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March 19th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1184.

Examination of Welding Failure on a
Cessna Aircraft Control Elevator Walking Beam.

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Origin of Request:

On March 5th, 1942, the Department of National
Defence (Air Services), Ottawa, Ontario, submitted for
examination a clip labeled:

"A/C A. Ferrier,
Ref. D19 Casualty, Red.
Crane 7717 (No. 4 S.F.T.S.)
and No. 2 T.C. Signal T 961, March 1st.
R. J. Grant."

This part is shown in Figure 1.

Accompanying this was a control elevator walking
beam, Part No. 32309, taken from Cessna No. 7658, and further

(Origin of Request, cont'd) -

identified as Section No. 26. CA, Ref No. N1V-11.

This part is shown in Figure 2. It is evident from an examination of Figure 2 that the clip in Figure 1 is a part of a control elevator walking beam.

It was requested that the weld joining the clip to the main body of the walking beam be thoroughly tested and examined, the testing to consist principally of applying a tensile load to the clip at an angle of 51° to the main body of the walking beam. We were also requested to examine the loose clip supplied (Figure 1) to ascertain whether or not this broke off because of faulty welding.

Physical Testing:

Two small portions were cut out of the broken edge of the loose clip and mounted in bakelite for hardness tests and microscopic examination.

An average hardness value of 259 Vickers was obtained, using a 5-kilogram load. There were no distinct hard or soft areas.

The weld on the complete control elevator walking beam was first subjected to X-ray examination. The workmanship and cleanliness seemed to be normal. In order to make this examination, it was necessary to cut off the lower end of the beam so that the films might be inserted inside the tube.

A special jig was constructed to hold the beam for testing. This is shown in Figure 3. For the actual test the lower half of the beam was not used but was replaced by a solid steel rod which was driven up into the upper part of the beam. Additional clamps were put on

(Physical Testing, cont'd) -

about $\frac{1}{8}$ inch on either side of the clip. The load was applied through a 7/36-inch diameter drill steel pin inserted through the holes in the clip. At a load of 6,822 pounds this pin sheared off, without damaging the weld.

Microscopic Examination:

Figure 4 is a photomicrograph taken at 200 diameters magnification showing a fragment of slag, containing some weld metal, clinging to the face where failure occurred on the loose clip. Figure 5 is the same area, at 200 diameters, etched in picric acid. Figure 6 is again this area, at a magnification of 1,000 diameters.

Discussion of Results:

The sample of welding done on the complete control elevator walking beam is good. It forms one of the strongest parts of the assembly.

The hardness of the metal adjacent to the weld in the loose clip is normal for X4130 steel. It would, therefore, not be reasonable to expect that failure had occurred because of a brittle hard weld.

Microscopic examination gives a clue as to why failure may have taken place and at what point in the weld this failure occurred. Evidence of dirty welding is clearly visible in the slag inclusion in Figure 4. Figure 5 shows that the face to which this slag is attached is the surface of the X4130 steel clip where it comes in contact with the weld metal. Failure, then, took place at the clip-weld interface. Note the characteristic martensitic structure present in the surface metal of the clip.

Conclusions:

1. The weld joining the clip to the control elevator walking beam in the complete assembly tested is satisfactory.

2. Microscopic examination of the area where failure occurred in the loose clip reveals evidence of dirty welding.

3. Microscopic examination of the area where failure occurred in the loose clip shows that failure took place between the weld metal and the clip.

4. There is no evidence that failure occurred because of hard brittle weld metal.

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HVK:GHB.

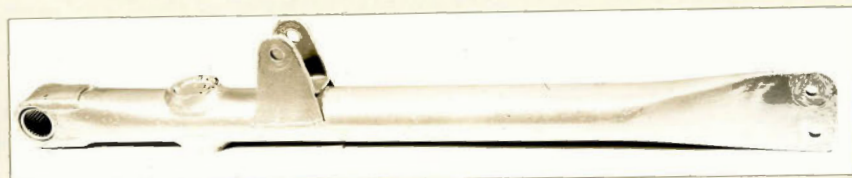
Figure 1.



Broken Clip (natural size) tagged as follows:

"A/C. A. Ferrier
Ref. D.19 Casualty, Red.
Crane 7717 (No. 4 S.F.T.S.)
and No. 2 T.C. Signal T 961, March 1st.
R. J. Grant."

Figure 2.



Control Elevator Walking Beam.

($\frac{1}{4}$ actual size)

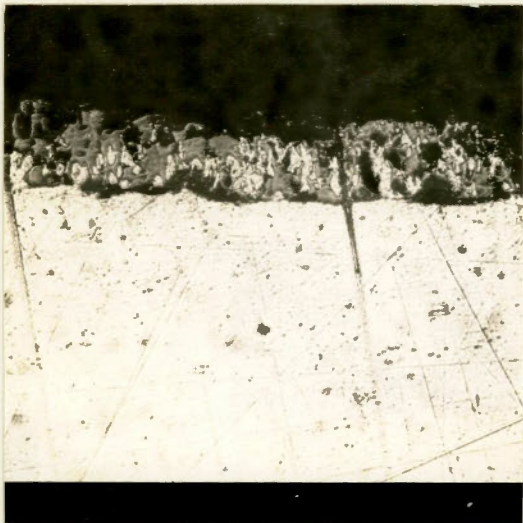
Part No. 52309
Taken from Cessna No. 7658
Ref. No. *NIV-11*
Section No. 26.CA.

Figure 3.



Jig for holding walking beam for testing.
($\frac{1}{2}$ actual size)

Figure 4.



Photomicrograph X200,
as polished, showing
fragment of slag on
metal-weld interface.

Figure 5.



Photomicrograph, X200.
Same as Figure 4
picral etch.

Figure 6.



Photomicrograph, X1000,
of slag found on metal-
weld interface.

HVK:GHB.

