1901

FILE COPY

O T T A W A July 3, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1901.

Metallurgical Examination of Aluminium Connecting Rod Bearing from Leyland Diesel Engine.

(Copy No. 10.)

O T T A W A July 3, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1901.

Metallurgical Examination of Aluminium Connecting Rod Bearing from Leyland Diesel Engine.

Origin of Material and Object of Investigation:

On May 14, 1945, a section of an aluminium connecting rod bearing from a Leyland Diesel engine (see Figure 1) was submitted by the Office of the Metals Controller, Department of Munitions and Supply, Ottawa, Ontario. A verbal request was received from Mr. A. S. Tuttle, of the Allocation and Conservation Division, for a complete metallurgical examination, including spectrographic analysis.

(Origin of Material and Object of Investigation, cont'd) -

Figure 1.

ALUMINIUM CONNECTING ROD
BEARING FROM LEYLAND DIESEL ENGINE.

(Approximately 3/4 actual size).

Spectrographic Analysis:

The results of a spectrographic qualitative analysis are given in Table I. (The elements are listed in order of decreasing magnitude.)

TABLE I.

Greatest Quantity			Least Quantity	
1	2	3	4	5
Aluminium		Silicon Iron Nickel Copper Magnesium Manganese		Molybdenum Titanium Lead Tin

Chemical Analysis:

The results of the chemical analysis are compared in Table II with the limits for the aluminium-copper-nickel-iron alloy known commercially as Hiduminium RR 56, reference (2).

(Continued on next page)

(Chemical Analysis, cont'd) -

TABLE II.

	As Found	Hiduminium RR 56
	- Per Cent -	
Copper -	1.96	1.8-2.5
Nickel -	1.31	0.6-1.4
Iron -	1.25	0.6-1.2
Magnesium -	0.62	0.65-1.2
Silicon -	0.48	0.55-1.25
Zinc -	0.13	--
Manganese -	0.07	--
Titanium -	0.07	0.05-0.15
Lead -	0.01	--
Tin -	None detected.	--

Mechanical Tests:

A microtensile test piece was machined from the bearing and pulled in a Hounsfield tensometer. Hardness tests were made both on a Brinell and a Vickers hardness testing machine, using a 500-kilogram load in the former and a 10-kilogram load in the latter.

The results are compared in Table III with the mechanical limits for Wrought Heat-Treated Al-Cu-Ni-Fe alloys (Hiduminium RR 56) given in reference (2).

TABLE III.

	As Found	Specification for Hiduminium RR 56 (Wrought, Heat-Treated)
Tensile strength -	53,200 p.s.i.	27-30 tons (60,480-67,000 p.s.i.)
0.1 per cent proof strength -	43,500 "	21-23 " (47,000-51,500 ")
Elongation, per cent -	7.3 (0.4-in. gauge length)	10-15 per cent (2-inch gauge length)
Reduction in area per cent -	21.7	--
Hardness -	100-119 Brinell	121-138 Brinell
-	136-147 Vickers	

Microscopic Examination:

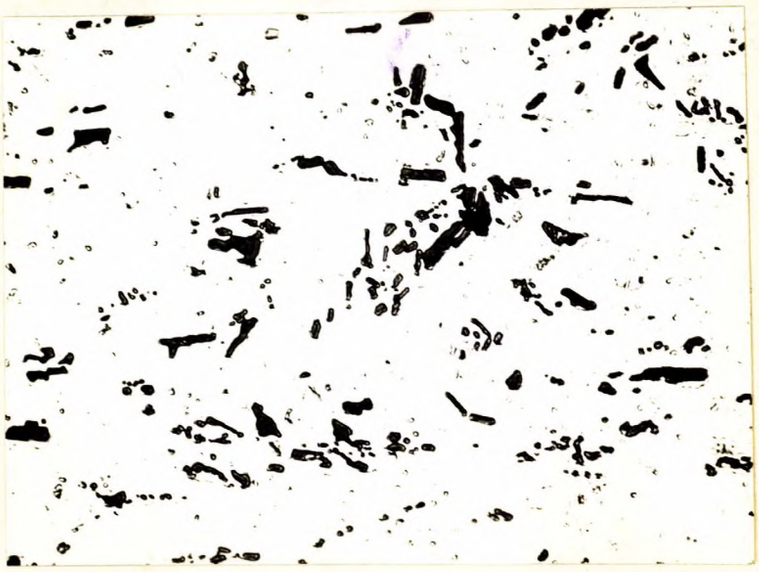
Figures 2 and 3, taken at X500 and X250 respectively, show the microstructure obtained by etching in ½ of 1 per cent hydrofluoric acid and Keller's etch, respectively.

(Continued on next page)

(Microscopic Examination, cont'd) -

The latter etchant reveals the grain structure, absent in Figure 2. The microstructure is typical for a wrought, heat-treated alloy.

Figure 2.



X500, (1/2 of 1 per cent HF etch).

MICROSTRUCTURE OF ALLOY.

—

Figure 3.

X250, Keller's etch.

MICROSTRUCTURE OF ALLOY.

Note grain boundaries revealed by etchant.

—

Discussion:

The results of the chemical and spectrographic analyses show that the bearing was fabricated from an alloy, belonging to the aluminium-copper-nickel-iron group, known commercially as Hiduminium RR 56 (General Purpose Wrought Alloy). The specifications for this alloy are: DTD 130A, DTD 184, DTD 220A, DTD 246A, DTD 410. The high mechanical properties (see Table III) and the evidence disclosed by the microscopic examination definitely prove that the alloy had been wrought and heat treated. The heat treatment designated for this type of alloy is as follows:

> "Soak at 525° to 535° C. for 2 to 6 hours. Quench in hot water. Age artificially by heating at 165° to 180° C. for 10 to 20 hours. Quench in water or cool in air."

The aluminium-copper-nickel alloys are widely used in Europe, and especially in England where they originated. They are characterized by high mechanical strength both at room and at high temperatures, a property imparted to them by the combination of copper and nickel. For this reason these alloys are widely used, both as castings and forgings, for pistons and parts requiring good mechanical properties at high temperatures.

A bearing alloy is one which contains hard particles in a plastic matrix. This condition is met by the aluminium-copper-nickel-iron alloys, since the iron and nickel constituents act as hard particles in the plastic aluminium matrix. However, the suitability of an alloy as a bearing metal can only be definitely established by actual service tests.

The machinability of these alloys is good as compared with other aluminium alloys. The corrosion resistance is not very good.

(Continued on next page)

Conclusions:

The following is a summary of the conclusions:

1. The bearing was made from a wrought, heat-treated aluminium-copper-nickel alloy high in iron, commercially known as Hiduminium RR 56.

2. The specifications covering this alloy are: DTD 130A, DTD 184, DTD 220A, DTD 246A, DTD 410.

3. The alloy is used widely for pistons and parts requiring good mechanical properties at high temperatures.

4. Bearing properties are imparted to the alloy as a result of the iron and nickel which act as hard particles in a plastic groundmass.

5. The machinability is good as compared with other aluminium alloys, whereas the corrosion resistance is not very good.

oooooooooooo
oooooooo
oo

References:

(1) "Metallography of Aluminium Alloys" - L. F. Mondolfo.

(John Wiley and Sons, Inc., New York - 1943.)

(2) "Diary, 1944" - Published by High Duties Alloys Ltd., England.

AF:LB.