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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1302.

A Metallographic Study of Two Bolingbroke
Compressor Springs.

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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 Samples:

Two Bolingbroke Aircraft compressor springs were submitted on August 4th, 1942, by L. F. Bisson, of the British Air Commission, Montreal, Quebec. One spring, which we shall designate No. 1, was light in colour and had a rounded end. The other, herein designated No. 2, was dark and had a sharp end.

Object of Study:

An investigation of the microstructure, physical properties, and hardness of the springs was desired in order that a comparison of their relative merits might be made.

Analysis:

Carefully prepared samples of both springs were chemically analysed for carbon, with the following results:

		Carbon, per cent
Spring No. 1	-	0.76
Spring No. 2	-	0.67

Macro Examination:

The relative dimensions of the two springs are given below:

		LIGHT SPRING (Spring No. 1)	DARK SPRING (Spring No. 2)
Overall length, in inches	-	0.653	0.614
Outside diameter, " "	-	0.824	0.834
Wire diameter, " "	-	0.115	0.115

Physical Examination:

A survey of the hardness of the springs was made, using a Vickers machine with a 30-kilogram load. The light spring gave a hardness number of 464, and the dark one, 456.

Compression tests were run on a Baldwin-Southwark tensile testing machine. Spring No. 1 gave a full compression of 0.226 inch with a load of 92 pounds. This initial loading gave the spring a permanent set of 0.005 inch. Further maximum loading did not increase this set.

The full compression of Sample No. 2, which was attained with a load of 84 pounds, was 0.235 inch. No permanent set occurred in this or subsequent maximum loadings.

A curve of compression, in thousandths of an inch vs. force in pounds, is shown in Figure 1.

(Figure 1 is at the end of this report.)

Microstructure:

Longitudinal sections of the springs were polished and etched in a 2 per cent solution of nitric acid in alcohol. Photomicrographs depicting the average structure of the springs were taken at 500 diameters. These are shown in Figures 2 and 3.

Figure 2, a photomicrograph of Spring No. 1, shows an elongated structure. Figure 3, of Spring No. 2, shows a homogeneous structure generally designated as sorbite.

Discussion of Results:

The structure of Spring No. 1 indicates that it received its hardness by cold drawing. The structure of Spring No. 2 is typical of quenched and tempered steel. The fact that the surface of Spring No. 2 has dark tempering colours while that of Spring No. 1 is shiny, supports the above assumptions. The hardness is typical for springs of this size.

The most important consideration would seem to be whether or not the difference between the rate of loading and full compression load of Spring No. 1 and the rate of loading and full compression load of Spring No. 2 is critical. Part or all of this discrepancy might be accounted for by the fact that Spring No. 2 is 0.010 inch larger in diameter than Spring No. 1. The difference in diameter may be very important, because spring performance (assuming the elastic limit of the material is not exceeded, and leaving out of consideration breakages brought about by fatigue, impact, etc.) is entirely dependent on spring design, as all ferrous materials have approximately the same modulus of elasticity. The slight permanent set of the shiny spring on the first loading might also be a point of considerable importance.

(Discussion of Results, cont'd) -

It is pointed out in an article, "A Review of Spring Wire Characteristics," by C. T. Eakin, of the Westinghouse Electric and Manufacturing Company, published in IRON AGE, August 16th, 1934, that the elastic limit of heat-treated wire is somewhat higher than that of corresponding diameter in hard drawn wire and also that its endurance limit is higher. If this is so, it would indicate that a spring made from heat-treated wire would withstand greater compression without taking a permanent set and would also give a longer life.

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Figure 1.

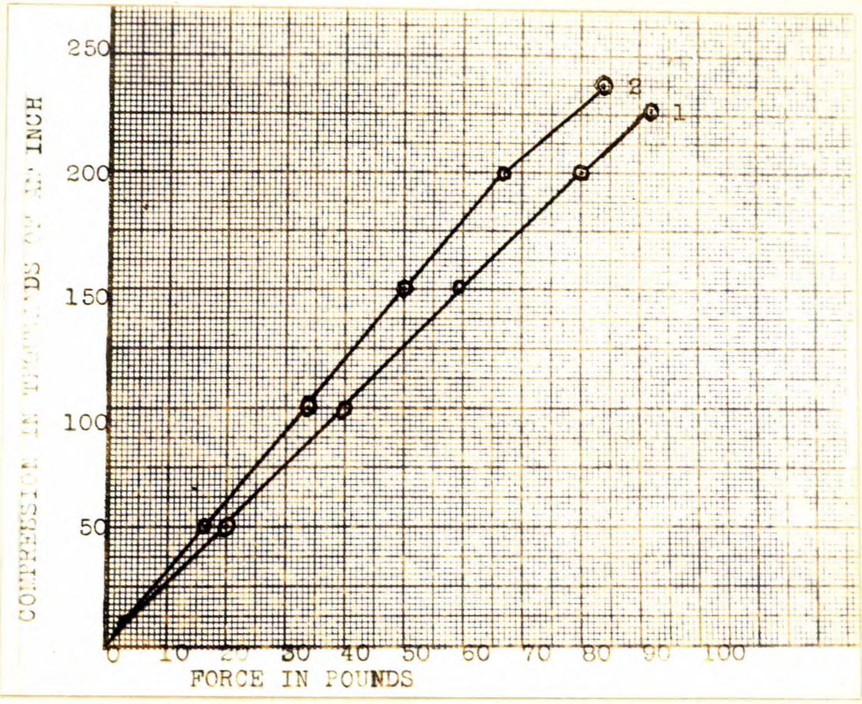

Figure 2.

X500, nital etch.

ELONGATED STRUCTURE
OF HARD-DRAWN SPRING.

Figure 3.

X500, nital etch.

HOMOGENEOUS STRUCTURE
OF HEAT-TREATED SPRING.

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