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O T T A W A August 27th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1078.

Four-Wheel-Drive Transmission
Jack Shaft Failures.

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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

OTTAWA August 27th, 1941.

REPORT

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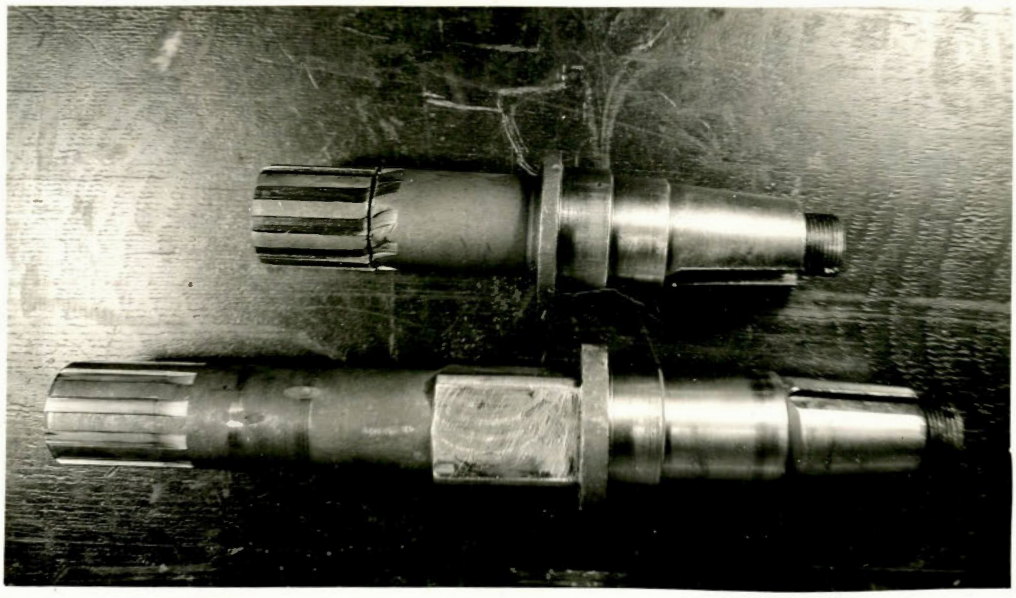
Origin of Material:

Mr. R. L. Martin, of the Motor Transport Division, Inspection Board of the United Kingdom and Canada, 58 Lyon Street, Ottawa, Ontario, reported that failures were occurring in a certain type of transmission shaft. One front and one rear shaft were submitted for examination, together with their blueprints and Analysis Requisitions Nos. M. T. 69 and 70, dated August 23rd, 1941.

Description of Shafts:

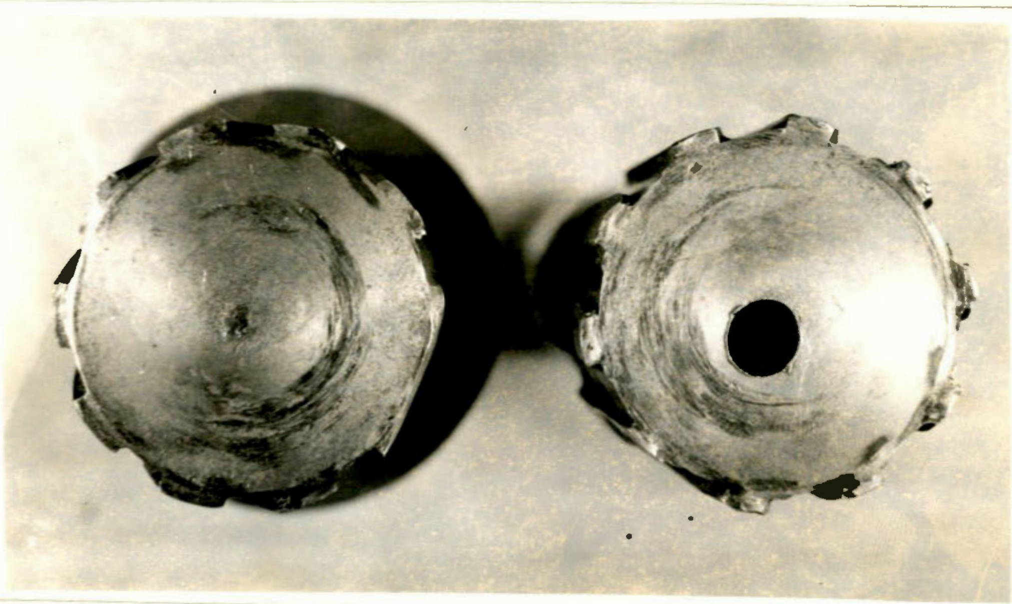
Figure 1.



SHAFTS AS RECEIVED.

Broken shaft (rear).
Long shaft (front).

Figure 2.

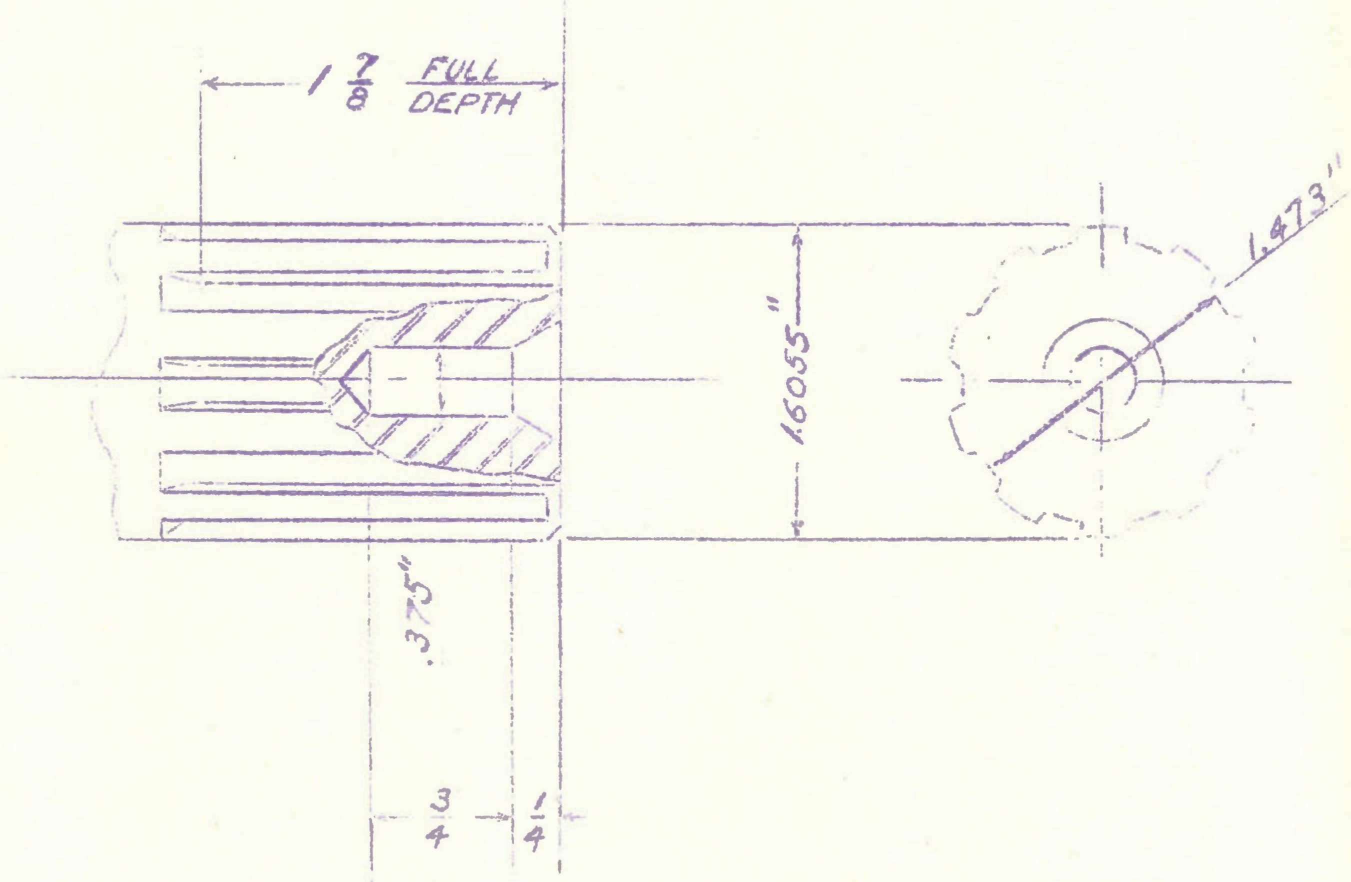


Appearance of Fracture.

(Description of Shafts, cont'd) -

The material specified is S.A.E. 4640 steel, heat-treated to a Brinell hardness of 290-330.

Figure 3.



Dimensions of Splined End.

Hardness Test:

Broken Shaft - 262-269 B.H.N.

Long shaft - 229 B.H.N.

Dimensions:

The hole in the end of the shaft (Figure 3) was not to specification. In the broken shaft an eccentric hole over 2 inches in depth had been bored. In the long shaft a hole about 1-7/8 inches deep was found.

Discussion:

Distortion of the splines at the point of failure indicated:

1. The shaft is soft.

2. Forces exceeding the elastic limit or yield point of the material have been exerted.

3. Fatigue failure must have started from the centre of the shaft.

The smooth fatigue fracture extends from the centre of the shaft to within 1/8 inch of the outside surface. Apparently the starting point for the fatigue crack was the bottom of an eccentric hole in the shaft.

Fatigue strength in soft steel is roughly proportional to hardness and tensile strength. The yield in torsion and the fatigue strength of this shaft would be considerably higher if the specified hardness (290-330 B.H.N.) had been obtained.

While soft steel has a high single-blow impact resistance, it fails under low loads in conditions of repeated alternating stress.

Conclusions:

1. The transmission shaft failed due to fatigue.

2. Fatigue failure was accelerated by:

(a) Strains exerted on the shaft which sometimes exceeded its elastic limit.

(b) Low elastic limit in the shaft due to its low Brinell hardness.

(c) An eccentric hole, ending at a highly stressed part of the shaft, served as a focal point for the start of fatigue cracking.

3. The shaft should be made harder and should be solid at the point of maximum stress.

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