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O T T A W A June 23rd, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1435.

Examination of a Broken Harvard Airscrew Blade.

(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:

In a letter (File No. 902-69-18, AMAE-DAI) dated May 14th, 1943, Air Commodore A. L. Johnson, for Chief of the Air Staff, Department of National Defence, Air Service, Ottawa, Ontario, requested the examination of a broken Harvard airscrew blade.

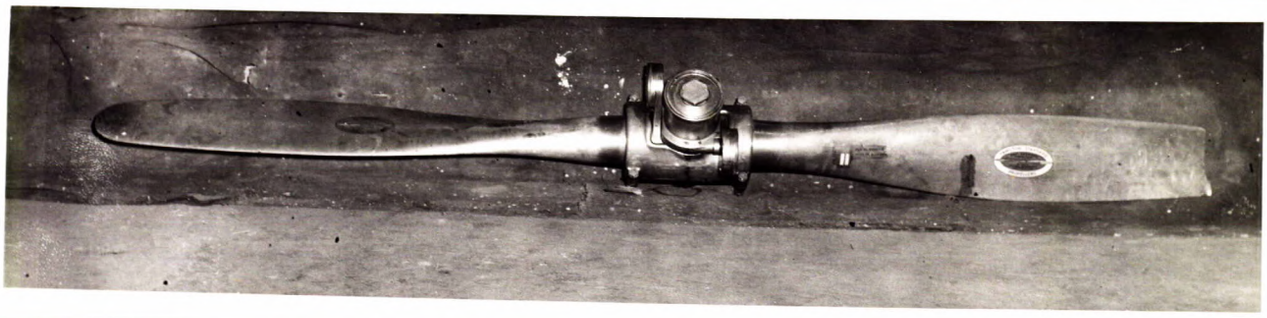
Information was given that the fracture of the blade has been referred to as an unusual type of defect, and it was requested that a detailed investigation for determination of the cause of the failure be conducted.

Additional information was obtained to the effect that the failure occurred during a ground run.

Description of Sample:

Figure 1 shows the broken airscrew blade as submitted.

Figure 1.



AIRSCREW AS SUBMITTED.

(Approximately 1/20th actual size).

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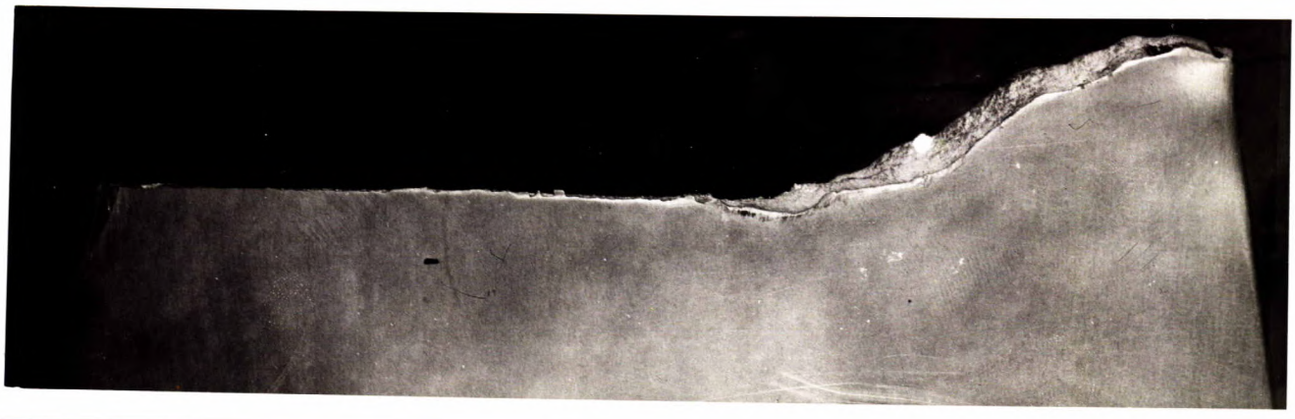
Figure 2 shows the shape of the fracture in larger scale.

Figure 2.



APPEARANCE OF THE FRACTURE.

(Approximately to size).

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The fracture occurred at a point six inches from the top of the blade. The tip was lost, probably in the snow.

It is evident (see Figure 2, top) that this airscrew

(Description of Sample, cont'd) -

blade has been dented and the dent smoothed out by filing and polishing. The appearance of the fracture (Figure 3) reveals that the failure started from this formerly repaired notch. The first part of the break (Figure 3, left side), about 3¾ inches long, is a typical fatigue fracture. The other part of the break was due to a sudden overstressing and shows that this part was strongly bent before it broke.

Figure 3.

APPEARANCE OF FRACTURE.

(Approximately to size).

Chemical Analysis:

	Examined Sample	S.A.E. Spec. AMS-4132A
	- Per cent -	
Copper -	4.47	3.9 - 5.0
Manganese -	0.70	0.4 - 1.2
Silicon -	0.57	0.5 - 1.2
Iron -	0.62	1.0 max.
Titanium -	0.018	-
Chromium -	0.0013	0.10 max.
Magnesium -	None detected.	0.03 max.
Zinc -	None detected.	0.25 max.
Nickel -	None detected.	-

Mechanical Properties:

Tensile Tests -

Specimens Nos. 1 and 2, 0.505 in. diameter, were cut out from the hub end; Specimens Nos. 3 and 4, 0.5 x 0.2 in. in size, were cut out near the fracture. Specimens Nos. 1 and 3 were longitudinal and Nos. 2 and 4, transverse, to the axis of the blade.

Specimen No. -	1	2	3	4
0.1 per cent proof stress, p.s.i. -	37,000	32,400	38,300	34,480
Ultimate tensile strength, p.s.i. -	59,900	53,000	59,250	55,900
Elongation in 2 inches, per cent -	19.5	15	14.5	12
Reduction of area, per cent -	35.5	34	-	-

The fracture of the transverse specimens Nos. 2 and 4 showed some directional fibring.

Impact Tests -

All samples were taken from the shank part of the blade.

	Longitudinal (to the axis of the blade) - Foot-pounds -	Transverse
a) Izod - round specimen -	11 - 14 - 11	8 - 12 - 6
b) Izod - square specimen -	10 - 10 - 11	6 - 9½ - 6
c) Charpy - square specimen -	8	4

The fractures of the transverse specimens again showed some directional fibring.

Hardness Tests -

To check the uniformity of the material the hardness tests were made at one-inch intervals along the centre line of the examined blade, the Vickers method with a 10-kilogram load being used. The following results were obtained:

Number of determinations	-	30.
Average hardness	-	125 V.H.N.
Maximum "	-	128 V.H.N.
Minimum "	-	123 V.H.N.

Metallographic Examination:

Macroscopic examination of a cross-section of the blade taken close to the fracture and etched in Tucker's reagent (15 per cent HFl + 45 per cent HCl + 15 per cent HNO_3 + 25 per cent H_2O) showed no sign of defective material.

Microscopic examination of a sample taken close to the fracture and adjacent to the original dent, formerly smoothed out, showed normal structure.

Discussion of Results:

The chemical analysis showed that the airscrew blade was made from 25ST aluminium alloy.

The results of the mechanical tests and the metallographic examination showed that the material was sound. No signs of any segregations, inclusions, or other non-uniformity were found.

The appearance of the fracture indicates that the failure was due to insufficient care in smoothing-off the previous damage (dent) on the edge of the blade.

CONCLUSION:

The examination revealed no metallurgical defect in the propeller. Failure, which started from a carelessly repaired notch, is considered to be "an isolated case". This conclusion is in agreement with R.C.A.F. Report of Defect No. 9822.

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JWM:GHB.