O T T A W A March 31st, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1196.

Examination of Broken Churchill
Tank Track Link.

(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

OTTAWA March 31st, 1942.

REPORT

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Tank Track Link.

Origin of Request:

On March 16th, 1942, Mr. L. D. Tatley, for Director of Automotive Design, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted a broken track link from a Churchill tank recently received from England. It was requested that this casting be examined and an opinion expressed thereon.

Macroscopic and X-Ray Examination:

Figure 1 is a photograph of the track link as it was received by this Department. It was stated that this link broke during the cold weather tests at Kapuskasing, Ontario, at 9.00 a.m., March 4th, 1942, when the temperature was 10° above zero and the humidity 100%. The track had a total mileage of 87.8 miles.

X-ray examination, carried out by the National Research Council, showed that the casting was commercially sound. There were areas of minor shrinkage but none that would be detrimental to the strength of the casting.

Chemical Analysis:

The chemical analysis obtained and the chemical specifications for Ford No. 7 steel are recorded in Table I.

Table I.

		Chemical Analysis, Per cent	
		Churchill Tank Track Link	Ford No. 7 Steel
Carbon	-	1.23	1.35-1.55
Manganese	-	0.46	0.40-0.60
Silicon	-	1.11	0.90-1.50
Phosphorus	-	0.065	0.10 Max.
Sulphur	-	0.040	0.08 Max.
Nickel	-	0.33	-

Microscopic Examination:

The microstructure consists of very finely spheroidized carbides in a ferrite groundmass. This is illustrated in Figure 2.

Discussion of Results:

It is evident that these track links have been produced from a material similar to Ford No. 7 steel. This steel is commonly used for such applications in England since it is particularly adapted to their own manufacturing facilities. This steel has the drawback that its toughness is rather

(Discussion of Results, cont'd) -

sensitive to proper heat treatment. This point is discussed by Dr. R. Genders of the British Ministry of Supply. The following quotation is taken from his report:

> "The Ford material (termed Ford No. 7-A Steel) is made by mixing in an electric furnace molten pig-iron and cold steel scrap, the principle of the method being the dilution of cast iron with steel to such a point that the resulting alloy is a high silicon steel capable of being made ductile to some extent by an annealing treatment which spheroidizes the hard carbide constituent. This condition of the carbide gives a structure suitable for wear resistance and at the same time capable of an appreciable amount of cold distortion without fracture. Its ductility depends entirely upon the final heat treatment, and it is understood that although the Ford works was capable of producing a large number of castings, their heat treatment capacity was relatively small, and it is possible that failures which occurred with Ford 7-A links were due to inadequate heat treatment. A high production of castings was dependent on the heating capacity of the electric furnace in which the cold steel scrap was introduced into the molten pig iron, and the composition specified was a compromise with the intention of giving a carbon and silicon content just low enough to permit the necessary properties to be obtained by heat treatment; i.e., to require a minimum addition of cold scrap and give a furnace output adequate to ensure a continuous supply of molten alloy for conveyor casting."

It is also pointed out in this memorandum that other steels better adapted to this type of service are available in Canada and also that Ford No. 7-A steel is not recommended for links of heavier character than the carrier type.

The fact also should be borne in mind that the impact properties of carbon steels are adversely affected by cold temperatures. High carbon steels, which are comparatively brittle to start with, respond more readily to drops in temperature than do low carbon steels. It would therefore be expected that the steel in these links would show a greater tendency to break in cold weather, at even such comparatively moderate temperatures as 10° F.

Conclusions:

1. The track link submitted was made out of a steel similar in chemical composition and microstructure to Ford No. 7 steel.

2. Ford No. 7 steel is not generally accepted as being the best steel for this application.

3. Heat treatment for this steel is rather critical.

4. The impact properties of Ford No. 7 steel would be adversely affected by cold weather.

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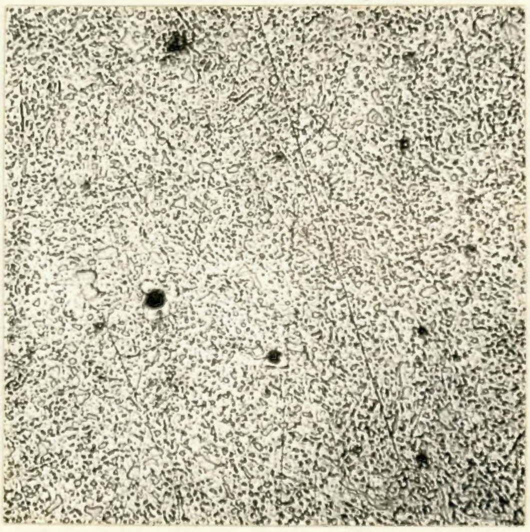
HVK:GHB.

Figure 1.

PHOTOGRAPH OF TRACK LINK AS RECEIVED.
(1/3 actual size).

Figure 2.



X500, picral etch.

MICROSTRUCTURE OF STEEL IN TRACK LINK.
(Note finely spheroidized carbides).

HVK:GHB.