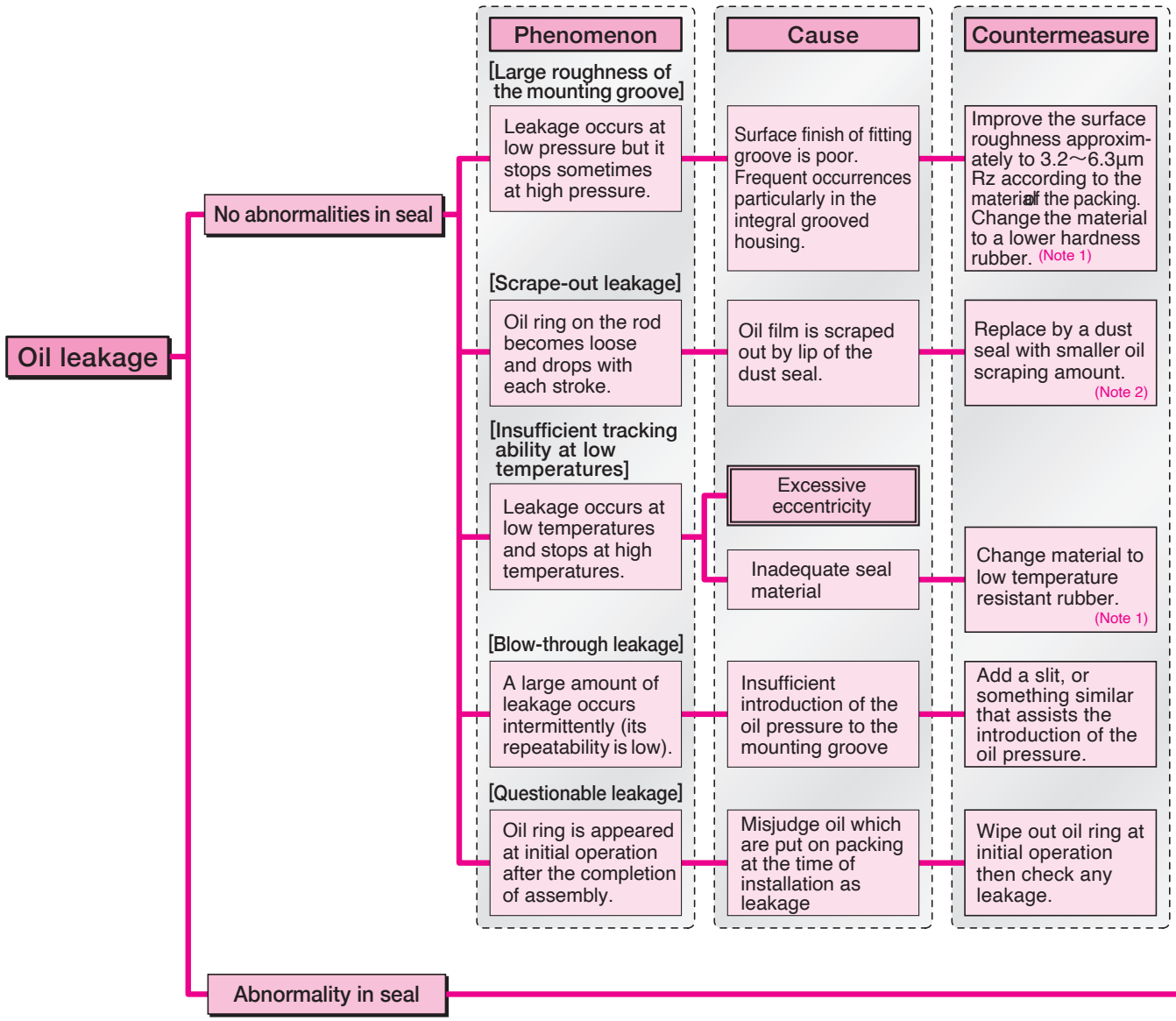
CAUSE OF LEAKAGE

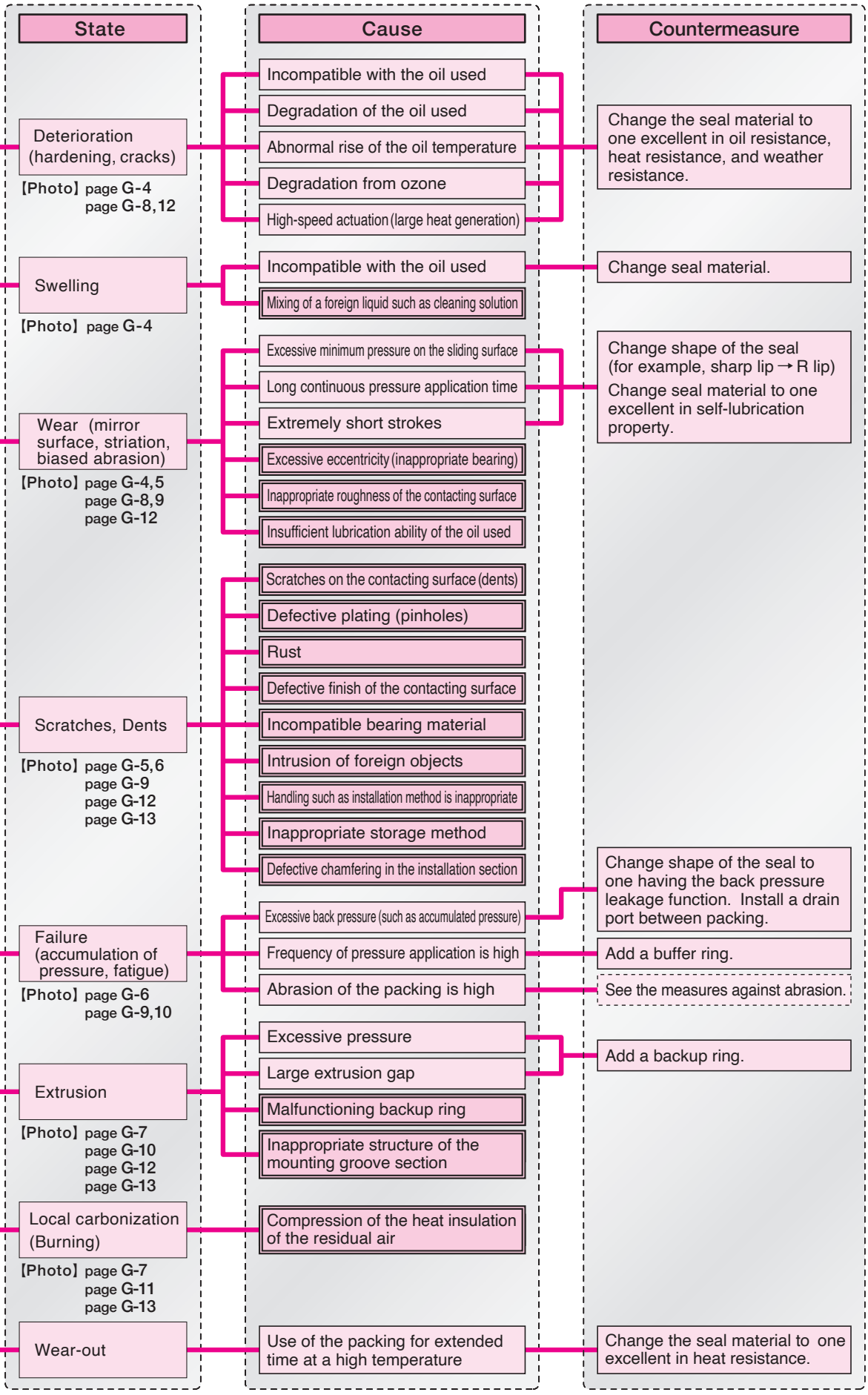
In this chapter, we will introduce the main causes of oil leakage from the sealing and examples of countermeasures.
When oil leakage is observed, first check the source of the leakage.
Sometimes a deposit of grease is mistaken for oil leakage. If leakage from the seal is confirmed, see if there are any abnormalities with the seal contact area.

The following examples of leakage are classified into two groups: Check cases where there are no abnormalities with the seal contact area.
And cases where abnormalities are observed with the seal contact area.

〈Table G-1〉

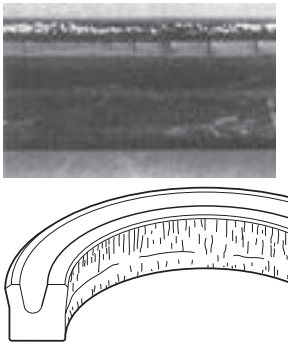
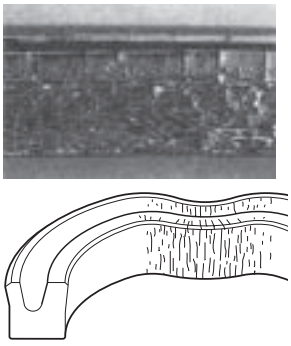
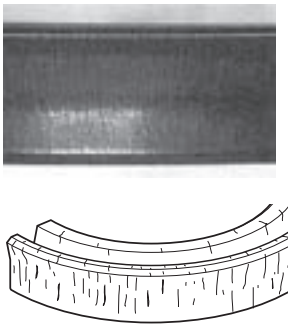
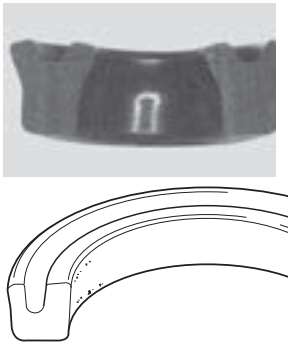
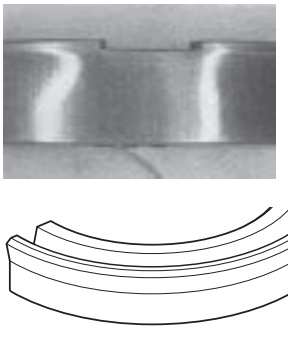


Note 1) When changing the seal material, consult NOK because other conditions must be considered.
Note 2) Dust resistance and seal performance are conflicting properties, so it is important to balance them.
Note 3) ▭, is difficult to take countermeasures for seal abnormalities by improving the seal, so improve the usage conditions.


State
Cause
Countermeasure
Deterioration (hardening, cracks)
【Photo】page G-4
page G-8,12
Swelling
【Photo】page G-4
Wear (mirror surface, striation, biased abrasion)
【Photo】page G-4,5
page G-8,9
page G-12
Scratches, Dents
【Photo】page G-5,6
page G-9
page G-12
page G-13
Failure (accumulation of pressure, fatigue)
【Photo】page G-6
page G-9,10
Extrusion
【Photo】page G-7
page G-10
page G-12
page G-13
Local carbonization (Burning)
【Photo】page G-7
page G-11
page G-13
Wear-out
Incompatible with the oil used
Degradation of the oil used
Abnormal rise of the oil temperature
Degradation from ozone
High-speed actuation (large heat generation)
Change the seal material to one excellent in oil resistance, heat resistance, and weather resistance.
Incompatible with the oil used
Mixing of a foreign liquid such as cleaning solution
Change seal material.
Excessive minimum pressure on the sliding surface
Long continuous pressure application time
Extremely short strokes
Excessive eccentricity (inappropriate bearing)
Inappropriate roughness of the contacting surface
Insufficient lubrication ability of the oil used
Change shape of the seal (for example, sharp lip → R lip)
Change seal material to one excellent in self-lubrication property.
Scratches on the contacting surface (dents)
Defective plating (pinholes)
Rust
Defective finish of the contacting surface
Incompatible bearing material
Intrusion of foreign objects
Handling such as installation method is inappropriate
Inappropriate storage method
Defective chamfering in the installation section
Excessive back pressure (such as accumulated pressure)
Frequency of pressure application is high
Abrasion of the packing is high
Change shape of the seal to one having the back pressure leakage function. Install a drain port between packing.
Add a buffer ring.
See the measures against abrasion.
Excessive pressure
Large extrusion gap
Malfunctioning backup ring
Inappropriate structure of the mounting groove section
Add a backup ring.
Compression of the heat insulation of the residual air
Use of the packing for extended time at a high temperature
Change the seal material to one excellent in heat resistance.

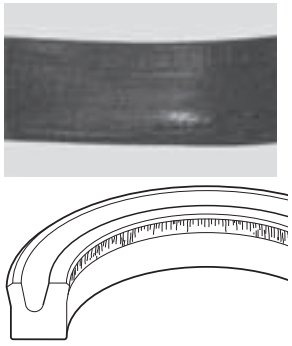
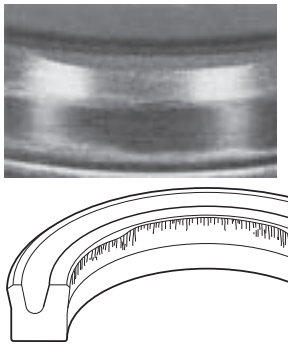
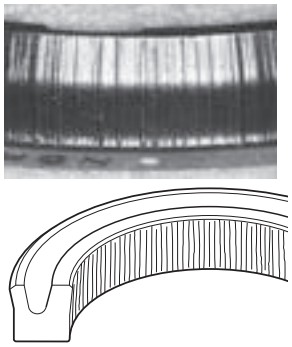
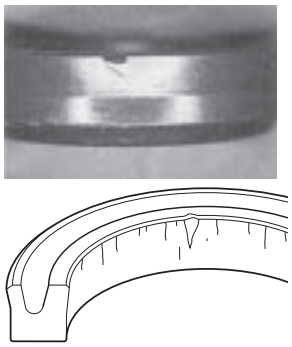
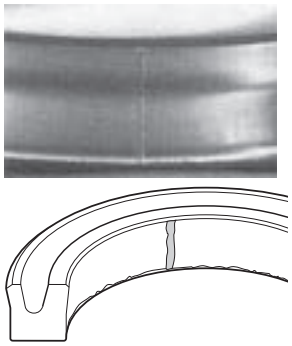
FAILURE MODE AND COUNTERMEASURES

NITRILE RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Deterioration	 Hardening of the whole sliding face. Glazing and cracks on the surface. Push with a finger and cracks appear.	● Heat generation by high speed or excessive internal pressure	● In case of a piston, change to SPG (SPGW). ● In case of rod, use buffer ring together.
	 The whole packing hardens and lip deflects greatly and when bent with a finger, cracks appear.	● High oil temperature	● Lower oil temperature or change to heat resistant material (fluorine rubber)
		● Influence of oil ● Incompatibility of oil and rubber material ● Deterioration of oil	● Change to oil resistant rubber material ● Renew oil.
	 Fine cracks all over the packing surface.	● Ozone cracks from exposing packing to air too long.	● Do not open package unnecessarily but store it in a cold place as sealed.
		● Ozone cracks from leaving it installed with piston.	● Do not leave packing installed with piston but assemble into cylinder as quickly as possible.
Swelling	 Whole packing is softened	● Oil and rubber material are incompatible.	● Change to oil resistant material.
		● Influence of cleaning liquid	● Change cleaning liquid. ● Remove cleaning liquid.
Wear	 The sliding surface shows wear with gloss.	● Sliding stroke was extremely short and caused insufficient lubrication.	● In case of a piston, change to SPG (SPGW). ● In case of rod, use buffer ring together.
		● Roughness of sliding surface is inappropriate (too good)	● Change to recommended roughness.

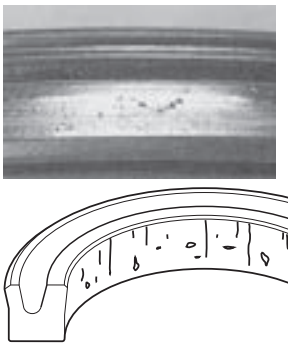
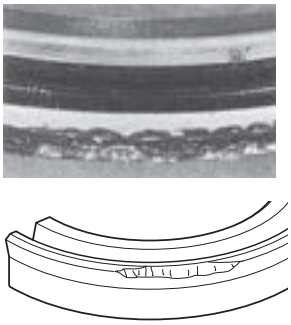
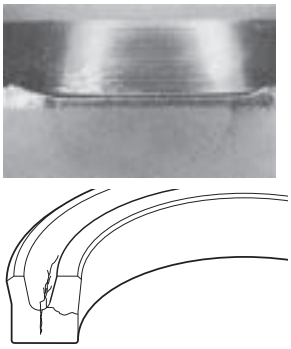
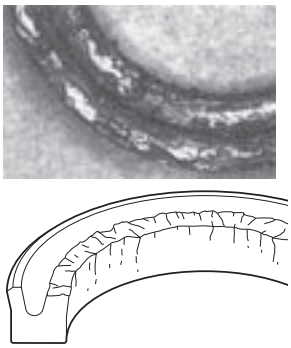
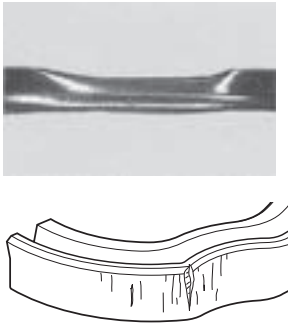
FAILURE MODE AND COUNTERMEASURES

NITRILE RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Wear	 The lip contact width continuously differs on the circumference, and the position of maximum and minimum width are roughly symmetrical.	● Eccentricity of rod and cylinder head and cylinder and piston head.	● Make eccentricity of installation within the tolerance of packings.
	 Abnormal wear observed at one portion of the circumference of the sliding lip (matching the direction of lateral load).	● Abnormal wear of wear ring (piston) and bearing by excessive lateral load.	● Change wear ring and bearing material to those which can withstand a heavy load.
Grooved Wear	 The sliding surface has worn in a striation pattern.	● The seal slides at an extremely short stroke, and the shape of the lubricating oil film is inadequate. ● Large sliding heat is generated, and the oil film is thin.	● Change a sharp lip to an R-lip type. ● Change the seal to a combination seal with excellent self-lubricating properties. ● For a rod packing, add a buffer ring.
Scratch	 Partial cut, dent on the edge of the lip	● By external force such as by hanging on a nail or wire for storage.	● Improvement to storage method
		● Insufficient chamfering of the mating material when fitting.	● Increase chamfering of the mating material and make it smooth so as not to cause “overturn”.
		● By driver, etc. when fitting	● Use fitting tool.
	 Scratch on sliding face.	● There was a scar on the mating sliding face.	● Check fully before fitting.
		● Due to “overturn” of chamfered part of the mating material at the time of fitting	● Increase chamfering of the mating material and make it smooth so as not to cause “overturn”.
		● By embedded foreign material	● Remove foreign matter.

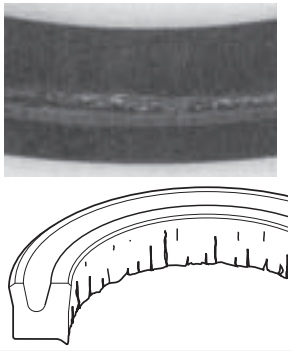
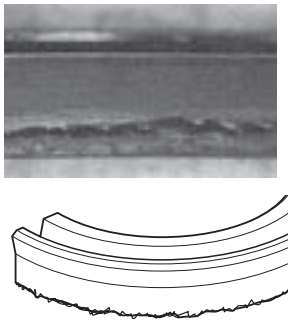
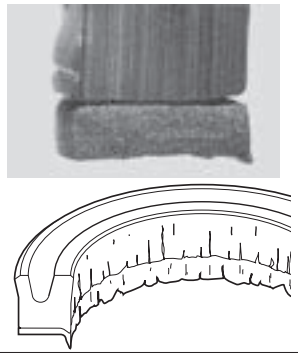
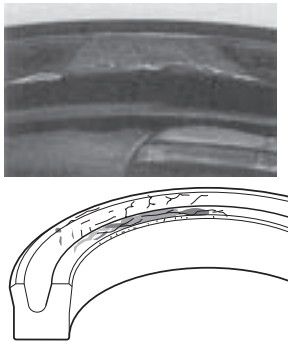
FAILURE MODE AND COUNTERMEASURES

NITRILE RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Dents	 Small dents on sliding face.	● Dust and cuttings embedded in the sliding face due to poor cleaning.	● Remove foreign materials sticking to the equipment.
		● Embedded foreign material or embedded oxidized products due to oxidization.	● Renew oil.
Failure	 A part of the packing lip is torn in an arc shape (piston seal).	● Excessive back pressure occurs.	● Change to OUHR. ● Change to SPG (SPGW).
	 Cracks grew from the groove of packing.	● Fatigue failure due to frequent impulse pressure.	● In case of a rod, use buffer ring together. ● In case of a piston, change to SPG (SPGW).
		● Breaking due to starting at low temperature.	● Change to packing of low temperature resistant material.
	 The whole part of the lip of the sliding part is broken.	● Deterioration of the packing material.	● Change to heat resistant and oil resistant rubber material
		● Deterioration of oil	● Renew oil.
	 Broken at one or two places on the circumference of the packing.	● Packing installed as twisted. ● Assembled with improper packing installation.	● Improve the method and tools of installation.

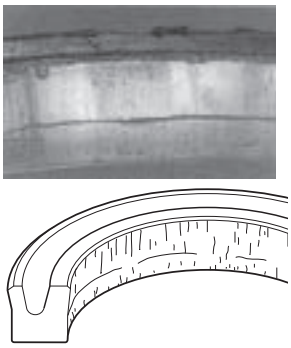
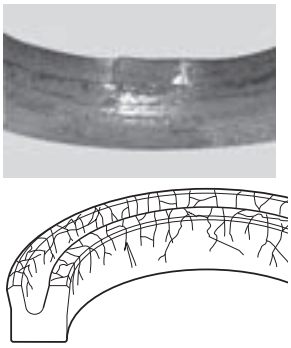
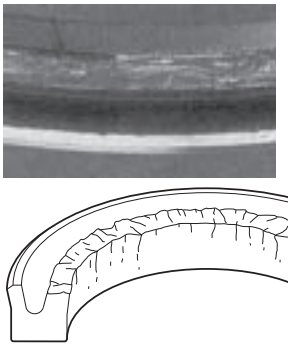
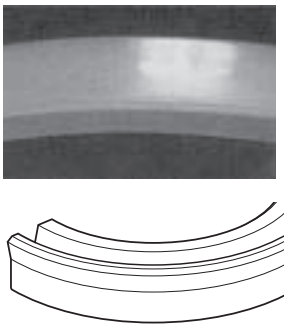
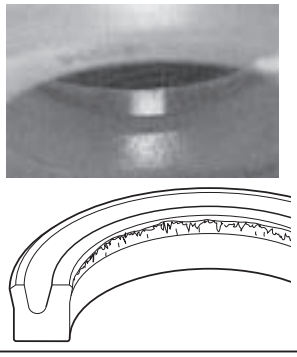
FAILURE MODE AND COUNTERMEASURES

NITRILE RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Extrusion	 The packing heel on the sliding side is torn off.	● Extrusion gap was too big.	● Reduce extrusion gap ● Use a backup ring.
		● Bearing worn too much causing a large gap.	● Change bearing material to an appropriate material.
		● Too much pressure.	● Use a backup ring together and reselect the packing. ● Use buffer ring together.
	 The packing heel at static side is torn off.	● The construction of installation part is inappropriate	● Correct chamfering
		● Gap generated due to insufficient rigidity of support plate.	● Improve rigidity of support plate
		● Inappropriate backup ring.	● Correct the size of backup ring. ● Change backup ring material to appropriate one.
	 Extrusion at both the packing heel and the backup ring.	● Excessive extrusion gap	● Reduce extrusion gap
		● Inappropriate backup ring	● Change backup ring to that of a more rigid material. ● Make thickness of the backup ring thicker. ● Use buffer ring together.
Burning	 The lip and groove are partly carbonized or melted.	● Burning by adiabatic compression of the residual air.	● Countermeasures shown on pages 262 and 263.

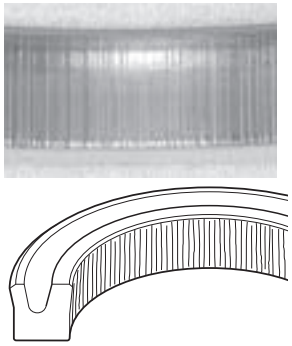
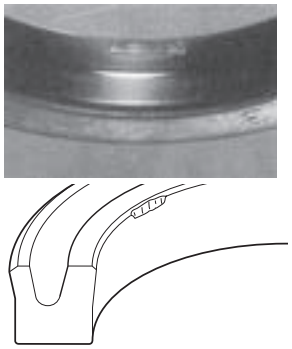
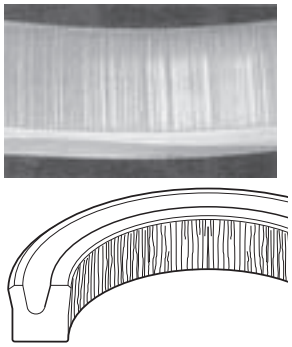
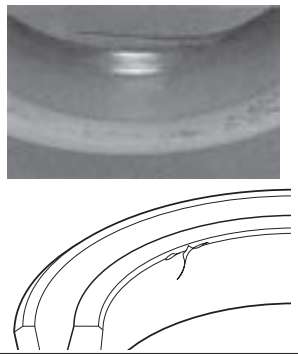
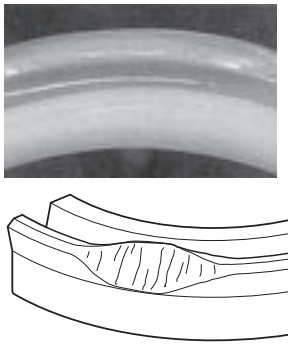
FAILURE MODE AND COUNTERMEASURES

IRON RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Deterioration	 Gloss and cracks on the surface. Push with a finger and cracks appear.	● Excessive rise of oil temperature.	● Lower oil temperature or change to heat resistant material (fluorine rubber)
		● Incompatibility of oil and rubber material.	● Check oil resistance of the packing and change the material of the packing or the hydraulic oil.
		● Deterioration of oil	● Renew oil.
	 Rubber looses elasticity and breaking off.	● Excessive rise of oil temperature.	● Change to rubber material with better heat and oil resistance.
		● Incompatibility of oil and rubber material.	● Check oil resistance of the packing and change the material of the packing or the hydraulic oil.
		● Deterioration of oil.	● Renew oil
	 The whole part of the lip of the sliding part is torn off.	● Excessive rise of oil temperature.	● Change rubber material to the one with better heat resistance.
		● Incompatibility of oil and rubber material Deterioration of oil. ● Deterioration of oil.	● Check oil resistance of the packing and change the material of the packing or the hydraulic oil. ● Renew oil.
Wear	 Wear with gloss on the sliding surface.	● Sliding was extremely short stroke and caused insufficient lubrication.	● In case of a piston, change to SPG (SPGW). ● In case of a rod, use buffer ring together.
		● Pressure higher than 3MPa is always exerted.	● In case of a piston, change to SPG (SPGW). ● In case of a rod, use buffer ring together. ● Check the piping resistance and change the piping structure to lower the pressure.
	 Abnormal wear at part of the circumference of the sliding lip (matching the direction of lateral load).	● Abnormal wear of wear ring (piston) and bearing by excessive lateral load.	● Change wear ring and bearing material to those which can withstand a heavy load.

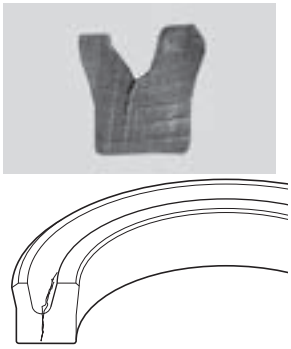
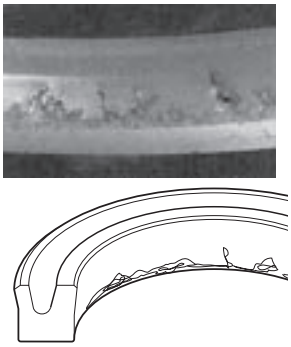
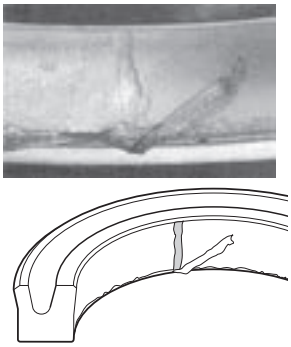
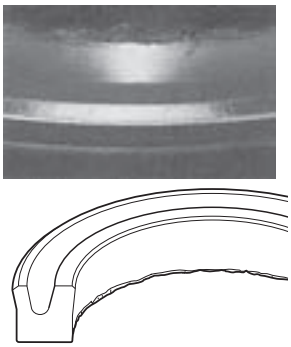
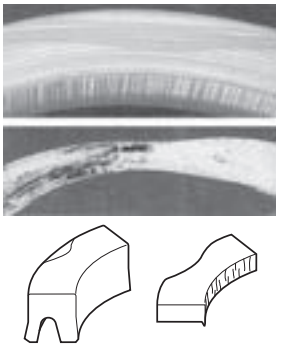
FAILURE MODE AND COUNTERMEASURES

IRON RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Wear	 The sliding surface has worn in a striation pattern.	● The seal slides at an extremely short stroke, and the shape of the lubricating oil film is inadequate. ● Large sliding heat is generated, and the oil film is thin.	● Change a sharp lip to an R-lip type. ● Change the seal to a combination seal with excellent self-lubricating properties. ● For a rod packing, add a buffer ring.
Scars	 Partial cut, dent on the edge of the lip	● By external force such as by hanging on a nail or wire for storage.	● Improvement to storage method
		● Cut and dent due to “overturn” of the mating material when fitting.	● Increase chamfering of the mating material and make it smooth so as not to cause “overturn”.
		● Cut and dent by driver, etc. when fitting	● Use fitting tool.
	 Scratches on sliding face.	● There was a “scar” on the mating sliding face.	● Check fully before fitting.
		● Due to “overturn” of chamfered part of the mating material at the time of fitting	● Increase chamfering of the mating material and make it smooth so as not to cause “overturn”.
		● By embedded foreign material	● Remove foreign matter.
	 Generation of “scratches” at edge of the lip.	● Due to “overturn” of chamfered part of the mating material at the time of fitting	● Chamfer the mating material according to the Dimensional Table and make it smooth so as not to cause “overturn”.
Failure	 The sliding lip of packing is extruded in an arc shape or torn off. (piston seal)	● Generation of excessive back pressure.	● In case of Iron rubber packing, change to OUIS. ● Change to combination seal (SPG, SPGW).

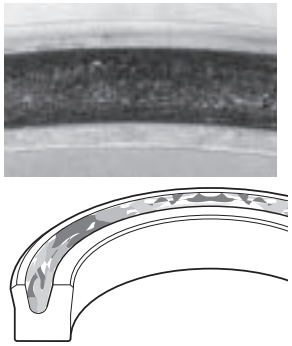
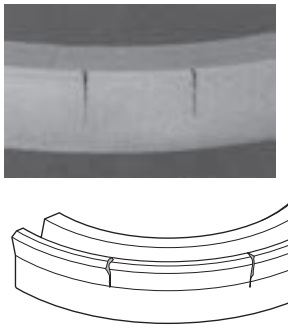
FAILURE MODE AND COUNTERMEASURES

IRON RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Failure	 Generation of cracks starting from the groove of U packing.	● Fatigue failure due to frequent shock pressure.	● In case of a rod packing, use buffer ring together. ● In case of a piston, change to SPG (SPGW).
Extrusion	 Heel part on sliding side is torn off.	● Excessive extrusion gap.	● Reduce the gap. ● Use backup ring together.
		● Increase of bearing gap due to great wear of bearing.	● Change bearing material to an appropriate one.
		● Excessive pressure.	● Use backup ring together and re-select packing. ● Use buffer ring together.
	 Trace of small dent exists from the heel side of the sliding surface to the edge of the lip and a thin film like extrusion fraction is left on the heel part.	● Excessive extrusion gap	● Reduce the gap. ● Use backup ring together.
		● Excessive pressure	● Use backup ring together and re-select packing. ● Use buffer ring together
	 The heel part of the sliding side shows extrusion and change of color into red all over.	● Excessive extrusion gap	● Reduce the extrusion gap. ● Use backup ring together.
		● Increase of bearing gap due to a significant wear of bearing.	● Change bearing material to an appropriate one.
		● Excessive pressure	● Use backup ring together and re-select packing. ● Use buffer ring together.
	 The out side of the pure PTFE backup ring is partially torn off, from where packing has extruded and deformed.	● Insufficient strength and wear resistance of the backup ring.	● Change material of backup ring to 19YF or 80NP.

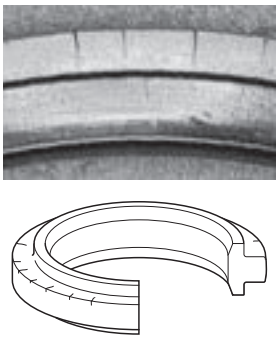
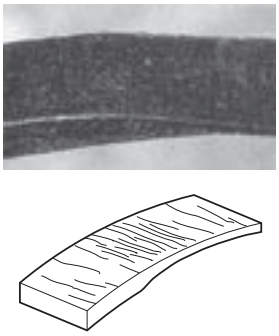
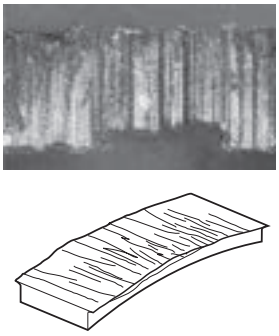
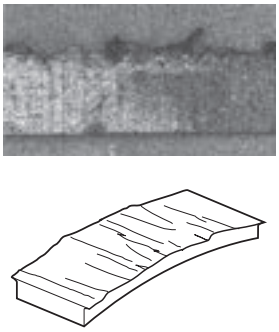
FAILURE MODE AND COUNTERMEASURES

IRON RUBBER PACKINGS

Appearance		Cause	Countermeasure
Fact	Condition		
Burning	 Groove of U packing is partially burned and carbonized.	● Burning by adiabatic compression of the residual air.	● Countermeasures shown on pages 262 and 263.
Deformation	 Deformation and cuts at 2 places on the out side of the packing.	● Poor installation in the integrated groove	● Shown on page 232.

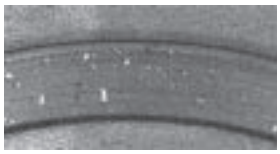
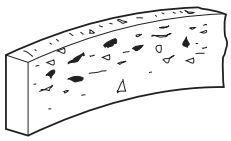
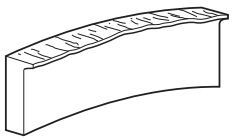
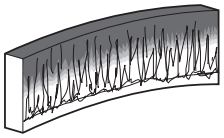
FAILURE MODE AND COUNTERMEASURES

COMBINATION SEALS

Appearance		Cause	Countermeasure
Fact	Condition		
Deterioration	 Cracking has occurred in the back ring.	● The back ring has been used at a high temperature	● Change the back ring material to one with excellent heat resistance.
Wear	 A part of circumference of the seal is abnormally worn (matching with the direction of lateral load)	● Eccentricity due to abnormal wear of wear ring and bearing caused by an excessive lateral load.	● Change the material of wear ring and of bearing to the one that can resist against the lateral load.
		● Sliding face of the mating material is partly rough.	● Finish roughness uniformly (Recommended value: 0.4 ~ 3.2 μm Rz).
Scars	 Heavy scratches on sliding surface.	● There was a "scar" on the mating sliding face.	● Check fully before fitting.
		● Due to "burr" and "overturn" of chamfered part of the mating material at the time of fitting.	● Increase chamfering of the mating material according to Dimensional Table and make it smooth so as not to cause "bur" and "overturn".
		● By embedded foreign material such as metal powder, etc.	● Remove foreign materials. ● Provide contamination seals (KZT) on both sides of the packing.
Extrusion (Rareflon ring)	 Film-like extrusion on the sliding surface of the seal.	● Excessive extrusion gap	● Reduce extrusion gap ● Change material to the one with higher rigidity ● Change to SPGW with backup ring.

FAILURE MODE AND COUNTERMEASURES

PARTS CONNECTED WITH SEALS

Appearance		Cause	Countermeasure
Fact	Condition		
Dents (Burying of foreign material)	  Foreign material is embedded in seal and backup ring.	● Existence of foreign material in oil and in pipings.	● Remove foreign matter. ● Provide contamination seals (KZT) on both sides of the packing.
		● Production of metal powder as a result of seizure of piston and cylinder.	● Change the material of wear ring and of bearing to the one that can resist against the lateral load.
Extrusion (Backup ring)	  Extrusion has occurred in the backup ring.	● Excessive extrusion gap ● High pressure	● Reduce extrusion gap ● Change the material of the backup ring to the one with higher rigidity.
Burning	  One side of the wear ring is carbonized.	● Burning by adiabatic compression of the residual air.	● Countermeasures shown on pages 262 and 263.