TORRINGTON®

Roller Bearing Service Damage and Causes

CONTENTS

Photographs of roller bearing damage

TORRINGTON
INGERSOLL-RAND

INTRODUCTION

Roller Searing Damage

This group of photographs was assembled to illustrate the appearance of various types of damage and failure occurring to spherical roller bearings in service.

The listing is by no means complete but does represent some of the more common types of damage.

Many failures are a combination of two or wore contributing causes and the resolution of the primary cause may be difficult.

Caution
To insure that bearings are in factory fresh condition when installed, they should be kept in the original package and stored in a dry warm place untl needed for mounting.

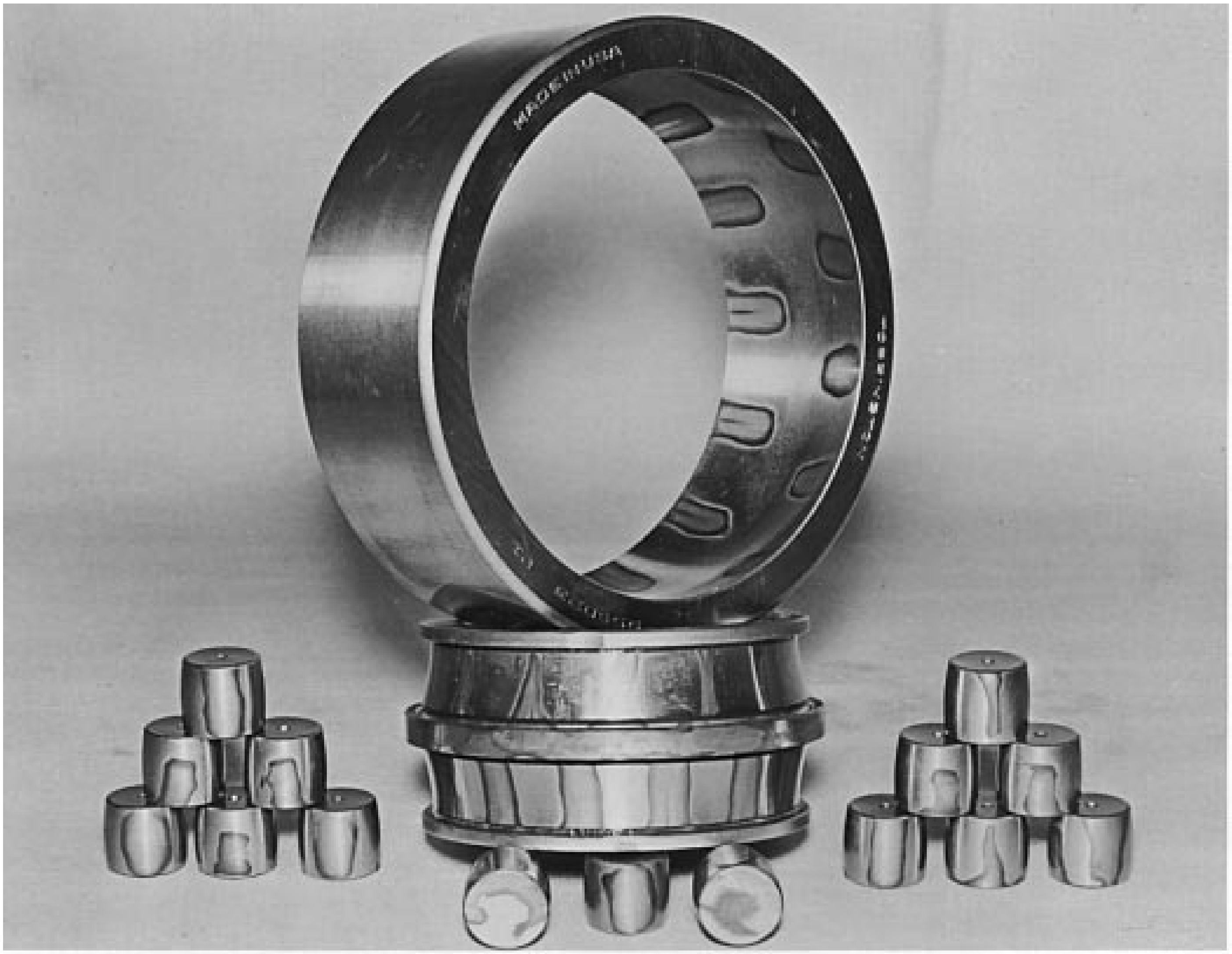


Figure 1

STAINING IN STORAGE

Improper storage conditions otten result in damage to bearings. Figure 1 shows staining that occurred on a bearing stored with inadequate protection in a humid atmosphere. Special types of packaging are available for storage of bearings in high humidity atmosphere.

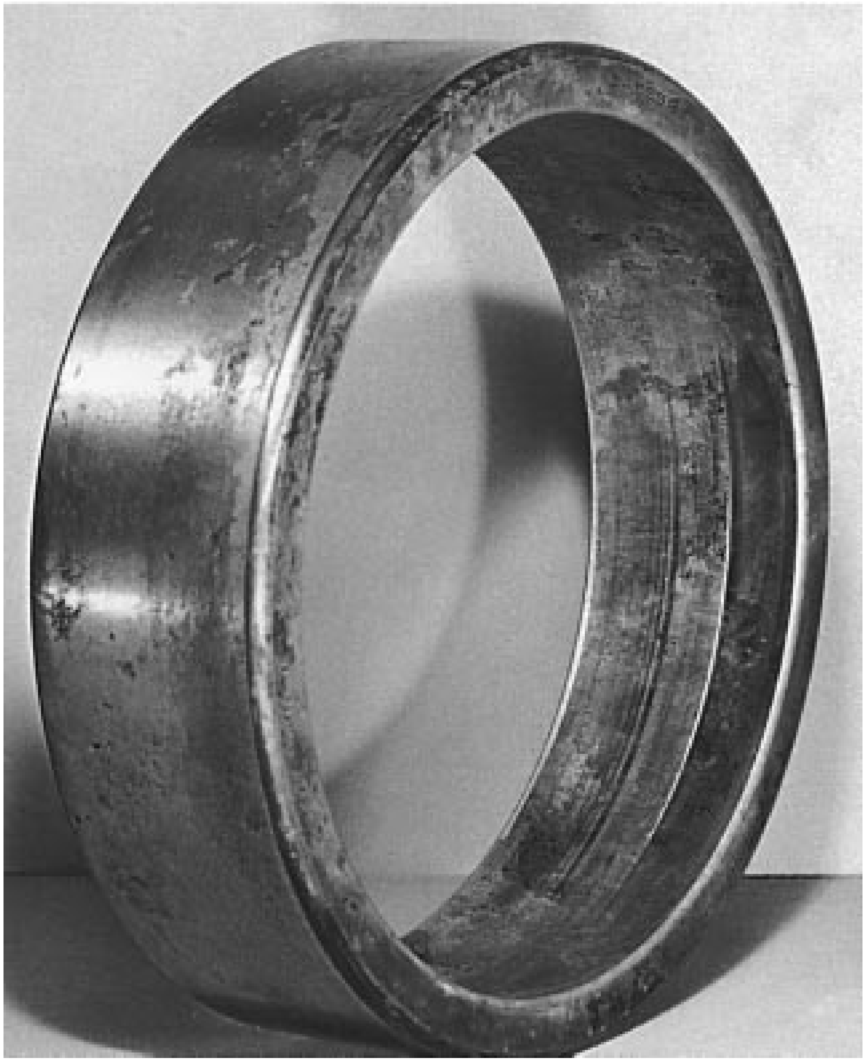


Figure 2

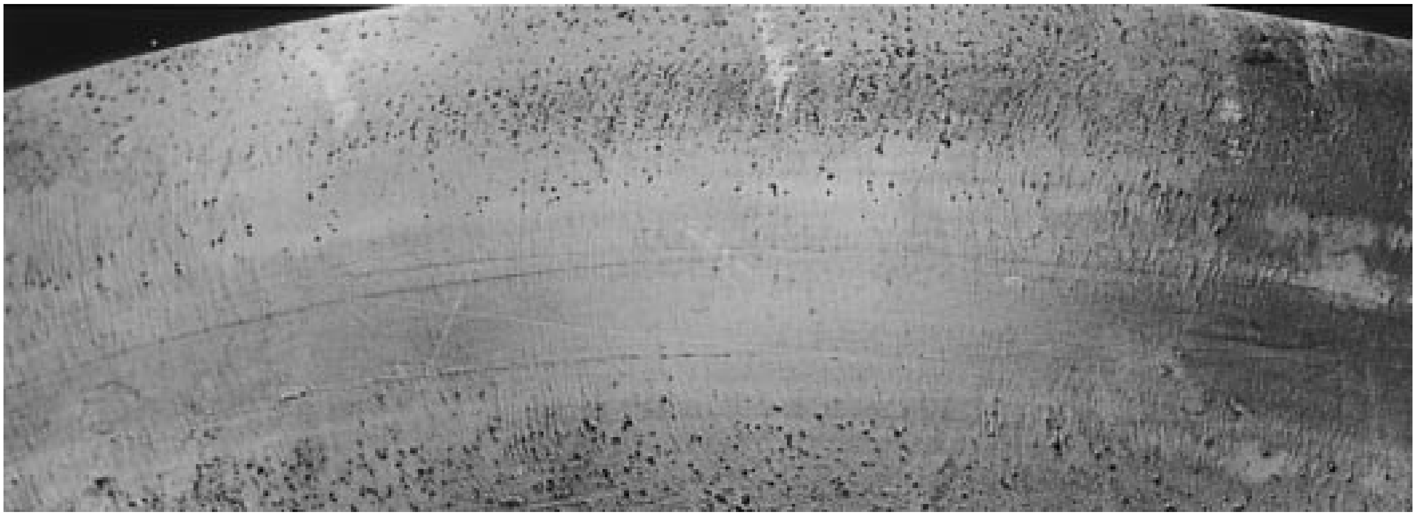
CORROSION

This outer ring was a component of a bearing operation in a high humidity atmosphere. Corrosion is general. See Figure 3.

Figure 3

CORROSION

An enlargement of Figure 2 shows the innumerable pits in the surface. Each can be a nucleus for complete failure.



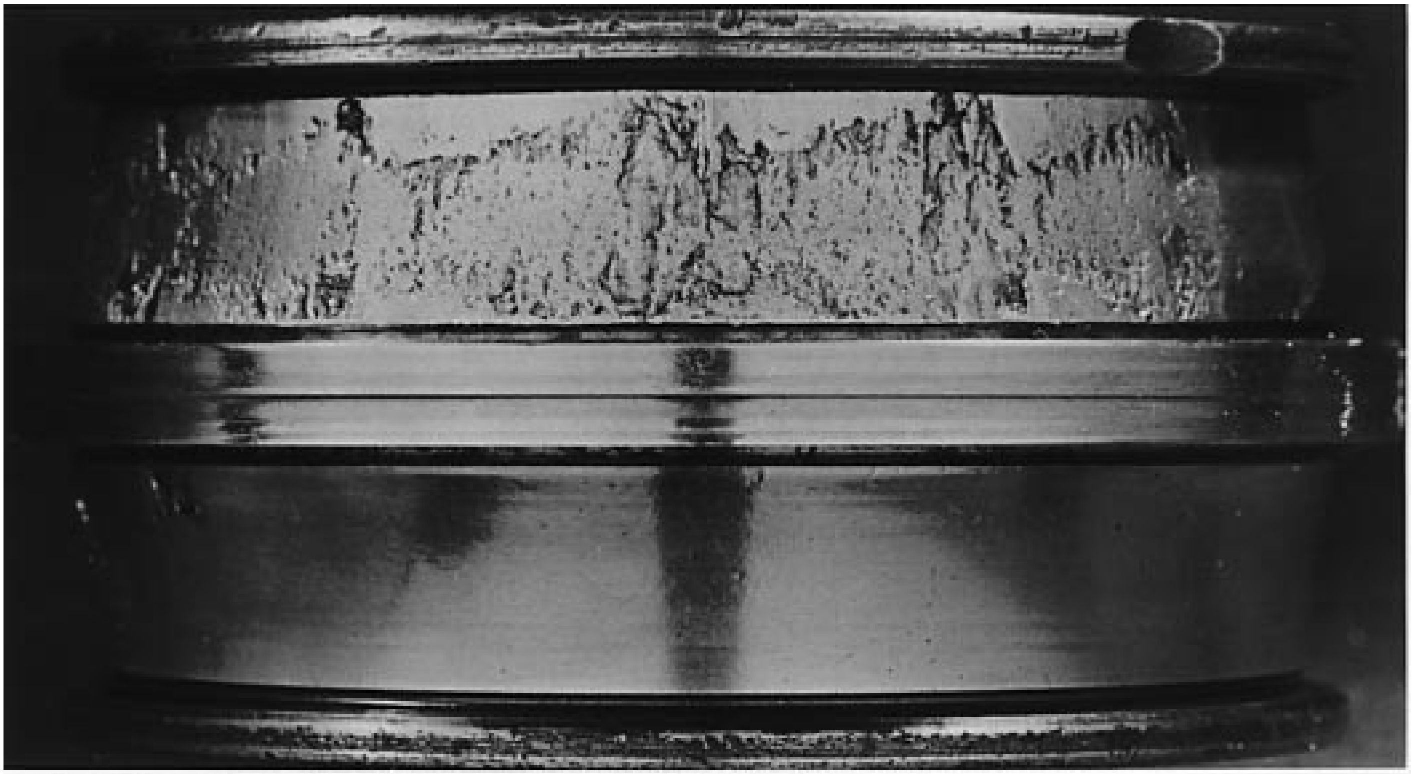


Figure 4

CORROSION AND FAILURE

Spalling trequently occurs from corrosion. This photograph shows an inner ring where failure has occurred at roller spaced intervals and had its inception in corroded areas. See Figure 5.

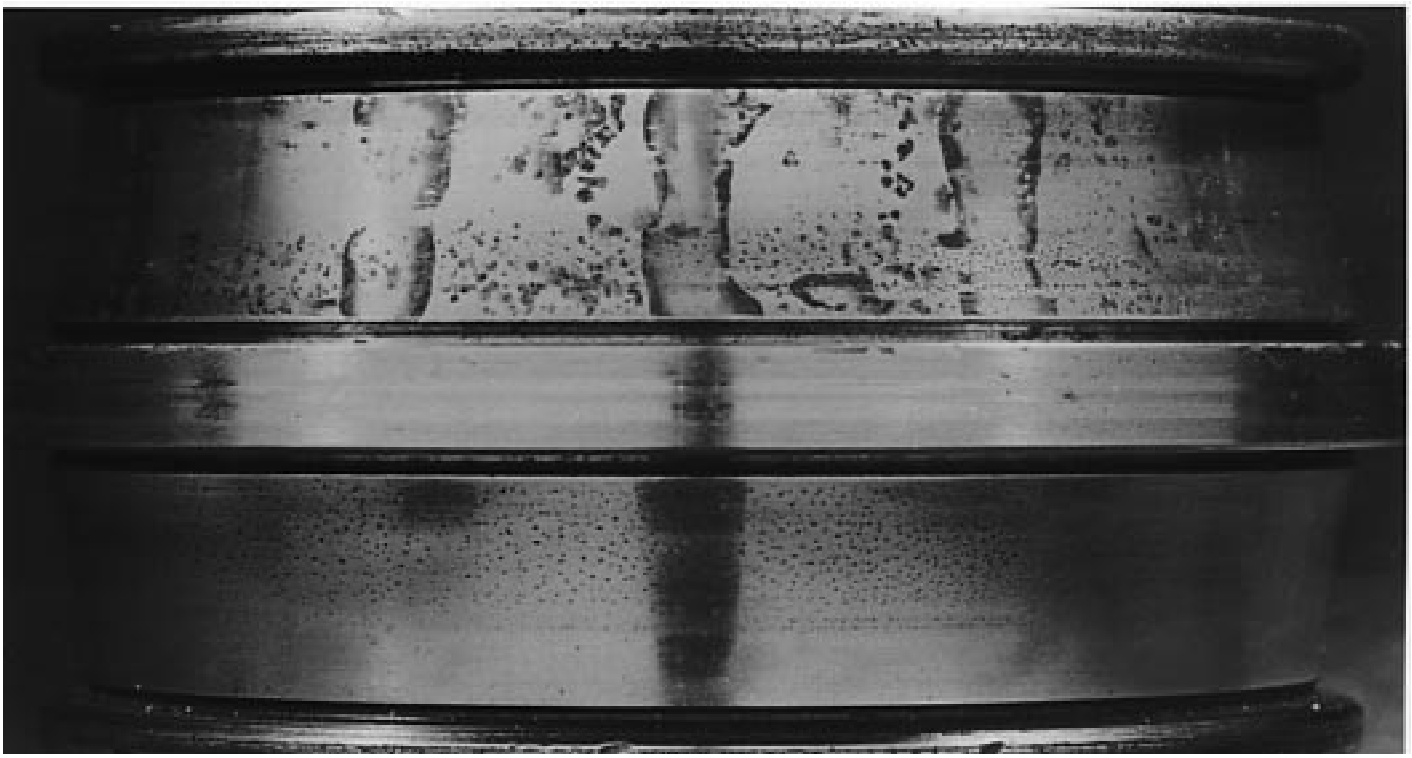


Figure 5

CORROSION AND FAILURE

The opposite side of the same race shown in Figure 4 is illustrated. The original corrosion pattern which resulted in the failure is apparent. The corrosion was due to entrapped moisture while the bearing was stationary.

Figure 6

CORROSION IN STORAGE

This is another example of the corrosion which results from storing bearings in a moist atmosphere. The corrosion takes place underneath the rollers where moisture is trapped.

If this bearing had been put in service, it probably would have failed in a manner similar to that shown in Figure 4.

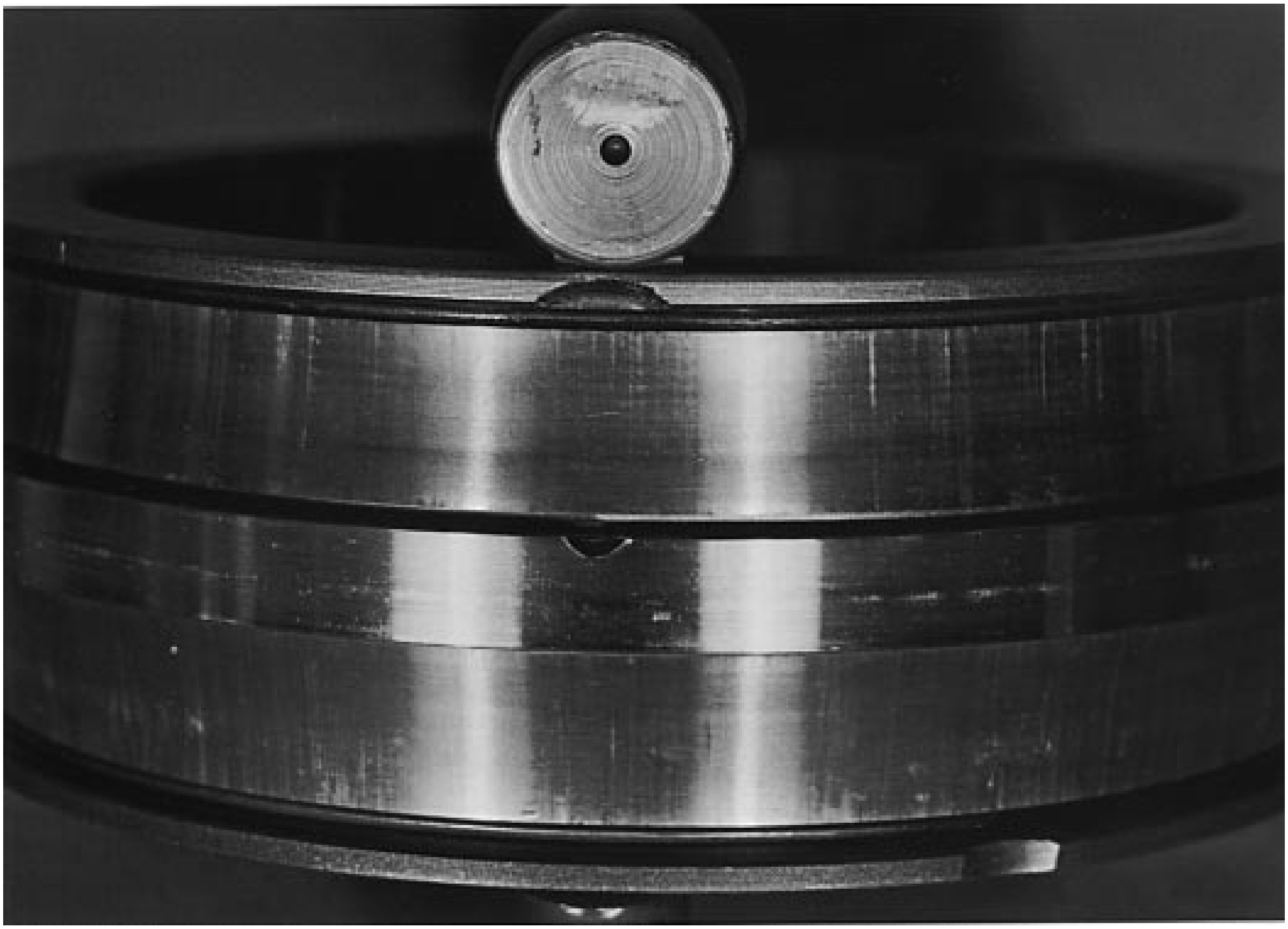


Figure 7

INSTALLATION DAMAGE

Bearings are frequently damaged when improperly handled, particularly during installation. Here are the inner ring and a roller of a bearing forcibly realigned after a roller had been radially displaced. Both flanges are broken and the roller is marked. Refer to Figure 8.

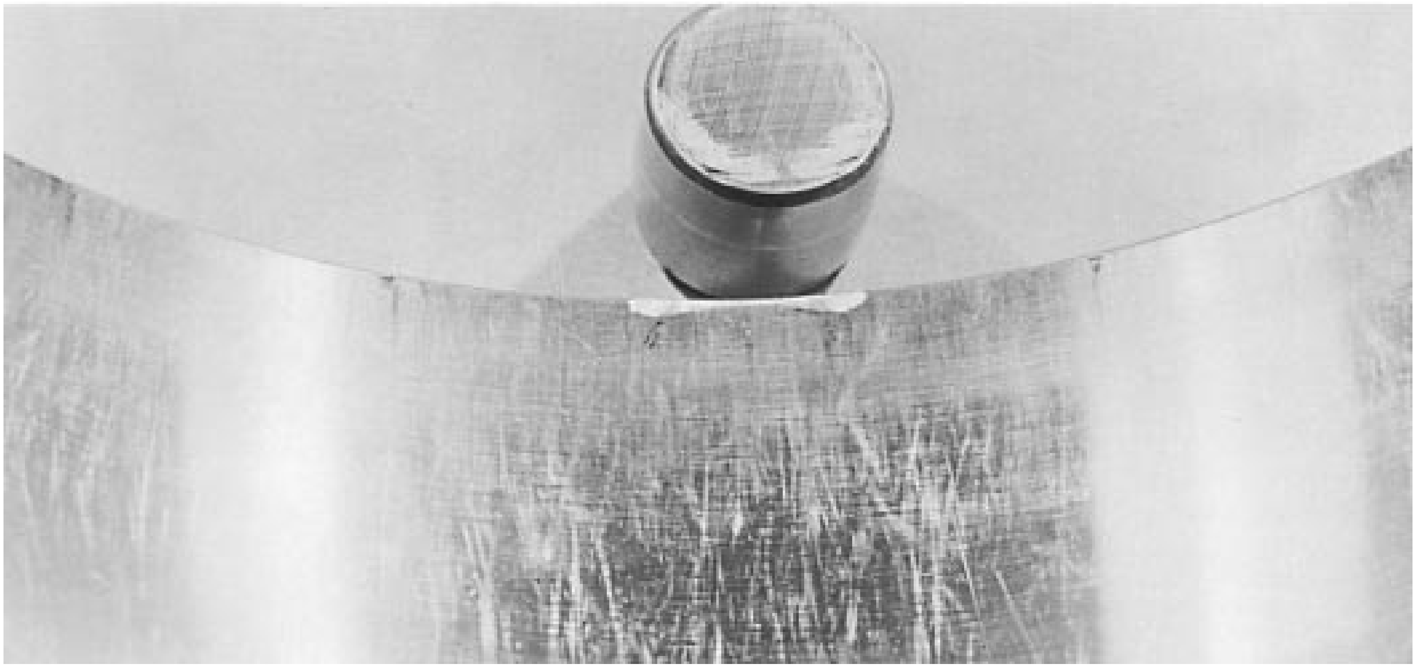


Figure 8

INSTALLATION DAMAGE

This is the companion outer ring (and a roller) of the inner ring of Figure 7. Severe mishandling is necessary to cause this damage.

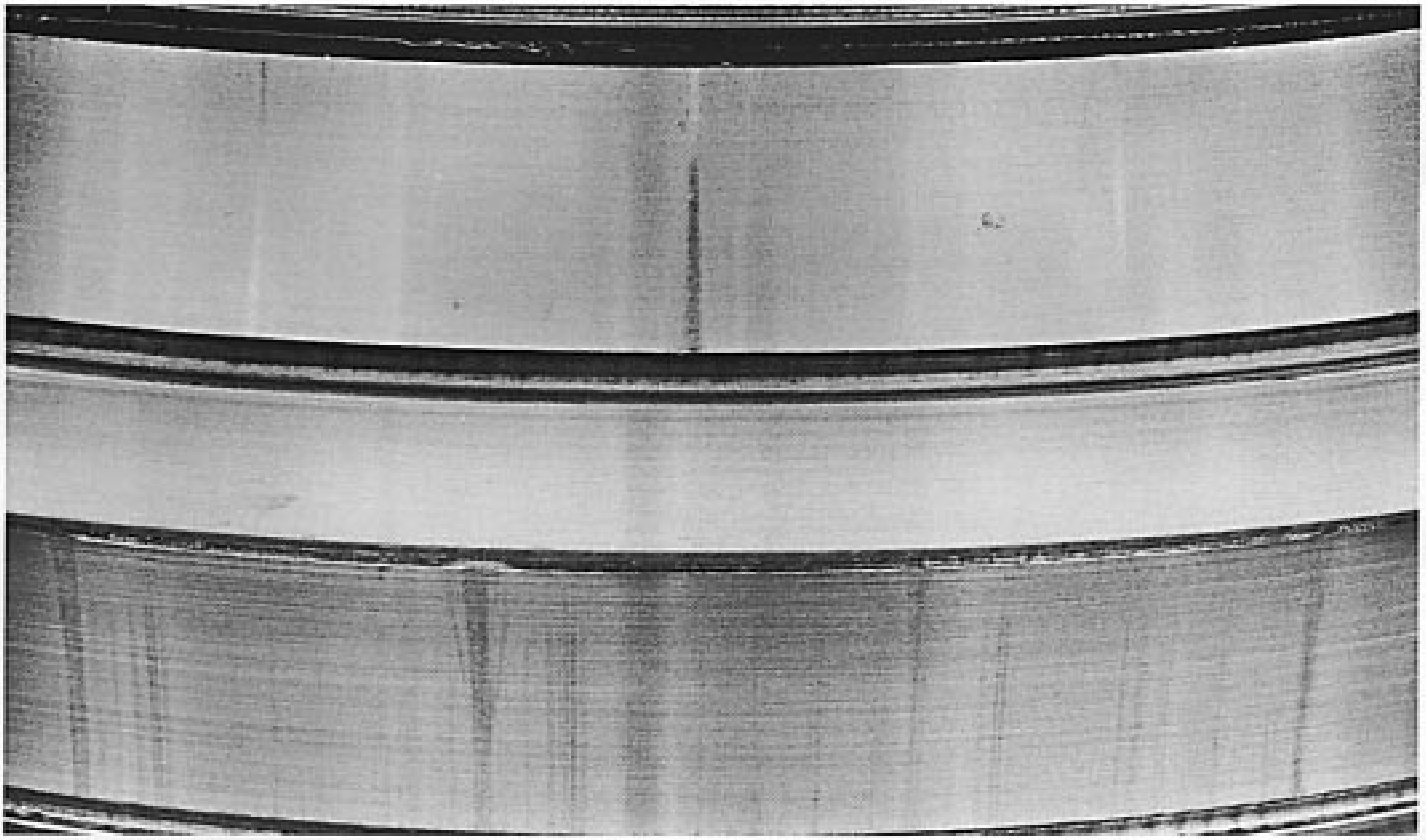


Figure 9

BRINELLED RACEWAY

Brinelling of the raceway illustrated was caused by roller impact. The damage occurred during mounting of the bearing. There is a displacement rather than a loss of metal in brinelling. Raceway surface brinelling results in a noisy bearing and such a mark can be the nucleus for premature failure.

Figure 10

DAMAGE IN TRANSIT

Vibration during shipping can be detrimental to a bearing and for that reason a new bearing is always wrapped and placed in a container in such a manner as to offer the maximum protection against such occurrence. This photograph shows scuffed rollers from a bearing which was installed on a piece of equipment and shipped without any provisions made to protect the bearing. The vibration in transit caused the scuffing. A bearing in this condition is noisy in operation and early failure can be expected. Figure 12 is of the companion outer ring.

Figure 11

INSTALLATION DAMAGE

This photograph shows a bearing on which the face of an inner ring was chipped by a blow during installation. (See Torrington Catalogs for proper procedure for mounting bearings.) It should be noted that the outer raceway and rollers were scuffed by the same impact. Such scuffs are nuclei for failure. See photo Figure 13.

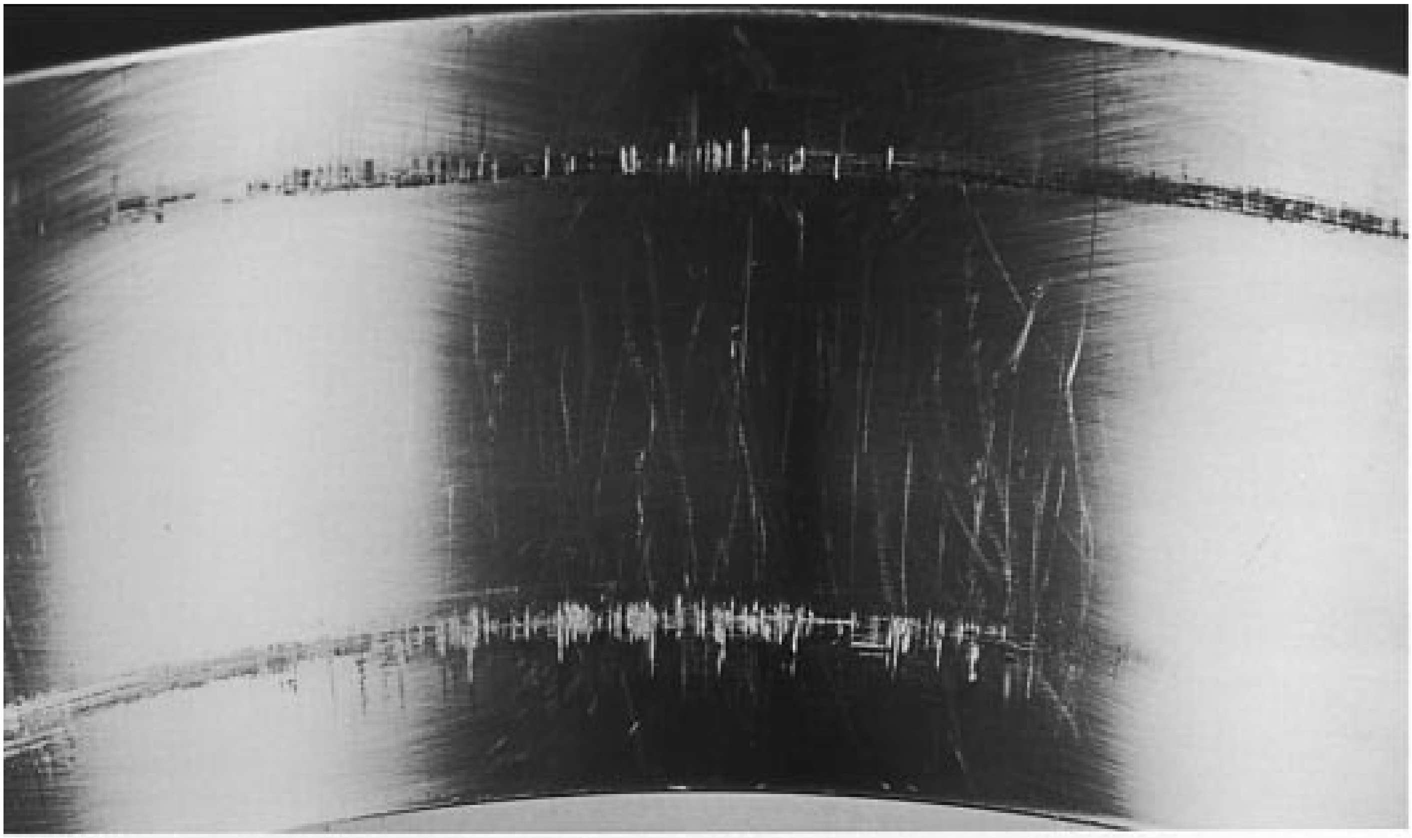


Figure 12

DAMAGE IN TRANSIT

See Figure 10. Shown in this photograph is the damaged raceway surface of the outer ring.

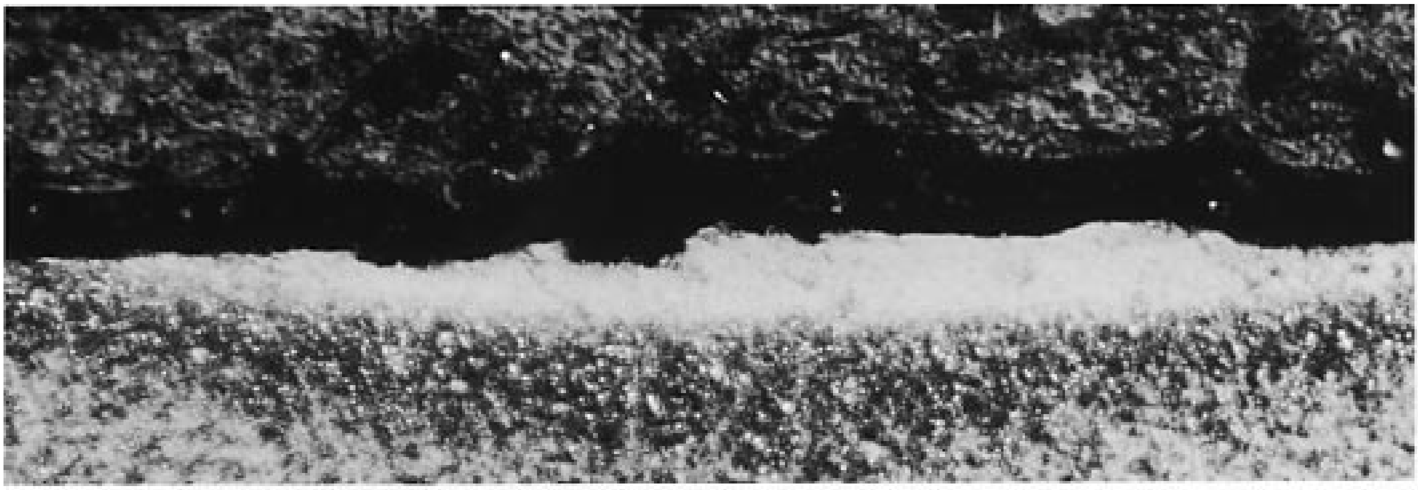


Figure 13

CROSS SECTION THROUGH A SCUFF MARK

This photomicrograph (at 250 magnification) shows the effect of a typical scuff mark on a bearing surface. Scuffing results when axial sliding motion is permitted between rings and rollers. Mishandling, prior to and during installation, is the chief cause. protective lubricant is usually absent or inadequate and the pressures and frictional heat, although instantaneous, are high enough to heat this area above the hardening temperature. The result is rehardening (the white areas) which yields a mixture of austenite and untempered brittle martensite. The darker underlying zone is softened, tempered structure. None of these are desirable tor sustaining load or shock. Thus they serve as nuclei for early failure of the bearing in service. Many early failures, often attributed to steel defects, have their origins in scuff marks.

The black upper part of the photograph is the bakelite mount which held the specimen.

Figure 14

POOR SEATING ON TAPERED SHAFT

Serious damage can occur to a tapered bore bearing which is not seated properly on the shah. An example of such damage is illustrated.

If the shaft taper is not correct, the inner ring will be improperly supported and failure can be expected.

Figure 15

FRETTING CORROSION

Insufficient interference fit of an inner ring on a ahaft will permit the ring to creep and result in fretting corrosion. The resulting oxides, being abrasive, accelerate wear of the shaft and the inner ring bore. The lapping action of the abrasive also causes wear in the bearing itself and increases the internal clearance. This is an example of fretting corrosion in the bore of an inner ring. Outer ring O.D.'s can be similarly affected.

Figure 16

HEAT CHECKS

Heat checks occur on the boundary surfaces of a bearing as a result of relative motion between the bearing and a contacting part. This usually occurs when they are either loose-fitted or mounted with insufficient interference fit. When a bearing ring creeps, sufficient heat may be generated to develop cracks on the rubbing surface. These cracks are normal to the direction of rotation. This photograph shows heat checks on the O.D. of an outer ring.

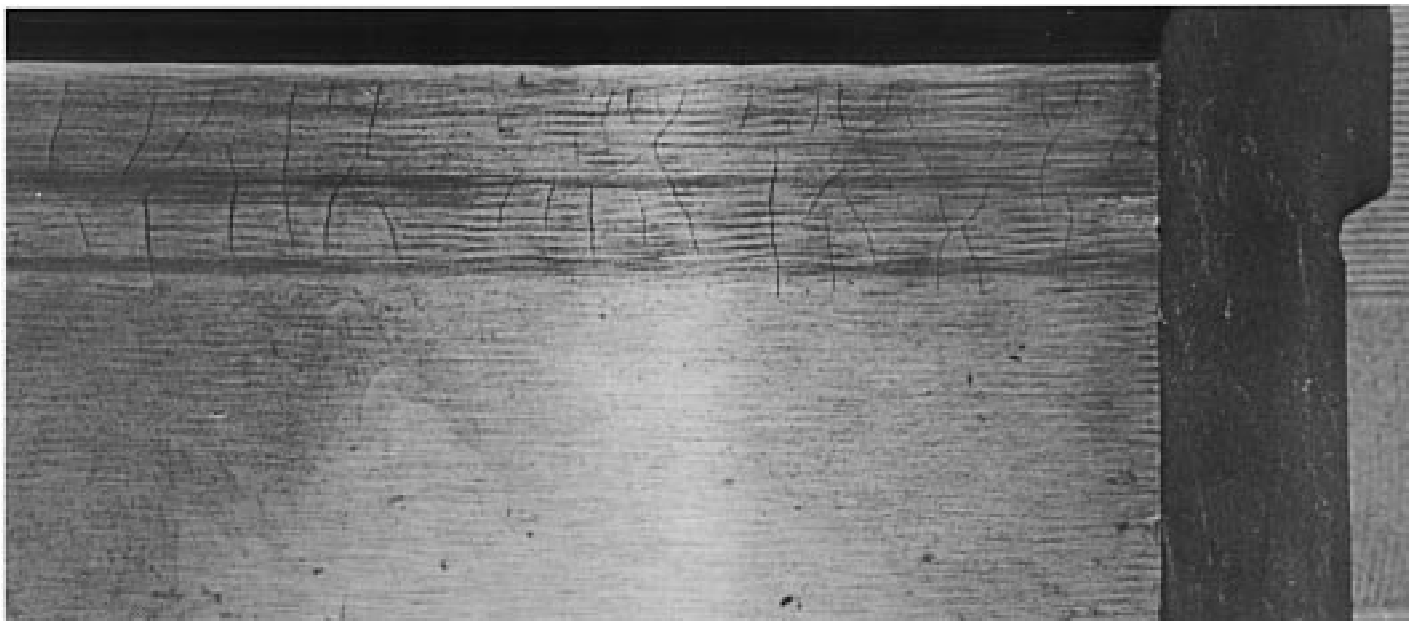


Figure 17 HEAT CHECKS

See description of Figure 16. These are heat checks on the bore of an inner ring. If the inner ring becomes heat checked. it should not be subsequently mounted with an interference fit, since heat checks can cause the inner ring to fracture.

Figure 18 HEAT CHECKS

See Figure 16. This is an illustration of heat checks on the face of an inner.

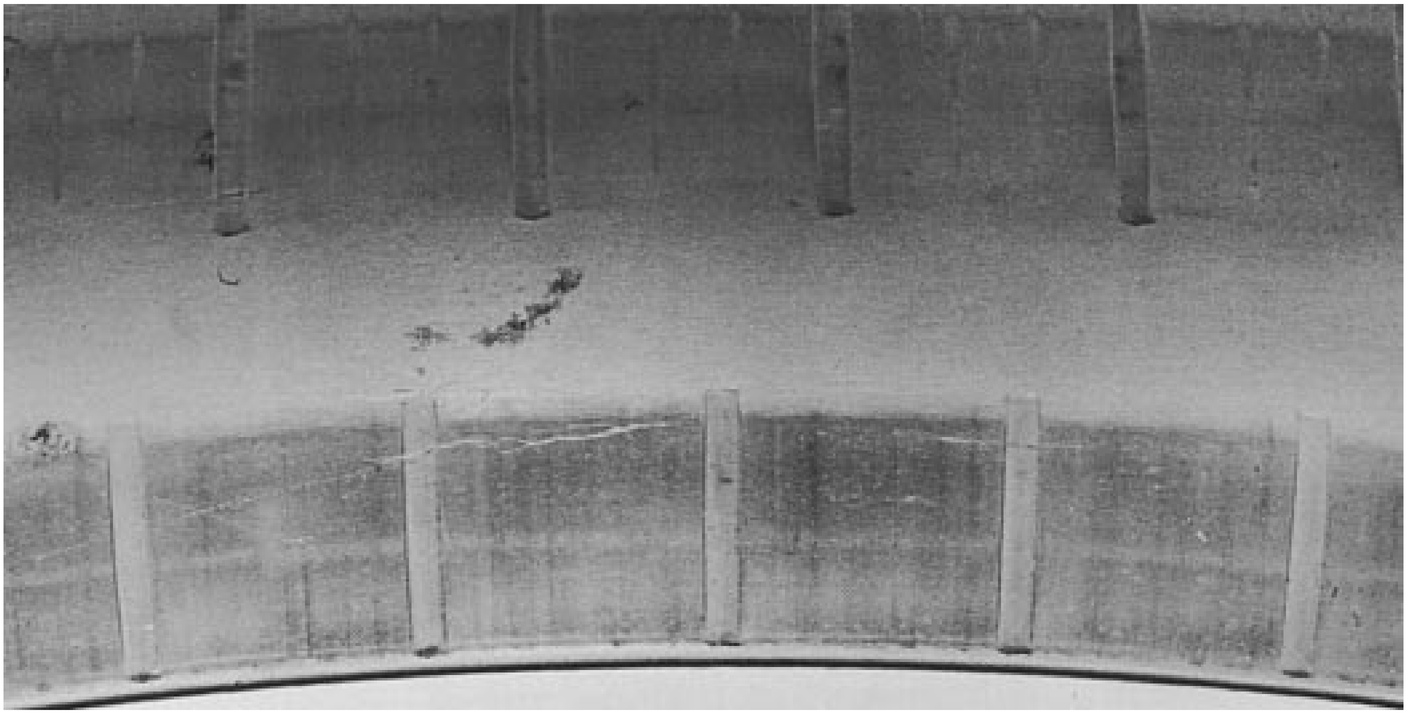


Figure 19

FALSE BRINELLING

While true brinelling is a flow of material due to excessive pressure that caused indentation in a part, false brinelling, on the other hand, involves an actual removal of material and is a wear condition.

The exact cause of false brinelling is not agreed upon by authorities. It is known that relative motion, load and oxygen are prerequisites.

Other names for this phenomenon are fretting corrosion and friction oxidation.

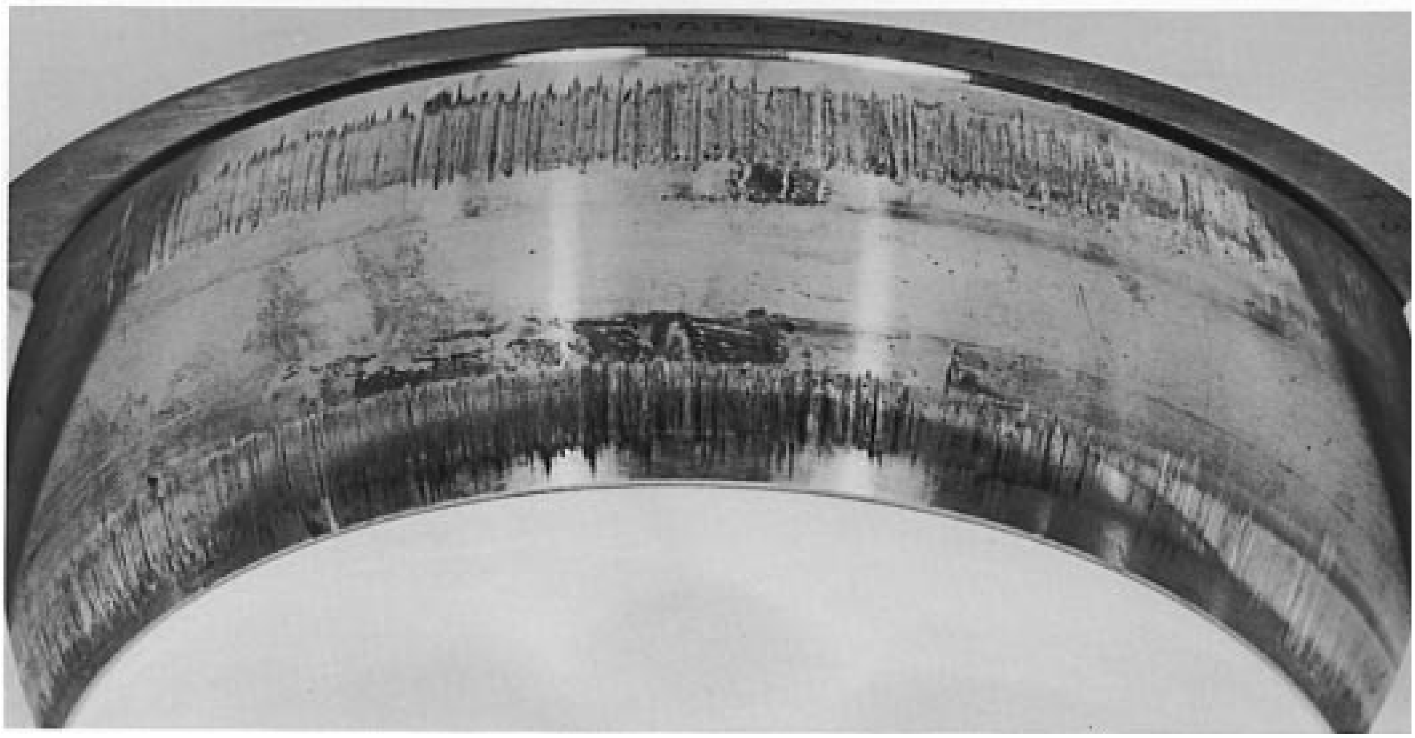


Figure 20

FALSE BRINELLING

This is another example of false bhnelling resulting from rollers vibrating in the bearing raceways.

Figure 21

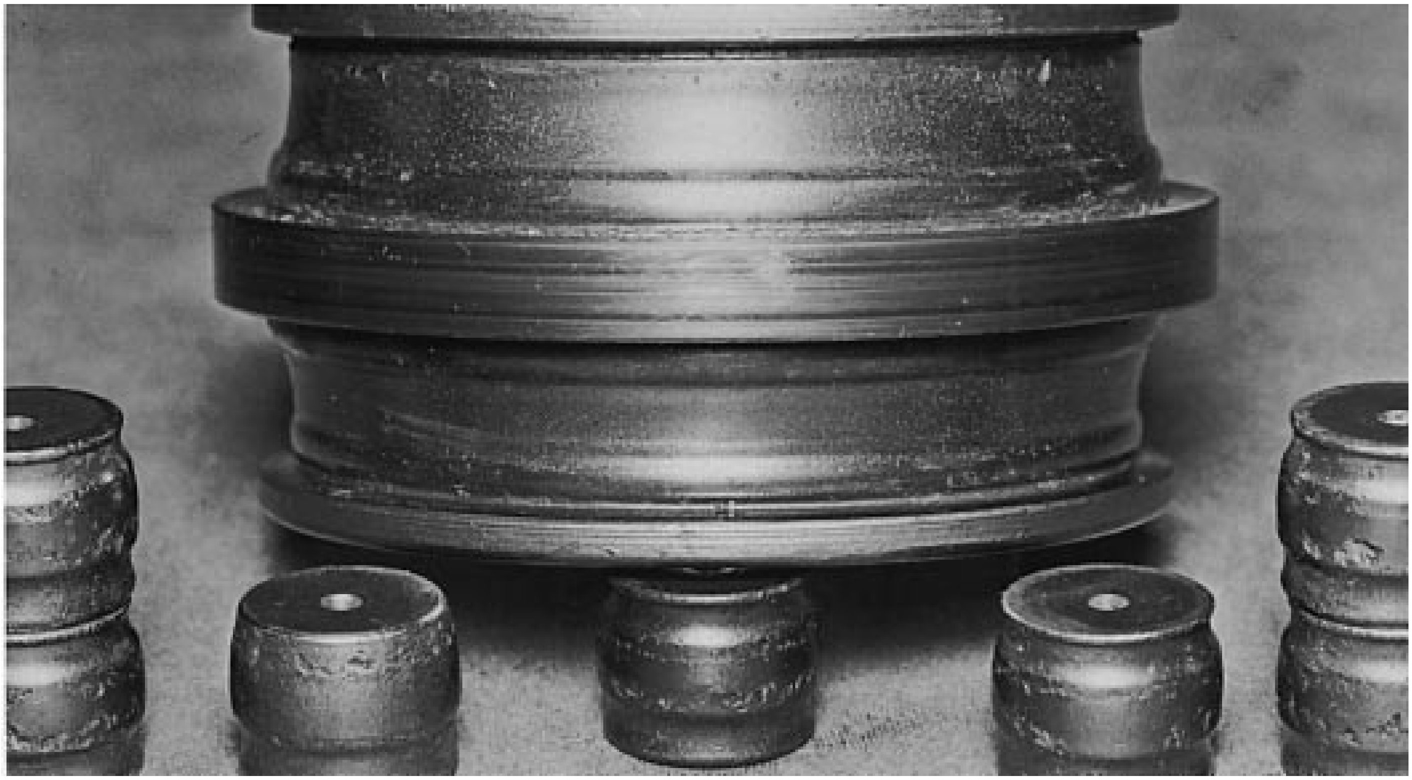
LUBRICATION FAILURE — RACEWAY

Here is an example showing an advanced stage of failure in a spherical roller bearing outer ring resulting from inadequate lubrication. The roller paths are deeply grooved. The spall pattern is fine grained contrasted to that of normal fatigue. (See Figures 33 & 34.)

Figure 22

LUBRICATION FAILURE — INNER AND OUTER ROLLERS

These are the companion parts for the outer of Figure 21. The roller paths are deeply grooved and the rollers severely worn to an inverted hour glass shape. Raceways and rollers usually have a dark brown discoloration in this type of failure.



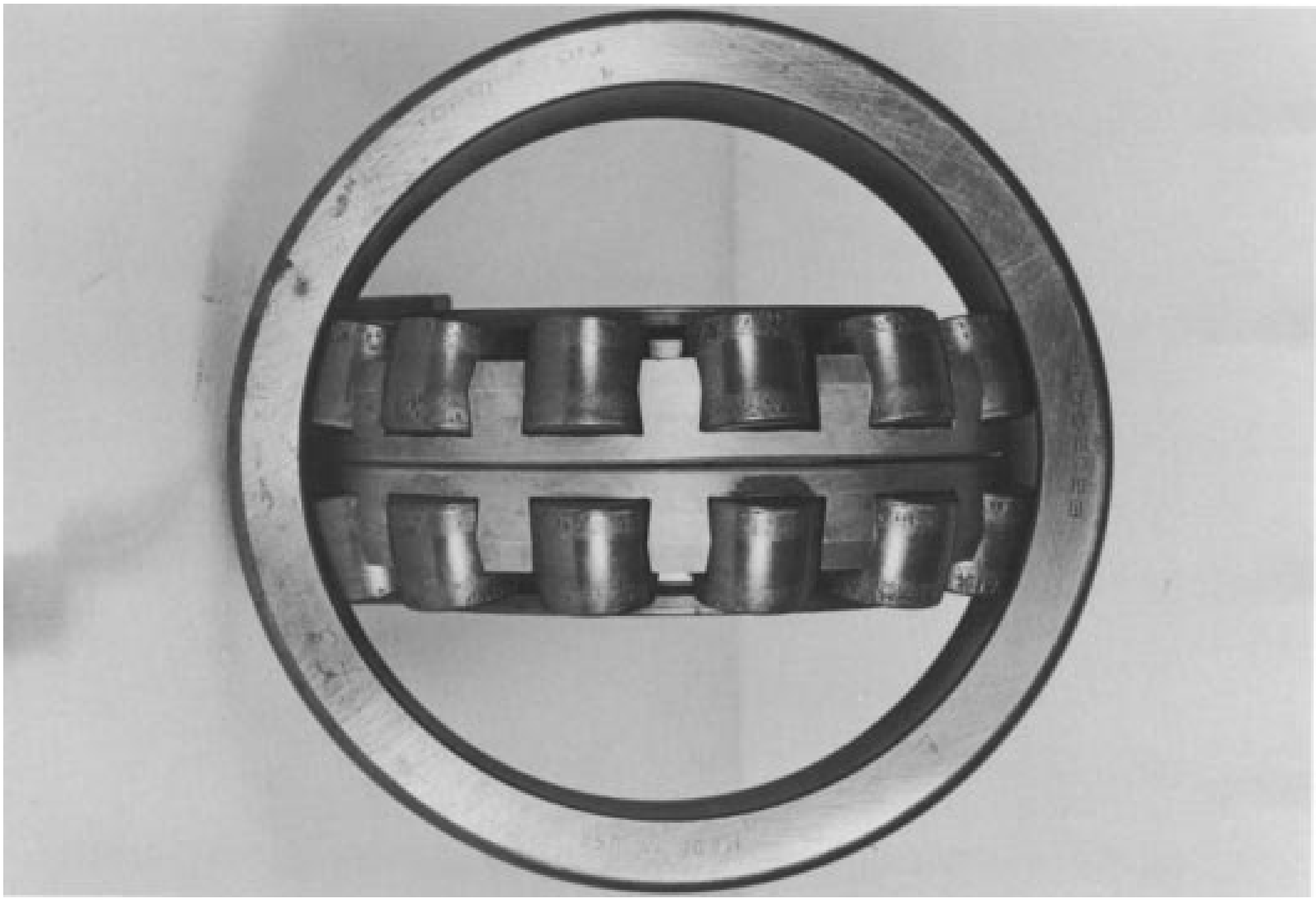


Figure 23

LUBRICATION FAILURE — ROLLERS

This is an example of a less advanced stage of spherical roller bearing failure due to inadequate lubrication. The rollers have started to spall on the ends in a comparatively fine grained pattern. Note that the ends of the rollers start to spall first while the centers are relatively intact.

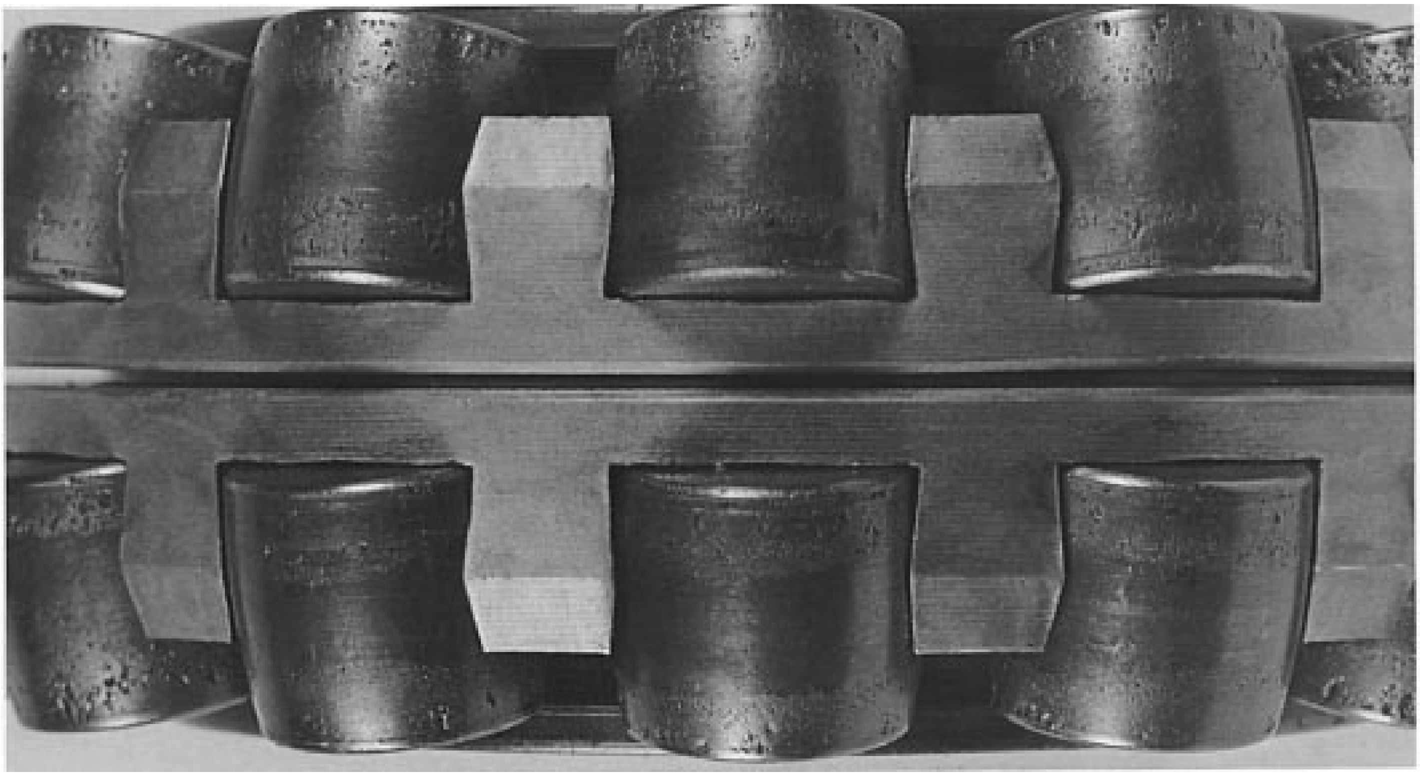


Figure 24

LUBRICATION FAILURE — ROLLERS

This is a close-up view of some of the rollers of Figure 23 and more clearly shows the spall pattern.

Figure 25

LUBRICATION FAILURE - ROLLERS

This is another example of roller damage due to inadequate lubrication.

Note the fine grained spall pattern. The failure feathers out from the large spalls to the original surface. In the lesser distressed areas, the surface has the pulpy appearance of a peeled apple.

Figure 26

LUBRICATION FAILURE — OUTER RING

This photograph shows an outer ring with a lubrication failure in an early stage. The failure is very shallow and has the appearance of a thin surface layer peeled from the raceway leaving a roughened area.

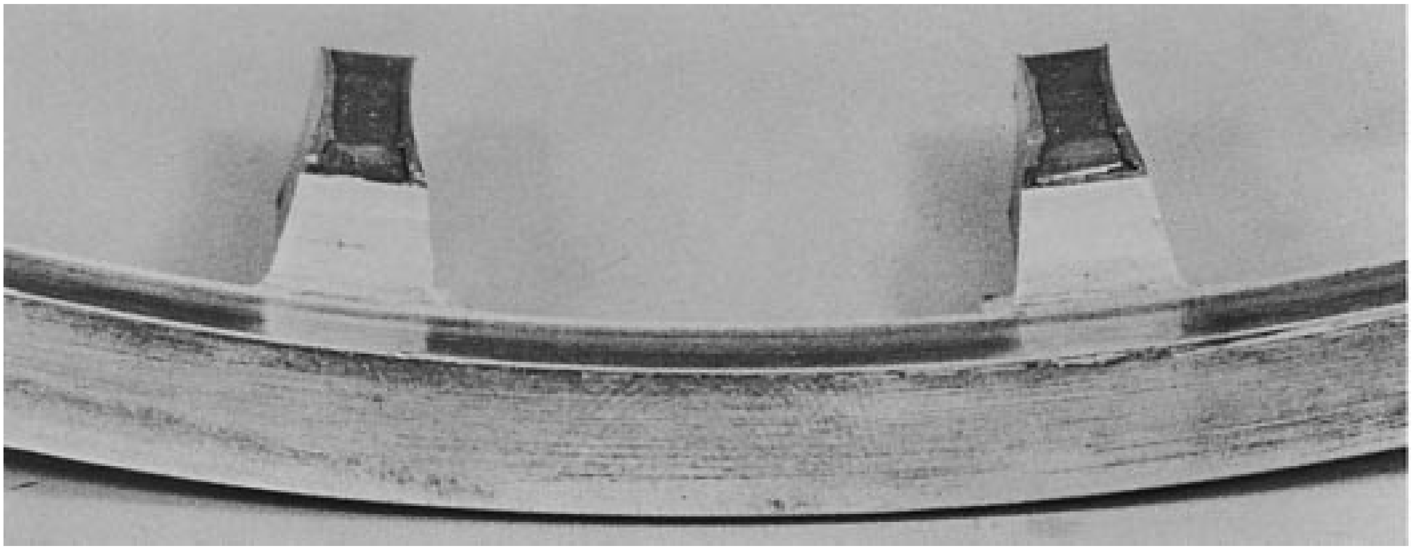


Figure 27

LUBRICATION FAILURE — RETAINER

Bronze retainers are sensitive to inadequate lubrication and can wear quite rapidly. In this case the web portion of the cage which rides on the center flange of the inner ring has worn to about half its thickness.

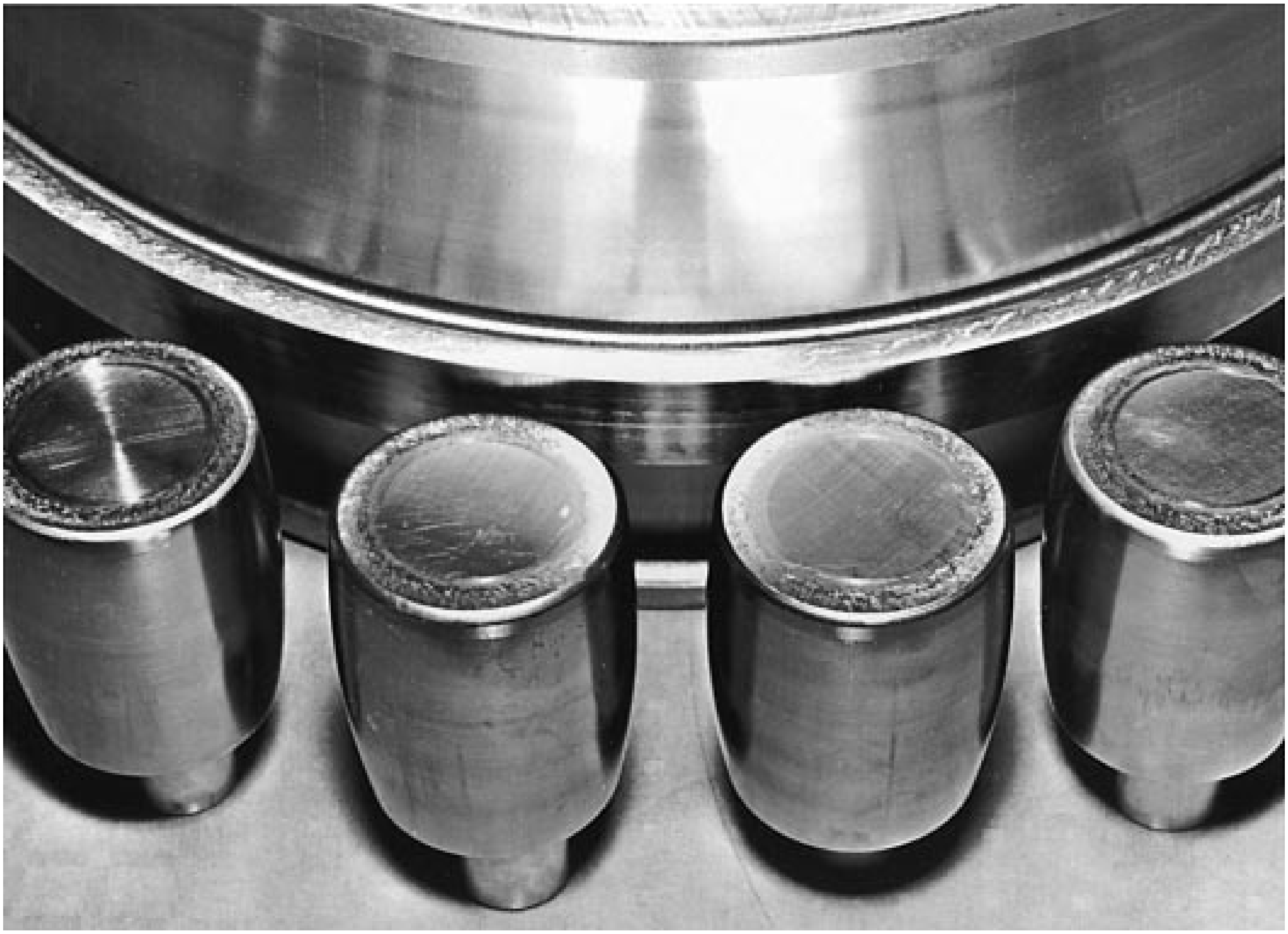


Figure 28

LUBRICATION FAILURE — THRUST CONTACT SURFACES

The cycloidal smear marks on the thrust flange and roller ends are due to the breaking of the oil film at this point.

This is the result of inadequate lubrication and/or overload.

Figure 29
ABRASIVE WEAR — RINGS AND ROLLERS

Abrasive wear can be identified by the frosty gray or lapped appearance of the affected surfaces.

Actual wear is usually most obvious on the O.D. of the inner ring center flange and on the thrust contact surfaces of the rollers. Wear on both of these areas can be seen in this illustration.

The roller path pattern in the outer raceway is interesting. Each path has the characteristic frosty lapped appearance. The narrow dark band in each path is the original surface of the raceway. The retainers of the bearing became charged with the abrasive contaminant which in turn caused the rollers to wear at their largest diameter. The rollers did not contact the outer ring at these zones, leaving the band of original surface. Continued operation would of course wear away these zones also.

The same phenomenon occurs on the inner raceways also but usually is not as pronounced as on the outer raceways.

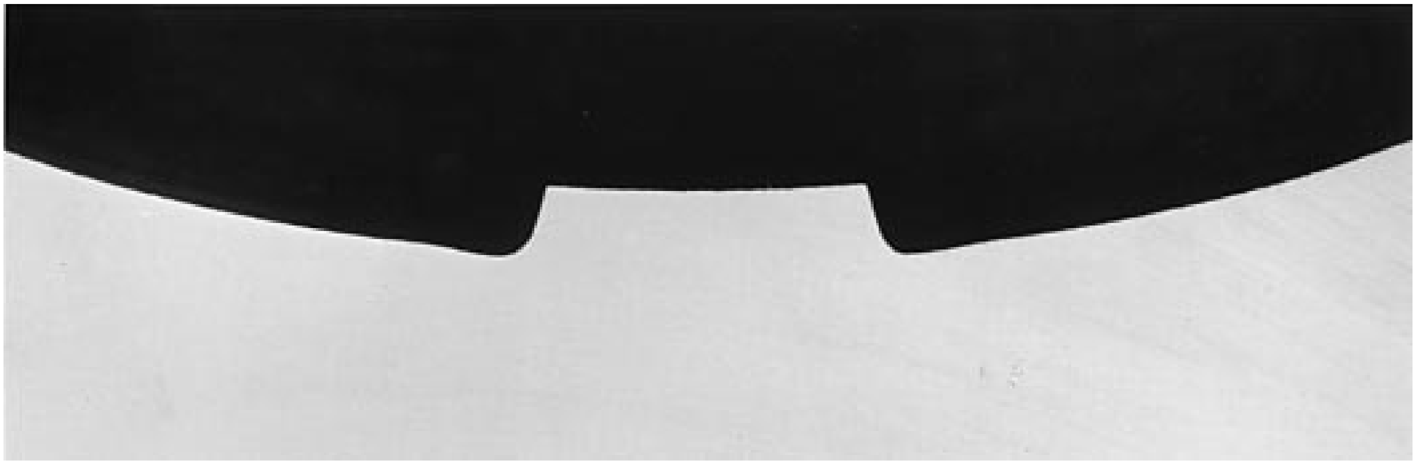


Figure 30

ABRASIVE WEAR — OUTER RING CROSS-SECTION

This photograph shows a cross-section of the outer ring of a self-aligning spherical surface, but the abrasives have worn the paths down to the shape shown, which is that of the roller contour.

Figure 31

ABRASIVE WEAR — INNER AND OUTER RING

The bearing pictured had been in service in a shaker screen. Wear was due to abrasive contamination. The wavy pattern of the inner raceways resulted from vibration and is not uncommon in screen applications.

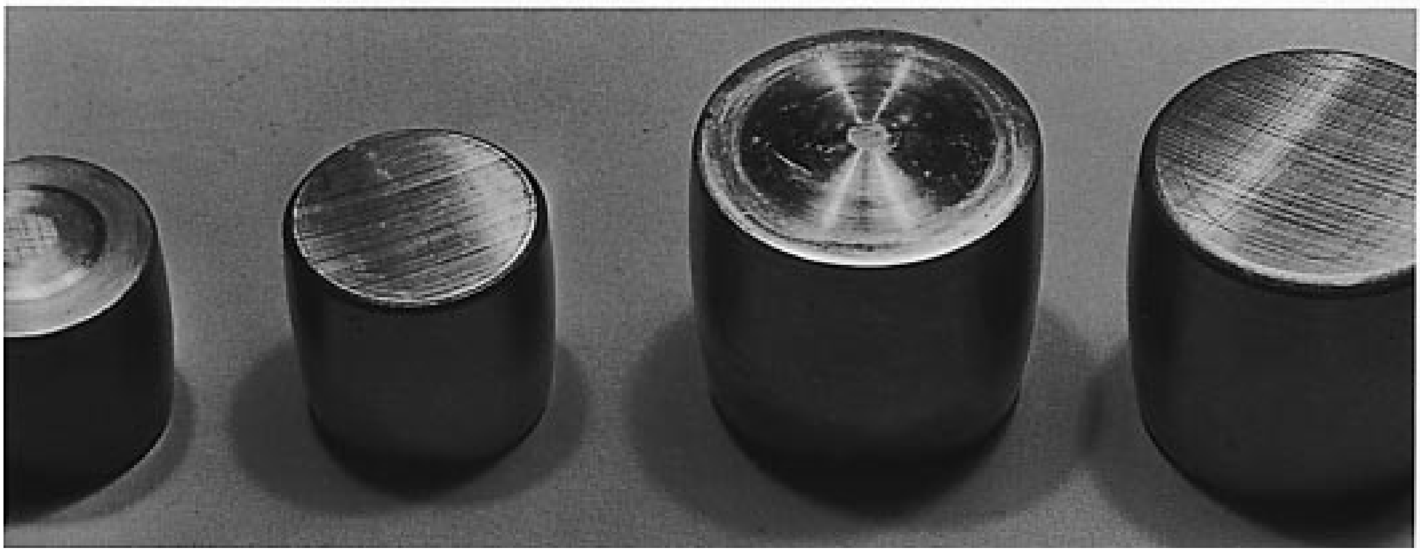


Figure 32

ABRASIVE WEAR — ROLLER END

This photograph shows the pattern on roller ends where abrasive wear had occurred. Two sizes of rollers are shown. Roller ends are worn to the contour of the retainer pocket bottom.

For comparison, two new rollers era also pictured.

Figure 33

FATIGUE

The normal failure of a bearing is fatigue. Pictured is a typical failure on an inner ring. The coarse grained pattern should be noted in contrast to the pattern of a lubrication or abrasion failure. Good loading conditions are evident, the load zone arcs on both roller paths being of equal length.

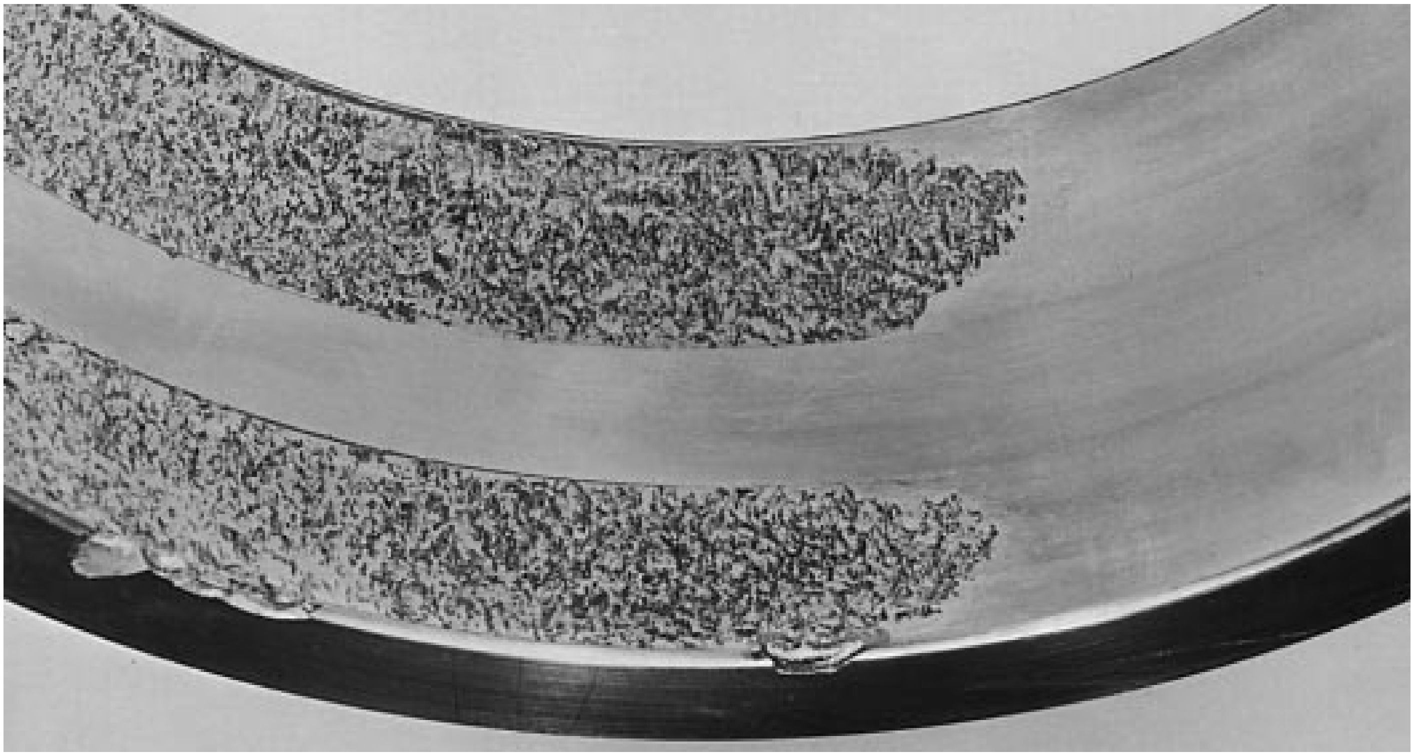


Figure 34

FATIGUE

Note comments on Figure 33. This is a typical fatigue of an outer ring. Again, loading options were good.

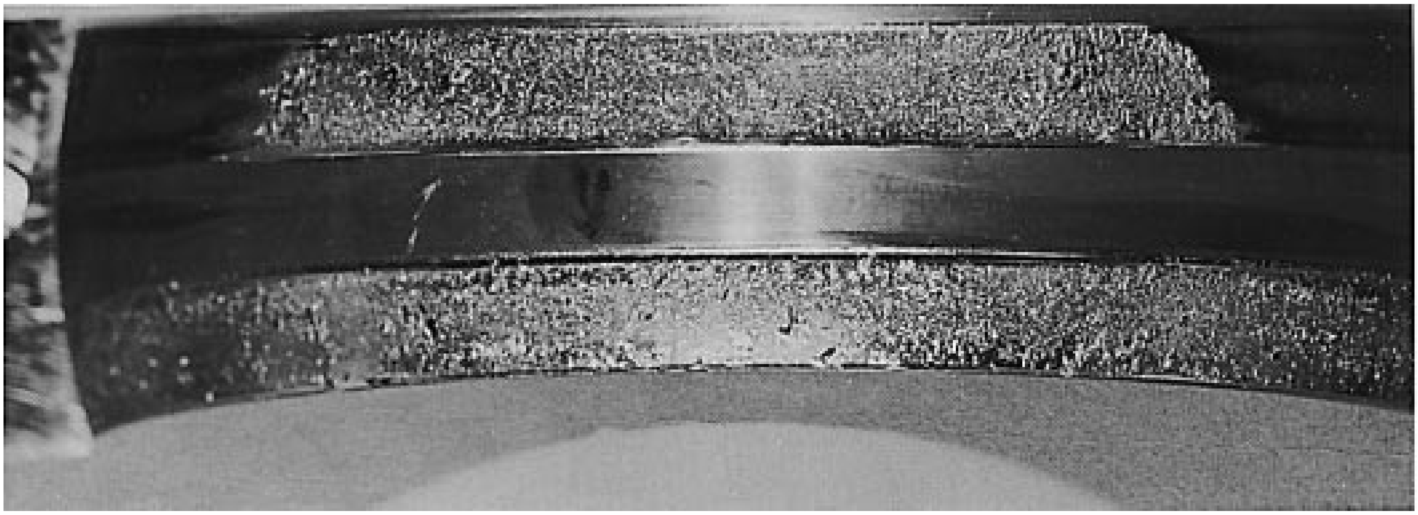


Figure 35

THRUST LOADING

This photograph shows the load pattern of an outer ring loaded in thrust. The spalling on one of the paths covers a much longer arc than on the other. In addition, there is an axial displacement of roller paths in the direction of the thrust load.

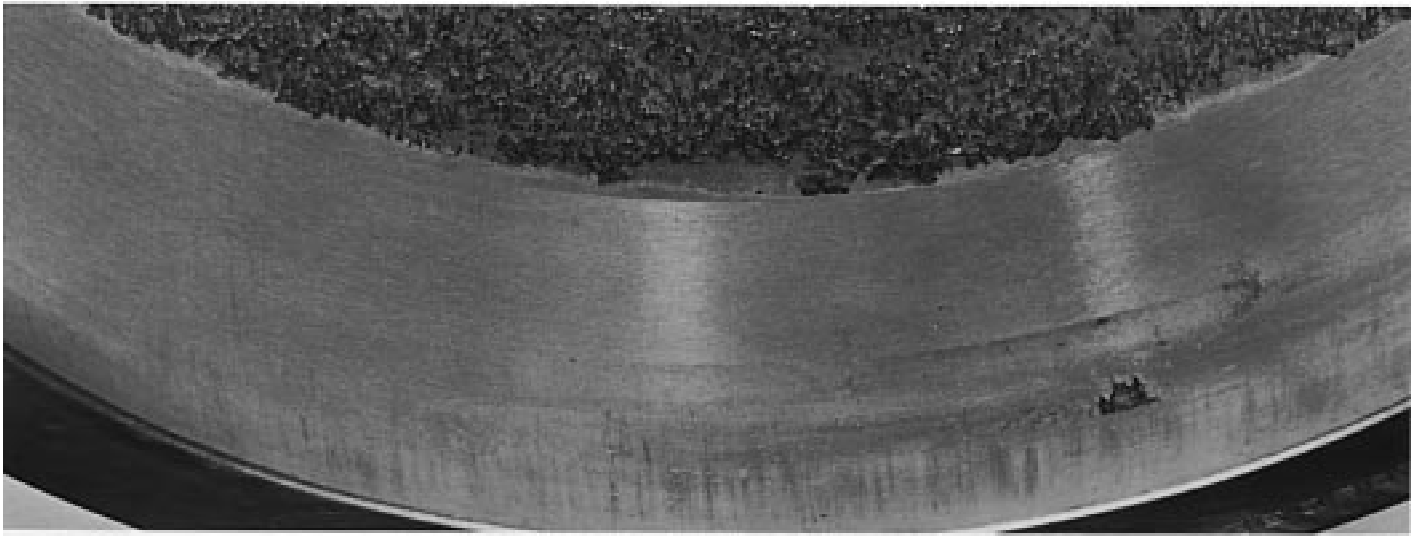


Figure 36

THRUST LOADING

This illustration is the same type of failure, thrust loading, as that of Figure 35. However, the thrust loading was more severe and the roller path has been displaced to the extent that it has run to the edge of the outer and fractured pieces from the edge. Failure in both cases resulted from fatigue.

Figure 37

SINGLE SPALL

The single spall on this inner ring was caused by mechanical damage to the bearing, either in handling or in operation; the material, being overstressed at this point, failed prematurely.