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O T T A W A August 20th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1480.

Examination of Defective Cheetah
Engine Crankcases.

(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

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Origin of Problem and Object of Investigation:

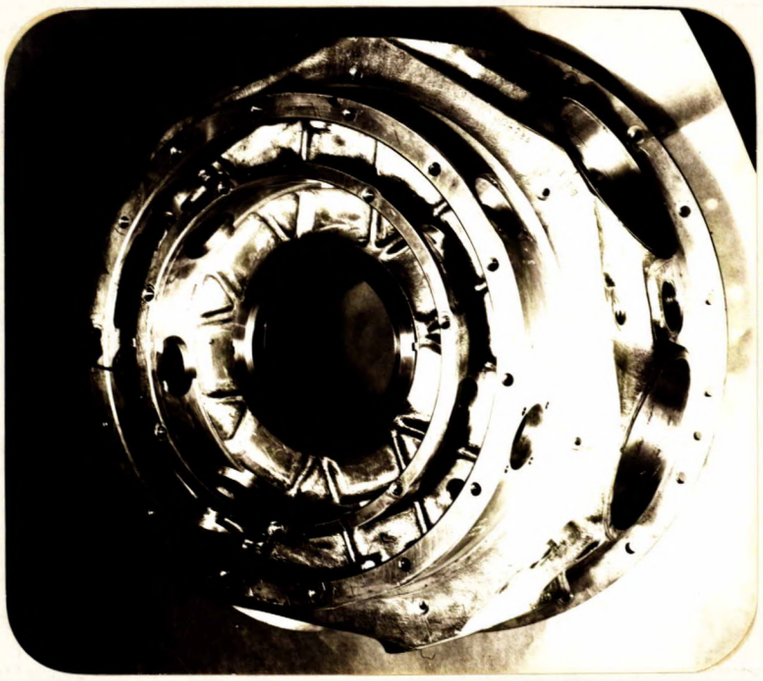
In a letter dated June 8th, 1943, (File No. 935U1-1-5 (AMAE-DAI)), A/C A.L. Johnson, for Chief of the Air Staff, Department of National Defence, Air Service, Ottawa, Ontario, requested the examination of two defective Cheetah Engine crankcases which were being submitted. It was stated that Crankcase No. AS32000 is an aluminium alloy casting and Crankcase No. AS13117 an aluminium alloy forging. Both crankcases show cracks, indicated by red paint marks.

It was requested that these crankcases be examined metallurgically to determine the nature of the cracks and their probable cause.

Description of Samples:

Figures 1 and 2 show the crankcases as submitted.

Figure 1.



CAST CRANKCASE NO. AS32000, AS RECEIVED.

(Approximately 1/6 size).

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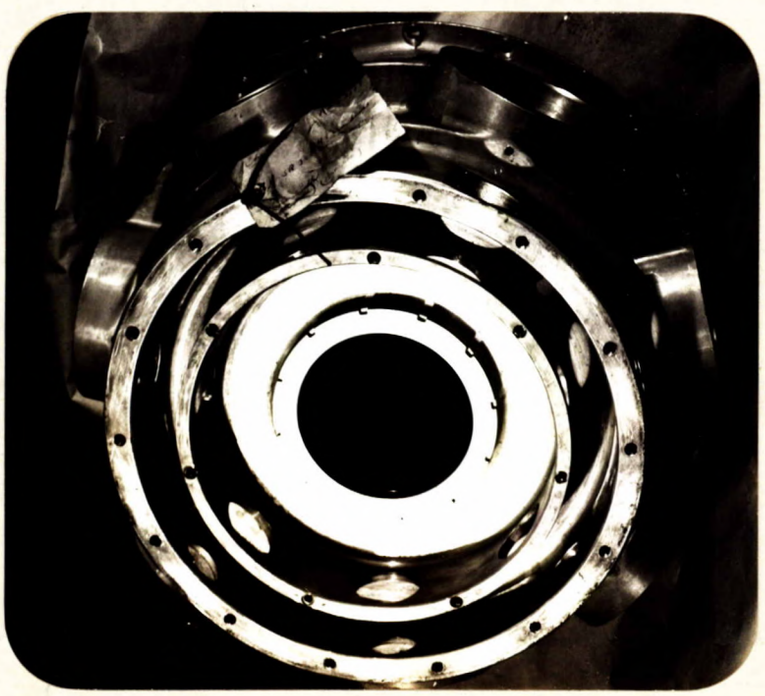
Figure 2.



FORGED CRANKCASE NO. AS13117, AS RECEIVED.
(Approximately 1/6 size).

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Figure 3.

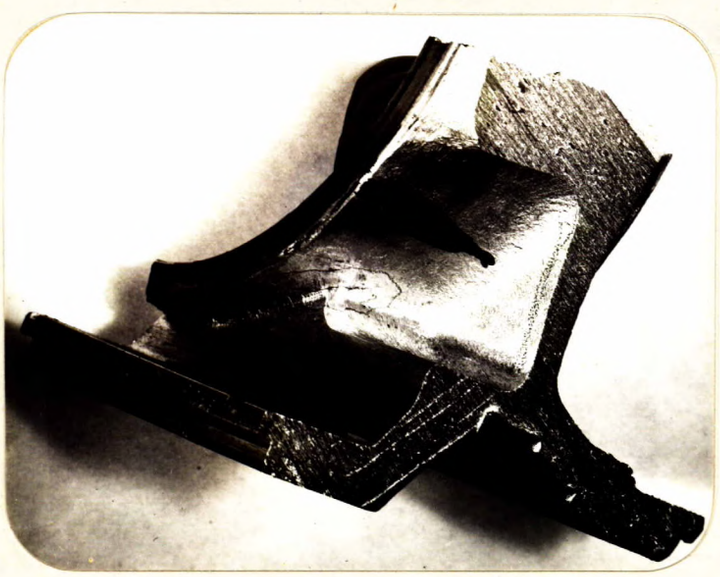

Figure 4.

CRACKS IN CAST CRANKCASE.

(Approximately 1/2 size).

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Figure 5.

CRACK IN FORGED CRANKCASE.

(Approximately 1/2 size).

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Chemical Analysis:

		Casting	Forging
		- Per cent -	
Copper	-	1.69	1.81
Silicon	-	2.40	0.66
Iron	-	1.22	1.20
Nickel	-	0.99	1.22
Magnesium	-	0.11	0.60
Manganese	-	0.05	0.04
Titanium	-	0.21	0.20
Chromium	-	0.002	Less than 0.003
Zinc	-	None detected.	None detected.

The requirements of the British specifications are as follows:

	D.T.D. 133B (RR 50)	D.T.D. 246A (RR 56 NS)
	- Per cent -	
Copper -	0.8-2.0	1.5-2.5
Silicon -	1.5-2.80	1.0 max.
Iron -	0.8-1.4	0.8-1.5
Nickel -	0.8-1.75	0.5-1.5
Magnesium -	0.05-0.30	0.6-1.2
Titanium -	0.05-0.25	0.12 max.

MECHANICAL PROPERTIES:

Tensile Tests:

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

The specimens were cut out from both examined crankcases, from locations near the cracks.

The dimensions of the machined test specimens were:

Diameter - 0.158 inch.
Gauge length - 0.586 inch.

The following results were obtained:

	Ultimate tensile strength, p.s.i.	Elongation, per cent
Casting: -	21,000	2
	25,500	2
Forging: -	34,500	6
	36,500	7.5

The specified minimum values are:

	Ultimate tensile strength, p.s.i.	Elongation, per cent
Casting (Spec. D.T.D. 133B)		
- Sand cast	24,600 min.	2.5 min.
- Chill cast	28,000 min.	4.0 min.
Forging (Spec. D.T.D. 246A)	36,000 min.	16.0 min.

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Hardness Tests:

The hardness was determined by the Vickers method, using a 10-kg. load. Average results obtained near the cracks were as follows:

	V.H.N.
Casting -	75
Forging -	85

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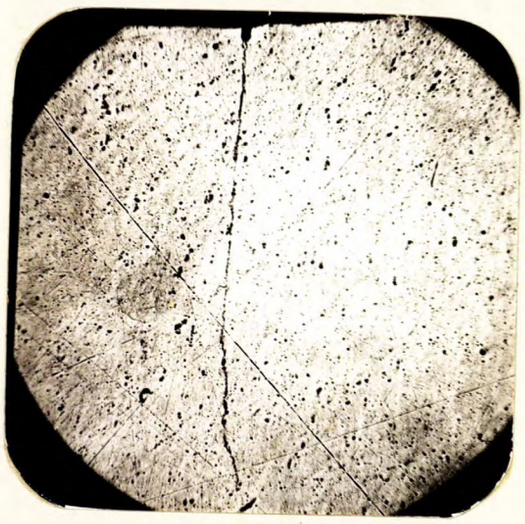
Metallographic Examination:

Macroscopic examination of sections of both crankcases showed no evidence of any metallurgical defects (segregation, inclusions, etc.).

Microscopic examination showed that the crack in the cast crankcase extends quite deeply (approximately 0.1 inch). The crack in the forging is rather shallow but shows some intercrystalline disintegration, probably due to beginning of stress-corrosion.

Figure 6.



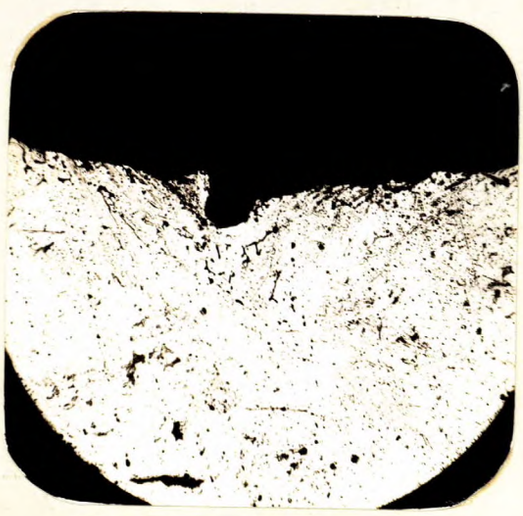
X25, unetched.

Figure 7.

X100, unetched.

CAST CRANKCASE.

Figure 8.



X25, unetched.

Figure 9.

X100, unetched.

FORGED CRANKCASE.

Discussion of Results:

Chemical analysis revealed that Crankcase No. AS32000 was cast from an RR 50 aluminium alloy (D.T.D. 133B). Crankcase No. AS13117 is a forging made from an RR 56 aluminium alloy (D.T.D. 246A).

Tensile results can be considered only as comparative, as the specimens were cut out directly from the casting and did not conform to the dimensions of the standard test bar.

Microscopic examination showed no metallurgical defects (segregation, impurities, inclusions, corrosion, overheating, etc.).

The failures were probably due to mechanical overstressing or to improper design which might have resulted in subsequent stresses during casting or heat treatment.

Repairing the cracked casting at the surface by means of welding would merely seal the outlet of the crack; it could not prevent the existing crack from extending further.

CONCLUSION:

The material was satisfactory, and no metallurgical reason for the defects was found.

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JWM:LB.