O T T A W A July 7th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1259.

Examination of Oxford Undercarriage Micro Switch Springs.

(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 Purpose of Investigation:

On June 5th, 1942, Group Captain A. L. Johnson, for Chief of the Air Staff, Air Service, Department of National Defence, Ottawa, Ontario, requested (by letter, File No. 938AN-1-5) the examination of eight Oxford undercarriage micro switch springs.

The eight submitted springs, received on June 6th, 1942,

(Origin of Problem and Purpose of Investigation, cont'd) -

were identified as follows:

1 - unmarked, from crashed aircraft,
1 - marked "XX",
5 - marked 1 to 5,
1 - made from steel.

It was requested that the unmarked spring from the crashed aircraft be compared with the one marked "XX", by checking the mechanical properties and chemical analyses.

The five springs numbered 1 to 5 were submitted for a comparison of the mechanical properties only, in order to obtain an index of the consistency of the manufacturing technique.

In the accompanying letter it was stated that the above referenced seven springs, which are made of copper alloy, have now definitely been replaced by steel springs which are being delivered from Britain, one of which was submitted. It was requested that this spring also be compared for mechanical properties.

It was also stated while it would appear that the steel spring would naturally give better performance than the one being replaced, it is, however, necessary to complete the investigation so that the report on the crash can also be completed.

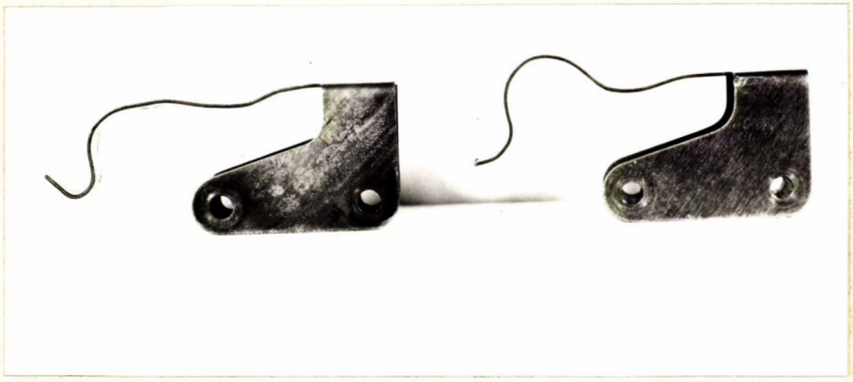
For identification purposes the unmarked spring from the crashed aircraft was marked "A" and the steel spring was marked "S".

Figure 1 shows two springs, marked "A" and "XX", as received. The picture shows the deformation of the spring "A" from crashed aircraft.

(Continued on next page)

(Origin of Problem and Purpose of Investigation, cont'd) -

Figure 1.



SPRINGS AS RECEIVED.

Left - "A"
Right - "XX"

(Approximately 4/5 size).

-

Chemical Analysis:

(a) Phosphor-bronze springs:

Sample marked:		"A"	"XX"
		- Per cent -	
Copper	-	95.02	93.92
Tin	-	4.86	5.84
Phosphorus	-	0.19	0.24
Lead	-	Trace	Trace
Iron	-	Trace	Trace
Zinc	-	None detected	None detected

(b) Steel spring, marked "S":

Carbon - 0.81 per cent.

Mechanical Properties:

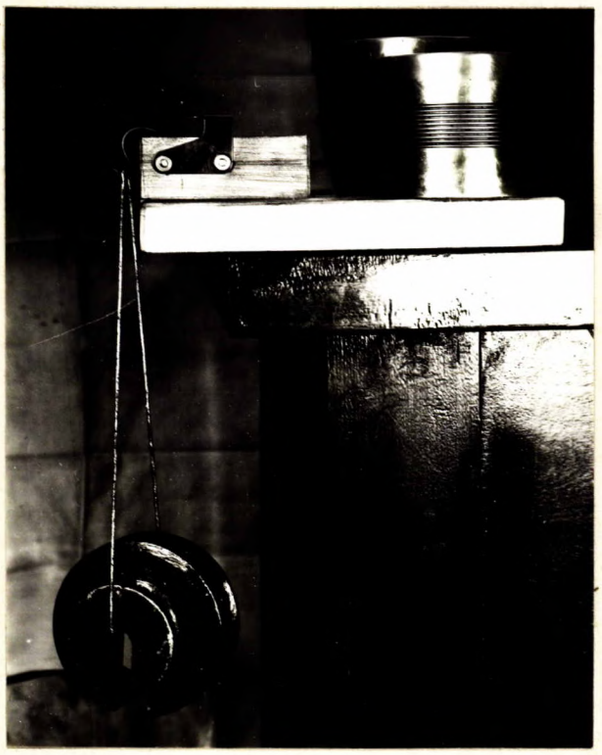
(a) Bending Tests:

Figure 2 shows the method of bending used for the examination of the springs.

(Continued on next page)

(Mechanical Properties, cont'd) -

Figure 2.



METHOD OF BENDING TEST.

(Approximately 1/3 size).

Table I shows the results of the bending tests:

Table I.

Results of Bending Tests.

Spring No.	LOAD, IN POUNDS							
	1	2	3	4	5	6	7	8
	- Deflection in mm. -							
1	2	3½	5	6½	7½	8½	-	-
2	1¾	3	4½	6	6½	6¾	-	-
3	2	3½	5	7	9	-	-	-
4	1½	3	4½	5½	6½	8	9½	10½
5	2	3	4½	6	6½	8	-	-
A	1½	3	4½	6	-	-	-	-
XX	2	4	5½	7½	8½	10	10½	-
S	2½	3¾	5½	6¼	6½	7	-	-

(Continued on next page)

(Mechanical Properties, cont'd) -

All springs were first measured and the load was applied increasing by one pound until the spring rested on the table surface, and the amount of deflection was measured.

The removing of the load was carried out in a similar manner and the former measurements checked. All phosphor-bronze springs showed a slight permanent set (about 0.5 to 1.0 mm.), while the steel spring returned exactly to its previous height.

All bending tests were carried out twice with very similar results.

One spring, marked "2", was tested for 18 hours under a load of 12 pounds. After the test the spring showed no increase in permanent set over the previous short tests.

It was found that the load necessary for making contact in the micro switch is approximately 1 pound.

(b) Tensile Tests:

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

The specimens were cut out from each of the examined springs. The dimensions of the finished test specimens were:

Thickness	=	0.027 - 0.030 inch (steel specimen, 0.021 in.
Width	=	0.180 - 0.186 inch.
Gauge length	=	10 mm. (0.4 inch).

The results of these tests are shown in Table II.

(c) Hardness Tests:

Hardness was determined by the Vickers method, using a 5-kilogram load. The results are given in Table II.

(Continued on next page)

(Mechanical Properties, cont'd) -

Table II.

Results of Tensile and Hardness Tests.

Sample	Ultimate tensile strength, p.s.i.	Elongation in 10 mm., per cent	Hardness, V. H. N.
A	81,000	20	160 - 170
XX	109,000	5@	200 - 230
1	91,600	10	160 - 170
2	83,700	10	150 - 160
3	86,400	15	150 - 160
4	76,700	15	155 - 165
5	89,000	10	160 - 170
S	210,000	-@	510 - 520

@ Broke in the grips.

CONCLUSIONS:

The results of the examination showed no defects in the spring submitted from the "crashed" aircraft. It would seem that the deformation of spring (Figure 1) was caused during the crash.

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JWM:GHB.