-65 V.H.N.

Micro-Examination:

Figure 4 shows the distribution of the microcavities in the section of the Canadian casting, location "b".

Figure 4.

DISTRIBUTION OF MICROCAVITIES

IN CASTING MG 208 x 97, LOCATION "b".

(Approx. 2x size).

(Continued on next page)

(Micro-Examination, cont'd) -

Figures 5 to 8 show the character of the microporosity as determined by the cloudiness in the radiographs.

Figure 5.

X100, unetched.
(Location "a").

Figure 6.

X100, unetched.
(Location "b").

CANADIAN CASTING MG 208 x 97.

Figure 7.

X100, unetched.
(Location "a").

Figure 8.

X100, unetched.
(Location "b").

AMERICAN CASTING N 433 HS.

(Continued on next page)

(Micro-Examination, cont'd) -

Figures 9 and 10 show the microstructures of both examined castings, normal for this type of magnesium alloy.

Figure 9 indicates that the Canadian casting was only solution heat-treated without ageing. The microstructure of the American casting (Figure 10) shows that this casting was solution heat-treated and subsequently aged.

Figure 9.

X100, etched.[*]
(Location "a").
CANADIAN CASTING
MG 208 x 97.

Figure 10.

X100, etched.[*]
(Location "a").
AMERICAN CASTING
N 433 HS

[*] Etching reagent: 75% diethylene glycol,
1% conc. nitric acid, and
24% distilled water.

Discussion of Results:

The chemical analysis and the mechanical tests show that the examined castings conform to the requirements of the Specification D.T.D. 278.

The results of the tensile tests, as obtained on non-standard-size test bars, give only comparable results and should not be considered as indicating the tensile strength that actually would be obtained on a standard test bar cast separately.

It will be noted that specimens from sections considered to be of poorer quality metal, as judged by the radiographs, gave higher results than those from the other, supposedly better, section; also that the American product gave somewhat higher results than the Canadian.

The higher mechanical properties obtained on the American casting should be considered also in relation with the different heat treatment given it.

The radiographs of all examined castings show areas of microporosity. This was verified by the results of the micro-examination.

It is known that magnesium alloys generally, and the alloy used for these castings (6% Al, 3% Zn) especially, have a great tendency to microporosity. For this reason[*], in Great Britain this particular alloy is now very seldom used, although it has still a widespread use in the U. S. A. on account of its high mechanical properties and corrosion resistance.

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[*] Metal Industry (London), vol. 60, No. 13, March 27, 1942, p. 223.

Conclusions:

The investigation shows that neither of the examined castings is absolutely sound, but that the American is of superior quality.

Without exact knowledge of the service conditions, it is difficult to give any definite conclusions in regard to the serviceability of these castings. If any casting made from this material should be highly stressed in service, it would seem advisable to take steps to improve the casting technique to eliminate the microporosity or to consider the selection of another material.

There might be, however, no point in changing this material in the case of control handles, if these parts are not highly stressed in service.

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