File

FILE COPY

O T T A W A January 11th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1569.

Examination of a Bosch Fuel Injection Valve.

(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

O T T A W A January 11th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1569.

Examination of a Bosch Fuel Injection Valve.

Source of Material and Object of Investigation:

On December 21st, 1943, a Dominion Engineering Sulzer engine Bosch fuel injection valve which exhibited scoring was submitted by Lt.-Cdr. J. R. Millard, Department of National Defence, Naval Service, Ottawa, Ontario, for sectioning and examination. It was requested ((letter, File No. 29-28-1 F.D. 205 (Staff))), that the nozzle body be sectioned through the oil inlet hole and returned for inspection. The spindle was retained for metallurgical examination in order to determine, if possible, the cause of corrosion and wear of this part in service.

Spark Test:

A spark test carried out on the spindle indicated that this part had been made from high speed steel.

Hardness Tests:

A hardness survey showed that the steel had been homogeneously hardened to 60 Rockwell 'C' scale.

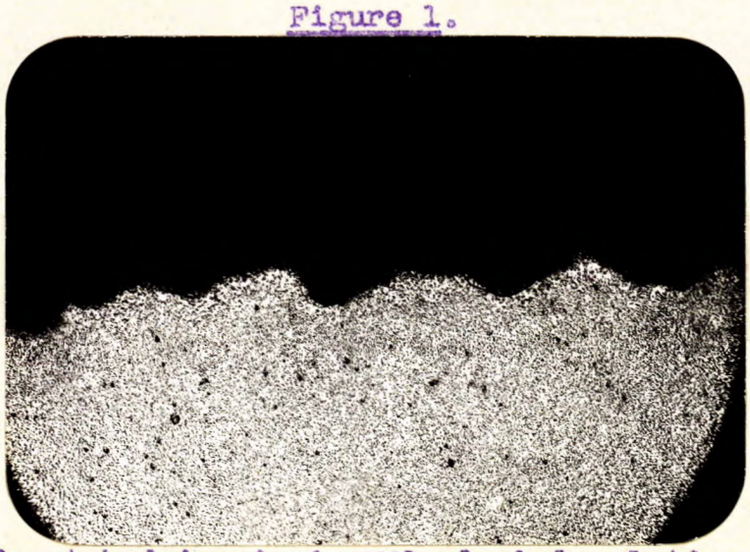
Macroscopic Examination:

The spindle showed evidence of pitting on the upper end. Fairly deep corroded lines running parallel to the longitudinal axis were also observed. These corroded grooves curved at the upper end of the spindle.

Microscopic Examination:

A section of the spindle was mounted in a steel clamp, polished, and examined under the microscope in the unetched condition. The steel was found to be fairly clean. The material was next etched in a solution of hydrochloric acid and picric acid in alcohol and re-examined. Figures 1 and 2 are photomicrographs, at X100 and X500 magnification, showing the etched structure of the material.

Figure 1.



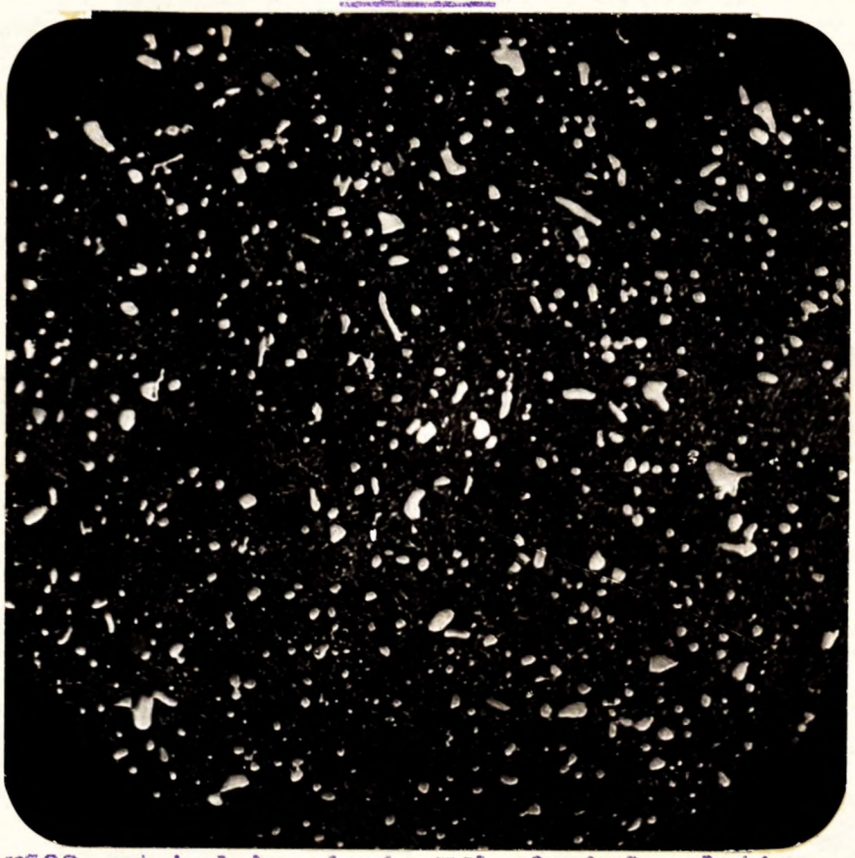
X100, etched in picric-HCl-alcohol solution.

CROSS-SECTION OF SPINDLE SHOWING GROOVED SURFACE.

(Microscopic Examination, cont'd) -

The structure of the steel illustrated in Figure 2 consists of carbides (white etched globules) in a dark etching matrix of tempered martensite.

Figure 2.



X500, etched in picric-HCl-alcohol solution.
SHOWING UNIFORM CARBIDE DISTRIBUTION.

DISCUSSION OF RESULTS:

A spark test indicated that the spindle was made from some grade of high speed steel. This was confirmed by a microscopic examination. The structure was found to be similar to that of a tungsten-chromium-vanadium 18-4-1 type of high speed steel. The extent of the attack on the surface of the spindle was found to vary, in some areas, such as shown in Figure 1, the surface was deeply grooved, while in other areas no attack was observed. No carbide segregation was noted, the

(Discussion of results, cont'd) -

distribution of the carbides throughout the matrix being quite uniform.

The curving nature of the grooving on the spindle would seem to indicate that the attack has not been entirely of an abrasive nature. Indeed, the high hardness of this steel should confer good wear resistance, although a properly heat-treated high speed steel should be harder, a Rockwell 'C' of 65 being usual. Had the grooves been straight one could have concluded that faulty operation (such as use of dirty oil, etc.) was responsible for the attack on the metal. The curving of the lines, it is believed, indicates a lack of homogeneity of the steel which led to a selective corrosion. No evidence of this condition could be obtained, however. The metallurgical examination, apart from the fairly low hardness for this type of steel, indicated a satisfactory material. The low hardness may have contributed to the failure but is not considered to have been the primary cause, as the attack seems to have been by corrosion rather than wear.

oooooooooo
ooooo
o

NBB:GHB.