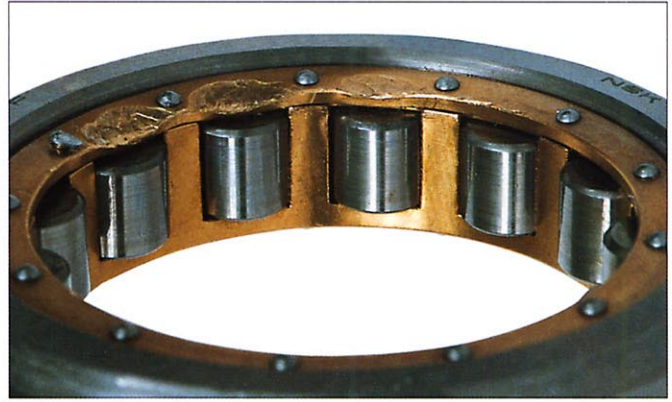
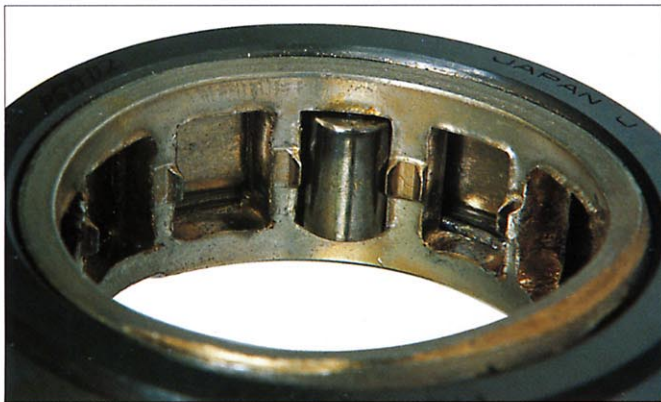




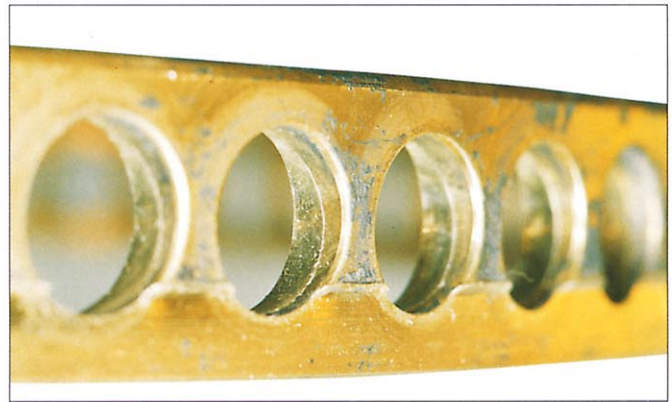
**Photo 7-7-5**  
**Part:** Cage of an angular contact ball bearing  
**Symptom:** Pressed-steel cage deformation  
**Cause:** Shock load due to poor handling



**Photo 7-7-6**  
**Part:** Cage of a cylindrical roller bearing  
**Symptom:** Deformation of the side face of a machined high-tension brass cage  
**Cause:** Large shock during mounting



**Photo 7-7-7**  
**Part:** Cage of a cylindrical roller bearing  
**Symptom:** Deformation and wear of a machined high-tension brass cage



**Photo 7-7-8**  
**Part:** Cage of an angular contact ball bearing  
**Symptom:** Stepped wear on the outside surface and pocket surface of a machined high-tension brass cage

## 7.8 Denting

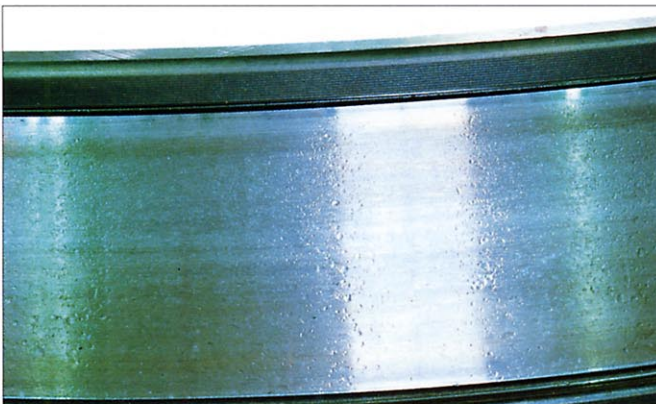
| Damage Condition  | Possible Cause  | Countermeasure   |
|---|---|--|
| When debris such as small metallic particles are caught in the rolling contact zone, denting occurs on the raceway surface or rolling element surface. Denting can occur at the rolling element pitch interval if there is a shock during the mounting (Brinell dents). | Debris such as metallic particles are caught in the surface<br>Excessive load<br>Shock during transport or mounting | <ul style="list-style-type: none"> <li>● Wash the housing</li> <li>● Improve the sealing mechanism</li> <li>● Filter the lubrication oil</li> <li>● Improve the mounting and handling methods</li> </ul> |



**Photo 7-8-1**  
**Part:** Inner ring of a double-row tapered roller bearing  
**Symptom:** Frosted raceway surface  
**Cause:** Debris caught in the surface



**Photo 7-8-2**  
**Part:** Outer ring of a double-row tapered roller bearing  
**Symptom:** Indentations on raceway surface  
**Cause:** Debris caught in the surface



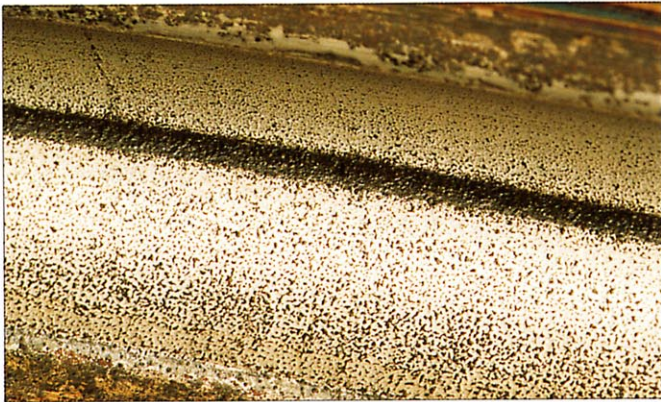
**Photo 7-8-3**  
**Part:** Inner ring of a tapered roller bearing  
**Symptom:** Small and large indentations occur over entire raceway surface  
**Cause:** Debris caught in the surface



**Photo 7-8-4**  
**Part:** Tapered rollers of Photo 7-8-3  
**Symptom:** Small and large indentations occur over the rolling surface  
**Cause:** Debris caught in the surface

## 7.9 Pitting

| Damage Condition  | Possible Cause   | Countermeasure   |
|---|--|--|
| The pitted surface has a dull luster which appears on the rolling element surface or raceway surface. | Debris becomes caught in the lubricant<br>Exposure to moisture in the atmosphere<br>Poor lubrication | <ul style="list-style-type: none"> <li>● Improve the sealing mechanism</li> <li>● Filter the lubrication oil thoroughly</li> <li>● Use a proper lubricant</li> </ul> |



**Photo 7-9-1**

**Part:** Outer ring of a slewing bearing  
**Symptom:** Pitting occurs on the raceway surface  
**Cause:** Rust at bottoms of indentations



**Photo 7-9-2**

**Part:** Ball of Photo 7-9-1  
**Symptom:** Pitting occurs on the rolling element surface

## 7.10 Wear

| Damage Condition  | Possible Cause   | Countermeasure  |
|---|--|---|
| Wear is surface deterioration due to sliding friction at the surface of the raceway, rolling elements, roller end faces, rib face, cage pockets, etc. | Entry of debris<br>Progression from rust and electrical corrosion<br>Poor lubrication<br>Sliding due to irregular motion of rolling elements | <ul style="list-style-type: none"> <li>● Improve the sealing mechanism</li> <li>● Clean the housing</li> <li>● Filter the lubrication oil thoroughly</li> <li>● Check the lubricant and lubrication method</li> <li>● Prevent misalignment</li> </ul> |



**Photo 7-10-1**

**Part:** Inner ring of a cylindrical roller bearing  
**Symptom:** Many pits occur due to electrical corrosion and wave-shaped wear on raceway surface  
**Cause:** Electrical corrosion



**Photo 7-10-2**

**Part:** Outer ring of a spherical roller bearing  
**Symptom:** Wear having a wavy or concave-and-convex texture on loaded side of raceway surface  
**Cause:** Entry of debris under repeated vibration while stationary



**Photo 7-10-3**

**Part:** Inner ring of a double-row tapered roller bearing  
**Symptom:** Fretting wear of raceway and stepped wear on the rib face  
**Cause:** Fretting progression due to excessive load while stationary



**Photo 7-10-4**

**Part:** Tapered rollers of Photo 7-10-3  
**Symptom:** Stepped wear on the roller head end face  
**Cause:** Fretting progression due to excessive load while stationary

## 7.11 Fretting

| Damage Condition   | Possible Cause   | Countermeasure  |
|--|--|---|
| <p>Wear occurs due to repeated sliding between the two surfaces.</p> <p>Fretting occurs at fitting surface and also at contact area between raceway ring and rolling elements.</p> <p>Fretting corrosion is another term used to describe the reddish brown or black worn particles.</p> | <p>Poor lubrication</p> <p>Vibration with a small amplitude</p> <p>Insufficient interference</p> | <ul style="list-style-type: none"> <li>● Use a proper lubricant</li> <li>● Apply a preload</li> <li>● Check the interference fit</li> <li>● Apply a film of lubricant to the fitting surface</li> </ul> |



**Photo 7-11-1**

**Part:** Inner ring of a deep groove ball bearing

**Symptom:** Fretting occurs on the bore surface

**Cause:** Vibration

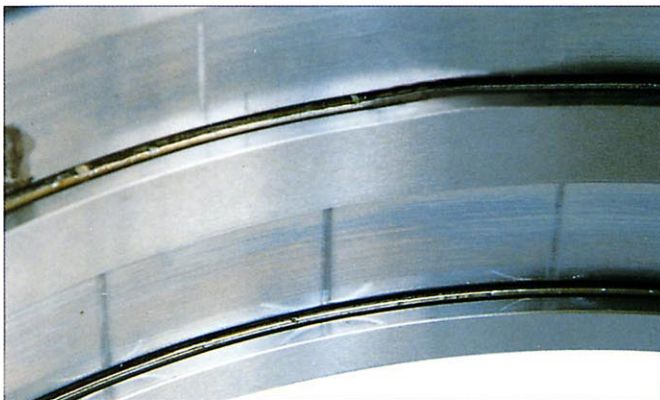


**Photo 7-11-2**

**Part:** Inner ring of an angular contact ball bearing

**Symptom:** Notable fretting occurs over entire circumference of bore surface

**Cause:** Insufficient interference fit



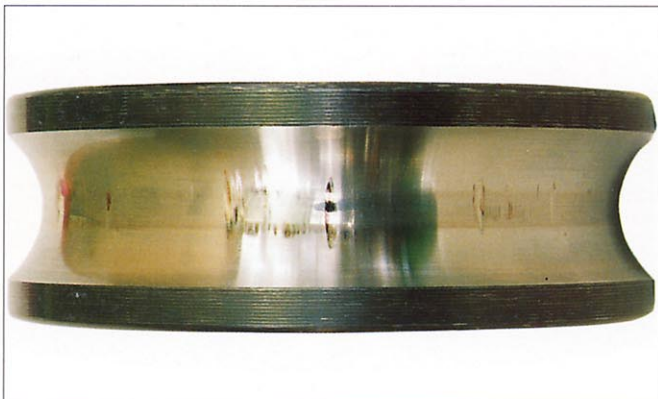
**Photo 7-11-3**

**Part:** Outer ring of a double-row cylindrical roller bearing

**Symptom:** Fretting occurs on the raceway surface at roller pitch intervals

## 7.12 False Brinelling

| Damage Condition   | Possible Cause   | Countermeasure   |
|--|--|--|
| Among the different types of fretting, false brinelling is the occurrence of hollow spots that resemble brinell dents, and are due to wear caused by vibration and swaying at the contact points between the rolling elements and raceway. | Oscillation and vibration of a stationary bearing during such times as transporting<br>Oscillating motion with a small amplitude<br>Poor lubrication | <ul style="list-style-type: none"> <li>● Secure the shaft and housing during transporting</li> <li>● Transport with the inner and outer rings packed separately</li> <li>● Reduce the vibration by preloading</li> <li>● Use a proper lubricant</li> </ul> |



**Photo 7-12-1**

**Part:** Inner ring of a deep groove ball bearing  
**Symptom:** False brinelling occurs on the raceway  
**Cause:** Vibration from an external source while stationary



**Photo 7-12-2**

**Part:** Outer ring of Photo 7-12-1  
**Symptom:** False brinelling occurs on the raceway  
**Cause:** Vibration from an external source while stationary



**Photo 7-12-3**

**Part:** Outer ring of a thrust ball bearing  
**Symptom:** False brinelling of raceway surface at ball pitch  
**Cause:** Repeated vibration with a small oscillating angle



**Photo 7-12-4**

**Part:** Rollers of a cylindrical roller bearing  
**Symptom:** False brinelling occurs on rolling surface  
**Cause:** Vibration from an external source while stationary

## 7.13 Creep

| Damage Condition   | Possible Cause   | Countermeasure  |
|--|--|---|
| Creep is the phenomenon in bearings where relative slipping occurs at the fitting surfaces and thereby creates a clearance at the fitting surface. Creep causes a shiny appearance, occasionally with scoring or wear. | Insufficient interference or loose fit<br>Insufficient sleeve tightening | <ul style="list-style-type: none"> <li>● Check the interference, and prevent rotation</li> <li>● Correct the sleeve tightening</li> <li>● Study the shaft and housing precision</li> <li>● Preload in the axial direction</li> <li>● Tighten the raceway ring side face</li> <li>● Apply adhesive to the fitting surface</li> <li>● Apply a film of lubricant to the fitting surface</li> </ul> |



**Photo 7-13-1**

**Part:** Inner ring of a spherical roller bearing

**Symptom:** Creep accompanied by scoring of bore surface

**Cause:** Insufficient interference



**Photo 7-13-2**

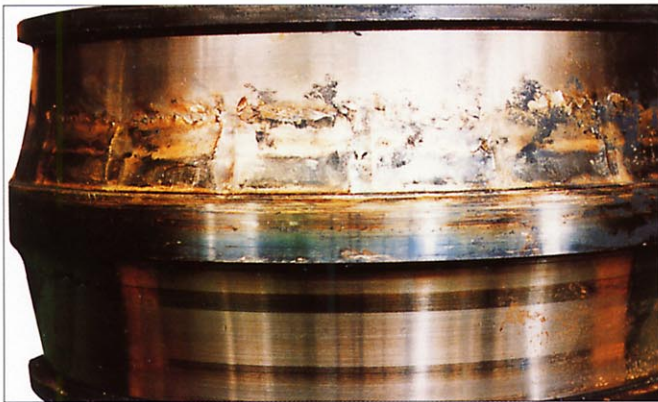
**Part:** Outer ring of a spherical roller bearing

**Symptom:** Creep occurs over entire circumference of outside surface

**Cause:** Loose fit between outer ring and housing

## 7.14 Seizure

| Damage Condition  | Possible Cause  | Countermeasure  |
|---|---|---|
| When sudden overheating occurs during rotation, the bearing becomes discolored. Next, raceway rings, rolling elements, and cage will soften, melt and deform as damage accumulates. | Poor lubrication<br>Excessive load (Excessive preload)<br>Excessive rotational speed<br>Excessively small internal clearance<br>Entry of water and debris<br>Poor precision of shaft and housing, excessive shaft bending | <ul style="list-style-type: none"> <li>● Study the lubricant and lubrication method</li> <li>● Reinvestigate the suitability of the bearing type selected</li> <li>● Study the preload, bearing clearance, and fitting</li> <li>● Improve the sealing mechanism</li> <li>● Check the precision of the shaft and housing</li> <li>● Improve the mounting method</li> </ul> |



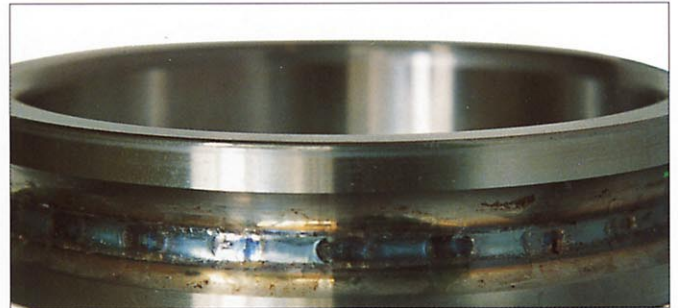
**Photo 7-14-1**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Raceway is discolored and melted. Worn particles from the cage were rolled and attached to the raceway  
**Cause:** Insufficient lubrication



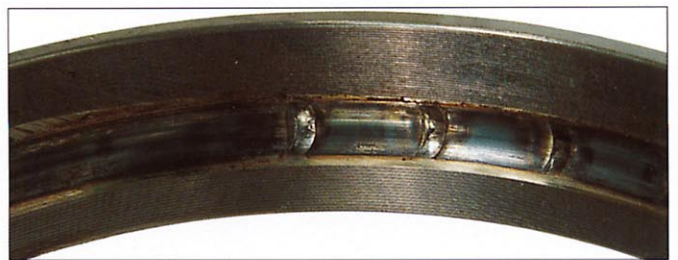
**Photo 7-14-2**

**Part:** Convex rollers of Photo 7-14-1  
**Symptom:** Discoloration and melting of roller rolling surface, adhesion of worn particles from cage  
**Cause:** Insufficient lubrication



**Photo 7-14-3**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Raceway discoloration, melting occurs at ball pitch intervals  
**Cause:** Excessive preload



**Photo 7-14-4**

**Part:** Outer ring in Photo 7-14-3  
**Symptom:** Raceway discoloration, melting occurs at ball pitch intervals  
**Cause:** Excessive preload



**Photo 7-14-5**

**Part:** Balls and cage of Photo 7-14-3  
**Symptom:** Cage is damaged by melting, balls become discolored and melted  
**Cause:** Excessive preload



## 7.15 Electrical Corrosion

| Damage Condition   | Possible Cause   | Countermeasure  |
|--|--|---|
| <p>When electric current passes through a bearing, arcing and burning occur through the thin oil film at points of contact between the race and rolling elements. The points of contact are melted locally to form "fluting" or groove-like corrugations which are seen by the naked eye. The magnification of these grooves will reveal crater-like depressions which indicate melting by arcing.</p> | <p>Electrical potential difference between inner and outer rings</p> | <ul style="list-style-type: none"> <li>• Design electric circuits which prevent current flow through the bearings</li> <li>• Insulation of the bearing</li> </ul> |



**Photo 7-15-1**

**Part:** Inner ring of a tapered roller bearing

**Symptom:** Striped pattern of corrosion occurs on the raceway surface



**Photo 7-15-2**

**Part:** Tapered rollers in Photo 7-15-1

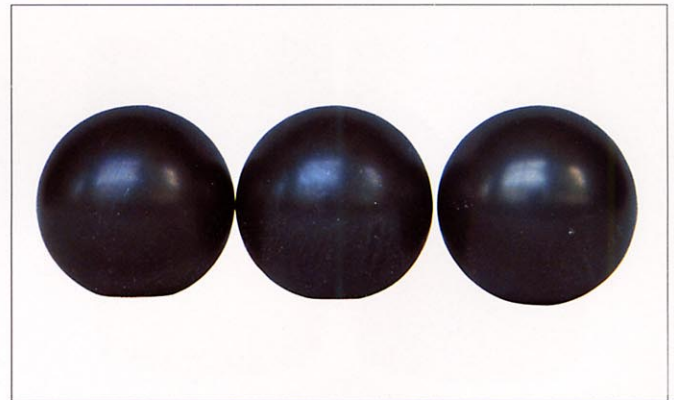
**Symptom:** Striped pattern of corrosion occurs on the rolling surface



**Photo 7-15-3**

**Part:** Inner ring of a cylindrical roller bearing

**Symptom:** Belt pattern of electrical corrosion accompanied by pits on the raceway surface



**Photo 7-15-4**

**Part:** Balls of a deep groove ball bearing

**Symptom:** Electrical corrosion has a dark color that covers the entire ball surface

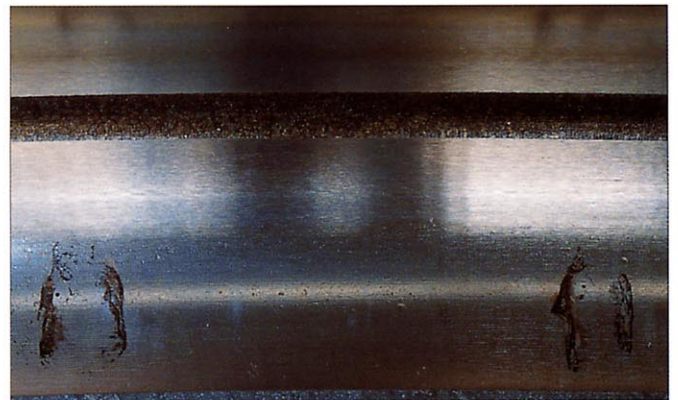
## 7.16 Rust and Corrosion

| Damage Condition  | Possible Cause  | Countermeasure  |
|---|---|---|
| Bearing rust and corrosion are pits on the surface of rings and rolling elements and may occur at the rolling element pitch on the rings or over the entire bearing surfaces. | Entry of corrosive gas or water<br>Improper lubricant<br>Formation of water droplets due to condensation of moisture<br>High temperature and high humidity while stationary<br>Poor rust preventive treatment during transporting<br>Improper storage conditions<br>Improper handling | <ul style="list-style-type: none"> <li>● Improve the sealing mechanism</li> <li>● Study the lubrication method</li> <li>● Anti-rust treatment for periods of non-running</li> <li>● Improve the storage methods</li> <li>● Improve the handling method</li> </ul> |



**Photo 7-16-1**

**Part:** Outer ring of a cylindrical roller bearing  
**Symptom:** Rust on the rib face and raceway surface  
**Cause:** Poor lubrication due to water entry



**Photo 7-16-2**

**Part:** Outer ring of a slewing ring  
**Symptom:** Rust on raceway surface at ball pitch  
**Cause:** Moisture condensation during stationary periods



**Photo 7-16-3**

**Part:** Inner ring of a spherical roller bearing  
**Symptom:** Rust on raceway surface at roller pitch  
**Cause:** Entry of water into lubricant

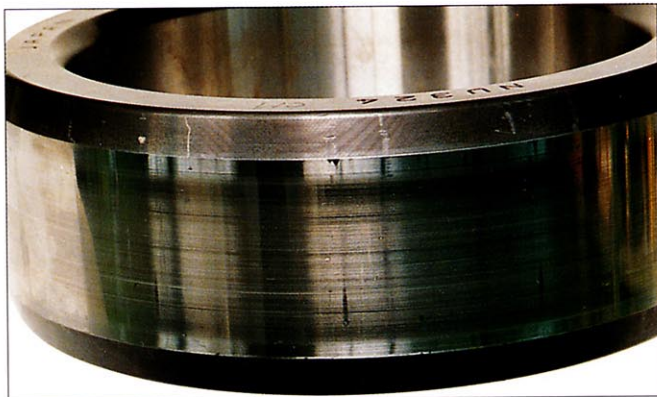


**Photo 7-16-4**

**Part:** Rollers of a spherical roller bearing  
**Symptom:** Pit-shaped rust on rolling contact surface. Corroded portions.  
**Cause:** Moisture condensation during storage

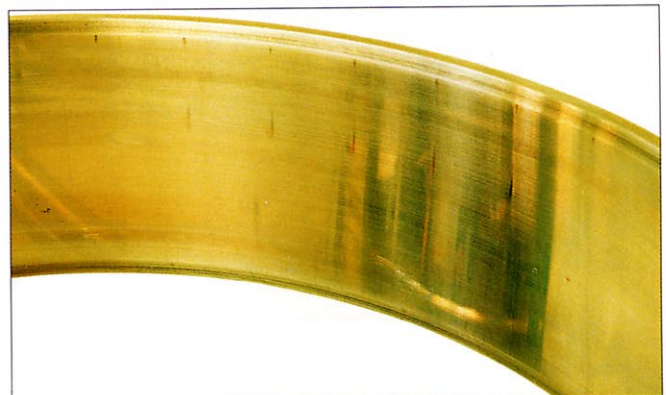
## 7.17 Mounting Flaws

| Damage Condition   | Possible Cause  | Countermeasure   |
|--|---|--|
| Straight line scratches on surface of raceways or rolling elements caused during mounting or dismounting of bearing. | Inclination of inner and outer rings during mounting or dismounting. Shock load during mounting or dismounting. | <ul style="list-style-type: none"> <li>● Use appropriate jig and tool</li> <li>● Avoid a shock load by use of a press machine</li> <li>● Center the relative mating parts during mounting</li> </ul> |



**Photo 7-17-1**

**Part:** Inner ring of a cylindrical roller bearing  
**Symptom:** Axial scratches on raceway surface  
**Cause:** Inclination of inner and outer rings during mounting



**Photo 7-17-2**

**Part:** Outer ring of a double-row cylindrical roller bearing  
**Symptom:** Axial scratches at roller pitch intervals on raceway surface  
**Cause:** Inclination of inner and outer rings during mounting

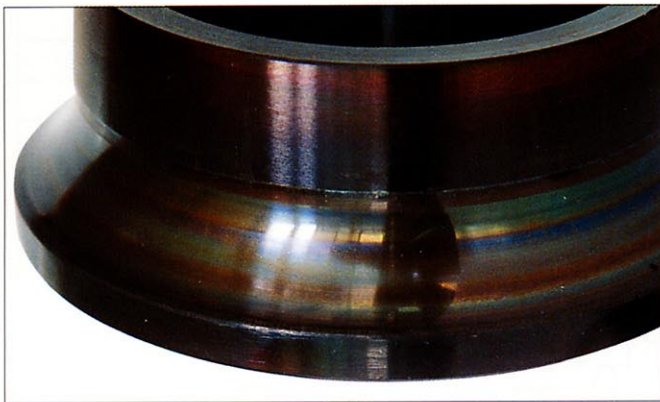


**Photo 7-17-3**

**Part:** Rollers of a cylindrical roller bearing  
**Symptom:** Axial scratches on rolling surface  
**Cause:** Inclination of inner and outer rings during mounting

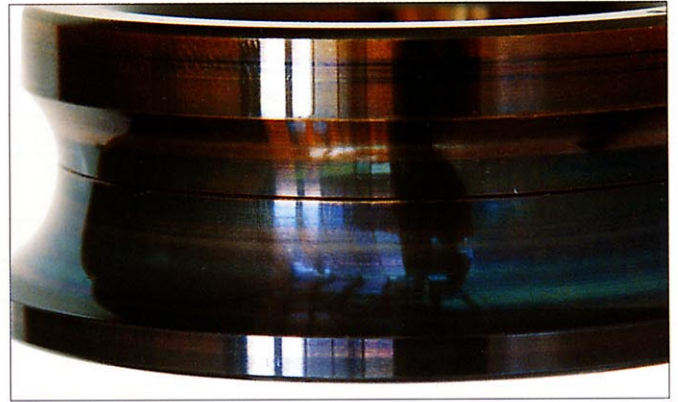
## 7.18 Discoloration

| Damage Condition  | Possible Cause   | Countermeasure   |
|---|--|--|
| Discoloration of cage, rolling elements, and raceway ring occurs due to a reaction with lubricant and high temperature. | Poor lubrication<br>Oil stain due to a reaction with lubricant<br>High temperature | <ul style="list-style-type: none"> <li>● Improve the lubrication method</li> </ul> |



**Photo 7-18-1**

**Part:** Inner ring of an angular contact ball bearing  
**Symptom:** Bluish or purplish discoloration on raceway surface  
**Cause:** Heat generation due to poor lubrication



**Photo 7-18-2**

**Part:** Inner ring of a 4-point contact ball bearing  
**Symptom:** Bluish or purplish discoloration on raceway surface  
**Cause:** Heat generation due to poor lubrication

# Appendix Bearing Diagnostic Chart

| Damage name              | Location (Phenomenon)   | Cause          |          |                     |                            |             |              |                    |                            |        |                  |  |                              | Remarks |  |
|--------------------------|---|----------------|----------|---------------------|----------------------------|-------------|--------------|--------------------|----------------------------|--------|------------------|--|------------------------------|---------|--|
|                          |   | Handling       |          | Bearing surrounding |                            |             | Lubri-cation |                    | Load                       |        |                  | Speed  |                              |         |  |
|                          |   | Stock-Shipping | Mounting | Shaft-Housing       | Sealed device Water-Debris | Temperature | Lubricant    | Lubrication method | Excessive load Impact load | Moment | Ultra small load | High speed, High acceleration & deceleration | Shaking-Vibration Stationary |         | Bearing Selection                                |
| 1. Flaking               | Raceway, Rolling surface  |                | ○        | ○                   | ○                          |             | ○            | ○                  | ○                          | ○      |                  |  |                              | ○       |  |
| 2. Peeling               | Raceway, Rolling surface  |                |          |                     | ○                          |             | ○            | ○                  |                            |        | ○                | ○  |                              |         |  |
|                          | Bearing outside surface (Rolling contact)                             |                |          | ○*                  | ○                          |             | ○            | ○                  |                            |        |                  |  |                              |         | *Mating rolling part                             |
| 3. Scoring               | Roller end face surface, Rib surface                                  |                | ○        | ○                   | ○                          |             | ○            | ○                  | ○                          | ○      |                  | ○  |                              |         |  |
|                          | Cage guide surface, Pocket surface                                    |                | ○        |                     | ○                          |             | ○            | ○                  |                            |        |                  |  |                              |         |  |
| 4. Smearing              | Raceway, Rolling surface  |                |          |                     | ○                          |             | ○            | ○                  |                            |        | ○                | ○  |                              |         |  |
| 5. Fracture              | Raceway collar, Rollers   | ○              | ○        | ○                   |                            |             |              |                    | ○                          | ○      |                  |  |                              |         |  |
| 6. Cracks                | Raceway rings, Rolling elements                                       |                | ○        | ○                   |                            | ○           |              |                    | ○                          | ○      |                  |  |                              |         |  |
|                          | Rib surface, Roller end face, Cage guide surface (Thermal crack)      |                |          | ○                   |                            |             |              | ○                  | ○                          | ○      |                  |  |                              |         |  |
| 7. Cage damage           | (Deformation), (Fracture)   |                | ○        | ○                   |                            |             |              |                    | ○                          | ○      |                  |  |                              |         |  |
|                          | (Wear)  |                | ○        |                     | ○                          |             | ○            | ○                  | ○                          | ○      |                  | ○  |                              |         |  |
| 8. Denting               | Raceway, Rolling surface, (Innumerable small dents)                   |                |          |                     | ○                          |             |              | ○                  |                            |        |                  |  |                              |         |  |
|                          | Raceway (Debris on the rolling element pitch)                         | ○              | ○        |                     |                            |             |              |                    | ○                          |        |                  |  | ○                            |         |  |
| 9. Pitting               | Raceway, Rolling surface  |                |          |                     | ○                          |             | ○            | ○                  |                            |        |                  |  |                              |         |  |
| 10. Wear                 | Raceway, Rolling surface, Rib surface, Roller end face                |                | ○        |                     | ○                          |             | ○            | ○                  |                            |        |                  |  |                              |         |  |
| 11. Fretting             | Raceway, Rolling surface  | ○              | ○        | ○                   |                            |             | ○            | ○                  | ○                          |        |                  | ○  | ○                            |         |  |
|                          | Bearing outside & bore, side surface (Contact with housing and shaft) |                | ○        | ○                   |                            |             |              |                    | ○                          |        |                  |  |                              |         |  |
| 12. False brinelling     | Raceway, Rolling surface  | ○              |          |                     |                            |             | ○            | ○                  |                            |        |                  |  | ○                            |         |  |
| 13. Creep                | Fitting surface   |                | ○        | ○                   |                            | ○           | ○*           | ○*                 | ○                          |        |                  | ○  |                              |         | *Clearance fit                                   |
| 14. Seizure              | Raceway ring, Rolling element, Cage                                   |                | ○        | ○                   | ○                          |             | ○            | ○                  | ○                          | ○      |                  | ○  |                              | ○       |  |
| 15. Electrical corrosion | Raceway, Rolling surface  |                | ○*       | ○*                  |                            |             |              |                    |                            |        |                  |  |                              |         | *Electricity passing through the rolling element |
| 16. Rust and corrosion   | Raceway ring, Rolling element, Cage                                   | ○              | ○        |                     | ○                          | ○           | ○            | ○                  |                            |        |                  |  |                              |         |  |
| 17. Mounting flaws       | Raceway, Rolling surface  |                | ○        | ○                   |                            |             |              |                    |                            |        |                  |  |                              |         |  |
| 18. Discoloration        | Raceway ring, Rolling element, Cage                                   |                |          |                     |                            | ○           | ○            | ○                  |                            |        |                  |  |                              |         |  |

Remark: This chart is not comprehensive. It lists only the more commonly occurring damages, causes, and locations.

