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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1869.

Examination of a Fractured Cast Iron Generator Crankshaft from H.M.C.S. "Lachine".

(Copy No. 10.)

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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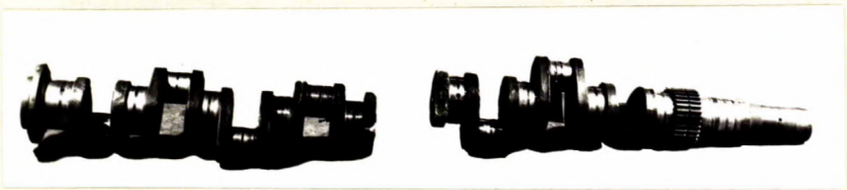
Source of Material and Object of Investigation:

On April 16, 1945, Mr. R. O. King, Director of Scientific Research and Development, Department of National Defence, Naval Service, Ottawa, Ontario, submitted a broken cast iron crankshaft from an eight-cylinder Diesel engine. It was requested (Requisition No. 53, File No. 8360-443/33) that a full metallurgical examination be carried out on the shaft in order to ensure that the metal is not defective and is suitable for the intended service.

Macro-Examination:

Figure 1 is a photograph of the broken crankshaft "as received" and shows the break between the fourth journal from the driving gear and web. The web fracture is shown in Figure 2. A section cut through the journal at the point of fracture is shown in Figure 3. It will be noted that the metal is quite sound.

Figure 1.



CRANKSHAFT AS RECEIVED.
(Approximately 1/24 actual size).

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Figure 2.

SHOWING FRACTURE OF CRANKSHAFT WEB.
(Approximately to size).

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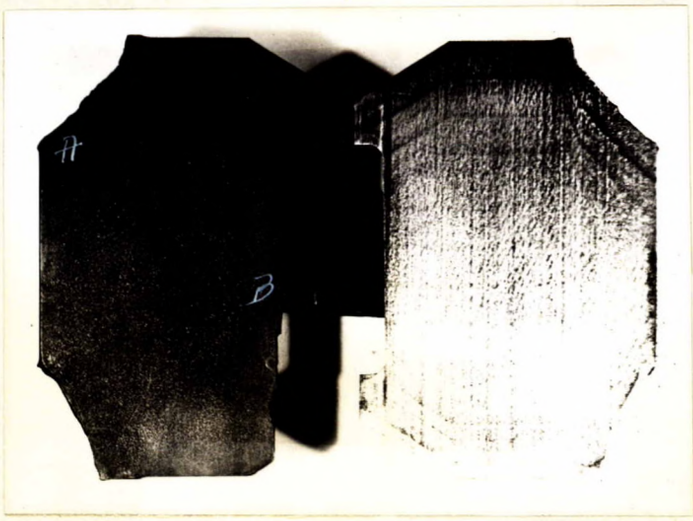
Figure 3.



SECTION THROUGH JOURNAL.
(Approximately 1/3 size).

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Material and Chemical Analysis:

The composition used in the manufacture of cast iron crankshafts for Diesel engines is a development of Campbell, Wyatt and Cannon, Muskegon, Michigan, and is referred to in the trade as "Proferral". Both the range of composition generally specified for this grade of metal and the "as found" composition of the broken crankshaft are given in the following table:

TABLE I.

	"Proferral"	Found
Total carbon -	2.25-3.00	2.32
Graphitic " -	1.25-2.50	1.75
Combined " -	0.50-1.00	0.57
Manganese -	0.80-1.35	1.02
Silicon -	1.75-2.75	2.28
Nickel -	0.75-1.50	1.07
Molybdenum -	0.75-1.50	0.97
Chromium -	0.20-1.00	0.20
Sulphur -	0.10 max.	0.020
Phosphorus -	0.25 max.	0.025
Vanadium -	-	Nil.
Titanium -	-	"
Copper -	-	"

Mechanical Properties:

The results of mechanical tests on tensile, Charpy impact and compression test pieces machined from the broken crankshaft are given in Table II. In a letter dated April 26, 1945, Mr. I. K. MacGregor, of the C. W. C. Crankshaft Corporation, Muskegon, Michigan, stated that these cranks were made to a general specification which requires that the iron have a minimum tensile strength of 52,000 pounds per square inch and a Brinell hardness range of 269 to 325.

(Continued on next page)

(Mechanical Properties, cont'd) -

TABLE II.

		Found
Ultimate stress, p.s.i.	-	57,500
Brinell hardness (3,000-kg. load)	-	293
Charpy impact, ft-lb.*	-	66
Modulus of elasticity	-	22,500,000
Compression strength, p.s.i.**	-	80,000
Fatigue strength, p.s.i.	-	27,500

* Specimen 8 in. long and 1-1/8 in. diameter supported on 6 inch centres.

** Specimen 3-3/8 in. long and 1-1/8 in. diameter.

Mr. MacGregor also stated, in a letter dated May 4, 1945, that this shaft was made from Heat No. 144, cast on February 11, 1941. The test bar taken from this shaft showed a Brinell hardness of 311 and had a tensile strength of 69,767 pounds per square inch. Brinell tests on the shaft itself showed hardness values ranging from 293 to 311.

Microscopic Examination:

Figure 4 is a photograph, at X100 magnification, showing the size and distribution of the graphite flakes in the unetched iron. Figure 5 is a photomicrograph, at X100 magnification, showing the nital-etched structure of the iron. The graphite flakes are normal and the matrix is pearlitic, with some quite small areas of ferrite.

Figure 4.

X100, unetched.

Figure 5.

X100, etched in 2 per cent nital.

Discussion of Results:

The chemical composition of the broken crankshaft is within the limits stated by the C. W. C. Crankshaft Corporation to be used in the manufacture of these shafts. The tensile strength, as determined on a specimen machined from the shaft, was above the minimum given in the general specification for this application. However, it will be noted that the value is considerably lower than that obtained on the test bar cast with the shaft at the time of manufacture. Hardness values were also found to be lower. The macro-examination, however, showed the metal to be quite sound and no flaws or imperfections were observed at the point of fracture. However, this absolute freedom from internal defects could only be confirmed by a high-powered radiographic examination, an examination which the makers of the shaft have offered to perform. The fatigue and impact properties were also found to be quite satisfactory and the microstructure was normal for this type of alloy cast iron.

No metallurgical defects were observed which would account for the failure of the shaft in service. Failure, therefore, was probably due to some mechanical rather than metallurgical cause.

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