Dr J. Convey

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EXAMINATION OF FAILED ROLLER BEARING

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

Chemical analyses indicated that the rollers were AISI 52100 steel and the inner race was a modified AISI L5 tool steel. The severity of damage precludes anything but speculation concerning the reason for failure, but it seems likely that a lubrication break-down caused sufficient over-heating to expand the inner race, thus allowing it to spin on its shaft. This resulted in heavy scoring of the inner race and rapid heating to at least 2200°F.

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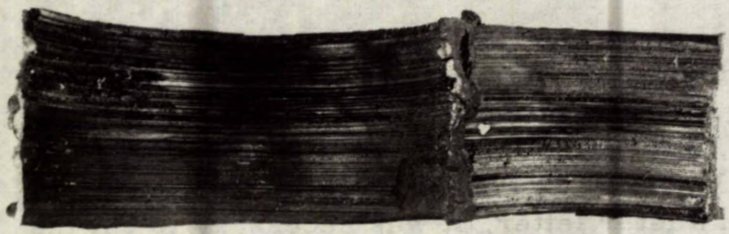
INTRODUCTION

A broken roller bearing was forwarded for examination by Mr. J.R. Dean, Assistant Manager of Production, The New Brunswick Electric Power Commission, Fredericton, New Brunswick, together with a covering letter dated January 13, 1964 (File 3-422b #3, G.L. #8 Coal Handling). As stated in a later letter, it was necessary to cut the bearing with an oxy-acetylene torch in order to remove it from the shaft.

VISUAL EXAMINATION

The surface of the inner race which had been in contact with the shaft was extremely heavily scored as shown in Figure 1. The raceways of the inner race were heavily brinelled and deformed as shown in Figure 2. The zone of maximum deformation appeared to be diagonally opposite the zone of least deformation. The rollers were flattened and deformed to various degrees, eight of the most severely deformed being shown in Figure 3. The outer race exhibited little damage.



Approx. X0.4

Figure 1. Photograph of heavily scored surface of inner race which was in contact with the shaft.

Approx. X0.4

Figure 2. Photograph of brinelled and deformed raceway surface of inner race.

Approx. X0.9

Figure 3. Photograph showing flattening and heavy distortion of many of the rollers.

CHEMICAL ANALYSIS

Drillings were obtained for chemical analysis from the rollers and from the inner race. The rollers appeared to be AISI 52100 steel, and the inner race an AISI L5 type tool steel modified by the elimination of the molybdenum addition. The analyses are shown in Table 1, along with the analysis limits and nominal target composition for AISI 52100 and AISI L5, respectively.

TABLE 1

Chemical Composition of Bearing Components

Steel	C, %	Mn, %	Si, %	S, %	P, %	Ni, %	Cr, %	Mo, %
Rollers	1.02	0.33	0.32	0.012	0.007	0.21	1.40	0.01
Inner Race	0.92	1.00	0.68	0.015	0.015	0.14	0.97	0.04
52100	.95 to 1.10	.25 to .45	.20 to .35	.025 max.	.025 max.	-	1.3 to 1.6	-
L5	1.00	1.00	-	-	-	-	1.00	0.25

MICROSCOPICAL EXAMINATION

Samples for microscopical examination were obtained from the inner and outer races and from the rollers. Their microstructures are shown in Figures 4 to 6. The outer-race material showed essentially the desired microstructure, but the inner race and the rollers had obviously been overheated to such an extent that the initial microstructure was completely altered.

Figure 4. **Microstructure of Outer-Race Material. Shows random distribution of fine carbides in a martensite matrix, which is the desired microstructure for bearings. The hardness was R_c 43. (X500 - Etched in 2% nital).**

Figure 5. **Microstructure of Inner-Race Material. Shows coarse grains of fine pearlite which have been formed by overheating during failure. (X500 - Etched in 2% nital).**

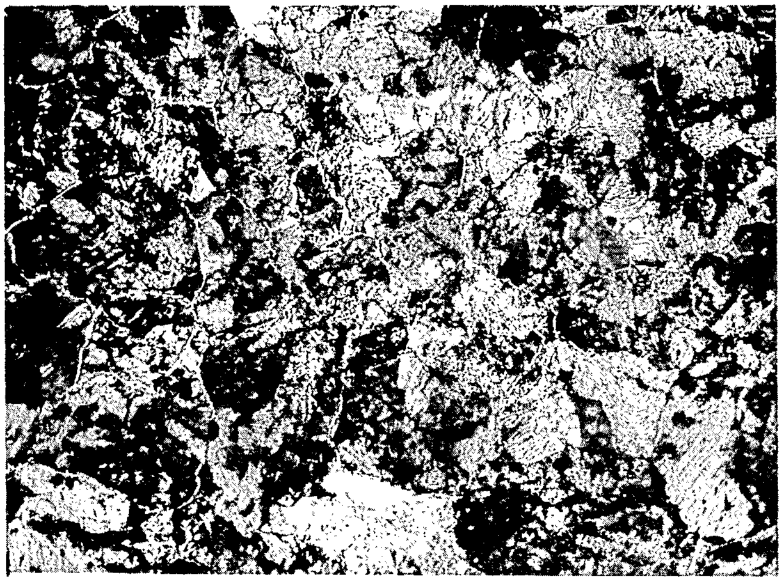


Figure 6. Microstructure of Roller Material. Shows essentially the same microstructure as the inner race material. Note presence of grain boundary carbides. (X500 - Etched in 2% Nital).

CONCLUSIONS

The results of chemical analysis indicate that the materials used for the roller bearing were normal for this application. The outer race, although softened, retained the desired type of microstructure. The damage to the inner race and the rollers was too severe to give any certain indication of the reason for failure. It is probable that overheating, possibly due to a lubrication failure, caused sufficient expansion of the inner race to allow its release from its shaft. The subsequent spinning on the shaft caused heavy scoring of the surfaces of contact and rapid overheating to a sufficiently high temperature, probably about 2200°F, to cause severe brinelling of the inner race and extensive distortion of the rollers. The temperature of the outer race probably reached about 1000°F resulting in a softening from about R_c 60 to R_c 43.

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