O T T A W A March 19th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1185.

Examination of Boeing Aircraft Casting 28-L-054.

(Copy No. 4 .)

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 Request and Object of Investigation:

In a letter dated February 24th, 1942, Group Captain A. L. Johnson, for Chief of Air Staff (Air Service), Ottawa, Ontario, requested an examination of a Boeing Aircraft Casting 28-L-054 made from Aluminium Alloy AC-220-T4.

The letter stated that the castings had been made about a year ago by the Robert Mitchell Company and that on being examined prior to installation cracks have been observed in the thin section. Due to aging the physical properties may

(Origin of Request and Object of Investigation, cont'd) -

have changed, which may have released the shrinkage stresses, hence the cracks. The thin-walled section, in contrast to the thick adjacent section, contributes substantially to the fault and is an obvious defective design.

It was further stated that these are class 1 castings and should all have been radiographed, which should have shown these defects.

It was requested that the submitted casting after sectioning be examined micrographically and also checked to determine if any welding or other treatment had been done.

Figure 1 shows the casting as submitted.

Figure 1.

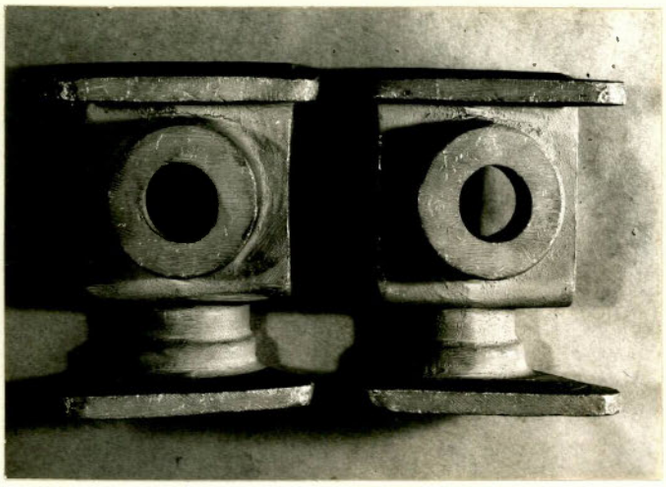
Casting as received.

(Approx. $\frac{1}{2}$ size).

Figures 2 and 3 show the location of the cracks after sectioning of the casting.

(Figures 2 and 3 appear on next page)

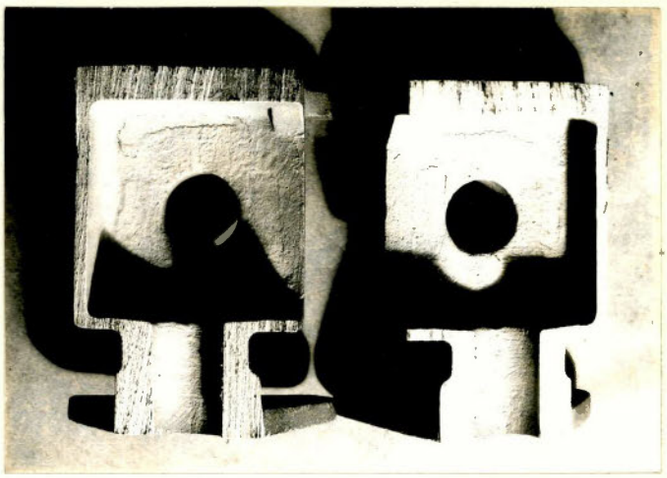
Figure 2.



Cracks on the outside surfaces.

(Approx. 1/3 size).

Figure 3.



Cracks on the inside surfaces.

(Approx. 1/3 size).

X-Ray Examination:

X-ray examination carried out by L. W. Ball of the National Research Laboratories, Ottawa, revealed that with exception of the cracks plainly visible on the surfaces the casting shows no further defects.

Chemical Analysis:

	Casting	Alcoa 220 (nominal)	Spec. DTD. 269.	Spec. DTD. 298, 304 and 361.
Copper, per cent -	4.20	-	4.0-4.6	4.0-5.0
Iron, " -	0.58	-	0.5-0.7	0.7 max.
Silicon, " -	0.82	-	0.7-0.9	0.9 max.
Magnesium " -	0.13	10.0	0.1-0.3	Other impur.
Manganese " -	0.04	-	0.3 max.	0.20 max.
Titanium " -	0.16	-	0.25 "	0.25 max.

Mechanical Properties:

Tensile Tests -

To check the strength of the material, three small test specimens were cut from the casting and tested on the tensometer; results were obtained as follows:

(Continued on next page)

(Tensile Tests, cont'd) -

Sample	Size of sample, inches	Y. P., p.s.i.	U. T. S., p.s.i.	Elongation on 10 mm., per cent
No. 1.	.157 diam.	24,000	40,800	8
No. 2.	.155 diam.	23,000	31,200	5
No. 3.	.185 x .125	23,900	31,200	8

British Specifications	0.1 % P.S., p.s.i. min.	U. T. S., p.s.i. min.	Elongation on 2 inches, % min.
DTD. 269	-	40,320	-
DTD. 298	24,500	31,500	7
DTD. 304	31,500	40,500	4
DTD. 361	45,000	47,000	1

Hardness Tests:

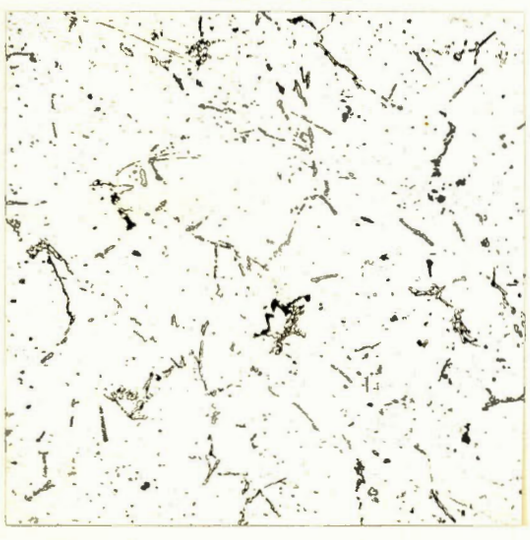
Hardness was determined by the Vickers method, using a 10-kilogram load:

75 - 85 V.H.N.

Micro-Examination:

Figures 4 and 5 show the average microstructure of the casting, normal for this type of aluminium alloy. There is a relative high amount of undissolved $CuAl_2$ constituent.

Figure 4.



X200, etched with 0.5% HF + 99.5% H_2O.

Figure 5.

X100, etched with Keller's reagent (1% HF, 1.5% HCl, 2.5% HNO_3, 95% H_2O).

Discussion of Results:

As mentioned in the accompanying letter, the casting has a very poor design. The considerable contrast in the thickness of adjacent sections should always be avoided if at all possible, more especially in castings intended for heat treatment.

The X-ray examination revealed no further defects.

The chemical analysis shows that the casting was not made from Aluminium Alloy AC-220-T4, as stated in the accompanying letter, but from an aluminium-copper alloy (Alcoa 195). The composition conforms closely to the British Specifications DTD. 269, 298, 304 and 361.

The mechanical properties, as measured on very small test specimens cut from the casting, should be considered as normal. Such small test specimens, specially cut from the casting, generally show lower results than those obtained on normal size test bars cast separately.

Conclusions:

1. The submitted casting was made from a different aluminium alloy than stated in the accompanying letter.

2. The cracks in the casting were due primarily to faulty design, which caused internal shrinkage stresses in the casting by unequal cooling rates, aggravated by additional stresses from the heat treatment. The cracking during the storage period can be attributed to the progress of the aging.

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