

# SHOP MANUAL



## **GUIDANCE FOR REUSABLE PARTS**

# **HYDRAULIC CYLINDER**



GUIDANCE FOR REUSABLE PARTS  
**KOMATSU**

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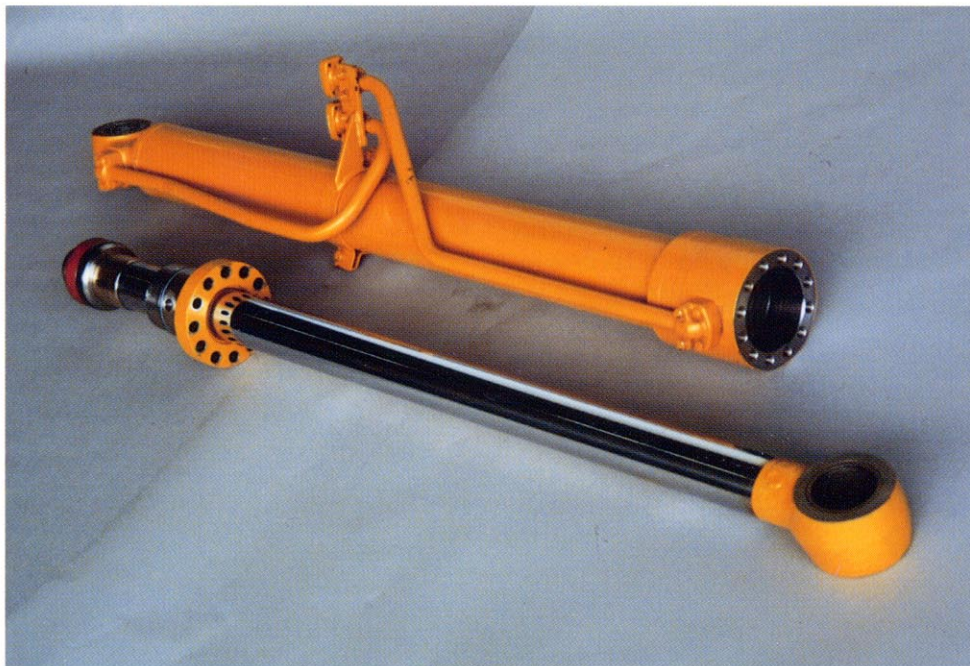
# INTRODUCTION

This Guidance for Reusable Parts provides basic knowledge and explanation of the causes for damage of hydraulic cylinders needed when disassembling, assembling or repairing construction equipment.

It includes photographs of various types of damage of main component parts (work equipment cylinders) so that judgment of category A, B, C can be made visually as to whether a part can be used again or not.

This Guidance for Reusable Parts is designed so that it can be used by a wide range of people in the repair and maintenance of hydraulic cylinders. We hope that it will be used to make suitable judgment about reuse or replacement of parts to reduce repair costs and to improve machine availability.

However, external damage of hydraulic cylinders and external leakage of oil are omitted.



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**Note:** This publication is intended for guidance only and KOMATSU LTD. hereby expressly denies and excludes any representation, warranty or implied warranty for the reuse of hydraulic cylinders.

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# OUTLINE OF HYDRAULIC EQUIPMENT

## Components of Hydraulic Equipment

As can be seen from the diagram of hydraulic equipment at the bottom, hydraulic equipment consists of the following elements.

### 1. Hydraulic pump

Hydraulic pumps take mechanical energy from a power source such as an engine, and convert it into the pressure needed to operate a hydraulic cylinder, so they correspond to the heart of the hydraulic equipment.

### 2. Control valve

Control valves change the pressure, flow, and direction of the oil sent to the hydraulic cylinder to freely control the speed, direction, and size of the force according to the purpose. Control valves can be divided into pressure control valves that control pressure, flow control valves that control the flow, and directional control valves that control the direction.

### 3. Hydraulic cylinder

Hydraulic cylinders convert the energy of the pressure sent from the hydraulic pump into mechanical energy. They have two-way movement.

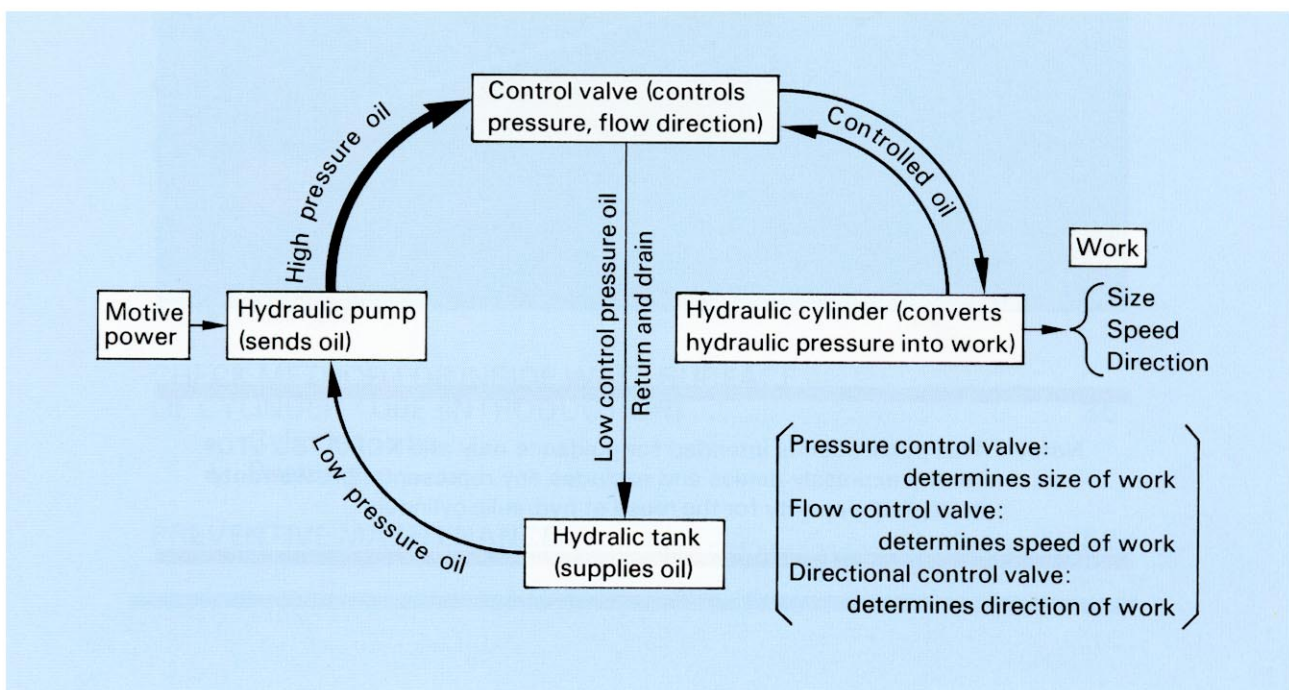
### 4. Hydraulic tank

With hydraulic equipment, the oil occasionally produces unneeded energy and generates heat, so it is necessary to cool this heat. Therefore, a tank must be installed in the oil flow to store the oil.

This tank acts to dissipate the heat of the oil, and also acts to compensate for any lack of oil caused by oil leakage and to remove the dirt of rust in the oil by allowing it to settle at the bottom of the tank.

### 5. Piping and other accessories

The accessories of the hydraulic equipment include pipes, high pressure rubber hoses, strainers, oil filters, and oil coolers.



# STRUCTURE AND FUNCTION OF HYDRAULIC CYLINDERS

## Outline

The hydraulic cylinder is a mechanism for converting fluid energy into mechanical energy for linear drive purposes. The cylinder has oil inlets and outlets at both the head end (piston rod end) and the bottom end, and by applying oil pressure to both ends, the oil is alternately forced in and out of the cylinder resulting in the piston and piston rod being moved back and forth.

Cylinders with this kind of action are referred to as double-acting cylinders and are used in bulldozers and hydraulic excavators, etc.

## Structure and Function Cylinder

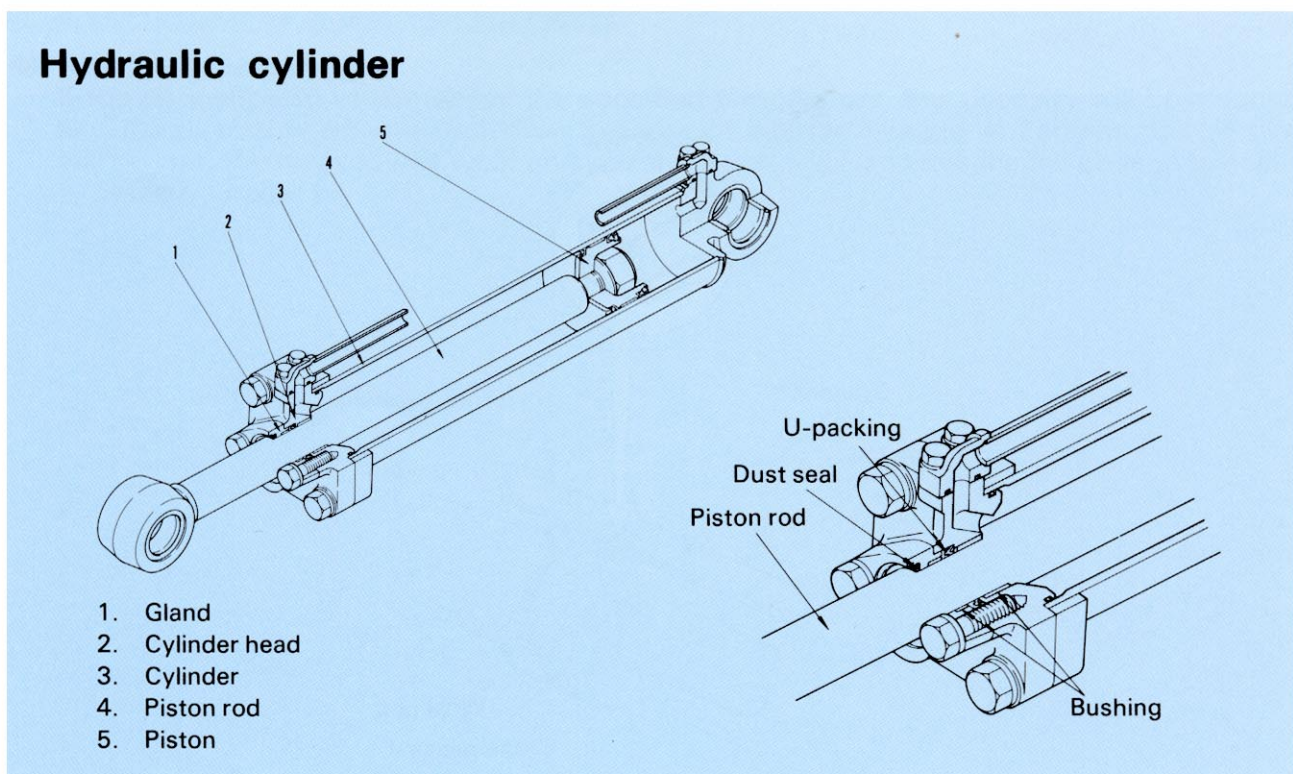
Cylinders are made of steel piping with a base welded to the bottom. The inside of the piping is finished by honing in order to prevent oil leakage and abrasion with the packing.

## Cylinder head

The cylinder head is secured to the cylinder by bolts as shown in the illustration at right, or by cutting a thread into the head and screwing it into the cylinder.

The cylinder head has a center hole through which the piston rod is passed. This hole is fitted with a bushing to prevent the piston rod from rubbing directly against the cylinder head.

This section is also packed to prevent leakage of cylinder oil through the gap between the cylinder head and piston rod. In addition, a dust seal is employed to prevent grit adhering to the piston rod from being carried into the cylinder when the rod is pushed in.



## Piston

The piston slides along the side of the cylinder. Fitted around the piston outer circumference are packings and piston rings which are designed to prevent oil leaks from surrounding clearances.

Since both the piston and cylinder are made of steel, a wear ring made of cloth-filled bakelite is fitted so that the piston does not directly touch the inside wall of the cylinder, which prevents the steel surfaces from being damaged by friction. The piston may or may not have a piston valve, depending on the type.

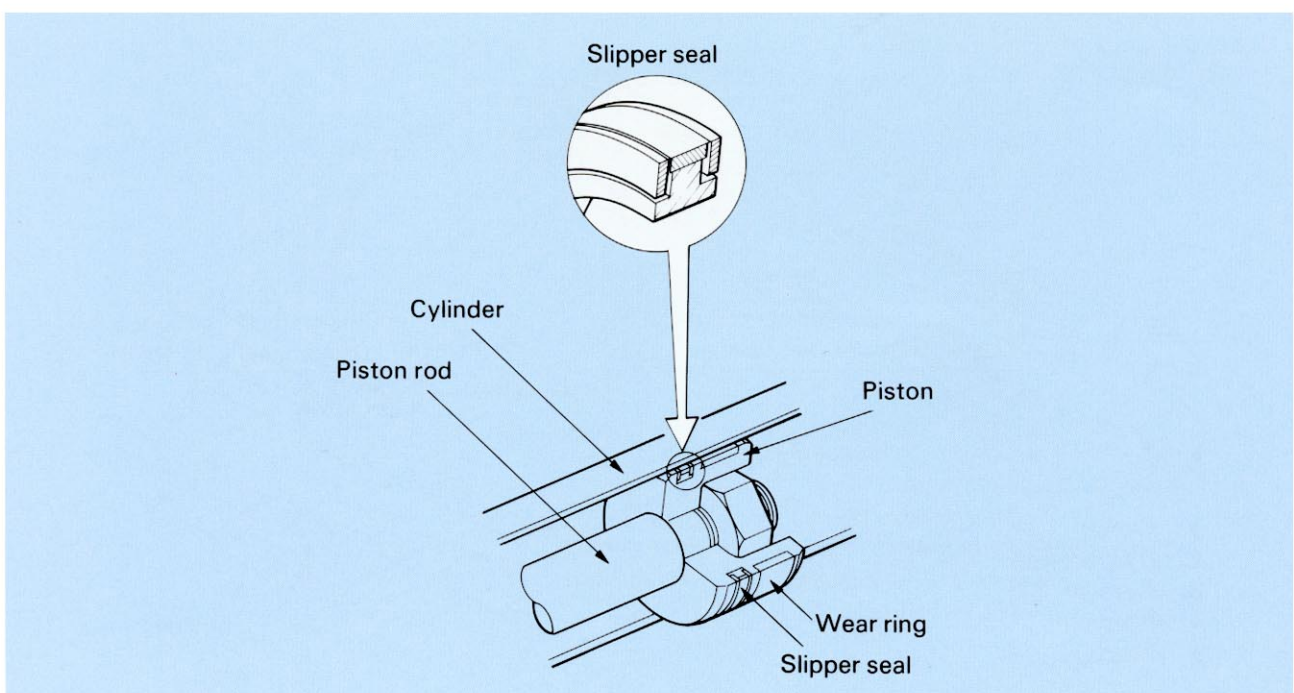
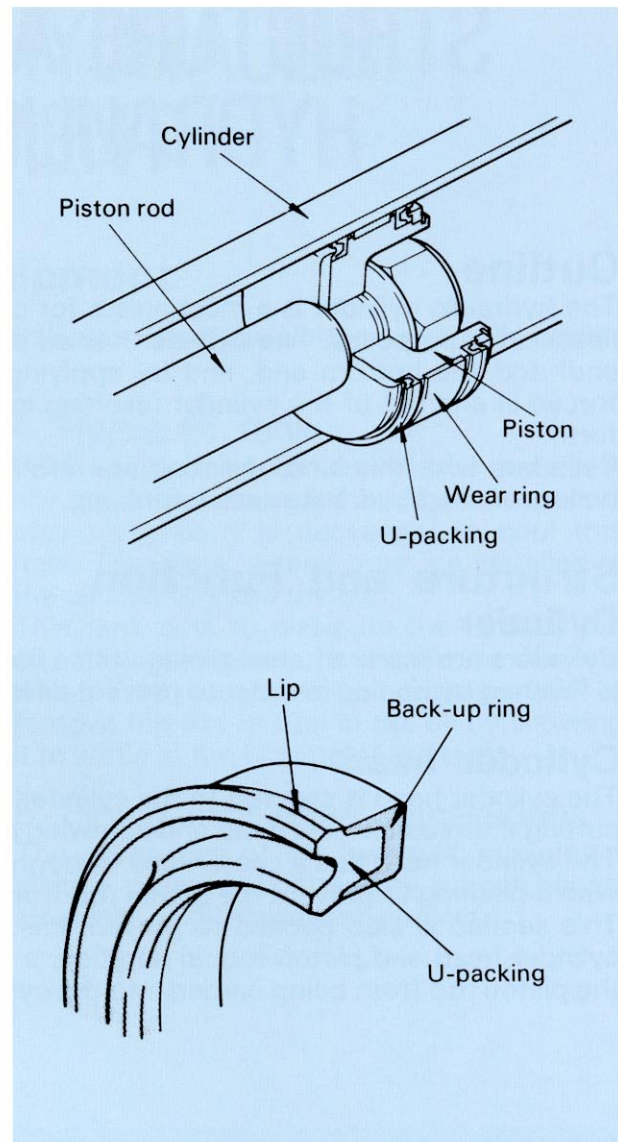
The illustration at right shows how U-packing or slipper seal is mounted to prevent oil leakage from the clearance between the piston and cylinder.

When hydraulic pressure is applied to the hollow side of U-packing, the lip (portion projecting outward) is pushed against the cylinder and piston to prevent oil leakage.

But, if hydraulic pressure is applied to the opposite direction, oil leakage will result.

Therefore, 2 sets of U-packings each in opposite directions should be used to prevent oil leakage from both directions so that hydraulic pressure may be applied from both directions.

For a slipper seal, hydraulic pressure can be applied from both directions.



# MAIN CAUSES OF DAMAGE

About 70% of damage to hydraulic equipment is caused by problems in maintenance and in the selection of hydraulic oil. Therefore, to prevent damage, and to use the machine efficiently, it is important to give careful consideration to the selection of hydraulic oil and to the way of handling the machine.

## Hydraulic oil

Hydraulic oil is an important element because it acts as the medium to transmit pressure. It also plays an important role as a coolant and lubricant for sliding parts.

As the hydraulic oil is used, it becomes contaminated by the entry of dirt or water, so the condition of the oil is generally checked by the following four items: discoloration, water content, viscosity, and acidity (alkalinity). Of these, the items which most frequently lead to damage of the equipment are water and contaminants causing discoloration.

### 1) Discoloration

Hard particles (contaminants), such as particles of worn metal, sand or dirt, cause wear or scuffing of the sliding surface. They also advance the change to acidity of the hydraulic oil. Generally speaking, discoloration is expressed by NAS grade. The oil should be within grade 10. Grade 11 and grade 12 can often be reused if the oil is cleaned.

### 2) Water content

*If water gets into the hydraulic oil, the oil does not lubricate properly. This leads to wear, seizure and rusting of parts.* The standard for water content is within 0.2%; above this level, the oil must be changed or cleaned.

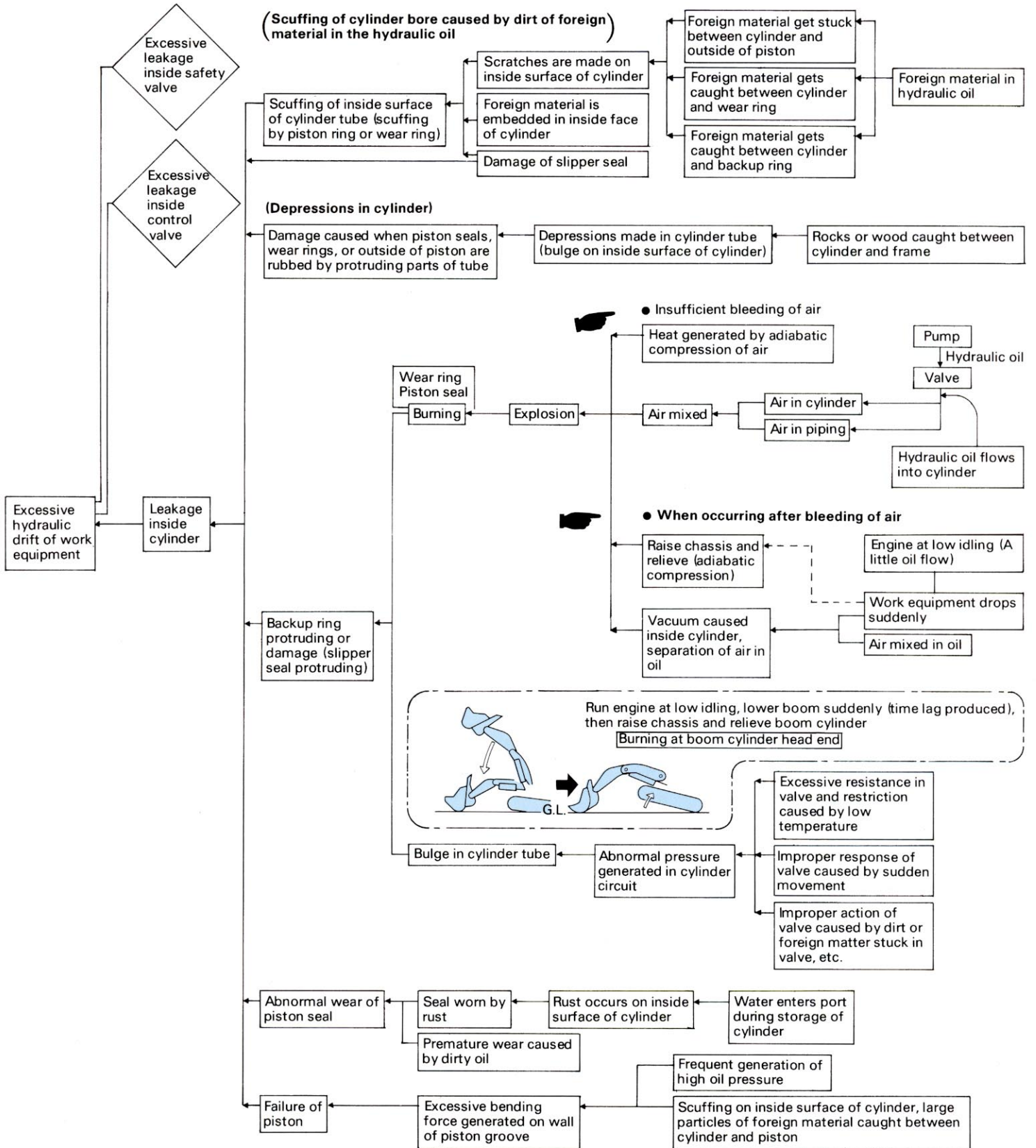
### 3) Cavitation

If air gets into the oil, it creates bubbles. When these bubbles burst, there is sudden high pressure at that point, which causes noise or vibration. In particular, around the discharge port of the pump, this causes damage by erosion.

### 4) Rise in oil temperature

If the oil is allowed to rise above the specified temperature, the viscosity will be reduced and the discharge quantity will drop because of internal leakage. In addition, the oil film will be lost, thereby causing wear and seizure, and it will also advance the change to acidity of the hydraulic oil.

# MECHANISM OF DAMAGE





# POINTS TO REMEMBER WHEN CHECKING OR JUDGING PARTS

There is a tendency to consider hydraulic cylinders as simple hydraulic equipment, but if we consider the work performed by the machine, hydraulic cylinders play the most direct role. They are used under heavy-duty conditions and have to bear large impact forces or loads, and there is frequent repeated movement of the piston in the cylinder tube, so the inside wall of the cylinder is particularly liable to damage by dirt or foreign material in the hydraulic oil getting caught.

In addition, the influence that hydraulic cylinders play on other equipment is large. Therefore, when checking, judging, or repairing damaged parts, it is necessary to work carefully and to give full consideration to prevention of repetition of the same damage. Furthermore, in addition to taking action with the damaged parts, it is also necessary to flush the hydraulic circuit at the same time.

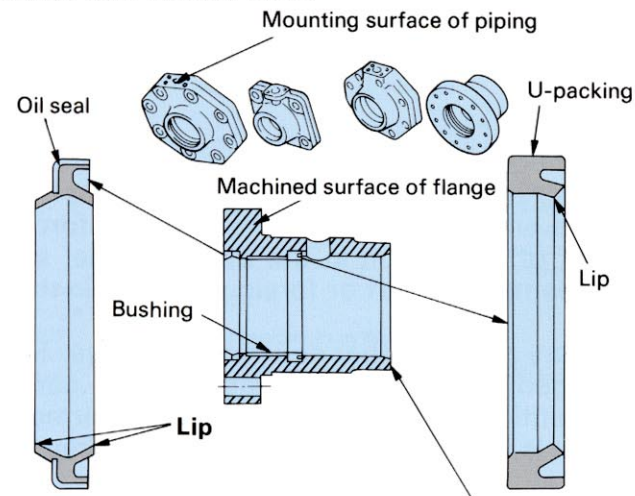
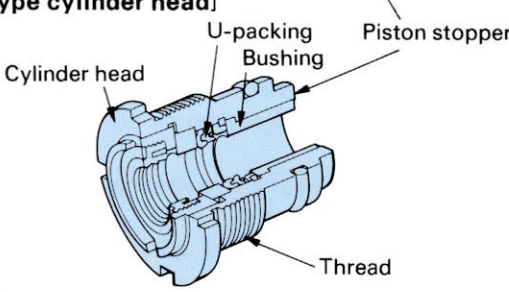
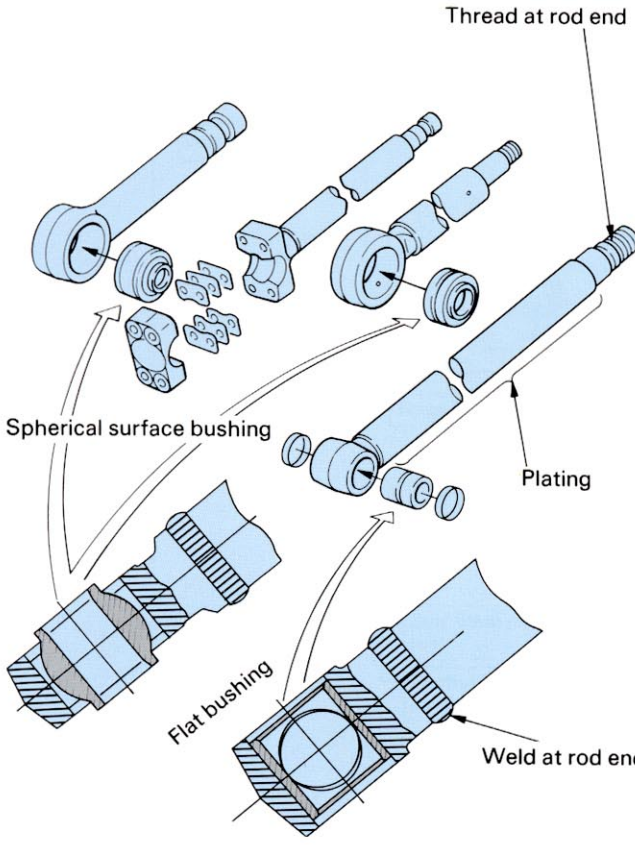
When making judgments about the reuse of parts, it is important to consider daily maintenance and operating conditions to find out exactly why that kind of damage was caused. In this Guidance Manual, there are photographs of damage ranked A, B or C. These photographs should be used together with the know-how derived from experience to make judgments about reuse of the part.

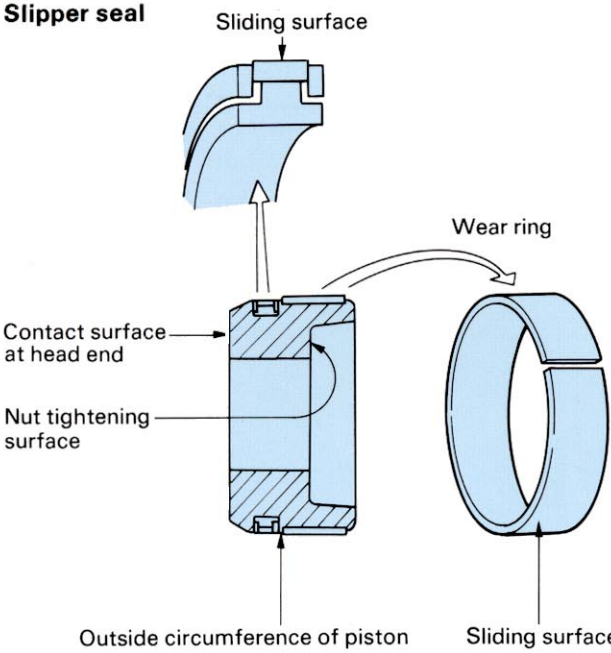
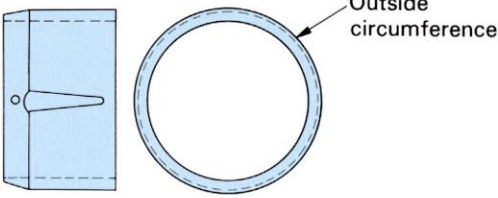
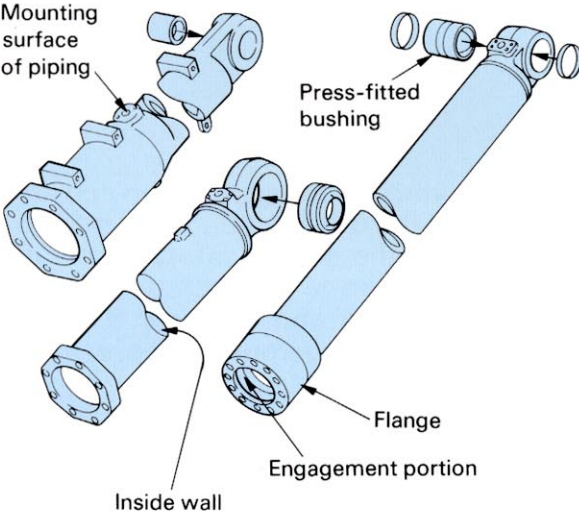
To make accurate judgment on damaged parts, it is necessary to wash and clean the parts first and then to pay careful attention to the following check points.

If there is any malfunction or inconvenience in the performance of a hydraulic cylinder, check the discoloration of the hydraulic oil and use the results as reference when looking for the cause of the problem.

- ★ When repairing parts or honing the cylinder bore locally, it is necessary to consider the capacity of available equipment and the technical level of the workers in rebuilding operations.

# CHECK ITEMS OF MAIN PARTS

Part Name	Check Portion	Check Point
<p>Cylinder head sub-assembly</p>	<p>[Flange type cylinder head]</p>  <p>[Screw type cylinder head]</p> 	<ul style="list-style-type: none"> <li>Check for any wear or scratches on the lips of the oil seal and U-packing.</li> <li>★ Check when removing from the piston rod, and if there are no scratches or wear, leave them assembled to the cylinder head and continue to use.</li> </ul> <p>If there is any oil leakage, replace them regardless of whether there are any scratches or wear.</p> <p>When overhauling, replace all O-rings, oil seals, and U-packings.</p> <p><b>Cylinder Head</b> [Flange type]</p> <ul style="list-style-type: none"> <li>Are there any dents or impressions in the machined surface of the flange?</li> <li>Are there any dents or scratches in the mounting surface of the piping (O-ring mounting surface)?</li> <li>Are there any impressions at the piston stopper?</li> <li>Is there advanced wear or uneven wear of the bushing?</li> </ul> <p>Are there any scratches? [For details of repair limits, see the shop manual.]</p> <p>[Screw type]</p> <ul style="list-style-type: none"> <li>Is there any scuffing of the thread? (Is it possible to screw in smoothly at the cylinder end?)</li> <li>Other points are the same as for the flange type.</li> </ul>
<p>Piston rod sub-assembly</p>		<p><b>Piston Rod</b></p> <ul style="list-style-type: none"> <li>Is there any damage such as scratches or dents in the plating (sliding surface)?</li> <li>Is there any scuffing or uneven wear of the bushing at the rod end, or is the wear advanced? [For details of repair limits, see the shop manual.]</li> <li>Is there any scuffing of the thread at the rod end?</li> </ul> <li>★ Check of weld at rod end and curvature of rod in the following cases:             <ul style="list-style-type: none"> <li>If the damage to the inside of the cylinder is excessive, or there is judged to be an abnormal condition.</li> <li>If the machine is being used under particularly heavy-duty conditions.</li> <li>If there has been any abnormality, such as rolling over of the machine.</li> </ul> </li> <p>If there have been these or other such abnormalities, carry out appropriate checks of the following items.</p> <p>Are there any cracks in the rod end weld? Carry out a color check to check for cracks.</p> <p>Is the rod bent? Use a dial gauge to measure the radial runout.</p>

Part Name	Check Portion	Check Point
Piston sub-assembly	 <p>The diagram illustrates the piston sub-assembly with several key components labeled: 'Slipper seal' at the top, 'Sliding surface' on the upper part of the piston, 'Wear ring' shown as a separate ring, 'Contact surface at head end' on the piston's top edge, 'Nut tightening surface' on the piston's side, and 'Outside circumference of piston' at the bottom. Arrows indicate the relationship between these parts and the 'Sliding surface' of the wear ring.</p>	<p><b>Wear ring &amp; slipper seal</b></p> <ul style="list-style-type: none"> <li>• Are there any abrasions, scratches, or damage to the sliding surface?</li> <li>• Are there any metal particles embedded or broken pieces caught?</li> <li>• Is there any damage or carbonization from explosions?</li> <li>• Is there advanced wear?</li> </ul> <p><b>Piston</b></p> <ul style="list-style-type: none"> <li>• Are there any abrasions, scratches or scuffing on the outside circumference? Are the scratches damaging the wear ring mounting groove or slipper seal mounting groove?</li> <li>• Are there any impressions or abrasions at the contact surface at the head end?</li> <li>• Is there any scuffing of the nut tightening surface?</li> </ul>
Cushion plunger	 <p>The diagram shows a cross-section of the cushion plunger and its 'Outside circumference'.</p>	<p><b>Plunger</b></p> <ul style="list-style-type: none"> <li>• Are there any abrasions, scratches, or scuffing on the outside circumference?</li> </ul>
Cylinder tube	 <p>The diagram shows the disassembled cylinder tube assembly with labels: 'Mounting surface of piping' on the top flange, 'Press-fitted bushing' on the tube, 'Inside wall' of the tube, 'Flange' at the bottom, and 'Engagement portion' where the tube meets the flange.</p>	<p><b>Cylinder tube</b></p> <ul style="list-style-type: none"> <li>• Are there any abrasions, scratches, or scuffing on the inside wall of the tube?</li> <li>• Are there any scratches or dents on the engagement portion of the flange (O-ring contact surface)?</li> <li>• Is there any scuffing of the insertion bushing at the bottom end? Is there any uneven wear? Is there advanced wear? (For details of repair limits, see the shop manual.)</li> </ul> <p><b>Appearance check</b></p> <ul style="list-style-type: none"> <li>• Are there any depressions in the tube? (Check for any rocks or wood caught, or abnormalities such as rolling over.)</li> <li>• Are there any bulges in the tube?</li> </ul>

- ★ When carrying out checks of the inside wall of the cylinder tube, first wash the inside thoroughly and dry off the oil completely before checking. It is easy to overlook deep but small scratches on the inside of the cylinder. Check carefully right to the end of the cylinder.
- ★ For details of the checking procedure, see page 35.
- Press-fitted bushing on cylinder (including bushing at rod end). There is a tendency to pay little attention to scuffing of the bushing. Seizure and scuffing are indirect causes of internal damage to the cylinder. Check the condition of damage at the pin end, and judge both when making a decision.  
[Explanation of the pin is not included in this manual.]

# LEVEL OF DAMAGE AND JUDGMENT ON REUSE

The level of damage for parts of hydraulic cylinders is categorized into three stages: A, B, C. Judgment about reuse of parts is made according to these categories.

Category	Level of damage	Action
<b>A</b>	This category indicates slight or minor damage which creates no problem for the performance of the machine. There is no risk of this damage causing secondary damage.	Can be used as it is
<b>B</b>	This category indicates medium damage which at present is no problem to the performance of the machine, but there is a risk of secondary damage, so replacement is preferable if the part is used for heavy duty work.	Repair and reuse
<b>C</b>	This category indicates serious or critical damage, or that the part has reached the end of its life. If this part is used it may break and cause serious damage, so it must be replaced.	Can not be reused

★ To determine the degree of normal wear, refer to the maintenance standards in the applicable Shop Manual.

Damage to part does not simply consist of one type of damage; it often consists of several types of damage occurring together. In such cases, take the most dangerous form of damage as a guide when making judgment, and always take the overall safety of the machine into consideration.

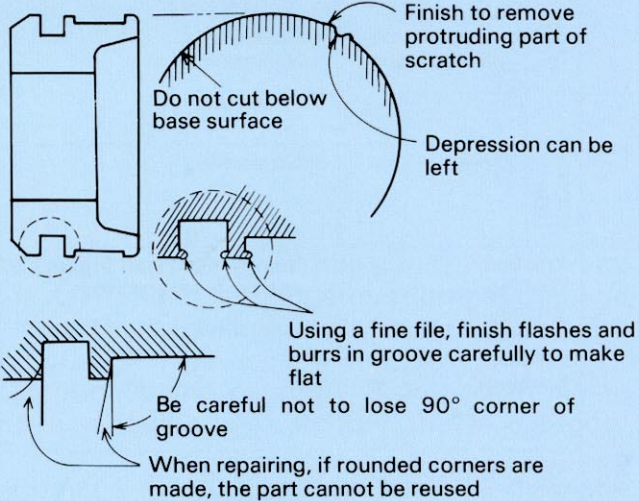
If the level of damage is ranked between category A and category B as shown in the photographs, the damage should be ranked at the more dangerous category, that is, category B.

This judgment frequently depends on the customer's needs (does the part still have the demanded remaining life?), so it is impossible to make an unconditional judgment. However, it is necessary to consider what kind of operation it will be used in, what level of capacity it must display, what length of time it will be used and if it can be used continuously.

Therefore, judgment on the harmful effects or danger of the damage must be based on experience, so when ranking the damage, use the photographs as reference.

# CRITERIA

Part Name	Location of Damage	Judgment Category			
		A	B	C	
Oil seal, U-packing	Lip	<ul style="list-style-type: none"> <li>No wear and scratches</li> </ul> <p>Note: (Replace when overhauling in principle.)</p>	Not applicable	<ul style="list-style-type: none"> <li>Wear and scratches</li> </ul>	
Cylinder head	Flange type	Machined surface of flange	<ul style="list-style-type: none"> <li>No dents and impression</li> </ul>	<ul style="list-style-type: none"> <li>There are light dents and impressions, but possible to repair and finish by hand</li> </ul>	<ul style="list-style-type: none"> <li>Damage such as marked dents that cannot be repaired by hand</li> </ul>
		Mounting surface of piping	<ul style="list-style-type: none"> <li>No dents and scratches</li> </ul>	<ul style="list-style-type: none"> <li>Light scratches that can be repaired by hand</li> <li>Scratches are away from O-ring contact surface</li> <li>Extremely shallow scratches in O-ring that do not affect function</li> </ul>	<ul style="list-style-type: none"> <li>Damage such as marked dents on O-ring contact surface</li> </ul>
		Inside wall surface of flange bore (Only for cylinder with cushion plunger)	<ul style="list-style-type: none"> <li>No scratches and scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Shallow scratches such as light scratches or scuffing</li> </ul> <p>★ Note: (When making judgment, confirm the condition of damage of the mating plunger, and judge as a pair so that there is no problem with the cushion effect.)</p>	<ul style="list-style-type: none"> <li>Marked, deep scratches</li> </ul>
	Common	Inside diameter of press-fitted bushing	<ul style="list-style-type: none"> <li>No wear, uneven wear and scratches</li> </ul>	Not applicable <p>★ Note: (When judging the condition of wear, see the maintenance standards in the shop manual. Consider also any external leakage from the oil seal when making judgment.)</p>	<ul style="list-style-type: none"> <li>Marked scratches and wear</li> </ul>
		Piston stopper	<ul style="list-style-type: none"> <li>No impressions</li> </ul>	<ul style="list-style-type: none"> <li>Light dents that can be repaired and finished by hand</li> </ul>	<ul style="list-style-type: none"> <li>Marked damage</li> </ul>
	Screw type	Thread	<ul style="list-style-type: none"> <li>No scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Light scuffing where the thread can be repaired by hand</li> </ul>	<ul style="list-style-type: none"> <li>Marked scuffing</li> </ul>
Piston rod	Rod end bushing (Including spherical surface bushing)	<ul style="list-style-type: none"> <li>No advanced scuffing, uneven wear and wear, etc.</li> </ul>	<ul style="list-style-type: none"> <li>Light scuffing, uneven wear, wear</li> </ul> <p>★ Note: (When judging the condition of wear, see the maintenance standards in the shop manual. Check also the mating pin and judge whether both need to be replaced.)</p>	<ul style="list-style-type: none"> <li>Marked scuffing, uneven wear, wear</li> </ul>	
	Weld at rod end	<ul style="list-style-type: none"> <li>No cracks</li> </ul> <p>★ (Carry out color check when visual check is difficult.)</p>	Not applicable	<ul style="list-style-type: none"> <li>Cracks</li> </ul>	
	Plating (Sliding surface)	<ul style="list-style-type: none"> <li>No damage such as abrasion, scratches and dents</li> <li>No curvature</li> </ul>	<ul style="list-style-type: none"> <li>Fine abrasions that can be repaired easily with an oilstone or sandpaper</li> <li>No curvature</li> </ul>	<ul style="list-style-type: none"> <li>Scratches and dents (Scratches that cannot be repaired and will probably cause damage to the oil seal lip)</li> <li>Curvature</li> </ul>	
	Thread at the rod end	<ul style="list-style-type: none"> <li>No scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Light scuffing where the thread can easily be repaired by hand</li> </ul>	<ul style="list-style-type: none"> <li>Marked scuffing</li> </ul>	

Part Name	Location of Damage	Judgment Category		
		A	B	C
Wear ring & slipper seal	Sliding surface and appearance	<ul style="list-style-type: none"> <li>• Slight abrasion</li> <li>• No scratches and damage</li> <li>• No metal particles embedded</li> <li>• No heat discoloration and carbonization</li> <li>• No advanced wear</li> <li>• No cracks</li> </ul>	<ul style="list-style-type: none"> <li>• Extremely shallow scratches that can be felt with the fingernail, scratches forming 4 – 5 stripes</li> <li>• No metal particles and broken pieces embedded</li> <li>• No heat discoloration and carbonization</li> <li>• No advanced wear</li> <li>• No damage and cracks</li> </ul>	<ul style="list-style-type: none"> <li>• Marked scratches</li> <li>• Metal particles and broken pieces embedded</li> <li>• Heat discoloration and carbonization</li> <li>• Advanced wear</li> <li>• Cracks and damage</li> </ul>
	★ Note: (Replace when overhauling in principle and do not use again.)			
Piston	Outside circumference and groove	<ul style="list-style-type: none"> <li>• No damage such as abrasion, scratches and scuffing</li> <li>• No flashes and burrs in groove</li> </ul>	<ul style="list-style-type: none"> <li>• Light scratches that can be repaired by hand</li> <li>• Light flashes and burrs in groove that can be repaired by hand</li> </ul> <p>★ When repairing B category scratches on the outside circumference, use a fine file and finish the main part of the scratch, then polish with #240 sand paper</p> 	<ul style="list-style-type: none"> <li>• Scuffing and marked scratches</li> <li>• Deep scratches reaching groove</li> </ul>
	Contact surface at head end	<ul style="list-style-type: none"> <li>• No impression and dents</li> </ul>	<ul style="list-style-type: none"> <li>• Slight dents</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme impressions and damage</li> </ul>
	Nut tightening surface	<ul style="list-style-type: none"> <li>• No scuffing</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>• Scuffing</li> </ul>

Part Name	Location of Damage	Judgment Category		
		A	B	C
Plunger	Outside circumference	<ul style="list-style-type: none"> <li>Slight abrasion, but no scratches and scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Light scratches (can be felt clearly with fingernail) with less than 4 – 5 stripes</li> <li>No scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Many scratches</li> <li>Scuffing</li> <li>Deep scratches caused by broken pieces getting caught</li> </ul>
Cylinder tube	Inside wall	<ul style="list-style-type: none"> <li>No damage such as abrasion, scratches and scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Light abrasions or extremely shallow striped scratches that can be barely felt with the fingernail</li> </ul> <p>&lt;Range of damage&gt; Vertical scratches with 3 – 4 stripes with length of up to 200 mm</p>	<ul style="list-style-type: none"> <li>Abrasions that feel rough to the fingernail</li> <li>Clear scratches that exceed the limits of category B</li> <li>Scuffing</li> <li>Damage deep inside cylinder that cannot be repaired</li> </ul>
	Flange	<ul style="list-style-type: none"> <li>No scratches and dents on cylinder head mounting surface and head mounting engagement portion</li> </ul>	<ul style="list-style-type: none"> <li>Mounting surface of head Scratches where the raised part of the scratch can be repaired by hand</li> <li>Engagement portion Scratches away from O-ring contact surface that will not damage O-ring when cylinder head is assembled; scratches that can be repaired by hand</li> </ul>	<ul style="list-style-type: none"> <li>Deep scratches that exceed range for category B, or scratches in O-ring contact surface</li> </ul>
	Mounting surface of piping	<ul style="list-style-type: none"> <li>No dents and damage on mounting surface</li> </ul>	<ul style="list-style-type: none"> <li>Scratches away from O-ring contact surface that can be repaired by hand</li> <li>Extremely fine scratches in O-ring contact surface that do not affect sealing when O-ring is tightened</li> </ul>	<ul style="list-style-type: none"> <li>Dents and scratches on O-ring contact surface</li> </ul>
	Inside diameter of press-fitted bushing of cylinder bottom	<ul style="list-style-type: none"> <li>No wear or scuffing</li> </ul>	<ul style="list-style-type: none"> <li>Fine scuffing that can be repaired by hand</li> <li>★ Make protruding parts in important places flat with pencil grinder</li> <li>★ When making judgment, check condition of damage of mating pin, and consider this result when making judgment</li> </ul>	<ul style="list-style-type: none"> <li>Marked scuffing</li> </ul>
	Outside appearance of tube	<ul style="list-style-type: none"> <li>No bulges or depressions in tube</li> </ul>	<ul style="list-style-type: none"> <li>Depressions can be seen, but measurement of cylinder bore so that depression does not extend to internal parts</li> <li>No bulges can be seen</li> </ul>	<ul style="list-style-type: none"> <li>Depressions can be seen that extend to inside diameter</li> <li>Bulges can be seen</li> </ul>

# EXAMPLE OF DAMAGE

**Cylinder Head (Piston Stopper Portion, Machined Surface of Flange, Inside Wall Surface of Bore)**

1



**Category: A**  
**Condition**

- There are slight abrasions on the inside surface of the cylinder head bore, but there are no dents, impressions, or scratches on either the machined surface of the flange or the piston stopper portion.

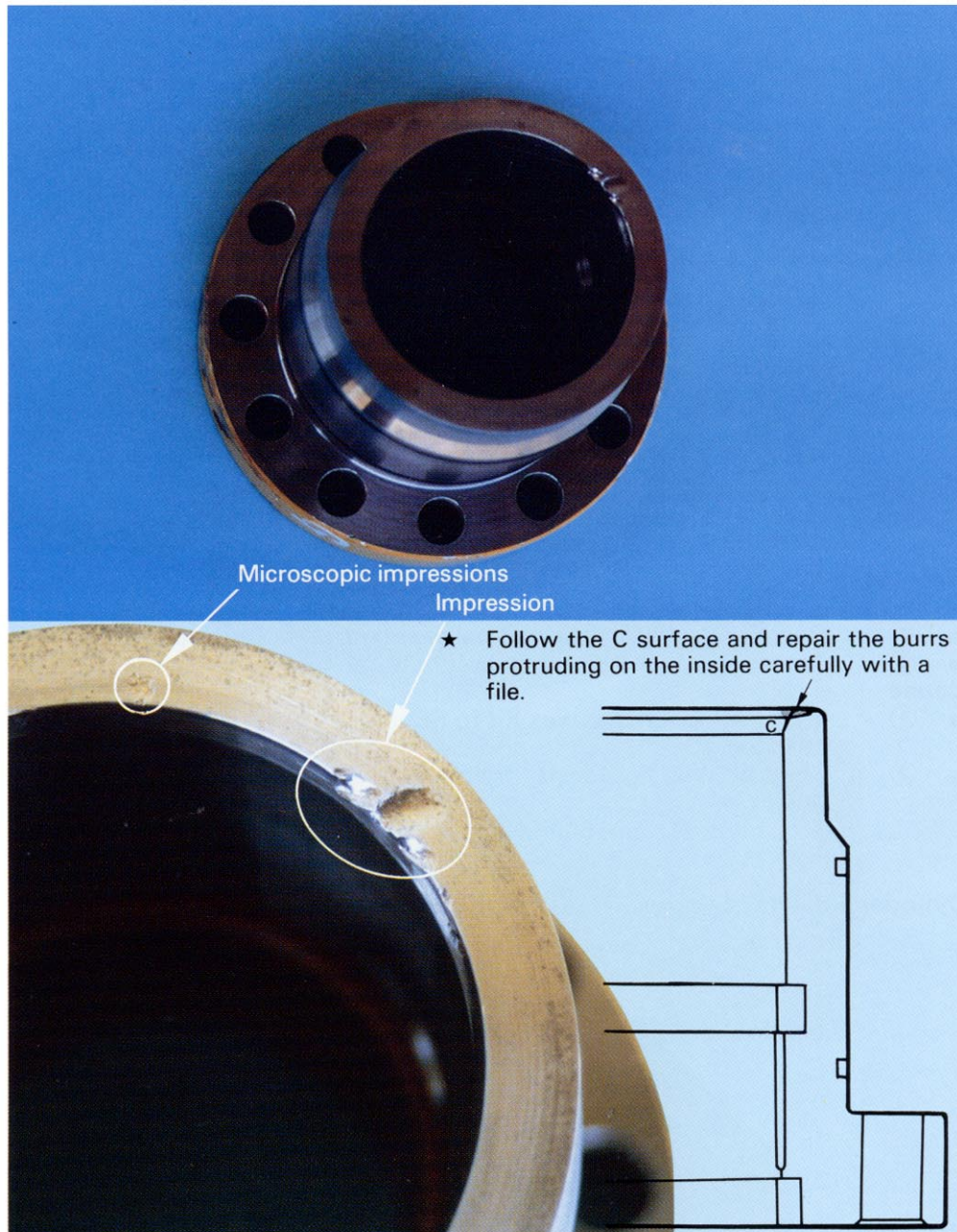
**Cause**

- Abrasion is caused by foreign material getting caught



## Cylinder Head (Piston Stopper Portion)

2



### Category: **B**

#### Condition

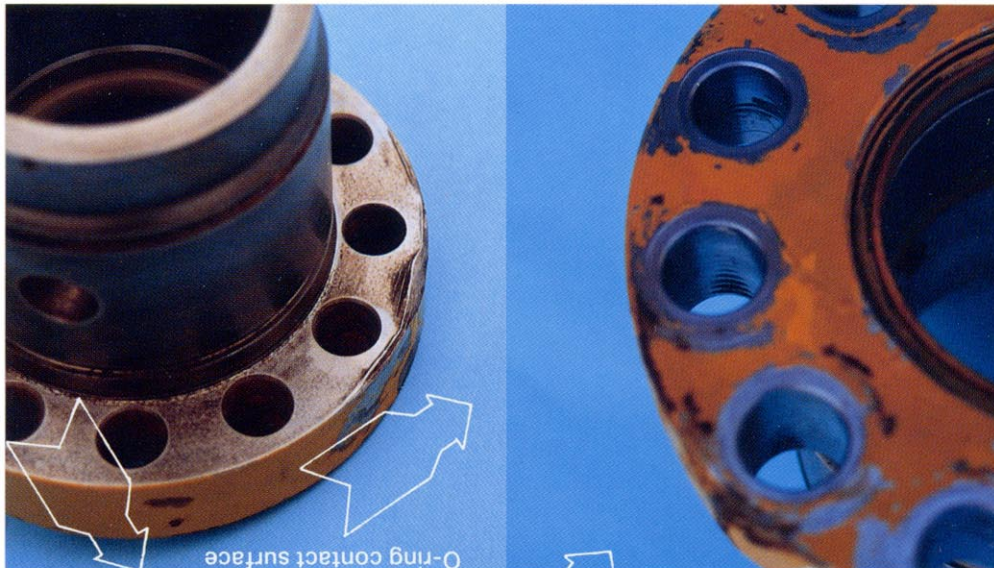
- There is an impression on the piston stopper portion and on the mating piston. See page 28.

#### Cause

- Broken pieces got caught

### Cylinder Head (Machined surface of flange, Bolt hole)

3



#### Category: B Condition

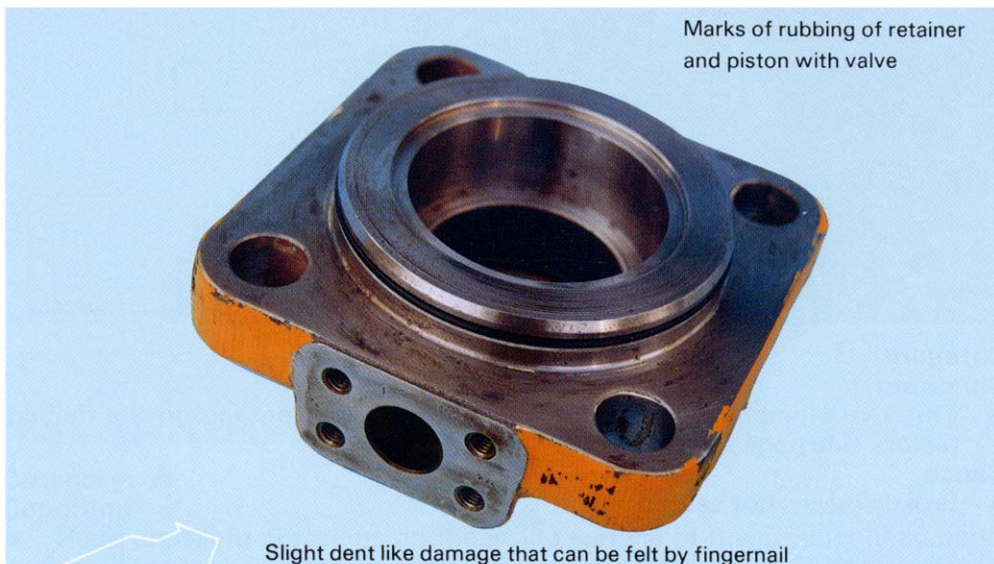
- ① Dents on end of flange and bulges in machined surface
- ② Traces of screw biting into bolt hole can be seen

#### Cause

- ① The part concerned was hit to remove it during disassembly of the cylinder.
- ② The bolt was tightened forcibly when not centered properly in the bolt hole.
  - ★ This may damage the screw, so be careful.Both caused by basic mistake during disassembly and assembly

### Cylinder Head (Mounting surface of piping and piston stopper portion)

4



#### Category: A Condition

- There is slight dent like damage that can be felt by the fingernail in the piping mounting surface.
- ★ Slight abrasion on the piston stopper contact surface. This is made by rubbing of the retainer of the piston with valve at the stroke end caused by the swivel movement of the cylinder mount and the ball joint at the end of the piston rod. This is not an abnormality.

#### Cause

- The damage to the mounting surface of the piping is caused by a mistake in handling the components.

## Cylinder Head (Inside surface of Bore)

5



### Category: **C**

#### Condition

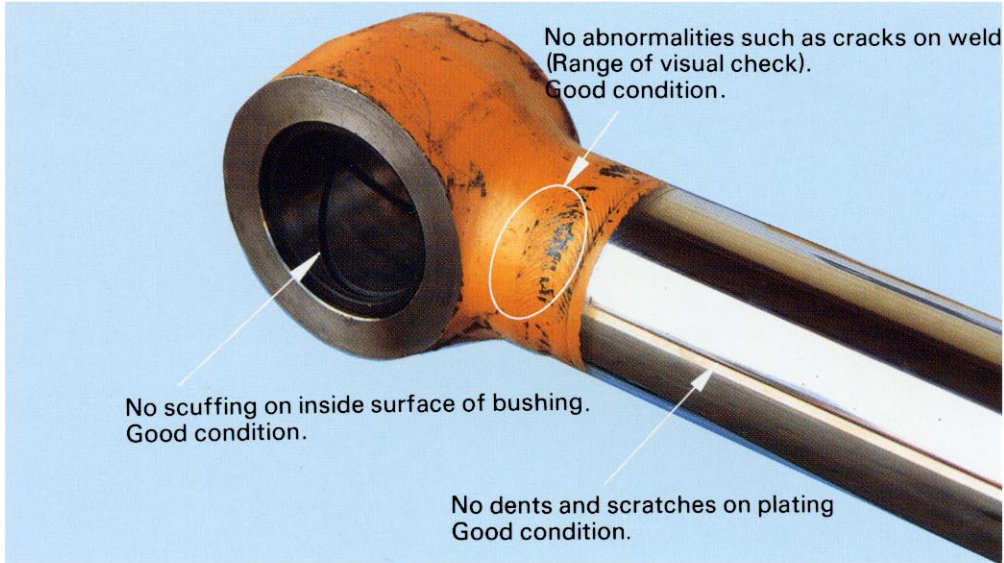
- There are marked scratches on the inside surface of the cylinder head bore. (There is also scuffing on the mating plunger, and the cushion effect is lost.)  
See Plunger, page 33.

#### Cause

- Broken pieces from damage inside the cylinder got caught.

**Piston Rod (Rod end bushing, Weld at rod end, Plating)**

**6**



**Category: A**

**Condition**

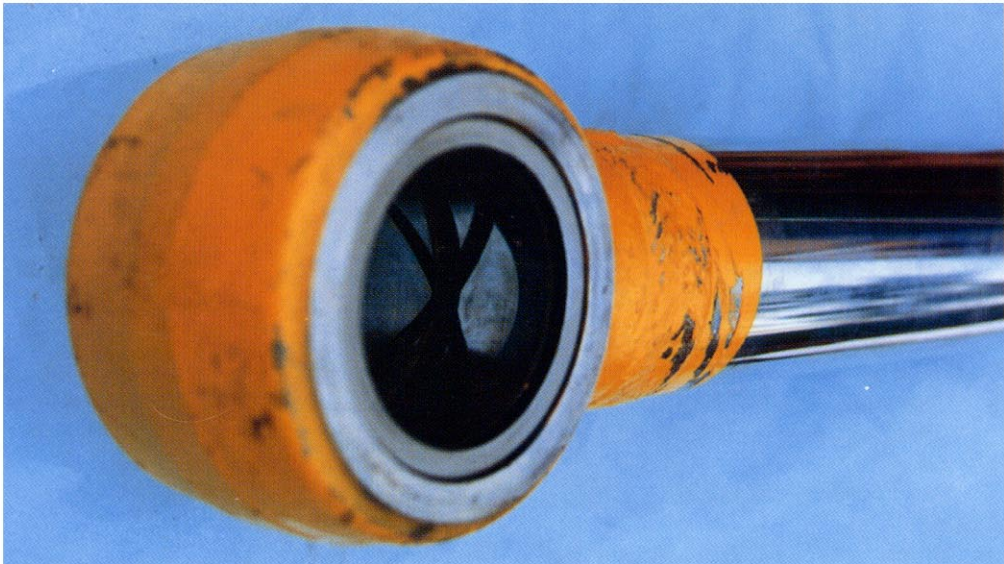
- No scratches, dents, or cracks on the weld at rod end, insertion bushing, outside of rod end, or plating. Good condition.

**Cause**

- Normal

**Piston Rod (Rod end bushing, Weld at rod end, Plating)**

**7**



**Category: A**

**Condition**

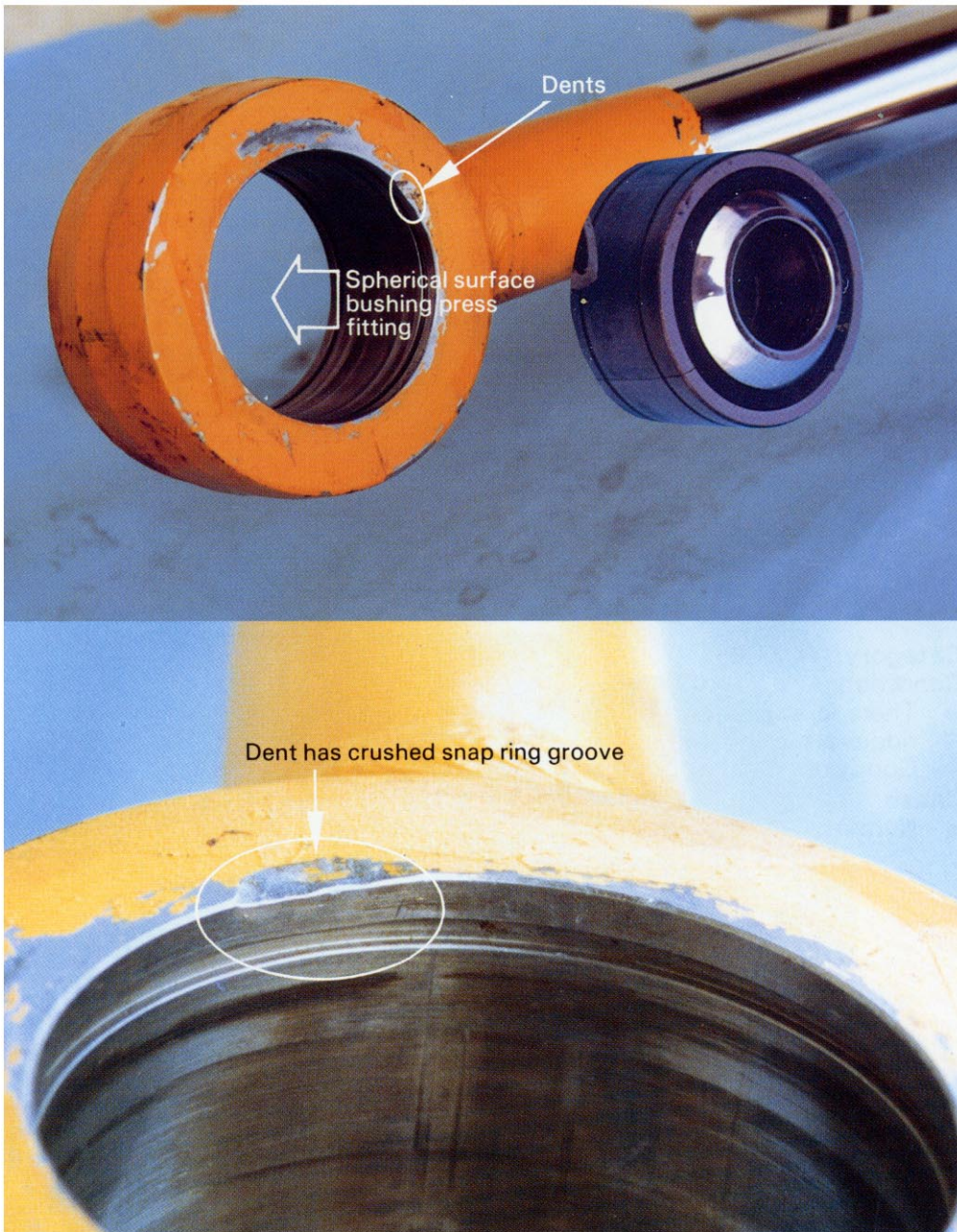
- No scratches, dents, or cracks on the weld at rod end, insertion bushing, outside of rod end, or plating. Good condition.

**Cause**

- Normal

**Piston Rod (Press fitting hole for bushing at rod end)  
(Outside appearance of rod end)**

**8**



**Category: B**

**Condition**

- There is a dent at the press fitting hole for the bushing at the rod end, and the snap ring groove is crushed.  
There are slight longitudinal scratches on the inside surface of the hole.

**Cause**

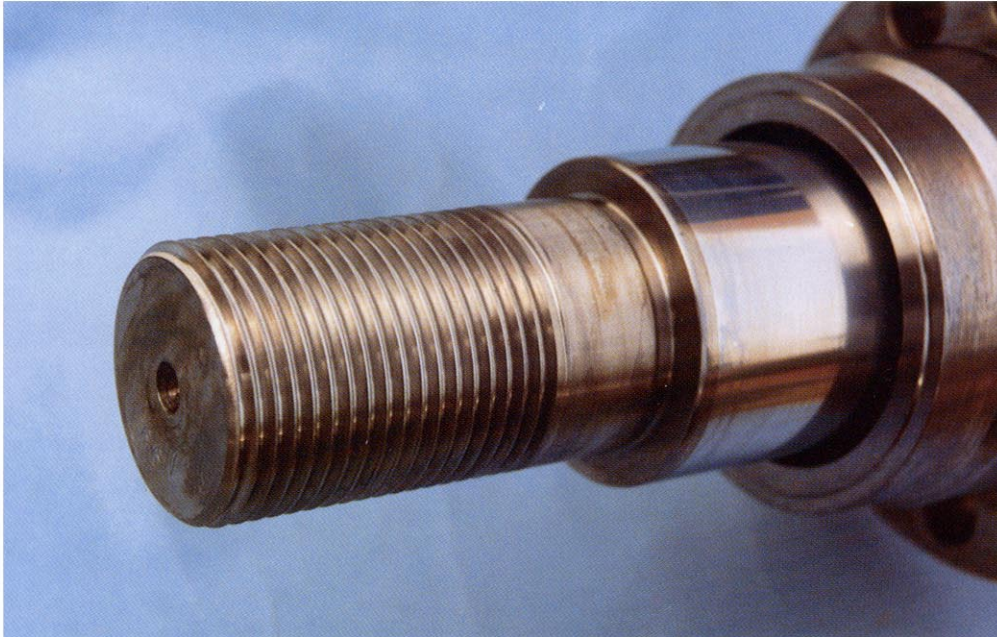
- The dent is probably caused by a mistaken blow when using a hammer in some work.  
The longitudinal scratch on the inside surface of the hole is normal abrasion caused when press fitting or removing the bushing.

**Remedy**

- Repair of dent:  
Remove the protruding part at the main part of the groove and the inside diameter of the hole with a hand tool.  
If the snap ring fits easily into the groove, there is no need to repair the groove.
- Repair of longitudinal scratch:  
Remove the burrs, and rub the main part several times with #180 sand paper to repair.

**Piston Rod (Screw at rod end)**

**9**



**Category: A**

**Condition**

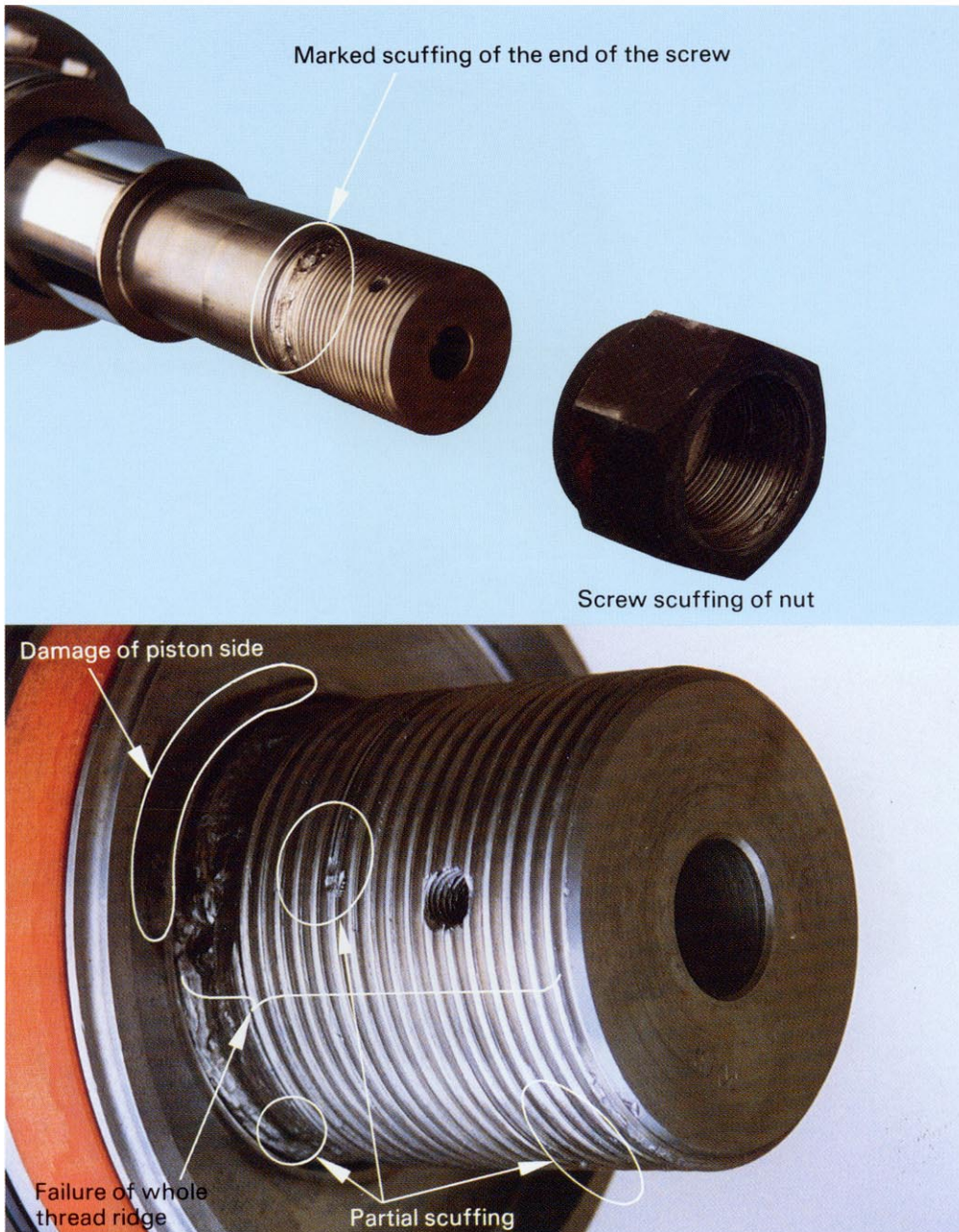
- There is no scuffing of the screw at the rod end, and none of the thread ridges are crushed.  
Good condition.

**Cause**

- Normal

**Piston Rod (Screw at rod end)**

**10**



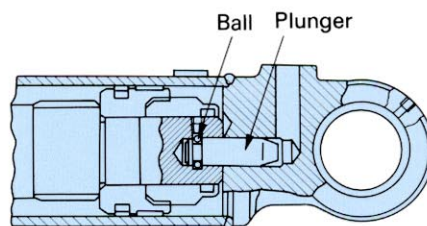
**Category: C**  
**Condition**

- Crushed thread ridges can be seen at various parts of the rod end screw, and there is partial scuffing at the end of the screw at the tip of the rod. In particular, the scuffing of the end of the screw is marked, and the damage extends also to the piston.

**Cause**

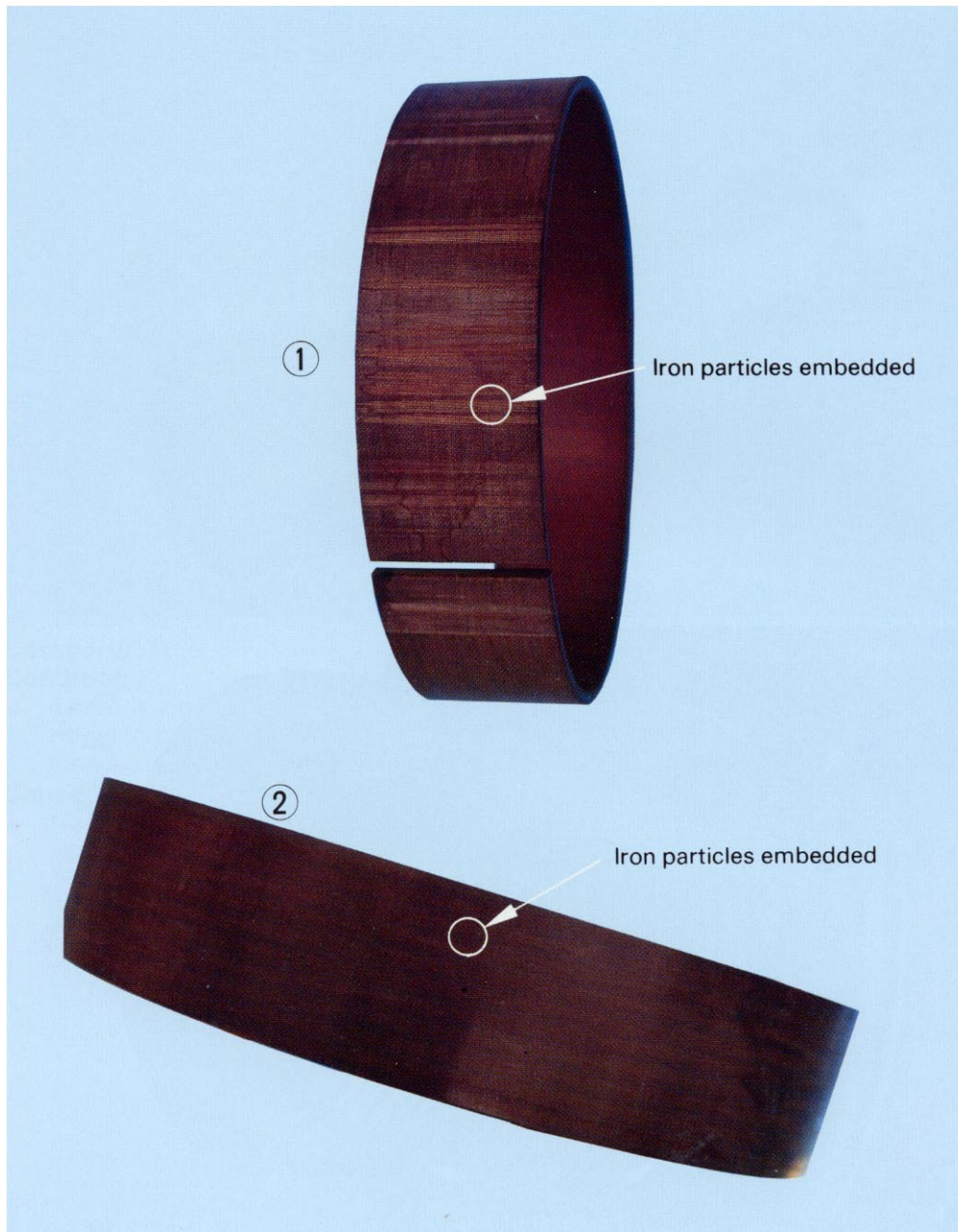
- Mistaken operation. This was probably caused by an abnormality in the assembly operation for the piston, or by an abnormality in the tightening operation. (The piston was fitted half way and then screwed in although it was at an angle)

The photograph shows piston rod with plunger.



## Wear Ring (Sliding surface and outside appearance)

11



### Category: C

#### Condition

- ① There are scratches on the sliding surface and iron particles embedded in the surface that cannot be removed by washing.
- ② At first sight, there seem to be no scratches and the sliding surface can be judged as good, but closer inspection shows that there are fine particles of iron embedded in the surface.

#### Cause

- The scratches in above ① are caused by foreign material getting caught or scuffing of the inside wall of the cylinder.



**Wear Ring (Sliding surface)**

**12**



**Category: C**

**Condition**

- There are many scratches on the sliding surface.

**Cause**

- This is caused by foreign material in the hydraulic oil getting caught.

## Wear Ring, Slipper Seal (Sliding surface)

13



### Category: C

Note: There are cases where the inside of the slipper seal is damaged by air blowing out from the combustion pressure.  
Replace the seal also.

### Condition

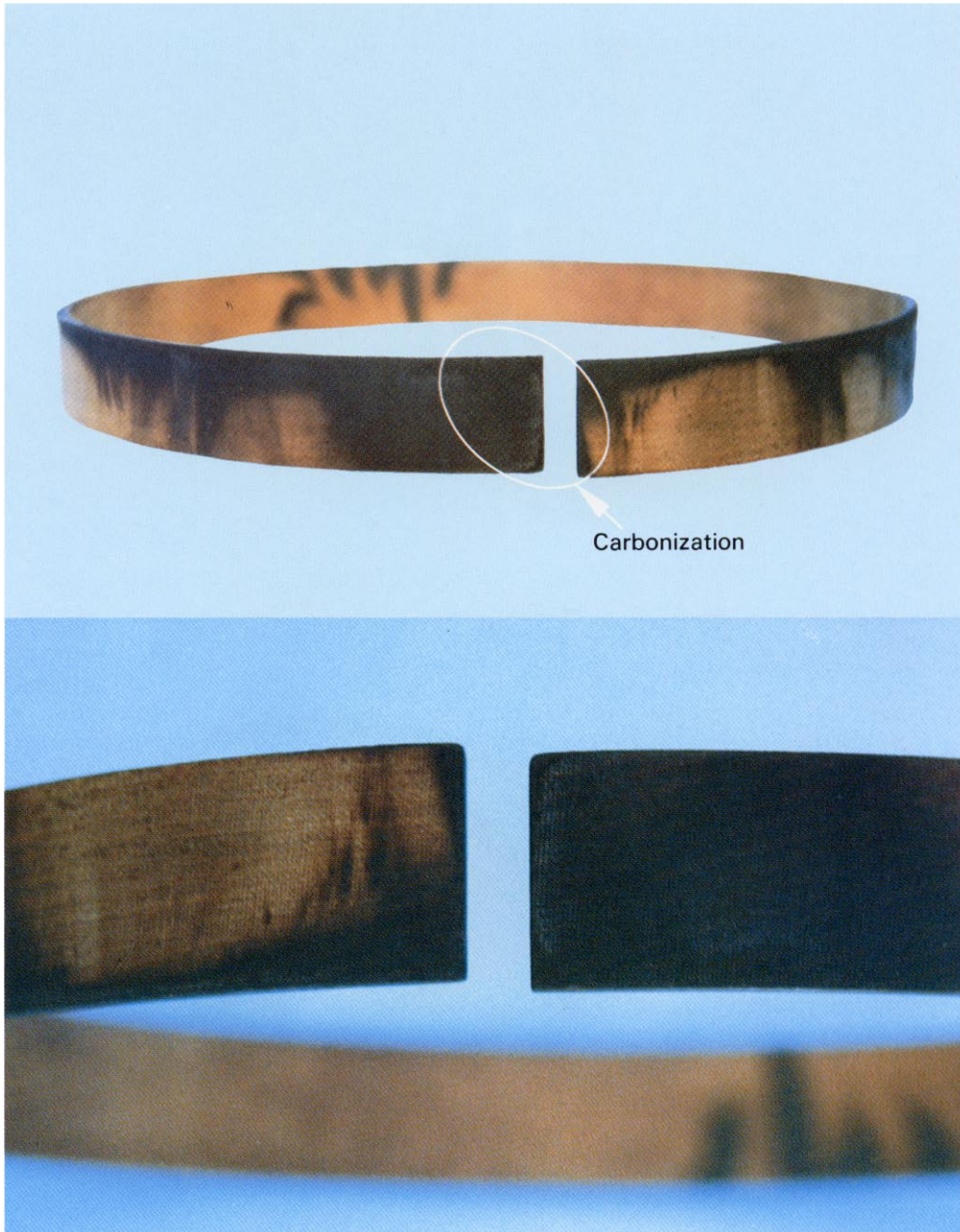
- The upper photograph:  
The wear ring at the front is cracked and failure.  
There is no damage to either the top wear ring or the slipper seal.
- The lower photograph:  
There are traces where the wear ring is burnt black (rear half of upper photograph).

### Cause

- Improper air bleeding (mistake in operation), failure of wear ring caused by impact force from internal explosion.  
Reference: Action was taken quickly, so the only failure was to the wear ring. (Example)

**Wear Ring (Outside appearance)**

**14**



**Category: C**

**Condition**

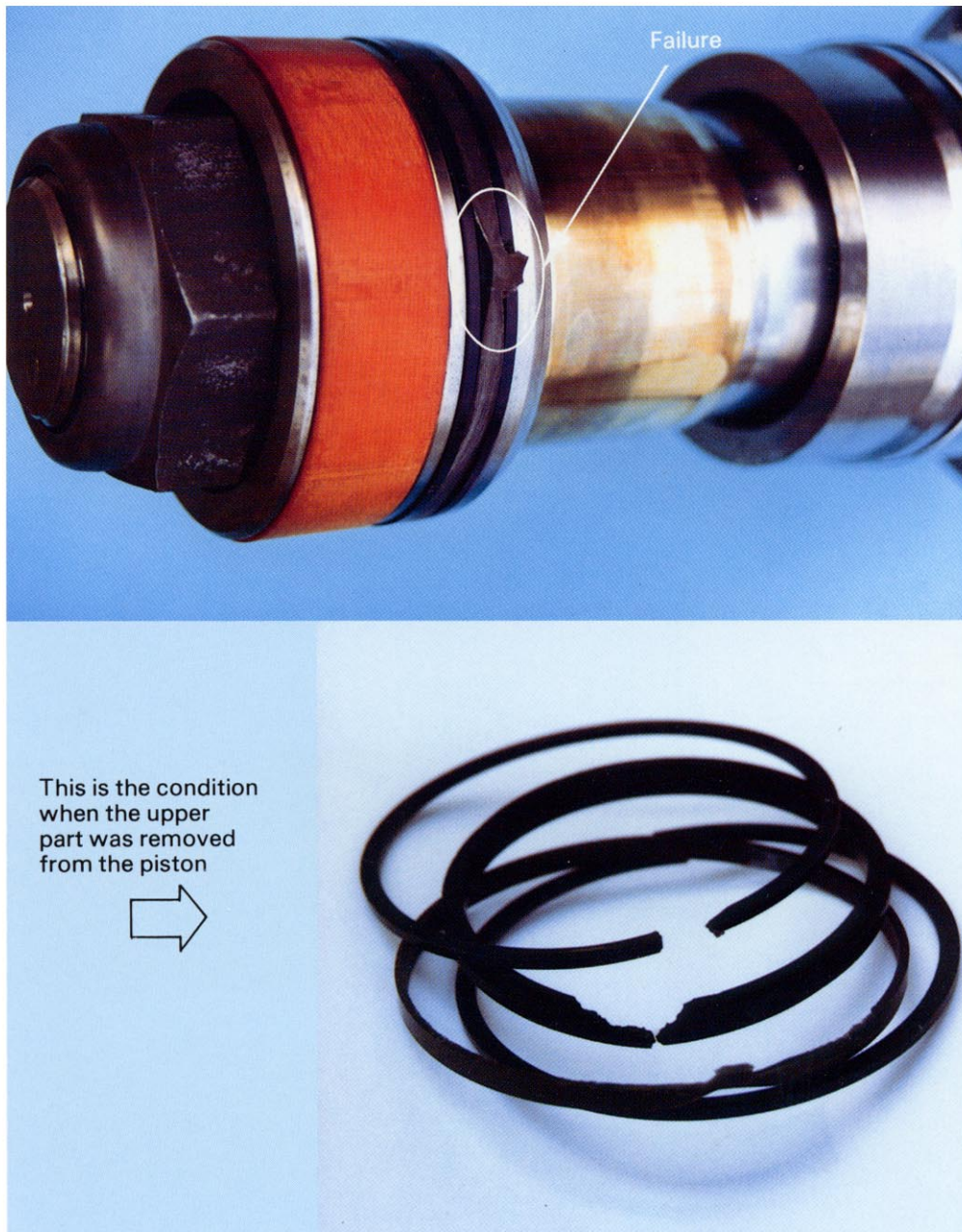
- The whole wear ring is burnt black, and the end gap is carbonized. There are no abrasions or scratches.

**Cause**

- Improper air bleeding has caused an explosion inside the cylinder.

## Slipper Seal (Sliding surface)

15



### Category: C

#### Condition

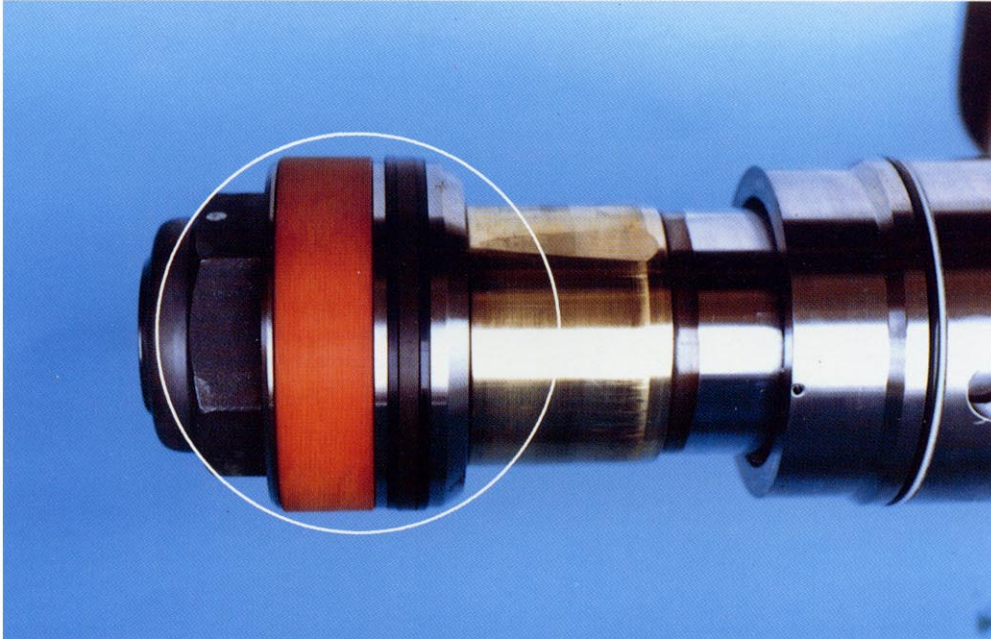
- Because of explosion inside the cylinder, the ring of the slipper seal was protruding like a tongue, and the rubber part of the seal was broken in pieces by the gas going out.  
There is no damage such as burning of the wear ring.

#### Cause

- Explosion inside the cylinder caused by defective bleeding of air.

**Piston (Outside circumference)  
(Including wear ring and slipper seal)**

**16**



**Category: A**

**Condition**

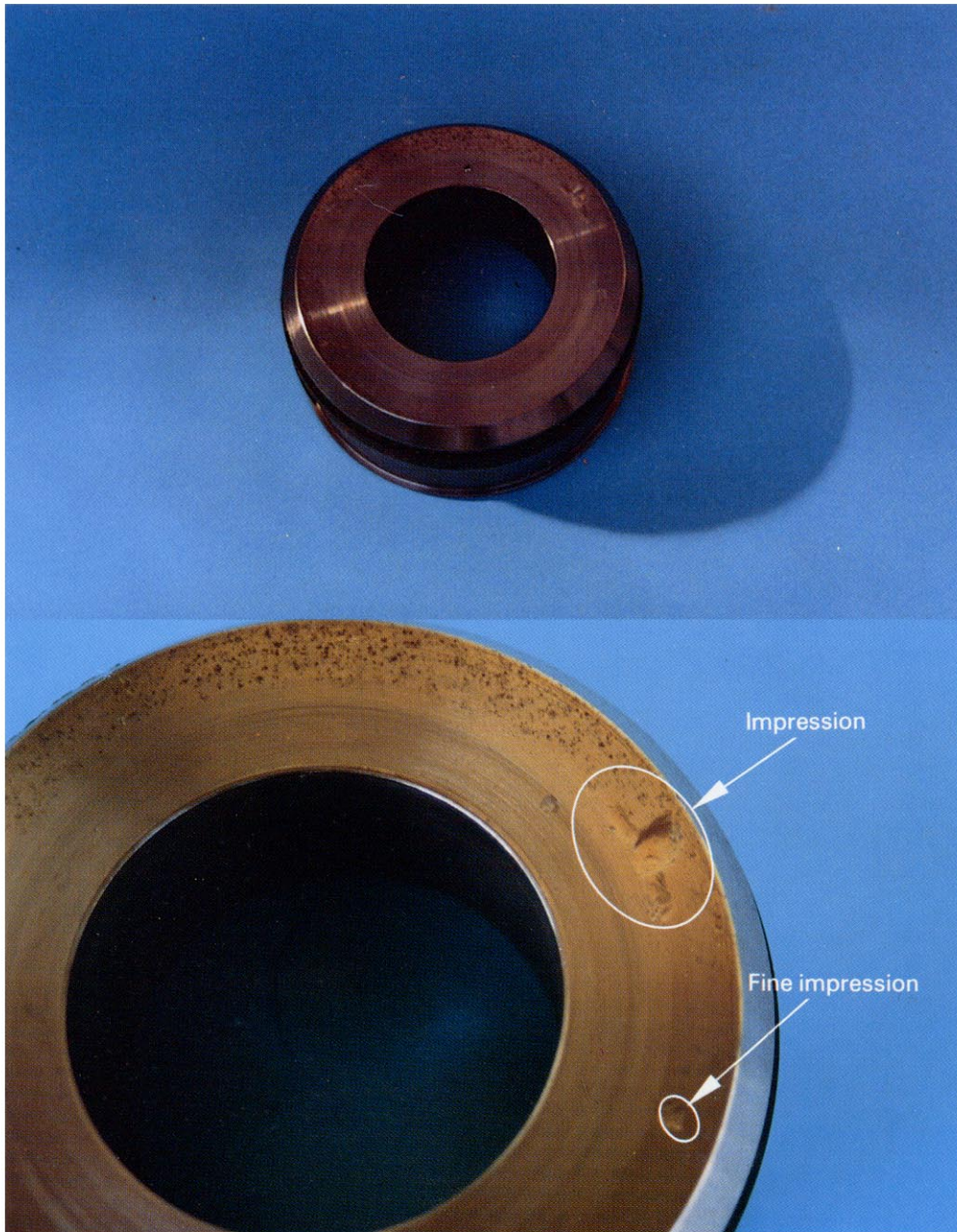
- No abrasions or scratches on the outside circumference of the piston or the wear ring or slipper seal sliding surface.  
Good condition.

**Cause**

- Normal

Piston (Contact surface at head end)

17



**Category: B**

**Condition**

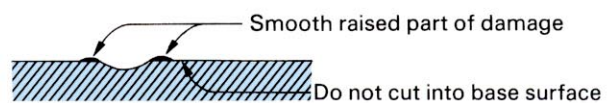
- Impression on contact surface at head end.  
Fine impressions can be seen all over the contact surface.

**Cause**

- Broken pieces were caught between the piston and the cylinder head.

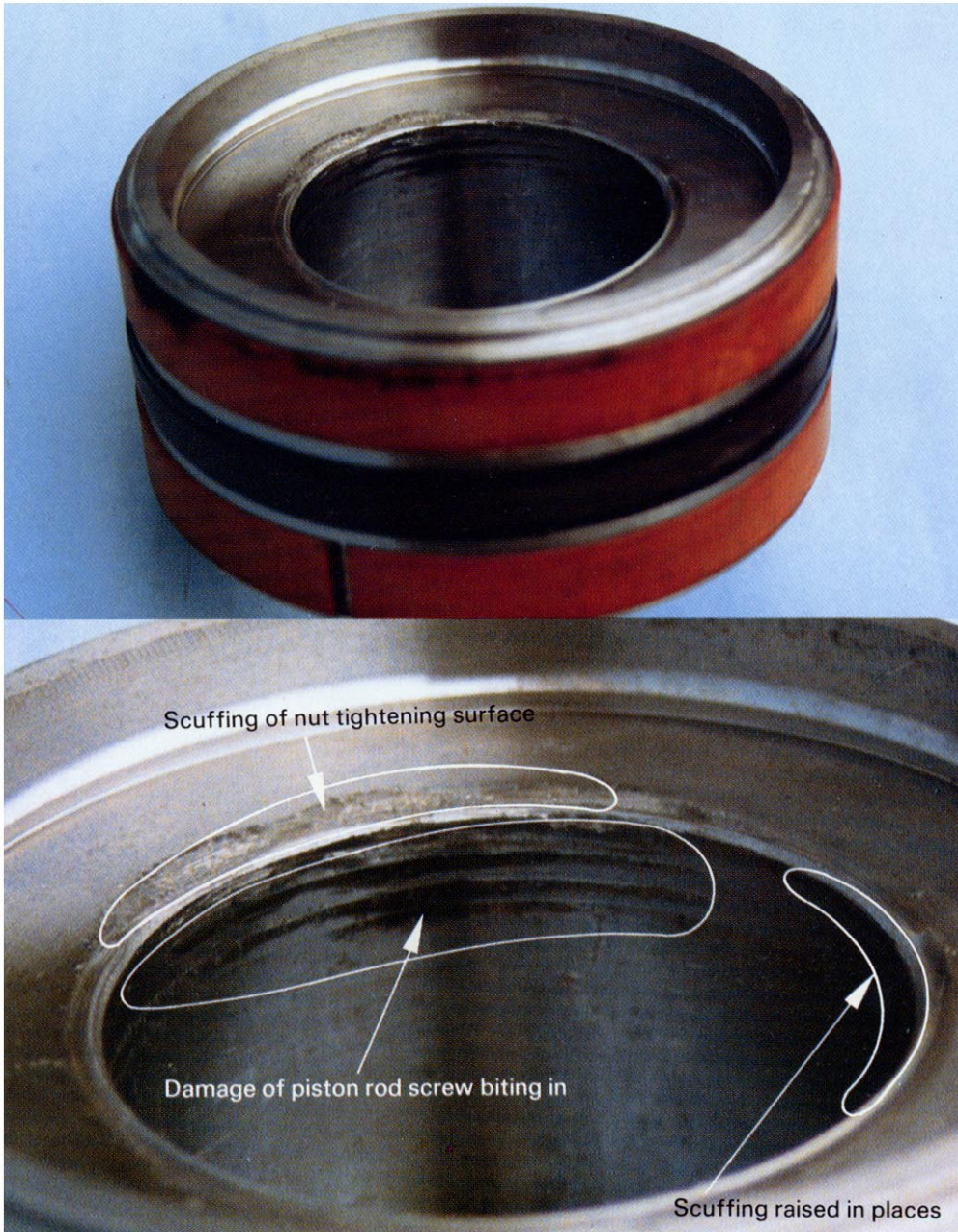
**Remedy**

- Repair the raised part of the surface with a fine file to finish it smooth.



**Piston (Nut tightening surface)**

**18**



**Category: C**

**Condition**

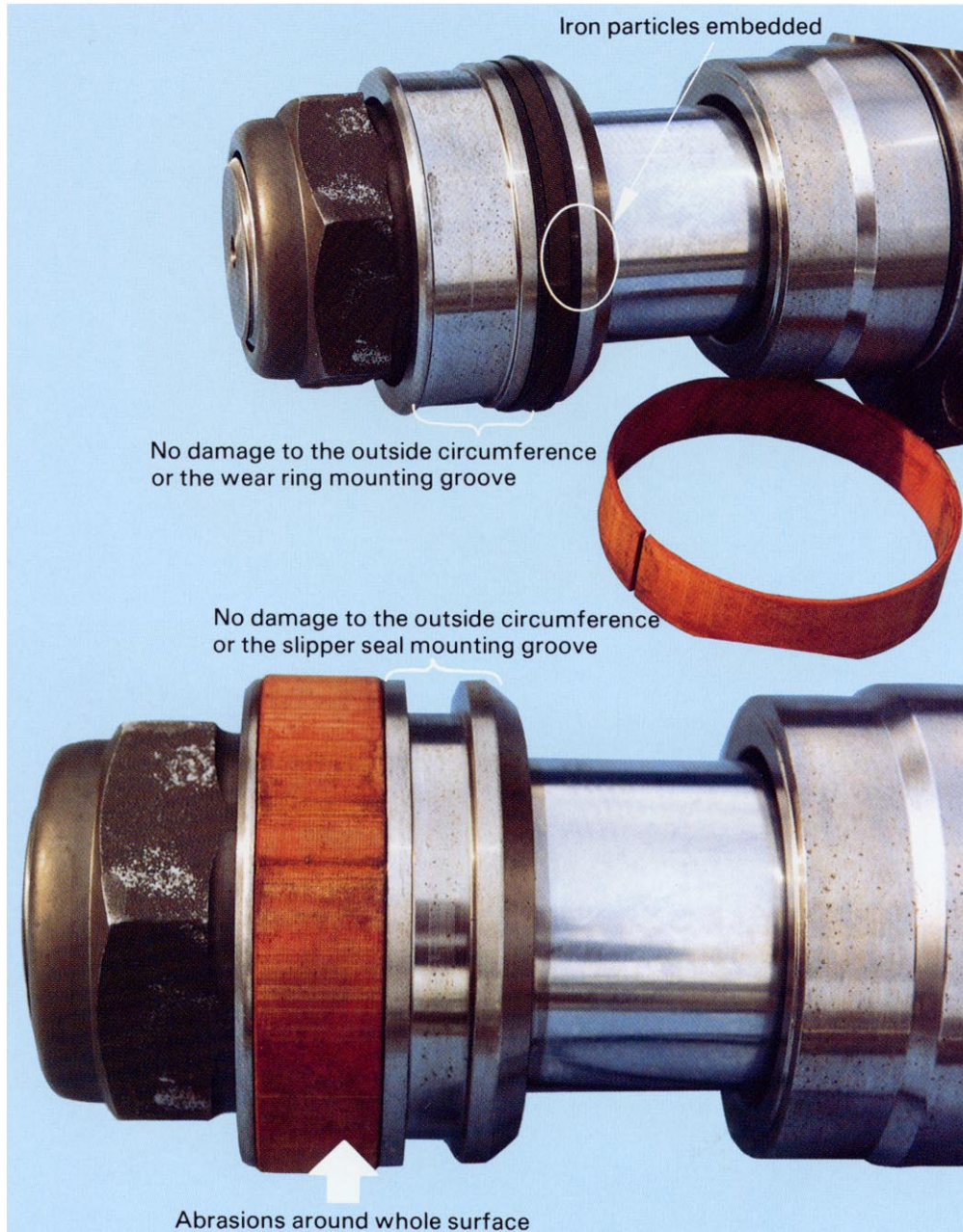
- Scuffing can be seen from the nut tightening surface to the piston rod mounting hole, and the surface is raised in places.

**Cause**

- This was probably caused by a mistake in operation when tightening the piston rod mount.

**Piston (Outside circumference and groove)  
Reference (Wear ring, slipper seal)**

**19**



**Category: A**

★ Replace wear ring and slipper seal.

**Condition**

The upper and lower photographs

Abrasions on wear ring and slipper seal, and iron particles embedded in seal.

- Piston in good condition. No damage to the outside circumference of the piston or the wear ring mounting groove or seal mounting groove. Judging from the scratches on the wear ring and slipper seal, the scuffing on the inside wall of the cylinder is still at an initial stage.

**Cause**

**Reference**

(The cause of the abrasions of the wear ring and slipper seal is dirty oil, or foreign material or metal particles getting caught.)



**Piston (Outside circumference and groove)**

**20**



**Category: C**  
**Condition**

- There are marked deep scratches from the end of the outside circumference of the piston to the wear ring, and they are biting strongly into the wear ring. Compared to the size of the scratches on the piston, the scratches on the wear ring are restricted in size.



The photograph shows piston with piston valve.

**Piston (Outside circumference and groove)**

**21**



**Category: C**

**Condition**

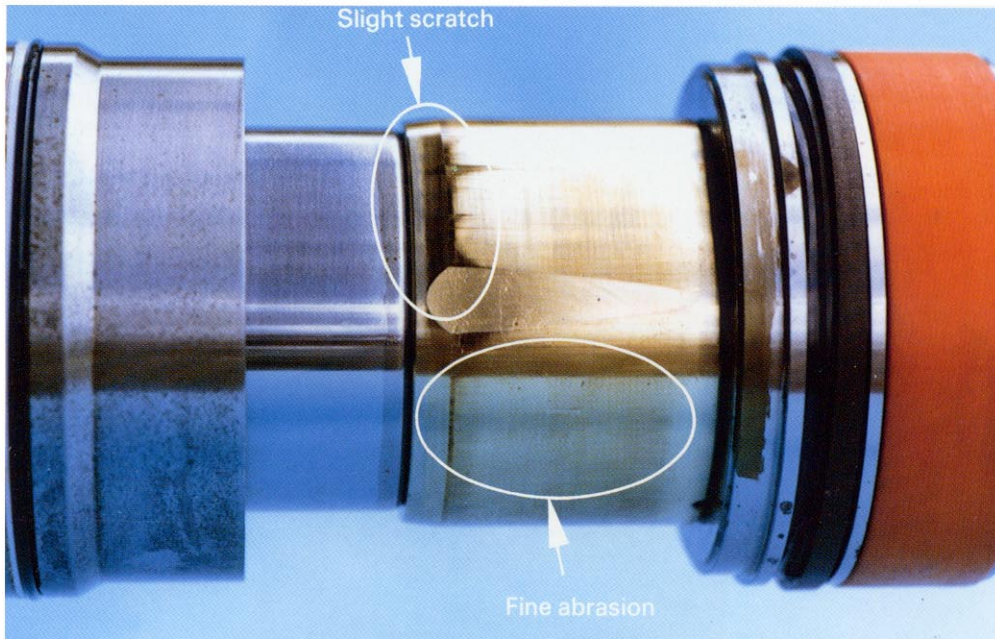
- Marked damage to the outside circumference of the piston and the groove  
The upper photograph:  
Scuffed pieces have bitten into the seal and complete seizure scuffing symptoms have developed.  
The lower photograph:  
The scuffing on the outside circumference has penetrated to the groove.

**Cause**

- Dirt in the hydraulic oil, or metal particles or foreign material getting caught were the main cause, and the wear ring broke, so the piston rod rubbed directly against the cylinder and was seriously damaged.

**Plunger (Outside circumference)**

**22**



**Category: A**

**Condition**

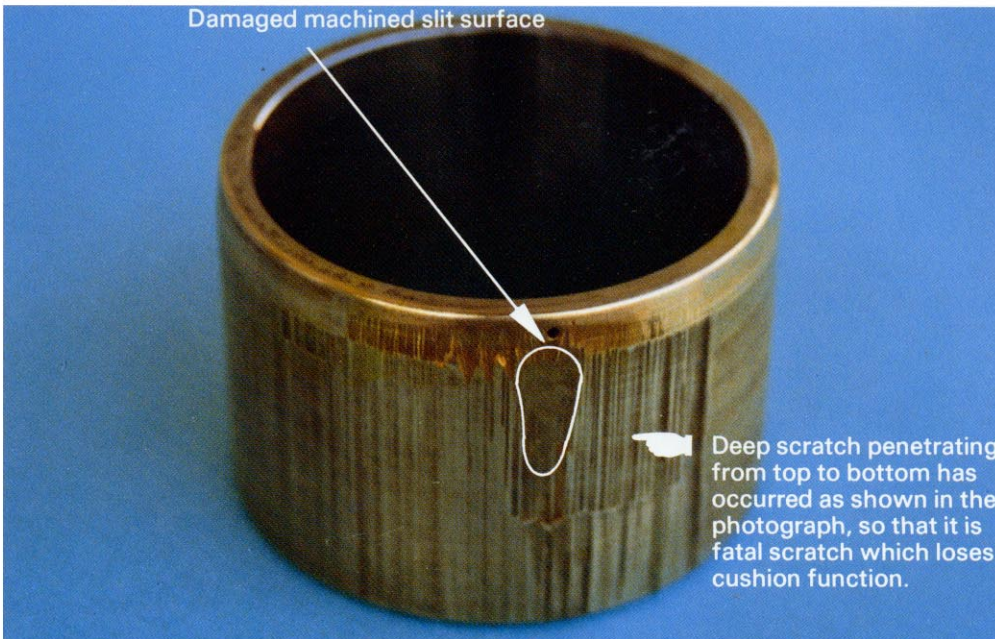
- There are light scratches on the outside circumference end of the plunger, and there are fine abrasions on the bottom half. There are no flashes or burrs on the scratches.

**Cause**

- Foreign material or broken pieces in the hydraulic oil getting caught, or wear of the head insertion bushing, etc.

**Plunger (Outside circumference)**

**23**



**Category: C**

**Condition**

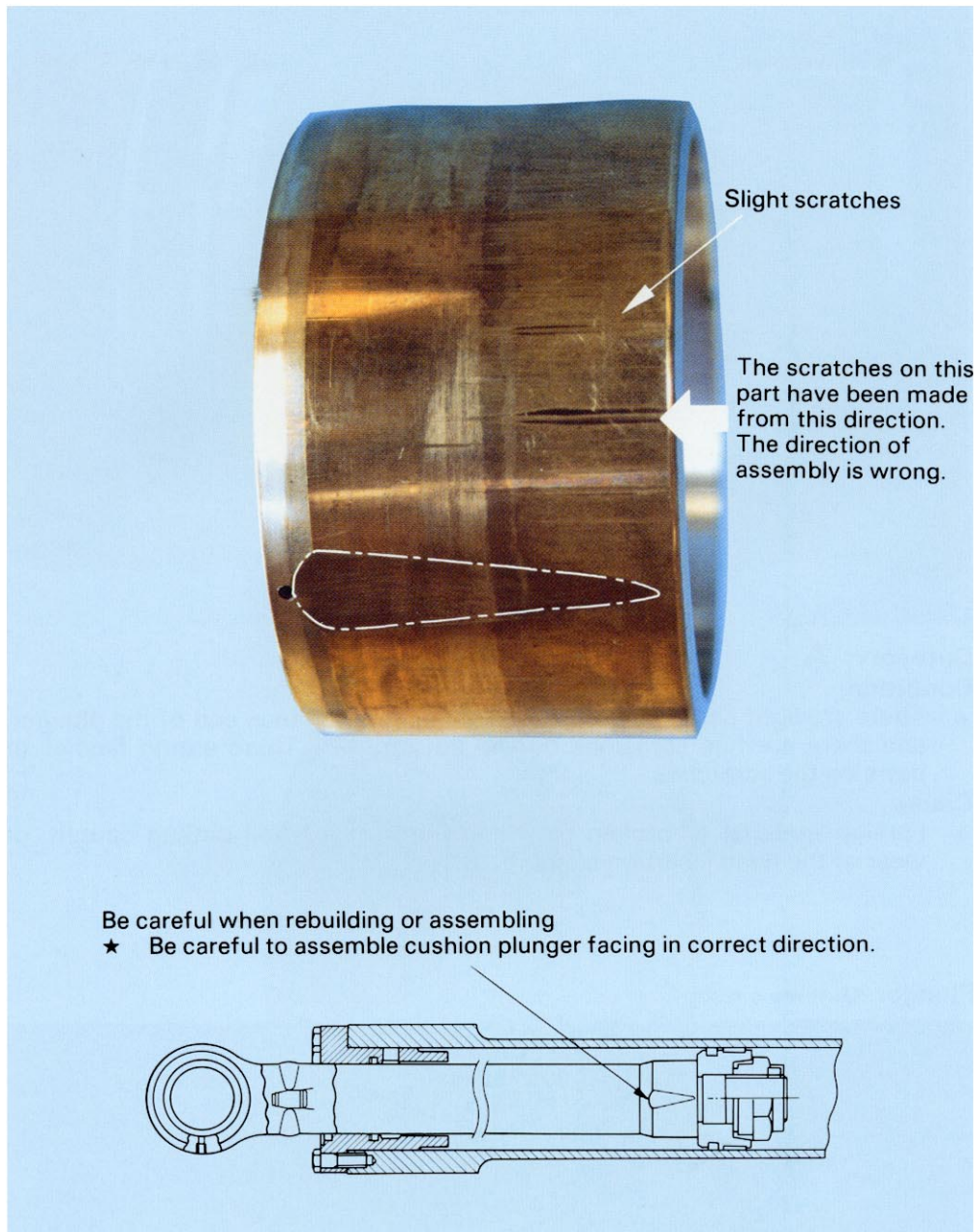
- Marked scratches
- Mating cylinder head also damaged. See page 17.

**Cause**

- Broken pieces due to scuffing of inside surface of cylinder have got caught.

## Plunger (Outside circumference)

24



### Category: B

- ★ Assemble so that wide slit is facing head

### Condition

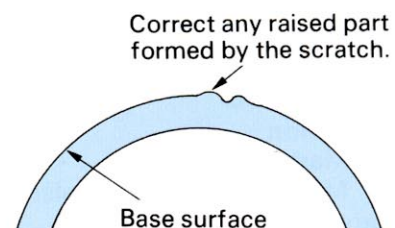
- Fine abrasions and slight scratches on outside circumference of plunger.

### Cause

- Foreign material in hydraulic oil or broken pieces caught between plunger and head.

### Remedy

- If there are burrs or protrusions formed on surface of scratch, use a fine file to lightly rub the raised part and remove the protrusion.
  - ★ Be careful not to cut into the base surface.



# CHECK METHOD FOR INSIDE WALL SURFACE OF CYLINDER TUBE



## INTRODUCTION

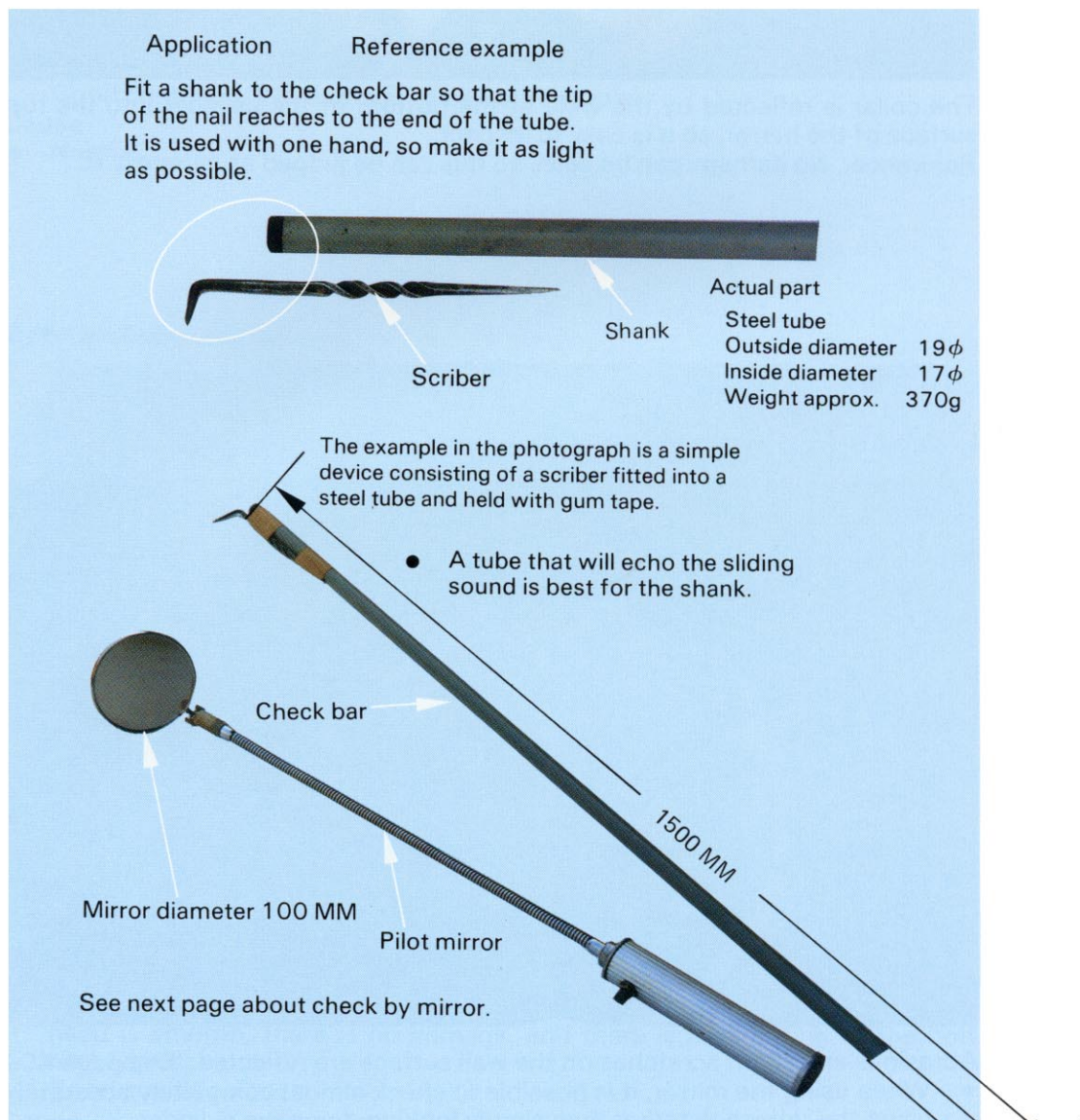
When checking the inside wall of the cylinder tube, point the tube towards natural light or use lighting to examine the inside visually. However, if there are small scratches far inside the tube, it is impossible to check visually and of course such areas cannot be reached easily by hand. For use in such cases, we would like to introduce here a simple check method using visual checks and feeling which can be used in the same way as feeling checks using fingertips or fingernails. Consider what happens in the following situations.

- (1) Hold a nail or pointed object perpendicular to a highly polished surface and slide the nail in any direction.
- (2) Hold the nail perpendicular to the surface of a record and pull it at right angles across the record grooves.

In case (1), there is a smooth feeling as the nail slides without any resistance, but in case (2), a grating sound can be heard, and an unpleasant resistance can be felt.

Use this principle to check the inside of the cylinder. The inside wall of the cylinder tube is polished smooth, so the pointed object catches in any scratch and this can be felt by the person checking.

## Applicable Example (Inspection by check bar)



## Check Method

Hold the check bar in one hand, move it up the cylinder along the inside wall of the cylinder tube swinging the check bar like the pendulum of a clock, and gradually move to check the surface. Push only with the weight of the bar, do not add any force.

# CHECK by PILOT MIRROR

Example of inside wall check of cylinder bottom

25

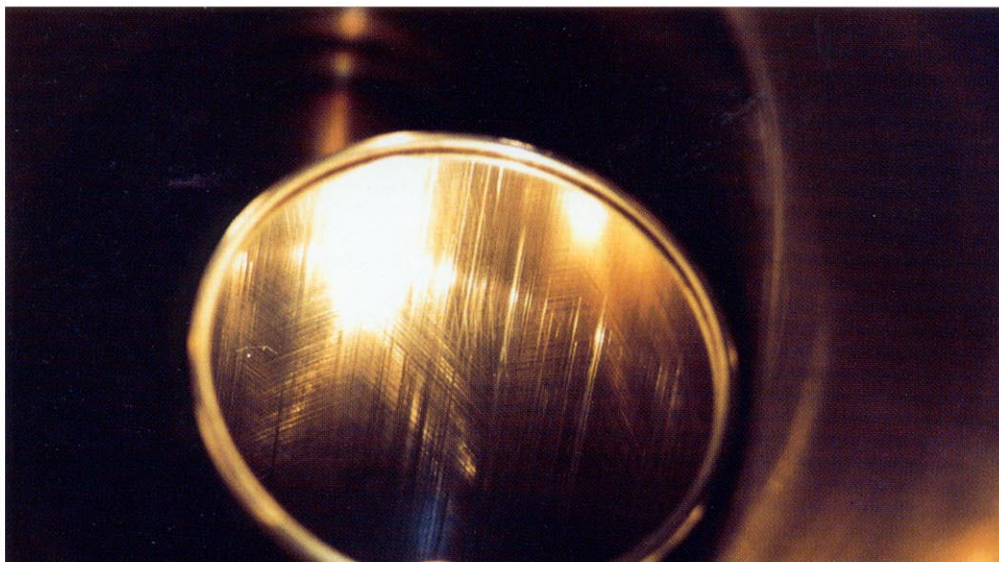


The collar is reflected by the weld at the bottom of the cylinder into the top surface of the mirror, so it is easy to inspect.

Reference: No damage can be seen, so this can be judged as category A.

Example of inside wall check of cylinder tube intermediate portion

26

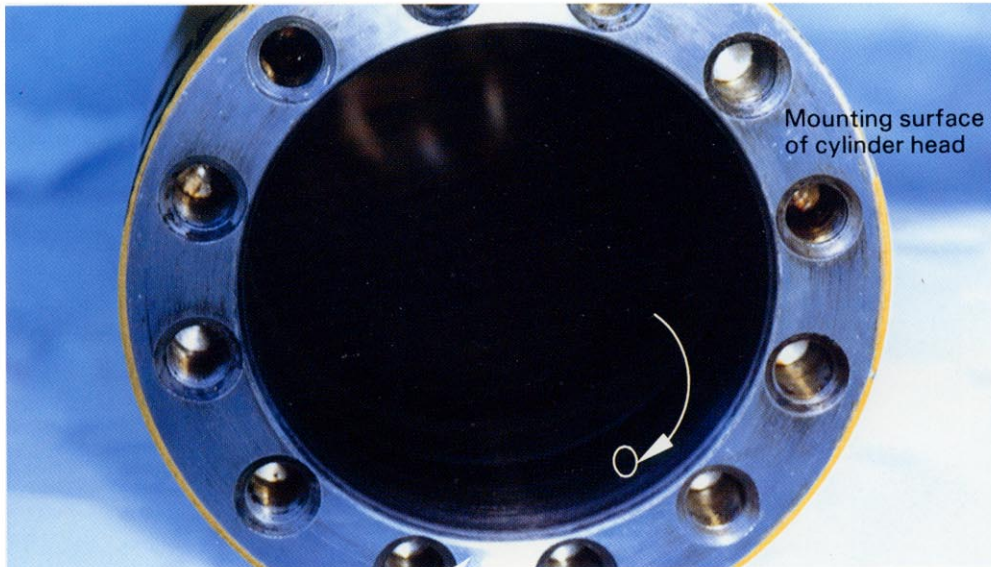


Abrasions and slight scratches on the wall surface are reflected. (See page 40.)

★ When using the mirror, it is possible to check almost completely accurately using the reflection rather than simply looking down the cylinder.

Cylinder Tube (Flange)

27



**Category: A**

**Condition**

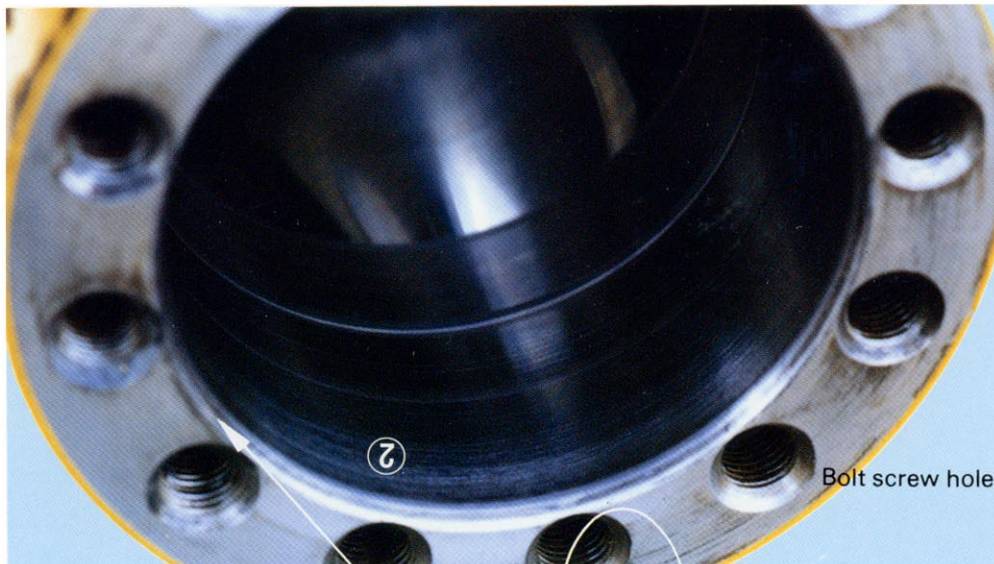
- There are no dents and impressions on mounting surface of cylinder head. Good condition. (No damage of bolt screw hole)

**Cause**

- Normal

Cylinder Tube (Flange)

28



**Category: A**

**Condition**

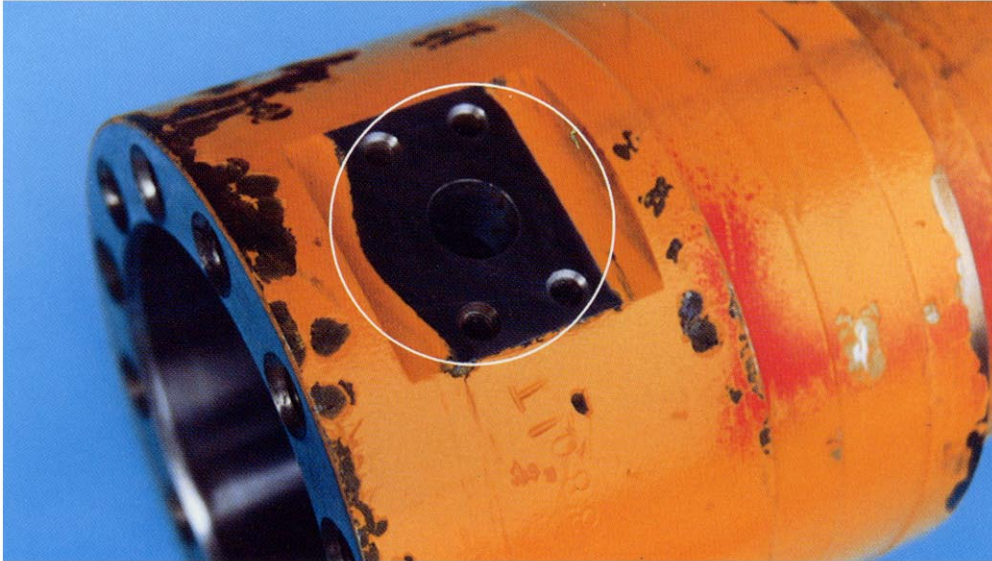
- The mounting engagement portion (O ring contact surface) of the cylinder head is smooth, there is no damage, and there is no scuffing of the bolt hole screw. Good condition.

**Cause**

- Normal

**Cylinder Tube (Mounting surface of piping)**

**29**



**Category: A**

**Condition**

- There is no damage such as dents or impressions on the piping flange mounting surface (O-ring mounting surface), and the surface is smooth. Good condition.

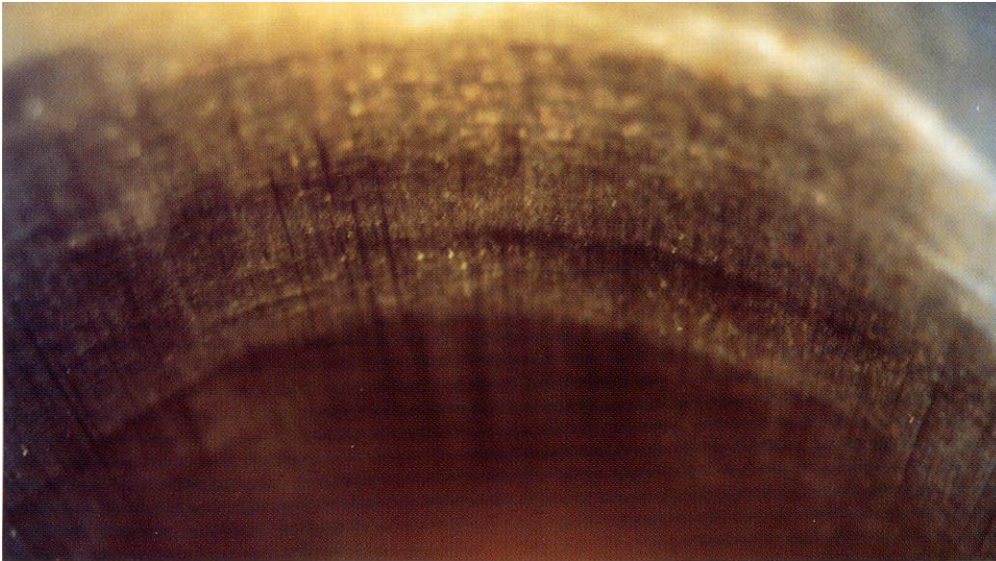
**Cause**

- Normal



**Cylinder Tube (Inside wall)**

**30**



**Category: A**

**Condition**

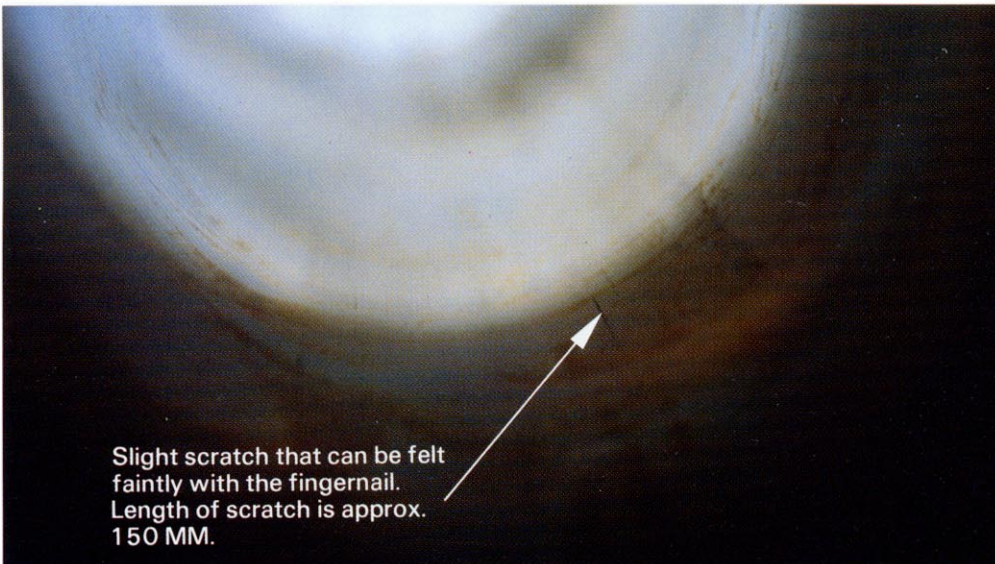
- Vertical stripes and arc-shaped traces of rubbing can be seen on the inside wall of the cylinder tube caused by the sliding of the wear ring. However, no damage can be felt when checking by rubbing with the fingertip or feeling with the fingernail.  
Good condition.

**Cause**

- Normal

**Cylinder Tube (Inside wall)**

**31**



**Category: B**

**Condition**

- When carrying out the feeling check, a shallow scratch in one place on the inside wall of the cylinder tube catches the fingernail.  
Good condition.

**Cause**

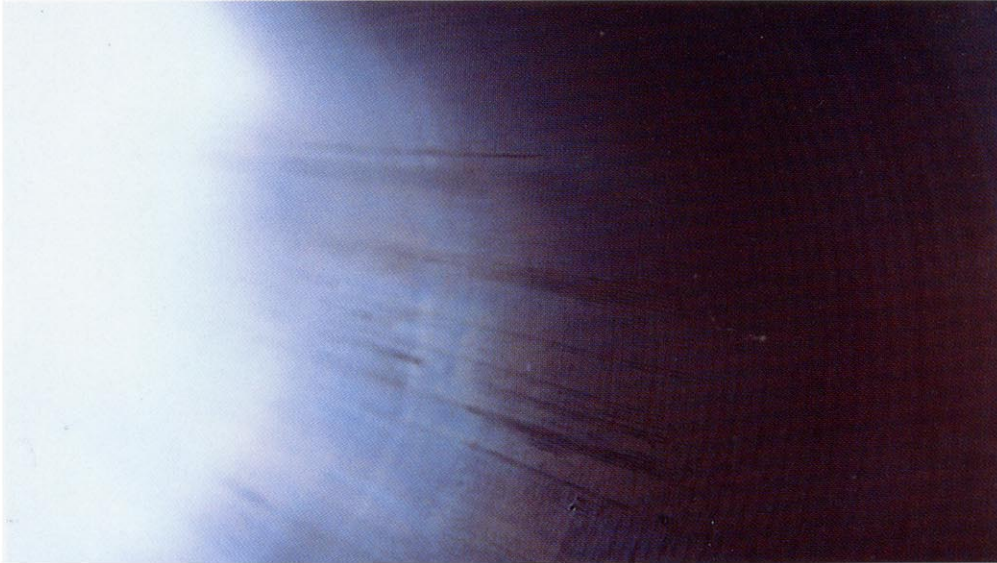
- Foreign material getting caught

**Remedy**

- Using the corner of a fine oil stone, rub carefully several times along the longitudinal scratch, then polish several times along the scratch with #800 sand paper. (Avoid as far as possible touching any area apart from the damaged area.)

Cylinder Tube (Inside wall)

32



**Category: C**

**Condition**

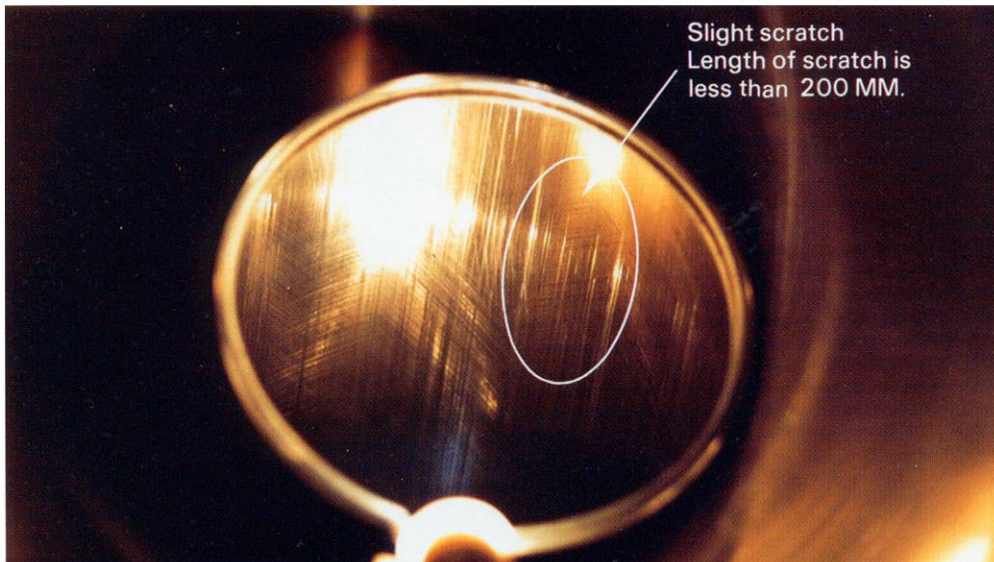
- There are many streaked scratches on the inside wall of the tube, and at the front, there is an impression caused by a granular shaped piece of foreign material getting caught.

**Cause**

- Contamination of hydraulic oil and foreign material getting caught.

Cylinder Tube (Inside wall)

33



**Category: B**

- ★ Note: If the damage at the end of the cylinder tube cannot be corrected by polishing with an oil stone or sandpaper, place in category **C**.

**Condition**

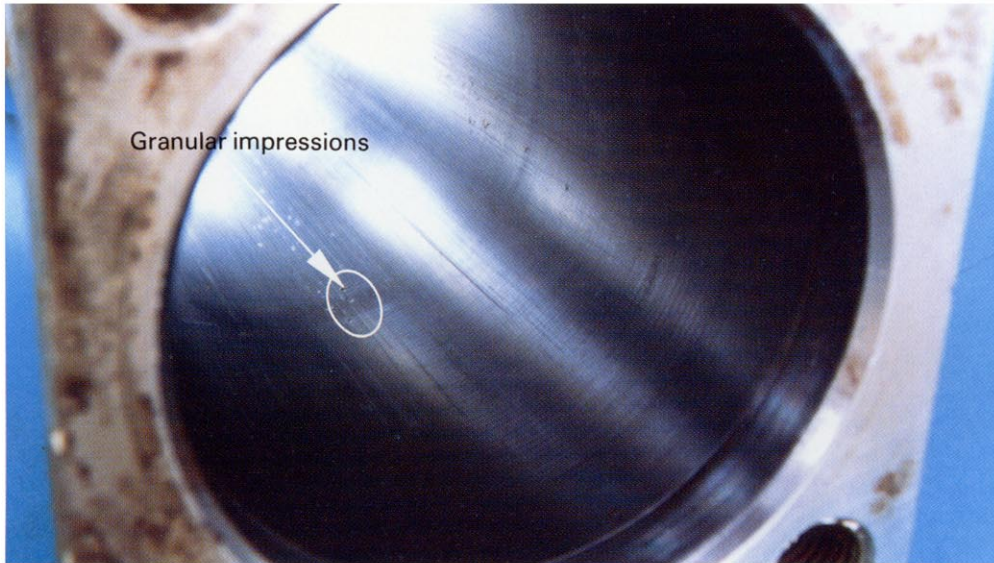
- Abrasions and slight scratches seen by the pilot mirror on the inside wall. (The striped pattern is the grain made by polishing when machine finishing.)

**Cause**

- Contamination of hydraulic oil and foreign material getting caught.

**Cylinder Tube (Inside wall)**

**34**



**Category: C**

**Condition**

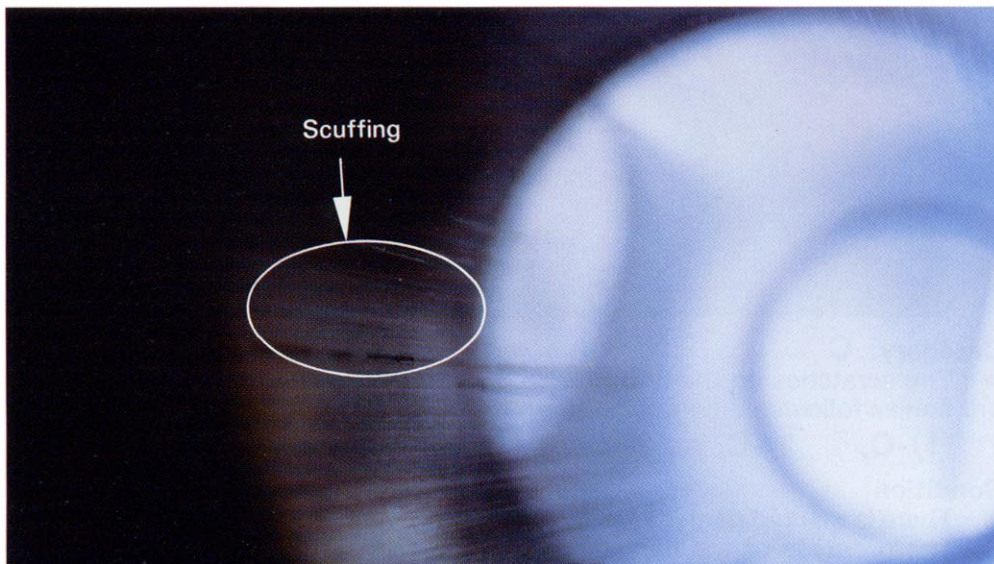
- On the inside wall of the tube, there are abrasions, scratches, and also granular impressions. The scratches start from the impression.

**Cause**

- Foreign material and metal particles getting caught.

**Cylinder Tube (Inside wall)**

**35**



**Category: C**

Note: If there is scuffing, the parts cannot be reused

**Condition**

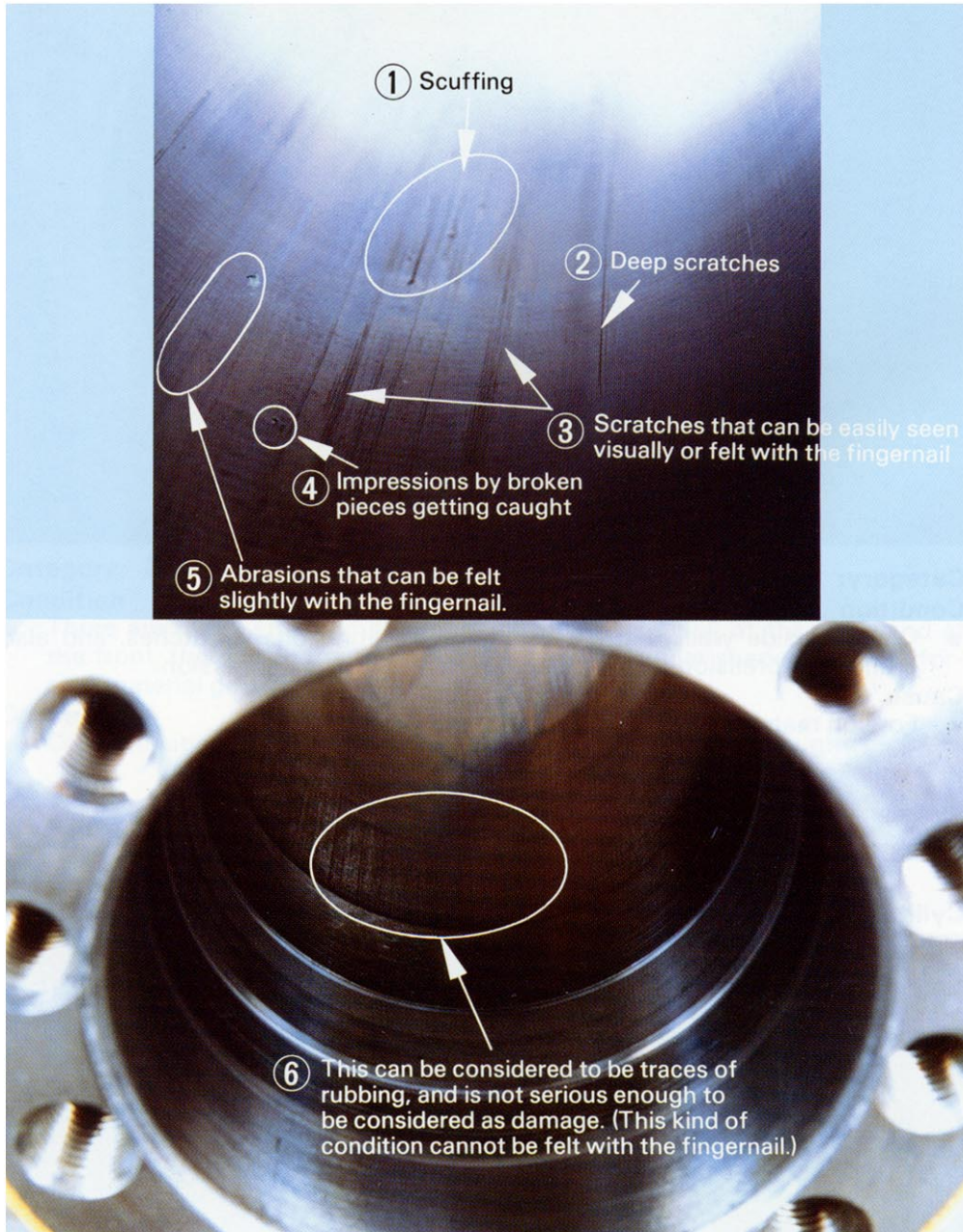
- There are abrasions and scratches on the whole inside wall of the tube, and several lines of scuffing can be seen.

**Cause**

- Contamination of hydraulic oil
- Foreign material and metal particles getting caught

## Cylinder Tube (Inside wall)

36



### Category: C

★ The scratches on the photograph can be judged according to their condition as follows.

① -C, ② -C, ③ -C, ④ -B, ⑤ -B, ⑥ -A

### Condition

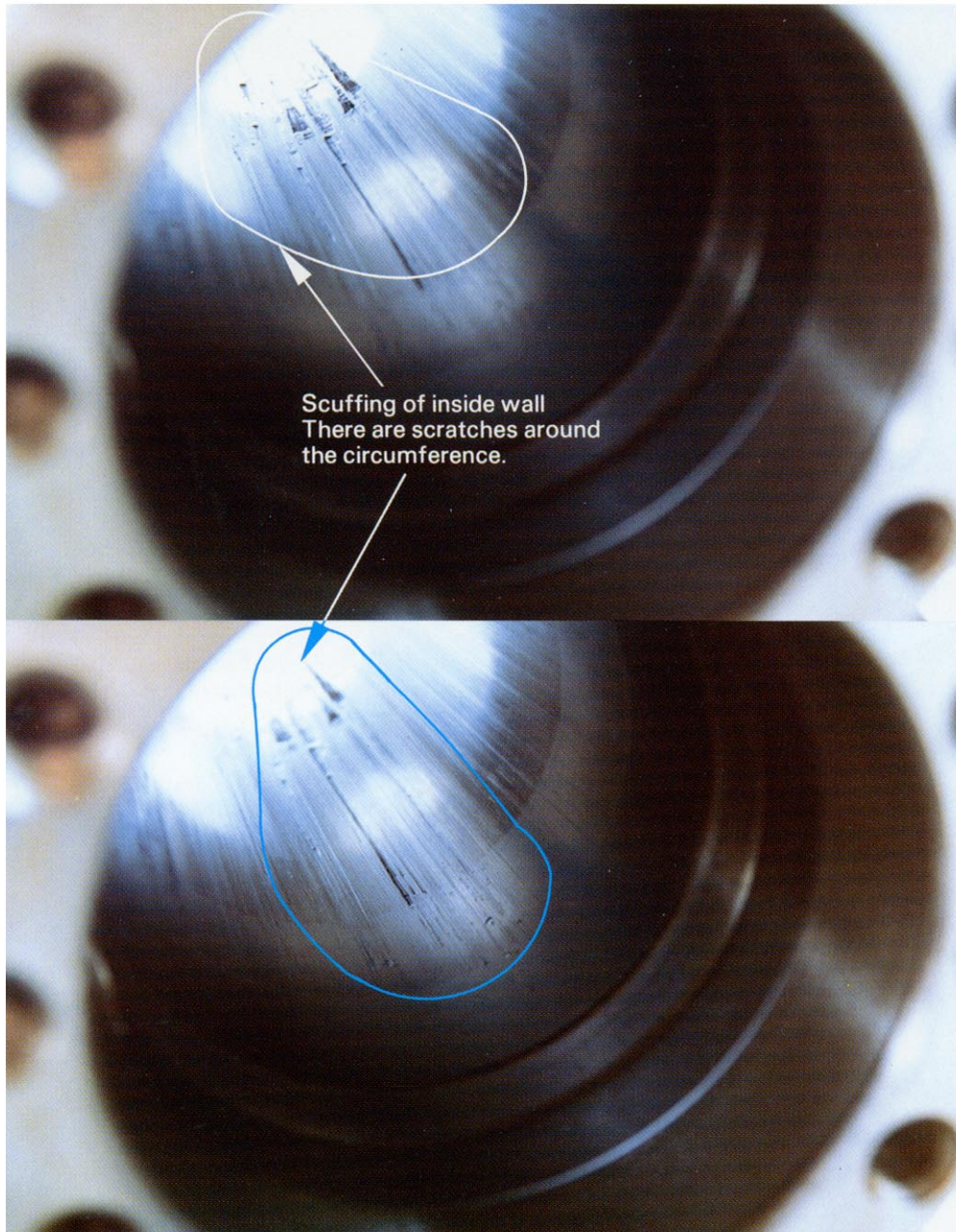
- There is marked damage to the inside wall of the cylinder tube. The progress of the damage can be seen from abrasions, scratches, impressions caused by pieces getting caught, and scuffing.

### Cause

- Contamination of hydraulic oil
- Foreign material mixed into oil getting caught

## Cylinder Tube (Inside wall)

37



**Category: C**

### Condition

- There are scratches and marked scuffing on the whole inside wall of the cylinder tube.

### Cause

- Foreign material getting caught into hydraulic oil.
- ★ The upper and lower photographs show the same part.  
(The photographs were taken from 2 focuses each other.)

Cylinder Tube (Inside wall)

38



**Category: C**

**Condition**

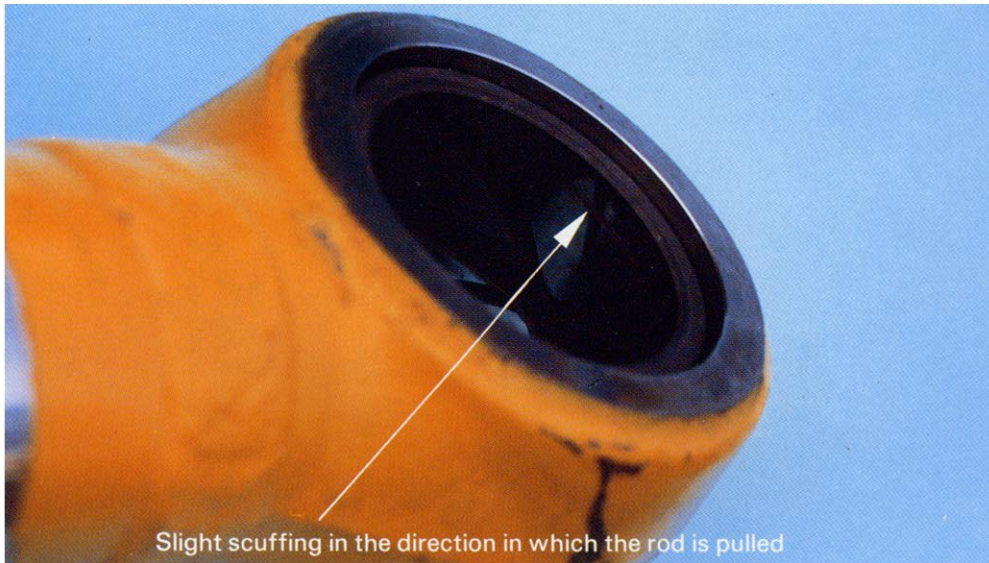
- Marked scuffing of inside wall
- There is marked scuffing on one side of the inside wall at the center of the cylinder, and the damage extends to the bottom of the cylinder.

**Cause**

- Metal particles getting caught

**Bushing (Inside diameter of rod end bushing)**

**39**



**Category: B**

Note: Remove the seizure from the mating pin also when correcting

**Condition**

- Scuffing caused by slight seizure in the rod return load direction from the seal on the inside diameter of the bushing (initial scuffing).

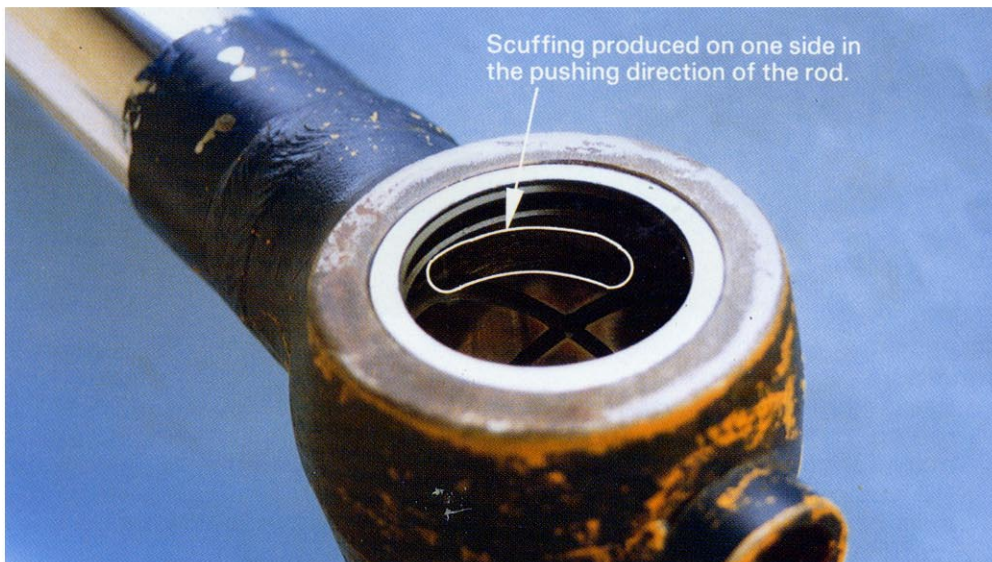
**Cause** ● Loss of oil film due to lack of grease

**Remedy**

- If there is any rise in the surface caused by seizure, grind the protruding part on the inside diameter carefully with a pencil grinder.

**Bushing (Inside diameter of rod end bushing)**

**40**



**Category: B** Note: Replace the mating pin

**Condition**

- There is scuffing caused by seizure in the pushing rod direction of the rod on the inside diameter of the bushing. (Good condition. No damage to dust seal lip.)

**Cause** ● Loss of oil film due to lack of grease

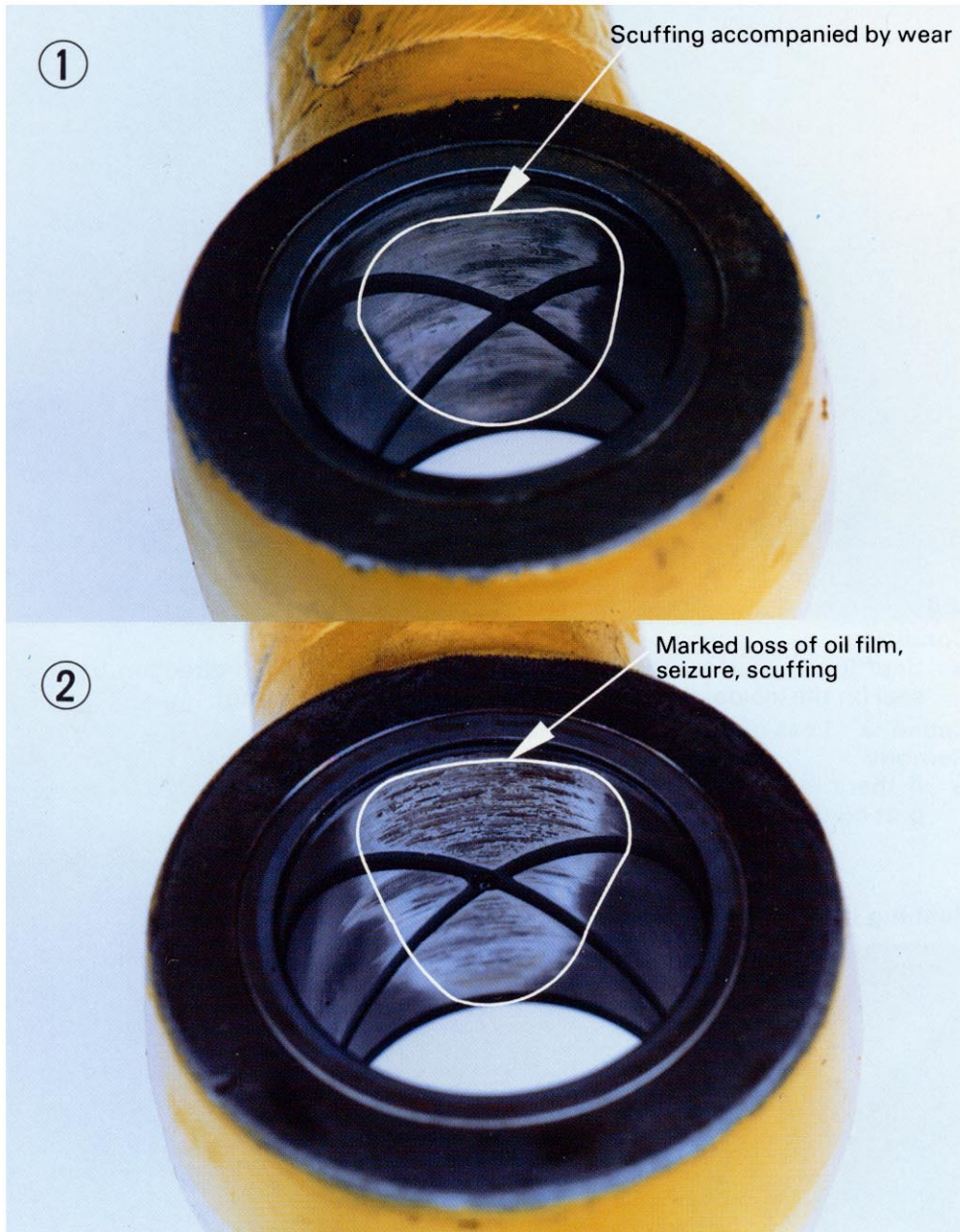
**Remedy**

- Remove the raised part caused by seizure on the inside diameter of the bushing by grinding the main parts carefully with a pencil grinder.

Note: In the case of this example, it was considered that there was excessive damage caused by seizure of the mating pin, so judgment was made assuming that the pin was replaced.

## Bushing (Inside diameter of rod end bushing)

41



### Category: C

#### Condition

- Scuffing has been caused by seizure in the pushing load direction of the rod on the inside surface of the bushing. The scuffing in photograph ② is more serious than that in photograph ①. The grease film in photograph ① was probably maintained better than in photograph ②. However, the main parts have been worn by being polished with iron particles caused by scuffing.

#### Cause

- Loss of oil film due to lack of grease



## Bushing (Rod end bushing)

42



### Category: C

#### Condition

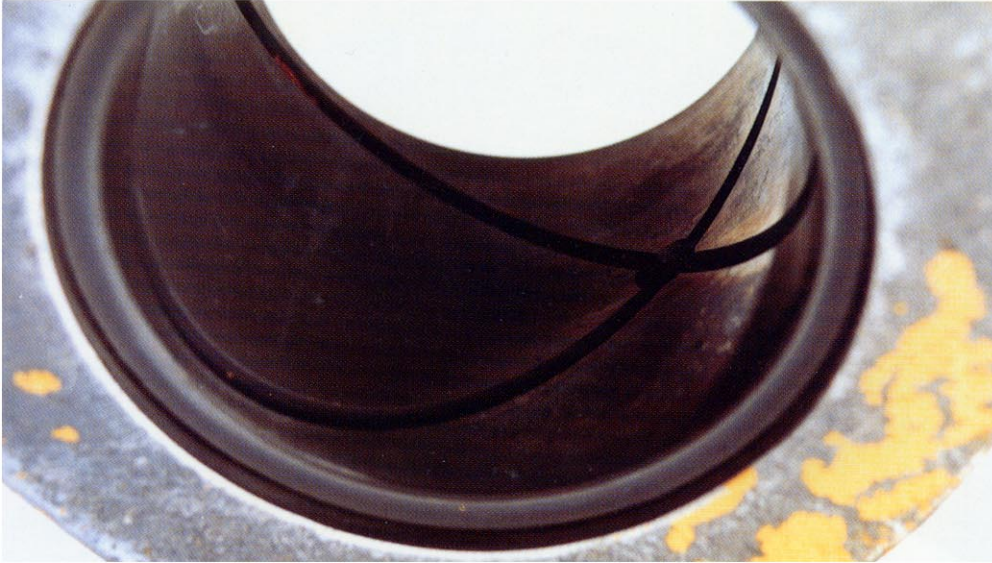
- Scuffing caused by marked seizure on one side of inside diameter of rod end bushing
  - ★ Replace after removing the bushing from the rod.

#### Cause

- Loss of oil film due to improper greasing maintenance.
  - ★ Check if the one-sided contact is caused by the simple one-sided scuffing, or if it is caused by curvature of the rod or an abnormality in the mating part.

**Bushing (Cylinder bottom)**

**43**



**Category: A**

**Condition**

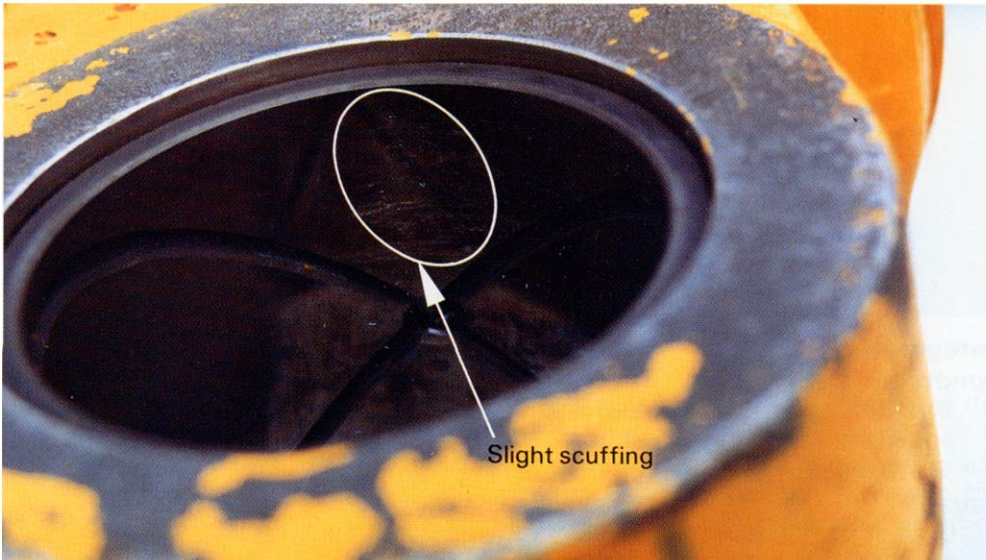
- No seizure, scuffing and scratches on inside surface of bushing. Good condition.

**Cause**

- Normal

**Bushing (Cylinder bottom)**

**44**



**Category: B**

**Condition**

- Slight scuffing of the inside surface of the bushing in the load direction when the cylinder is pushing out.

**Cause**

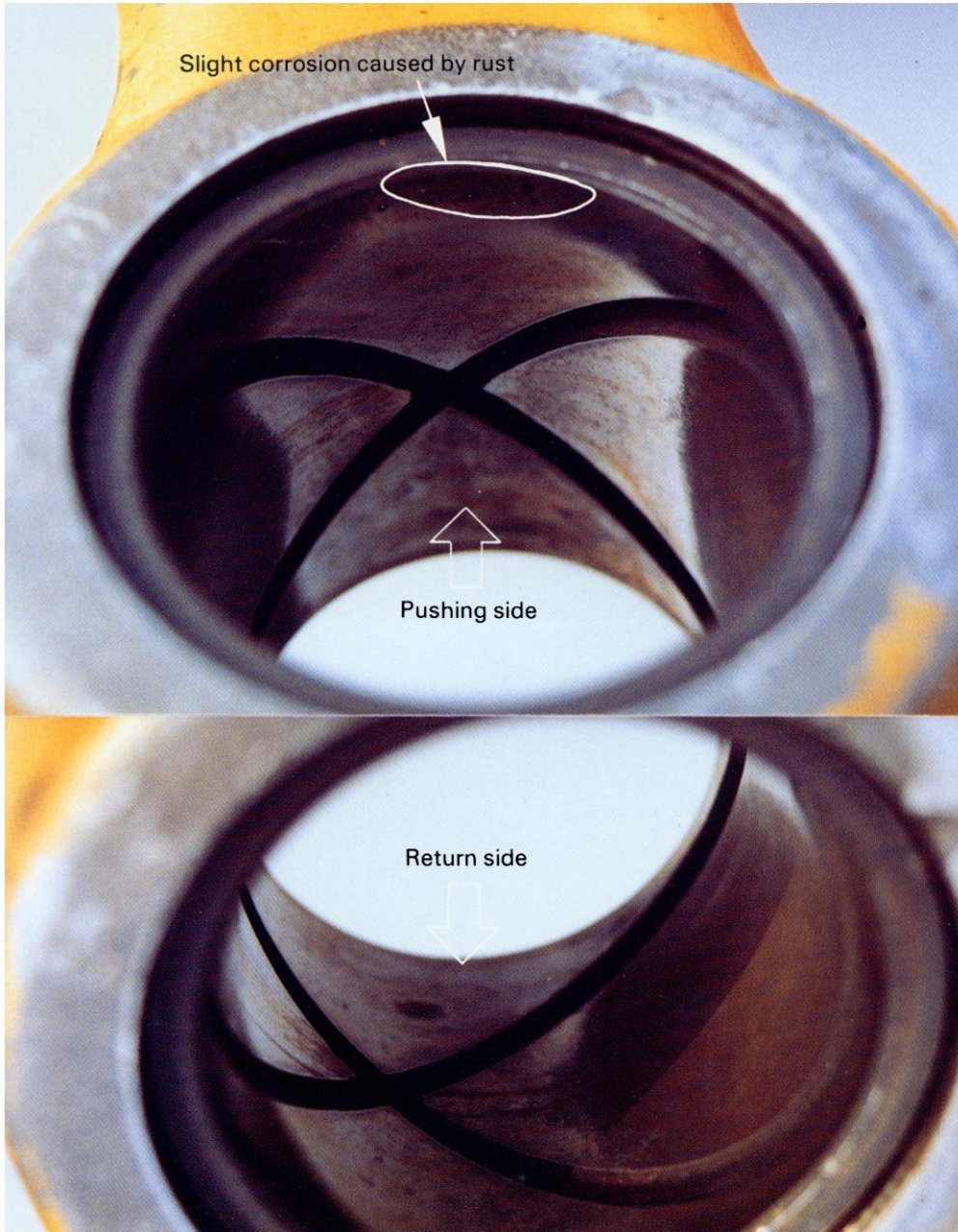
- Loss of oil film due to lack of grease

**Remedy**

- Use an oil stone to remove the protruding parts of the damage to make the surface smooth. check the mating pin, and if the seizure is slight, correct that part.

## Bushing (Cylinder bottom)

45



### Category: **A**

#### Condition

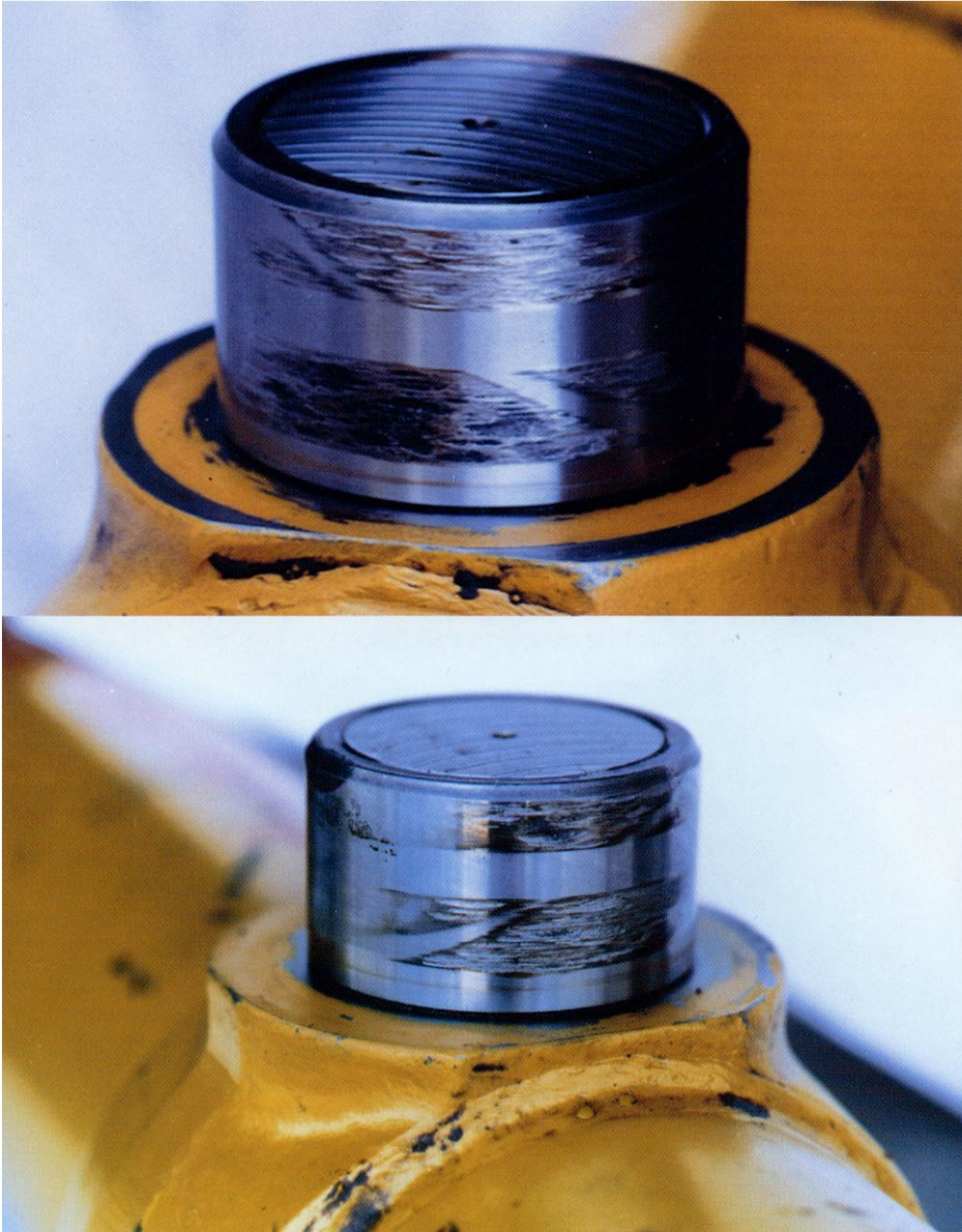
- There is slight corrosion caused by rust at the end of the bushing, but there is no seizure or scuffing of the inside surface of the bushing either on the cylinder pushing load side or the return load side.  
Good condition.

#### Cause

- The rust is caused by a defective dust seal allowing the entry of water.

**Bushing (Bulldozer blade cylinders)  
(Trunnion portion)**

**46**



**Category: C**

**Condition**

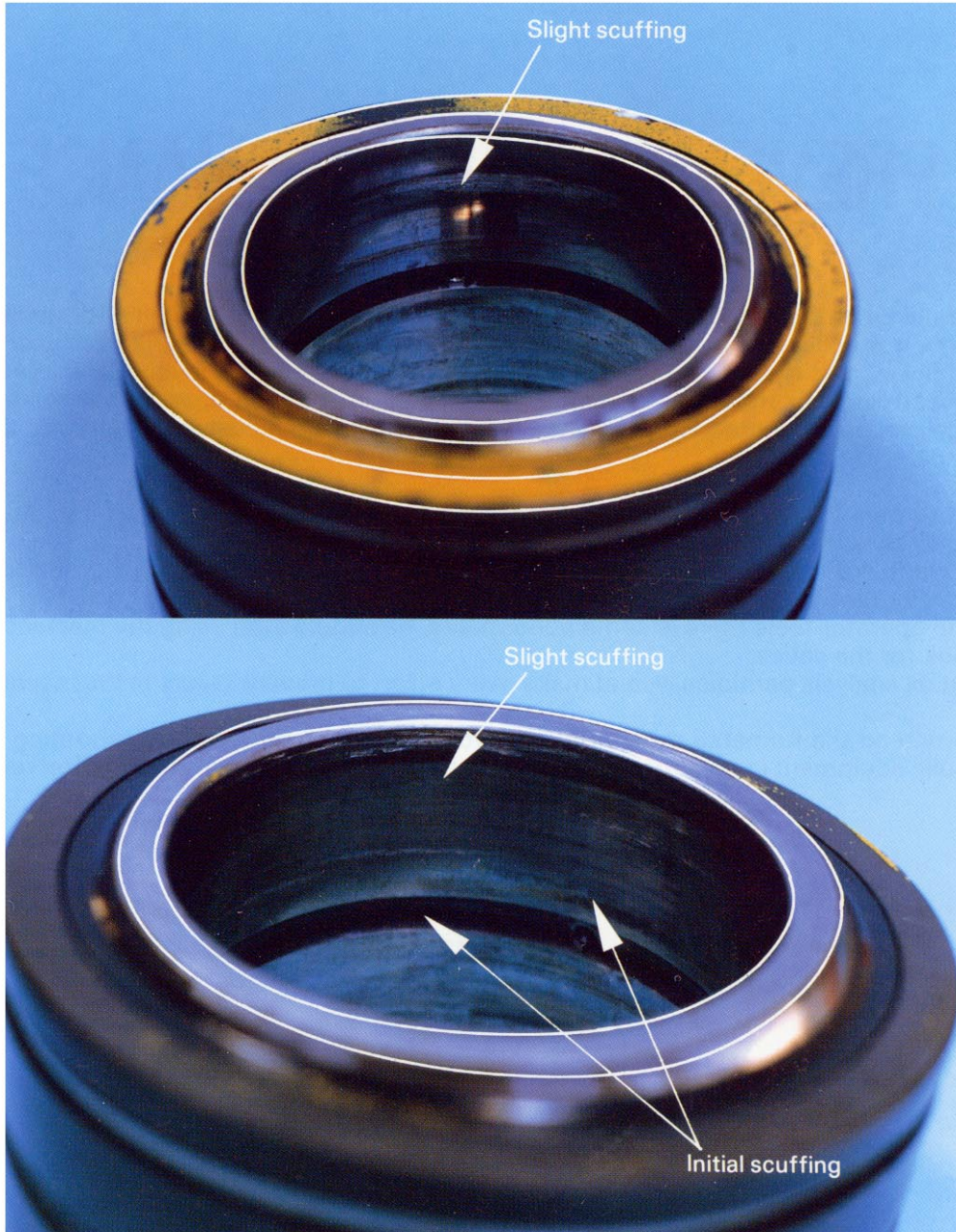
- Seizure and scuffing of blade cylinder trunnion bushing.
- ★ Replace after removing bushing from cylinder.

**Cause**

- Loss of oil film due to lack of grease

**Spherical surface bushing (Bulldozer blade cylinder)**  
(Inside diameter of rod end bushing)

47



**Category: B**

Note: Even if there is damage to the pin hole, if there is no damage such as scuffing on the ball of the spherical bushing, it can be reused.

**Condition**

- Slight seizure and scuffing have occurred on inside surface of pin insertion hole of spherical bushing.  
(There is no damage of spherical surface and outer ring side.)

**Remedy**

- Remove the raised part of the damage cause by scuffing carefully with a pencil grinder to finish the surface.



# PREVENTIVE MAINTENANCE

To prevent failures in the machine before they occur, and to allow the machine to demonstrate its function 100% it is necessary always to know the condition of the machine, in particular to be aware of abnormal noise, particles of worn metal in the lubricating oil, and the level of the lubricating oil. In addition, by carrying out maintenance correctly as listed in the Operation & Maintenance Manual, most damage can be prevented, but be particularly sure to have the customer carry out the following points properly.

- Always use genuine Komatsu lubricating oil, keep to the prescribed change intervals, and use lubricating oil to correspond with changes in the ambient temperature.
- Always warm up the engine thoroughly. Avoid as far as possible applying sudden excessive loads, accelerating suddenly or stopping suddenly.
- When the operator feels there is some abnormality, he should stop using the machine immediately and look for the cause.
- Carry out oil analysis periodically, and make every effort to prevent failure in the machine.

We recommend the Komatsu multi-purpose hydraulic test stand for troubleshooting and rebuilding of hydraulic equipment in construction equipment, and confirmation of quality after repair.

## Komatsu multi-purpose hydraulic test stand

[Part No. 799-402-1003]



Weight; Main body:	5100 kg
Oil tank:	1800 kg
Output;	75 kW

