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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, November 6, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2128.

Metallurgical Examination of a Rock Drill Piston Hammer.

(Copy No. 4 .)

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

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OF
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Origin of Material and Object of Investigation:

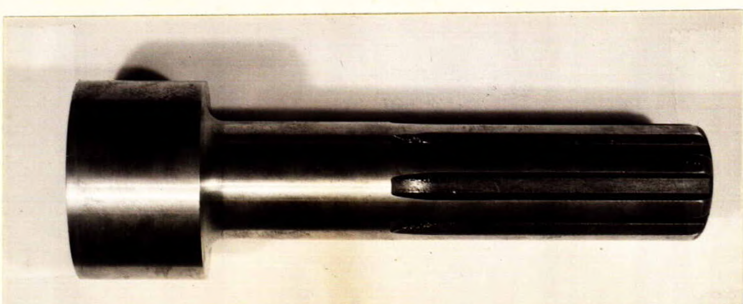
On October 6, 1946, the Canadian Johns-Manville Co., Limited, Asbestos, Quebec, submitted one defective piston hammer, one new piston hammer, a chuck and a piece of rock drill steel to these Laboratories. It had been requested, in a letter dated October 1, 1946, from Mr. H. C. Marek, mine superintendent, that a complete examination be made on the damaged piston hammer. The company was concerned with the excessive peening of their piston hammers in service.

The defective piston submitted was used for only

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

22 drill shifts in an Ingersoll-Rand Jackhammer JA-45 which was placed in service on April 13, 1937. This piston was installed in the machine on August 29, 1946, and taken out in its present condition on September 20, 1946. The chuck was installed new at the same time and does not show excessive wear according to the gauge supplied by Ingersold-Rand. The machine is a blower-type rock drill. Figure 1 illustrates the piston hammer. Figure 2 shows the assembly of the piston hammer(A), chuck(B), and shank end of the drill steel(C).

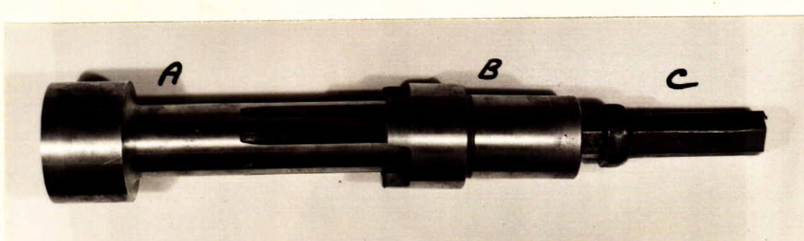
<u>Figure 1.</u>



PISTON HAMMER.

(Approximately 1/2 size.)

<u>Figure 2.</u>



ROCK DRILL ASSEMBLY.

(Approximately 1/3 size.)

Chemical Analysis:

Drillings were taken from the piston hammer for chemical analysis. The following results were obtained:

		As Found	Atlas X-10
		- Per Cent -	
Carbon	-	1.05	1.00
Manganese	-	0.23	0.25
Silicon	-	0.23	
Sulphur	-	0.016	
Phosphorus	-	0.017	
Molybdenum	-	Trace.	
Nickel	-	Nil.	
Chromium	-	Nil.	
Vanadium	-	Nil.	
Tungsten	-	Nil.	

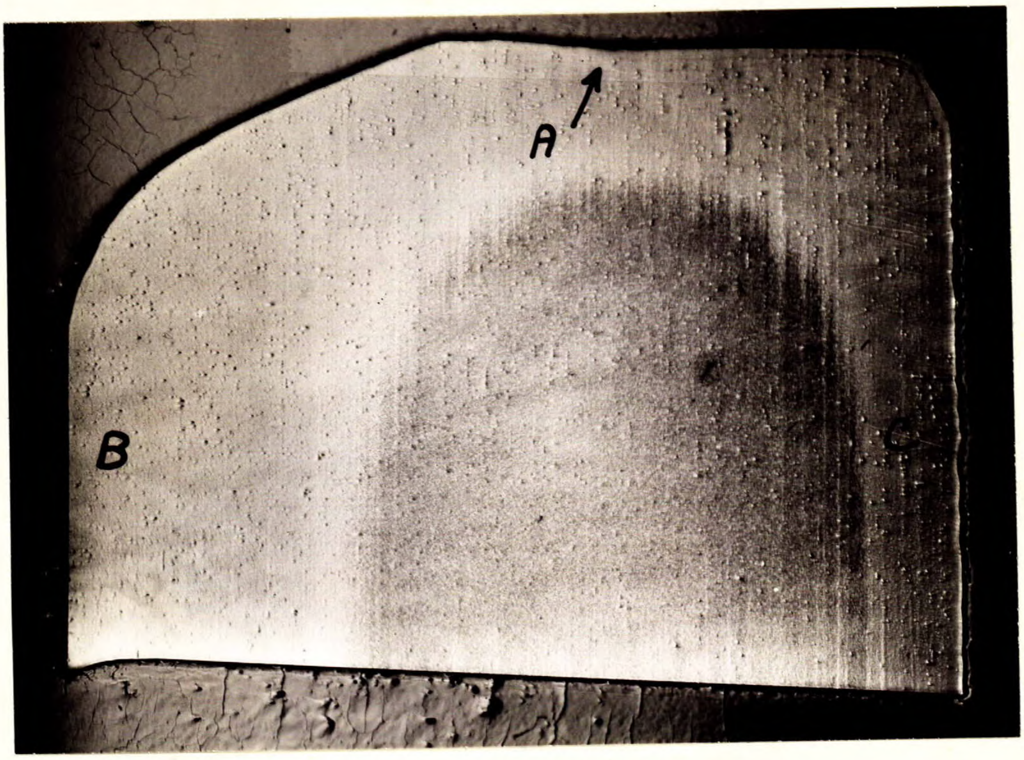
Macro Examination:

Examination of the face of the piston hammer seemed to indicate an uneven line of wear when progressing from the centre of the face towards the outside circumference. In order to check this, a longitudinal sample was cut through the face down the shaft of the piston. It was polished on the inner surface which is perpendicular to the face of the piston. The sample was etched in 2 per cent nital and examined under the microscope. Figure 3(X7½) is a macrograph of this surface. The arrow at A points to the section on the peening face where the wear appears to be greatest. The surface at B is the spline. The surface at C is the hole down the centre of the piston hammer. THE ETCH INDICATES THAT THE DEPTH OF HARDNESS PENETRATION IS NARROWEST (0.090 INCH APPROXIMATELY) AT THAT SECTION OF THE FACE (POINT A) WHERE THE WEAR APPEARS TO BE GREATEST.

(Figure 3 appears)
(on Page 4.)

(Macro Examination, cont'd) -

Figure 3.



X7½, etched in
2 per cent nital.

Note arrow at section A.

-

Hardness Tests:

Hardness tests were taken, using the Vickers machine and a 10-kg. load, on the face of the microspecimen shown in Figure 3. Two series of readings were taken. No. 1 series is from the centre of the specimen towards the worn surface A. No. 2 series is from the centre to surface C.

TABLE I.

Distance from the surface, in inches		Hardness, V.P.N. Series No. 1	Hardness, V.P.N. Series No. 2
0.005	-	743	734
0.010	-	743	734
0.020	-	743	734
0.050	-	743	724
0.075	-	687	515
0.10	-	528	402
0.15	-	382	387
0.25	-	376	376

The hardness on the face of the spline for both the defective and the new piston was 630 Vickers (57 Rockwell 'C

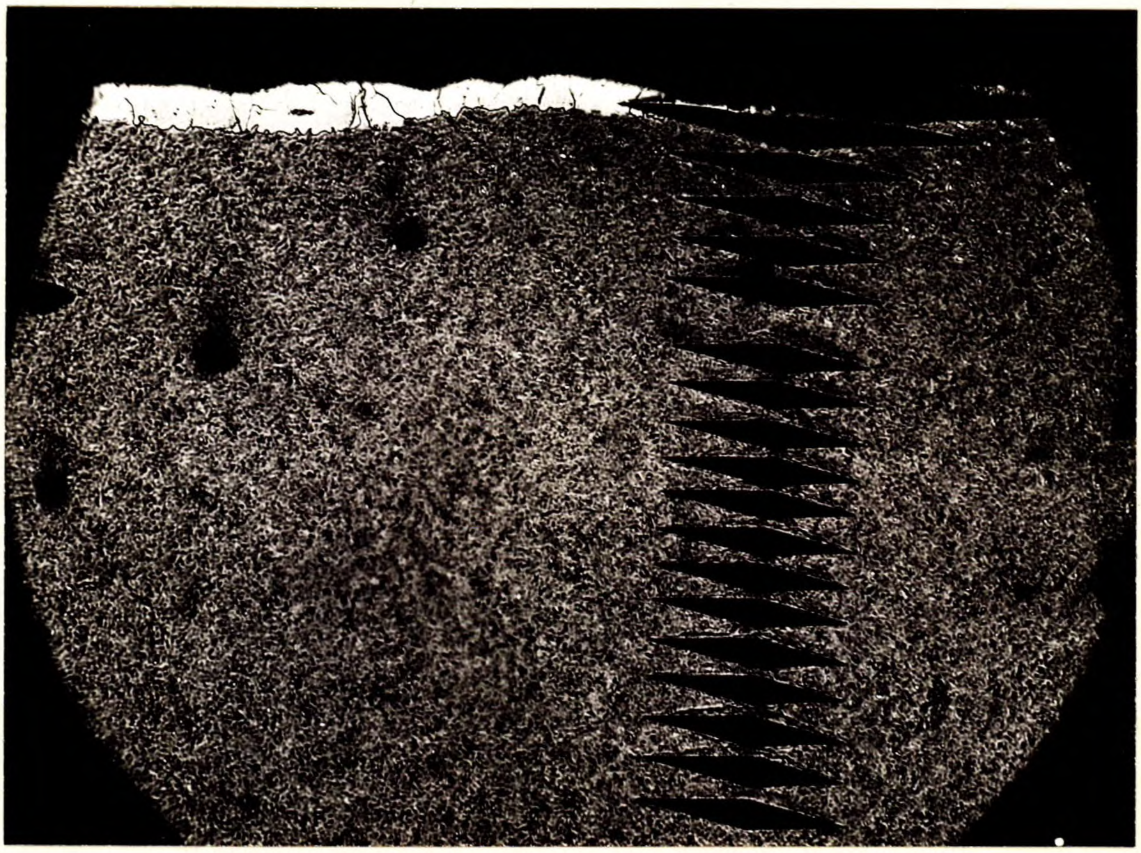
(Hardness Tests, cont'd) -

The hardness on the wearing face of the new piston hammer was 575 Vickers (54 Rockwell 'C').

Decarburization:

In order to check the surface for decarburization, Tukon hardness tests were made toward the exposed but unground surface of the central hole of the piston face C in Figure 3 and a photomicrograph was taken. It can be assumed that the condition found at this face would be similar to that of the wearing (peening) surface prior to its having been placed in service. Figure 4 (X300) illustrates the decarburized layer at the surface (white colour) and the Tukon hardness impressions. The decarburized layer is less than 0.001 inch deep.

Figure 4.



X300, etched in
2 per cent nital.

DECARBURIZED LAYER.

Less than 0.001 inch deep.

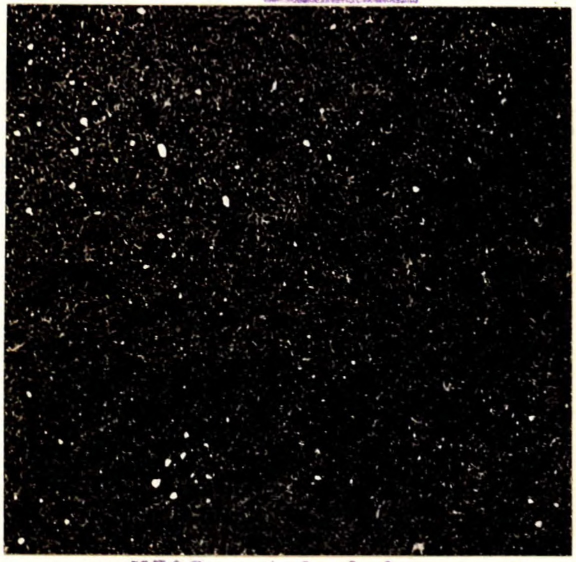
-

Microscopic Examination:

Figure 5 (X500) is a photomicrograph showing the structure of the hardened layer. It is composed of tempered martensite with nodules of free carbides (white constituent).

Figure 6 (X500) shows the structure of the softer interior of the piston. This consists of fine pearlite with small nodules of free carbides throughout.

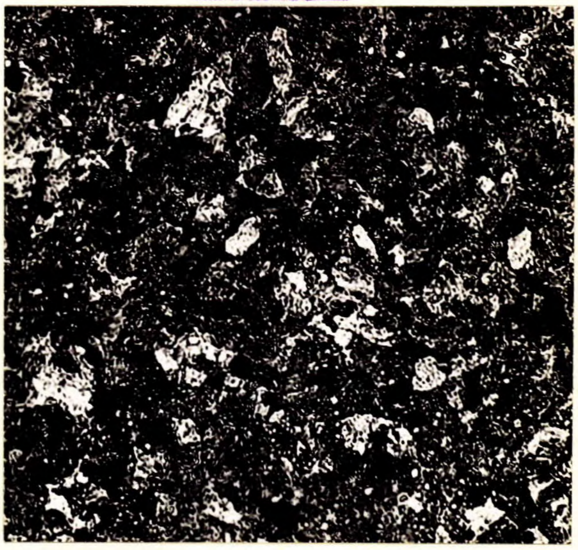
Figure 5.



X500, etched in
2 per cent nital.

STRUCTURE OF HARDENED LAYER.

Figure 6.



X100, etched in
2 per cent nital.

STRUCTURE OF INTERIOR.

Discussion:

The steel used compares with Atlas X-10 tool steel. This is a shallow hardening, water quenching steel which has been widely employed for this purpose.

The hardness of the steel at 0.005 inch from the surface is 745 V.P.N. near the peened face and 734 V.P.N. near the face of the spline. This is sufficiently hard and should give good wear. The amount of decarburization found at the exposed and unground surface of the centre hole was less than 0.001 inch. Therefore it is reasonable to assume that the peened surface prior to use also had this small amount of

(Discussion, cont'd) -

decarburization. This would account for the Rockwell 'C' 54 hardness figure obtained on the peening face of the new piston. The decarburized layer, however, is so shallow that it must be discounted from the standpoint of excessive wear on the face.

From Figure 3 it appears that the peening face has given unsatisfactory service not due to unusually rapid wear but rather due to another phenomenon, namely, "brinelling." This is a term given to the pushing in of a hardened surface layer on impact. It will be noted, in Figure 3, that maximum compression at the surface has taken place at Section A where the hardened layer was thinnest. A thicker hardened section could be expected to have the strength to withstand the blows and prevent "brinelling." It might be mentioned that this effect usually occurs rather early in the service life of the part. After a period of use the subsurface layers work-harden and prevent any further collapsing of the surface layers.

In order to increase the depth of the hardened layer, two possibilities are available:

(1) Increase the severity of the quench on heat treatment.

(2) Change to a steel having somewhat greater hardenability.

The structure at the surface and at the centre of the piston is normal for a water-quenched steel of this type.

Conclusions:

1. The steel used conforms to Atlas X-10 Specification.

2. The hardness of the piston 0.005 inch below

(Conclusions, cont'd) -

the surface is 734 to 743 V.P.N. This is sufficiently hard, and should give good wearing properties.

3. The hardness of the peening face of the new piston is 575 V.P.N. probably due to a slight amount of decarburization.

4. The amount of decarburization found at an unground exposed surface is less than 0.001 inch. Therefore, the original peened surfaces could be expected to have the same small amount of decarburization. This small decarburization would not contribute greatly to an excessive wear condition.

5. What appears to be wear is actually a "brinelling" effect (collapsed surface).

6. The structure of the hardened layer is tempered martensite with nodular carbides.

7. The structure of the core is fine-grained pearlite with nodular carbides.

Recommendations:

1. To obtain a greater depth of the hardened layer, increase the severity of the quench in heat treatment.

2. If the above is not possible, change to a steel having somewhat more hardenability.

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