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October 9th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1106.

Examination of a Fractured 4130X Steel  
Aircraft Tube.

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ORE DRESSING AND  
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CANADA  
DEPARTMENT  
OF  
MINES AND RESOURCES  
MINES AND GEOLOGY BRANCH

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Origin of Material and Object of Investigation:

On September 25th, 1941, Flight Lieutenant A. J. Smith, of the Department of National Defence (Air Services), Ottawa, Ontario, submitted for investigation a wing elevator assembly (Cessna Aircraft Company, Blueprint No. T 50400). An examination of the S.A.E. 4130X steel tube was requested.

Nature of Sample:

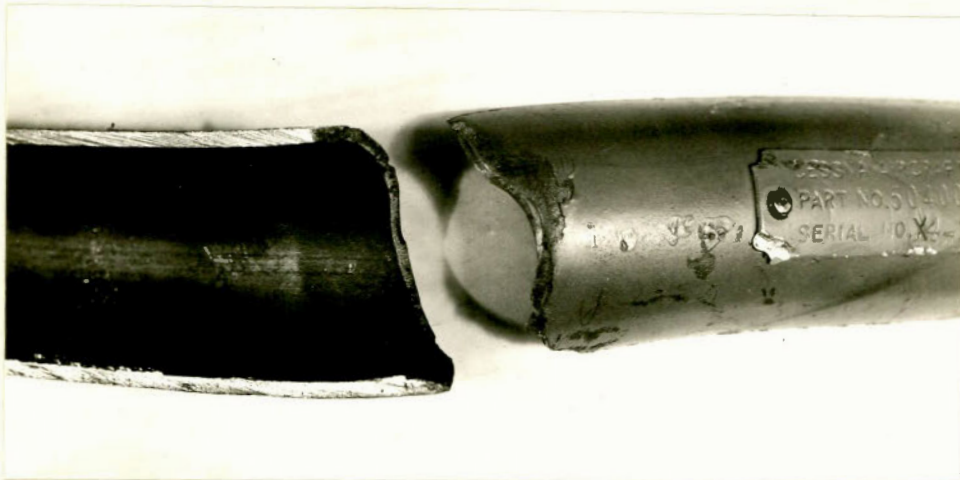
A piece of tubing three inches long was submitted. The fracture on the end of this section was reported to

(Nature of Sample, cont'd) -

have been made either prior to or during a crash. The remainder of the wing elevator assembly also was submitted and physical tests on the S.A.E. 4130X steel tube were requested.

Appearance of Fracture:

Figure 1.



Approximately 7/8 size.

Figure 2.



Approximately  $\frac{3}{4}$  size.

Chemical Analysis:

	<u>Cessna Aircraft Tubing</u>	<u>S.A.E. 4130X Specifications</u>
	(Per cent)	
Carbon	- 0.31	0.25-0.35
Manganese	- 0.63	0.40-0.60
Silicon	- 0.24	0.15-0.30
Phosphorus	- 0.005	0.040 max.
Sulphur	- 0.009	0.050 "
Nickel	- 0.19	-
Chromium	- 1.17	0.80-1.10
Molybdenum	- 0.22	0.15-0.25
Vanadium	- None detected.	

Hardness Tests:

Near the fracture - 276 V.H.N.  
Two inches from the fracture - 250 V.H.N.

Tensile Tests:

Welds were spaced at such short distances from each other that it was necessary to include welded areas in the sections under tension. No weld failures were obtained. Fracture in tension occurred at approximately 1 inch from the nearest welded area.

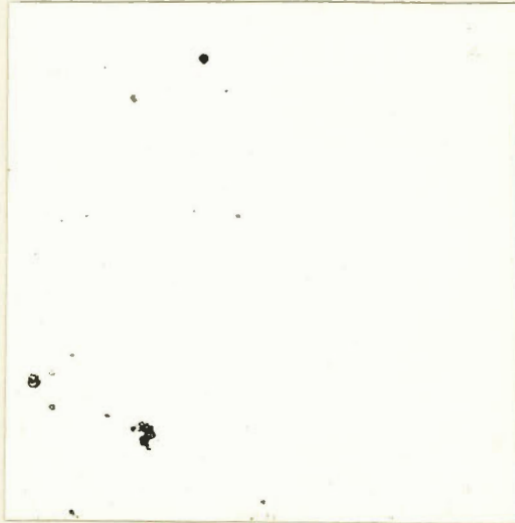
<u>Test No.</u>	<u>Elastic limit, p.s.i.</u>	<u>Ultimate load, p.s.i.</u>	<u>Elongation, per cent in 2 inches</u>
1.	--	106,000	9
2.	68,000	104,400	6
3.	52,000	105,200	7

Since there were welds on the tubing under tension, the elongation would not represent the true ductile properties of the steel.

Microstructure:

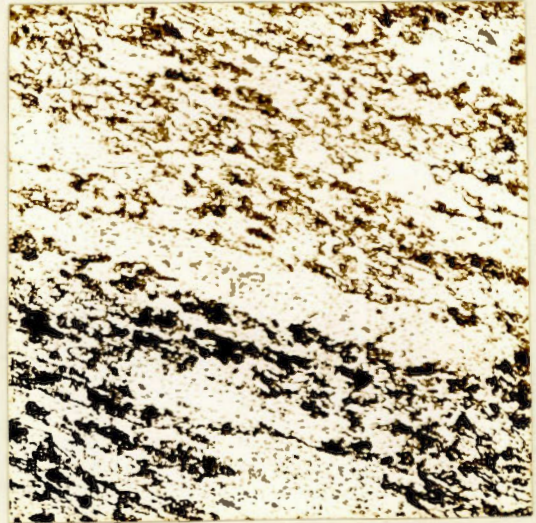
The photomicrographs shown below, Figures 3 and 4, indicate that this tubing had a structure normal for S.A.E. 4130X steel.

Figure 3.



X500, unetched.

Figure 4.



X500, nital etch.

DISCUSSION OF RESULTS:

The distortion at the point of fracture is of the type usually associated with failure due to tension or torsion. However, the fracture has been somewhat damaged and the appearance may be misleading. Distortion at the fracture may have been caused in the accident, so there is a possibility that the part failed in fatigue. One would expect, however, that any fatigue failure in this tube would have started in the tapped thread holes holding the name-plate screws.

The chemical composition of this tubing conforms quite closely to the composition specified for S.A.E. 4130X. The small amount of chromium exceeding the maximum specified should not produce any deleterious effect.

In Technical Report 348<sup>Ⓢ</sup> of the National Advisory Committee for Aeronautics, entitled "Strength of Welded

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Ⓢ 1930, pp. 323-359.

(Discussion of Results, cont'd) -

Joints in Tubular Members for Aircraft", by Whittemore and Brueggeman, the following physical properties for average aircraft tubing from  $\frac{3}{4}$  inch to 2 inches in diameter are given:

Tensile strength	-	105,000 p.s.i.
Elastic limit	-	50,600 p.s.i.
Elongation in 2 inches	-	19 per cent.

In the same article some typical hardnesses recorded adjacent to a weld in 2 inch by 0.065 inch tubing were given as

$\frac{1}{4}$ inch from weld	-	275	V.H.N.
" " "	-	200	V.H.N.
" " "	-	250	V.H.N.
" " "	-	250	V.H.N.

The results obtained on the piece of tubing submitted for examination are in line with the data given. Due to the restraining action of the welded areas, a normal elongation test could not be taken.

The microstructure is normal for an S.A.E. 4130X steel.

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Conclusion:

S.A.E. Steels 4130 and 4130X are considered very satisfactory for aircraft tubing. Considering the results of this investigation, it is probable that the tubing examined would meet the specifications for this class of steel.

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