File

FILE COPY

O T T A W A March 29th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1377.

Examination of Broken Front Axle Egg Cup for a Rzeppa Universal Joint.

(Copy No. 6.)

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 March 29th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1377.

Examination of Broken Front Axle Egg Cup for a Rzeppa Universal Joint.

Source of Material and Object of Examination:

On March 18th, 1943, Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted for examination a broken front axle egg cup (flange end) for a Rzeppa universal joint, which had been mounted on a 3-ton Ford military vehicle. It was stated that the casting had broken after 128 miles of service on the "Figure 8" test course of the No. 1 Proving Ground, Montreal Road. It was desired to know whether failure was due to defective material.

Chemical Analysis:

A chemical analysis was carried out on drillings taken from the casting and the following results were obtained:

		Per cent
Carbon	-	0.42
Manganese	-	0.69
Silicon	-	0.26
Phosphorus	-	0.030
Sulphur	-	0.046
Copper	-	0.14

Macroscopic Examination:

The fracture of the casting, shown in Figure 1, is of the non-duplex type.

Figure 1.

(Approximately to size).

—

Physical Tests:

Tensile and izod test bars were machined from the casting. The steel had an izod impact value of 16 foot-pounds. The tensile bar broke adjacent to a shrinkage cavity outside the gauge length. The coarse dendritic structure of the fracture of the tensile test bar is shown in Figure 2.

Figure 2.

(Approximately 5 times actual size).

Results:

Ultimate strength, p.s.i.	-	95,500
Yield strength, p.s.i.	-	65,500
Elongation, per cent in 1 inch*	-	3.0
Reduction in area, per cent	-	13.0

* Broke outside gauge length.

Hardness Tests:

Brinell hardness (3,000-kg. load) - 172.

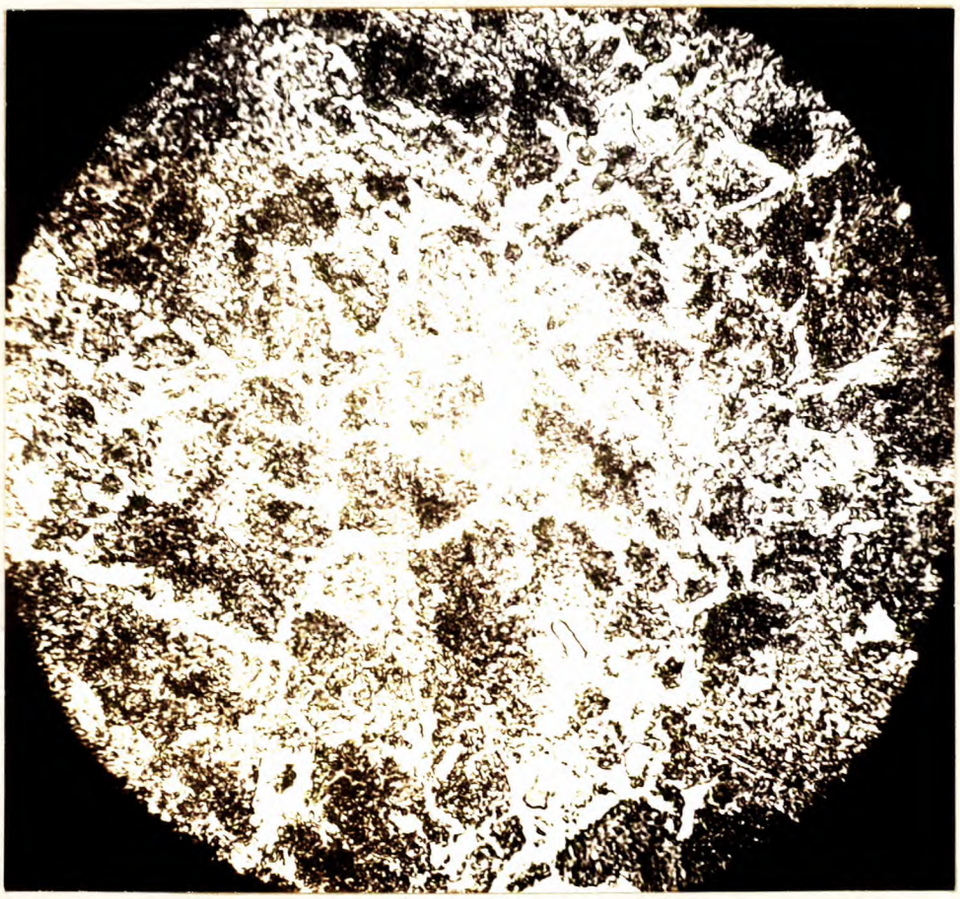
Microscopic Examination:

A polished specimen of the steel was etched in 2 per cent nital solution. Figures 1 and 2, photomicrographs at 100 and 1000 magnifications respectively, show the structure as revealed by the etch. In Figure 3 the white areas are ferrite (the iron content) and the dark areas are pearlite (the iron-iron carbide constituent). The grain size, while fine, is somewhat mixed. Figure 4 shows that the pearlite is beginning to spheroidize.

Figure 3.

X100, etched in 2 per cent nital.

Figure 4.



X1000, etched in 2 per cent nital.

Discussion of Results:

The steel was found to have a composition similar to that of an SAE 1040 steel. The non-duplex nature of the fracture would indicate that failure was caused by impact stresses which the steel could not resist because of its relatively low impact strength.

The steel was found to contain shrinkage cavities adjacent to the fracture. The structure of the steel with its relatively small amount of ferrite and its tendency to spheroidization in the pearlite indicated that the casting had probably received a normalizing-and-draw heat treatment. A quench from below the upper critical followed by a high-temperature draw would produce the same structure. It is thought unlikely, however, that the casting had been quenched. Inasmuch as the composition and structure of the steel was fairly satisfactory it is concluded from the examination of this casting that failure was due to the presence of shrinkage cavities in the metal.

oooooooooo
ooooo
o

NBB:GHB.