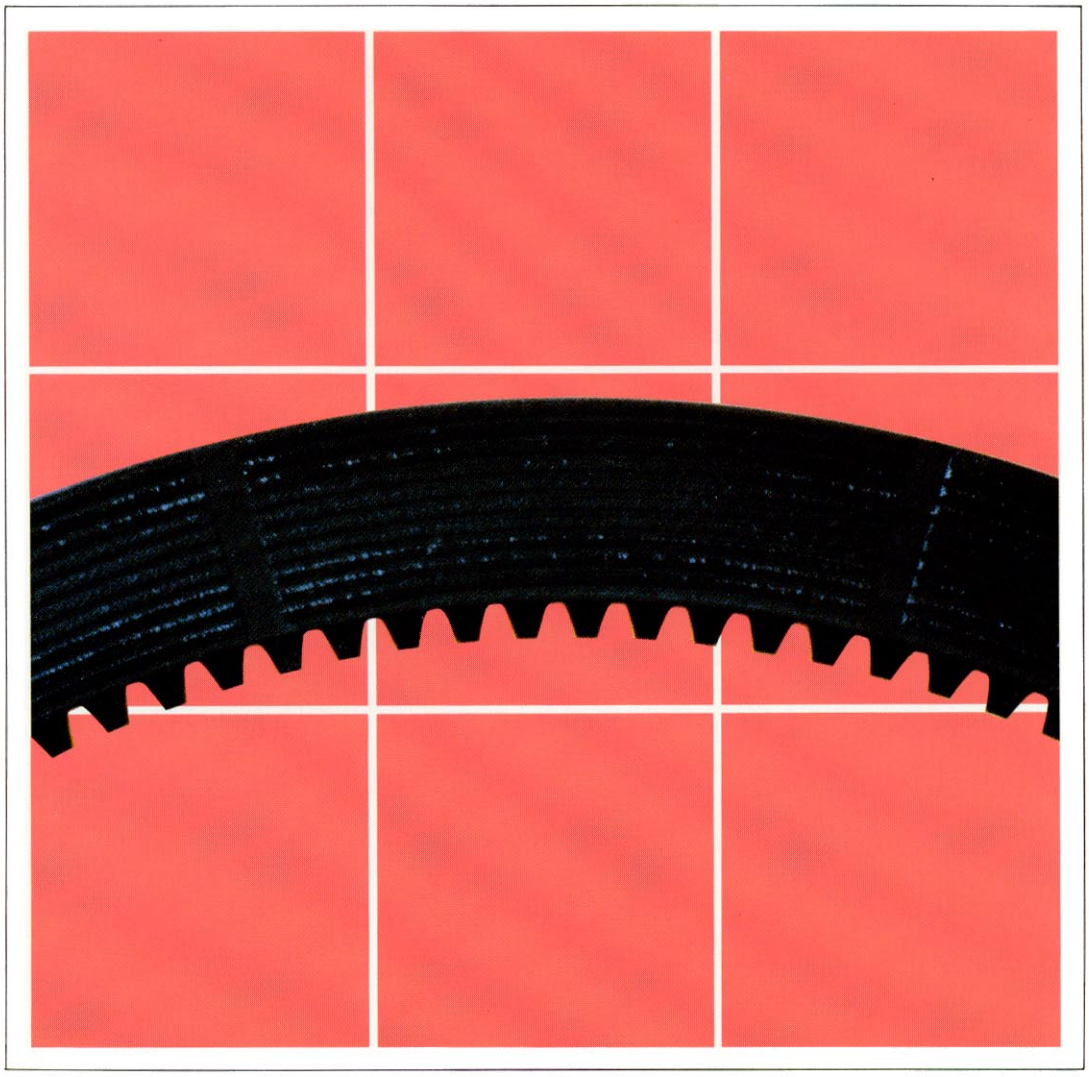
FORM NO. SEBG4220-01

SHOP MANUAL

GUIDANCE FOR REUSABLE PARTS

RUBBER DISCS



GUIDANCE FOR REUSABLE PARTS

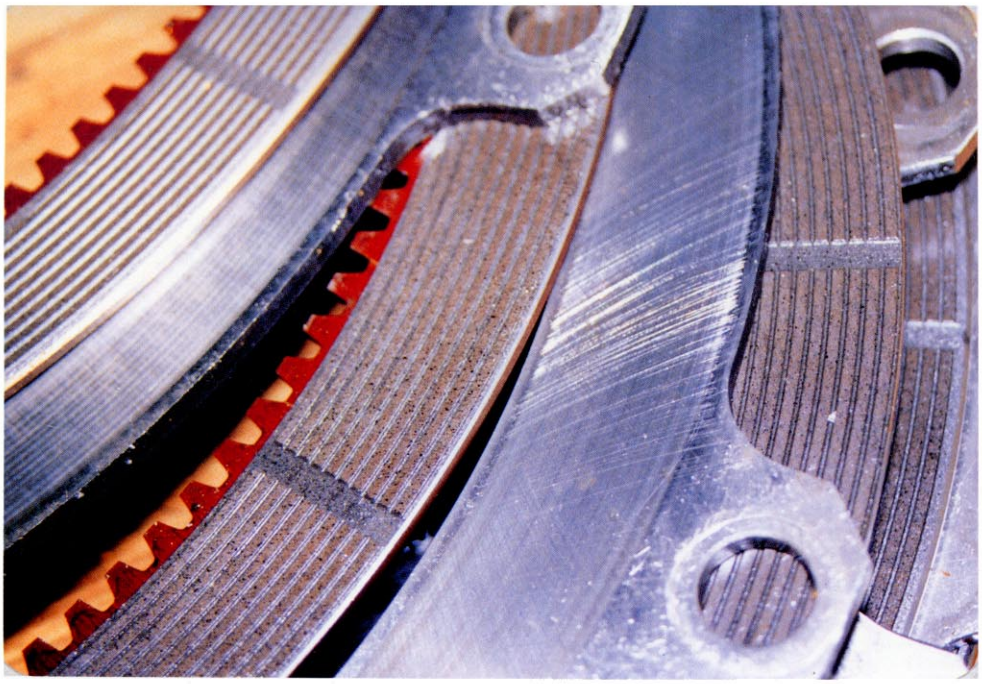
KOMATSU

INDEX

INTRODUCTION

The last issue of CLUTCH PLATES AND DISCS was concerned mainly with sintered alloy discs. Recently, an increasing number of models are using rubber discs, so this edition covers the use of rubber discs. This edition gives the basic knowledge needed for clutch discs when disassembling, assembling, or repairing construction equipment. It also explains the causes of damage and gives photographs to aid in judging whether the parts can be reused.

This GUIDANCE is desirable to be utilized well by those who are engaged in trouble shooting and servicing on construction machines. Consequently, the servicing cost reduction can be obtained through proper reuse or replacement of parts, and proper preventive actions of failures can be taken after correct determination of failure causes.



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

STRUCTURE AND FUNCTION OF CLUTCHES

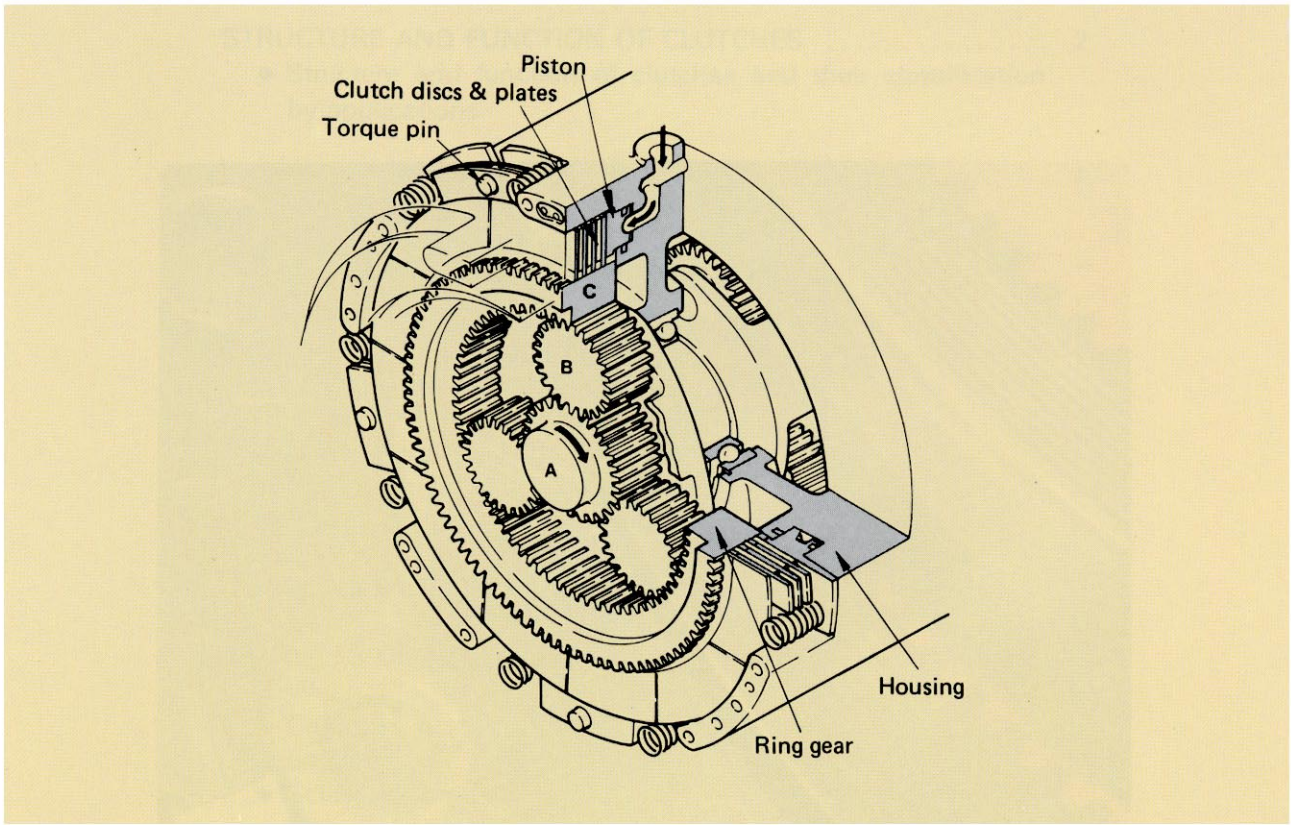
Structure and Function of Clutches and their Classification by Applications

Clutches used in construction machines are classified mainly into a "spring loaded type" and "hydraulic type".

Major component parts of clutches, namely, discs and plates, have different purposes depending on their applicable machines or devices. However, those of spring-loaded or hydraulic clutches have the same function that the power is transmitted by the frictional force at the contacting surfaces of discs and plates.

Structure and Function of Planetary Gear Type Transmission

As an example, the construction and function of a clutch in the planetary transmission (TORQFLOW transmission) are explained briefly.



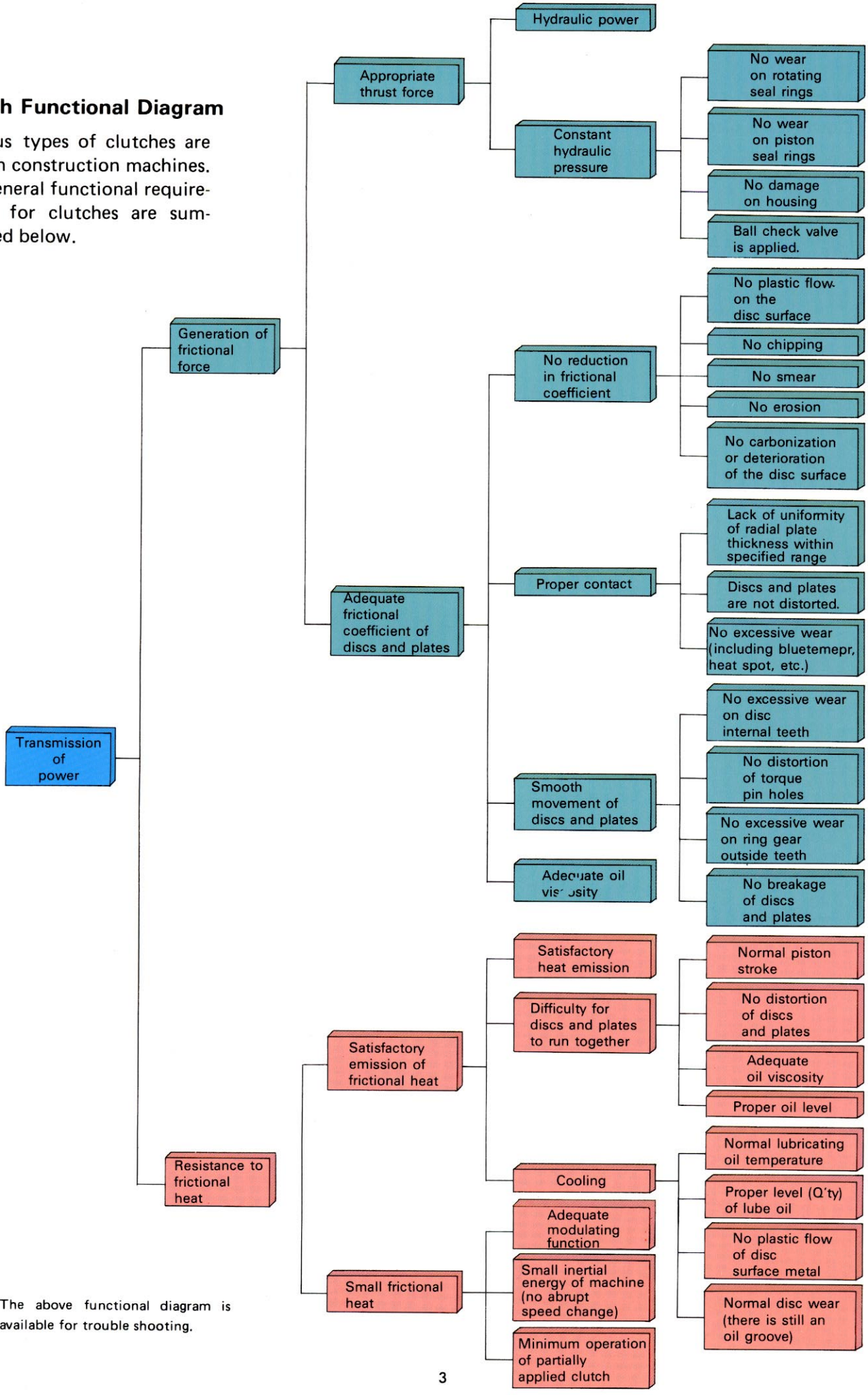
Clutches used in the TORQFLOW transmissions are normally of a wet, multiple-disc type with discs and plates arranged alternately. Discs have internal teeth to mesh with external teeth of a ring gear or a hub. Plates have torque pin holes or external teeth to mesh with internal teeth of the clutch housing.

While the hydraulic oil from control valve does not work on clutch piston, discs and plates are running idle, keeping clearances between themselves. If the hydraulic pressure is applied to the piston, the discs and plates are pushed to each other by the piston. Thus, the clutch is actuated by the frictional force between the discs and plates. The ring gear is kept stationary and the planetary mechanism runs at a given reduction ratio.

The clutch is cooled by a forced lubrication method, thereby preventing the clutch temperature from being elevated by the clutch frictional heat.

Clutch Functional Diagram

Various types of clutches are used in construction machines. The general functional requirements for clutches are summarized below.



* The above functional diagram is available for trouble shooting.

Classification of Clutches by Application

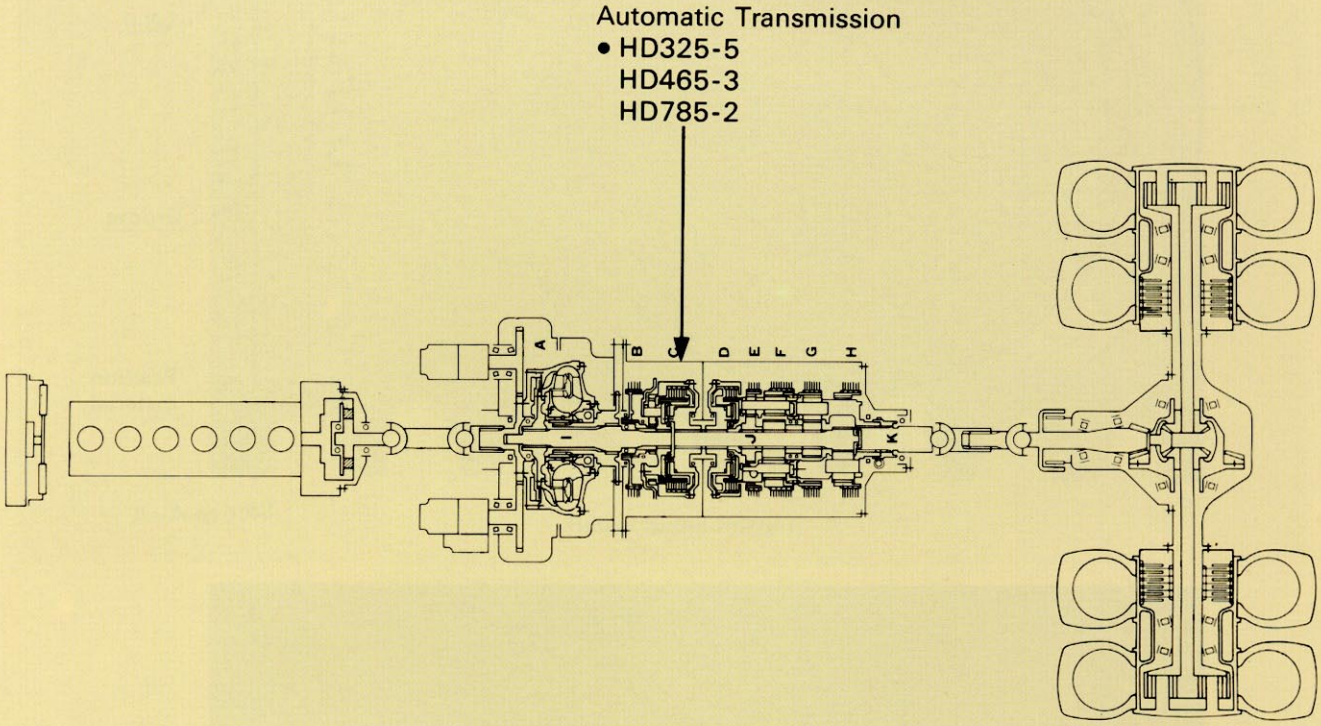
Clutches are classified by their major applications in construction machines as indicated below.

Classification / Applications	Lube type		Plate disc type			Actuation		
	Dry type	Wet type	Single plate type	Double plate type	Multiple disc type	Spring-loaded type	Hydraulically operated type	Air pressure operated type
Main clutch	○	○	○	○	○	○		
Lockup clutch		○			○		○	
Steering clutch	○	○			○	○		
TORQFLOW transmission (includ.hydroshift transmission)		●			●		●	
Brake system		○			○		○	
Differential lock		○			○		○	○

● : There are some models which use rubber discs.

Example of use of Rubber Disc

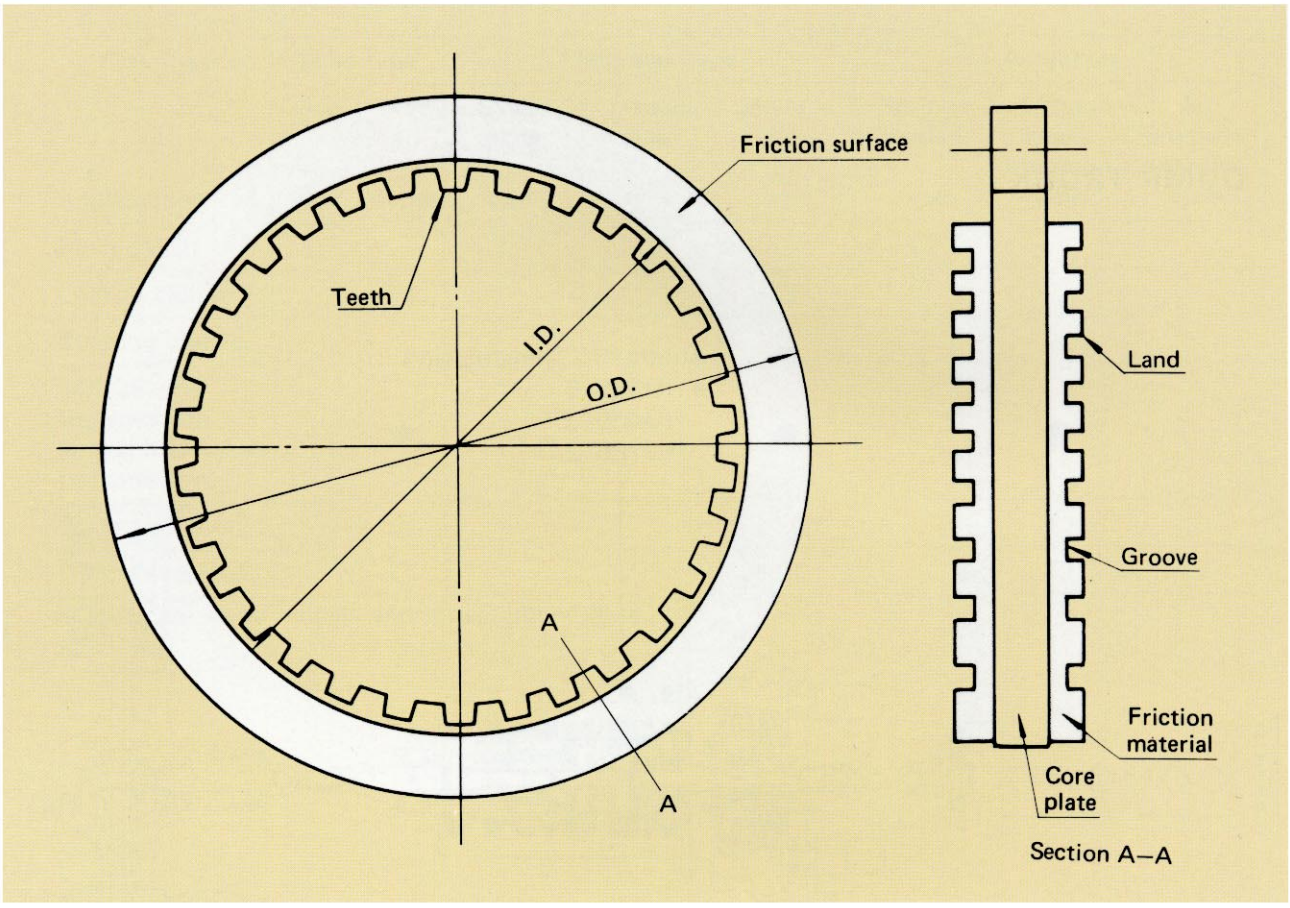
DUMP TRUCK



DISCS

Types and shapes of discs vary with purposes of clutch applications. The standard shape of discs and disc technical term are indicated below.

Nomenclature of Disc



Materials and heat treatments

The following materials and heat treatments are used for clutch discs.

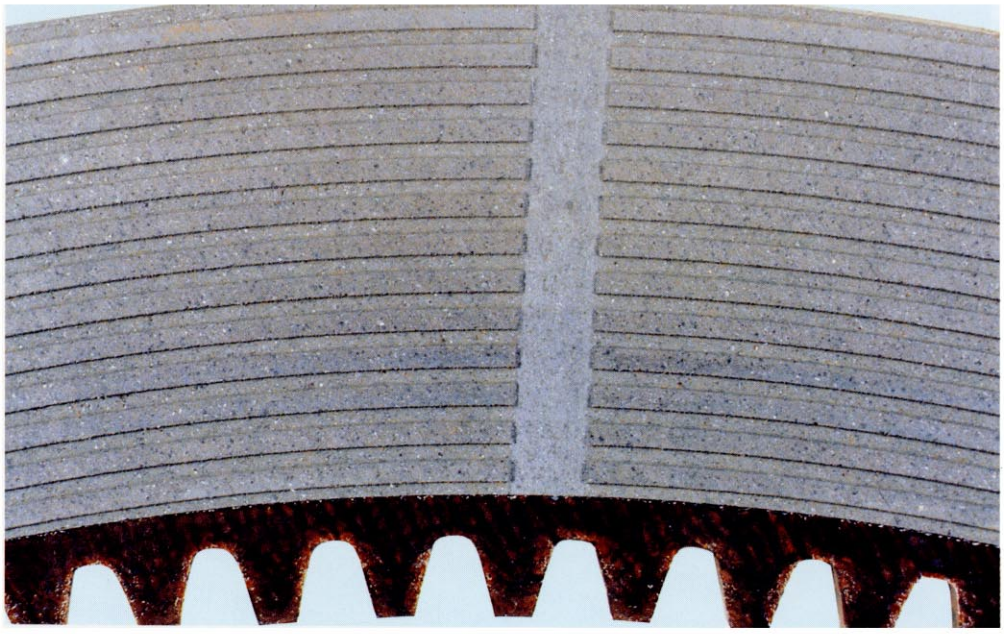
Parts		Material	Heat treatment	Friction surface roughness
Disc	Disc for sintered alloy	Sintered alloy friction material (facing) is sintered to the carbon steel plate.	Teeth are induction-hardened to prevent wear	Finishing by grinding
	Disc for fiber	Paper friction material (facing) is bonded to the carbon steel plate.	Blank plate is heat treated.	Finishing by grinding
	Disc for rubber	Rubber friction material facing is bonded to the carbon steel plate.	Teeth are induction-hardened to prevent wear	Finishing by grinding

Disc Groove Patterns

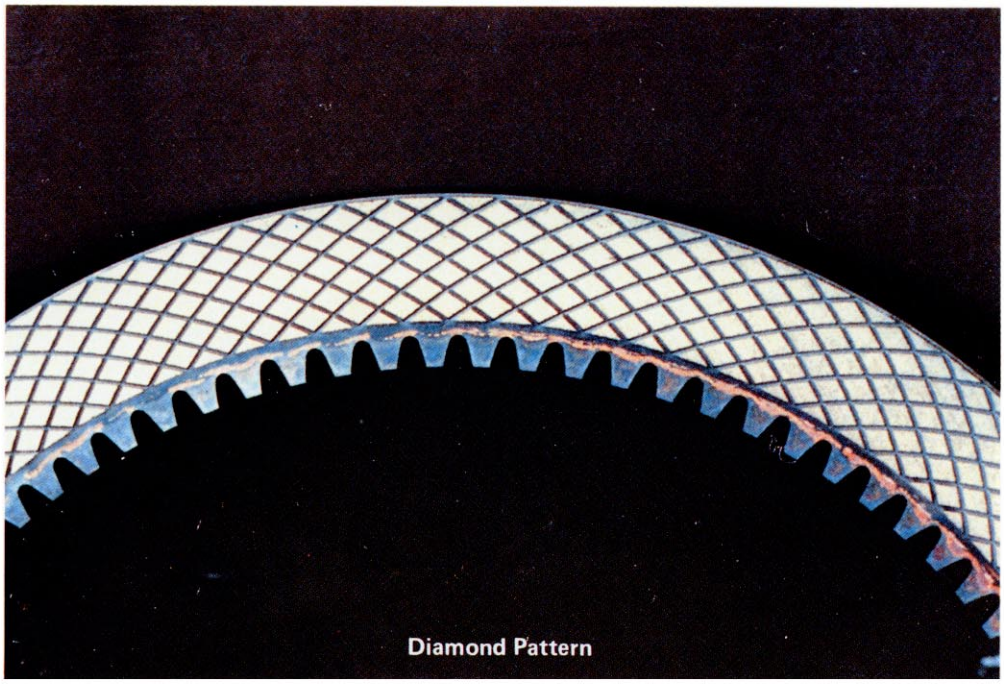
Various patterns of grooves are machined on the disc facings for cooling clutch, minimal idling loss, flowing away of oil in actuating clutch, etc.

Groove patterns are featured for the resistance of discs to heat, wear and friction. Thus, discs having grooves of the optimum types are used in various devices and machines.

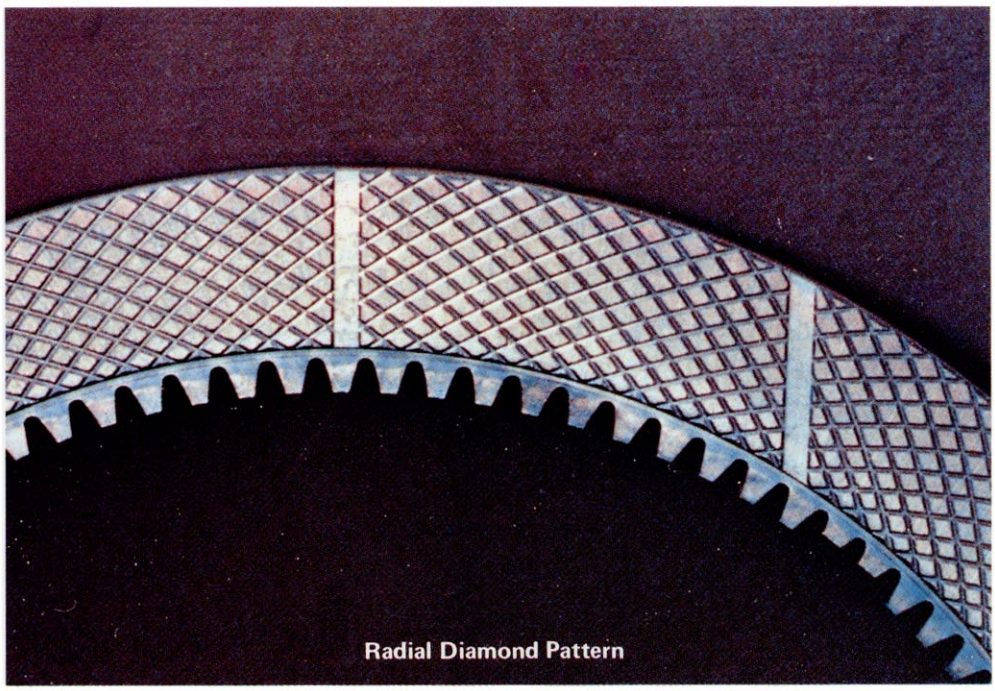
Various patterns of grooves and the surfaces of new discs are shown below.



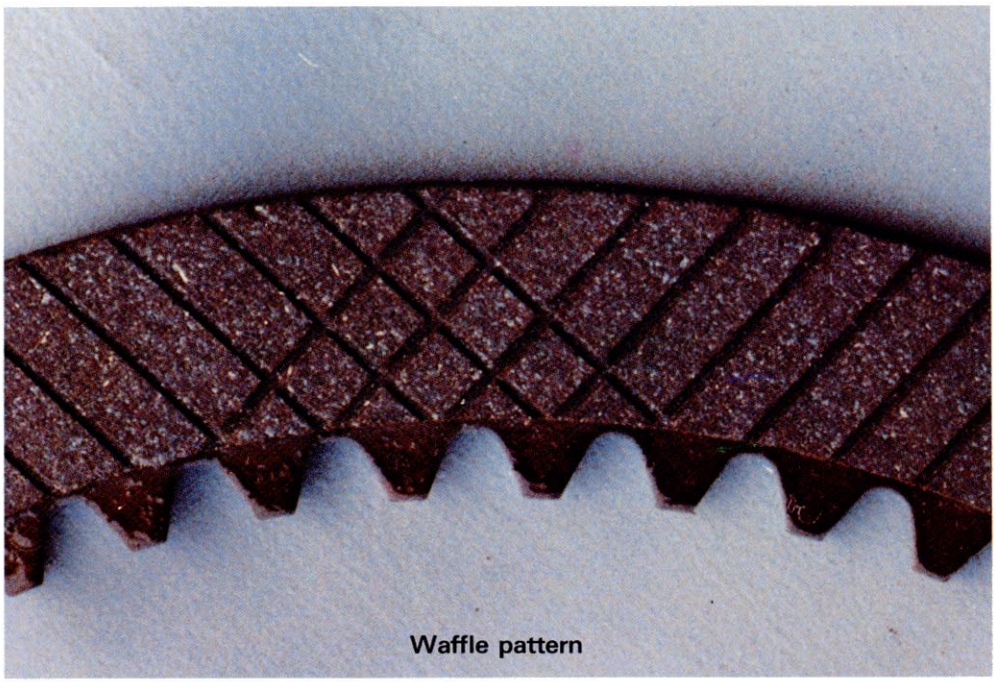
Radial Spiral Pattern



Diamond Pattern



Radial Diamond Pattern



Waffle pattern

FAILURE ANALYSIS

Discs and plates are one part of the components of clutches and brakes. These discs and brakes are repeatedly engaged and disengaged during gear shifting or braking operations, which occur frequently during daily operations. When the discs and plates are engaged, frictional force and frictional heat are generated. The disc teeth, and plates flanges and teeth are subjected to the reaction force of the clutch torque generated by the frictional force.

Therefore, the damage to the discs and plates can be classified into mechanical damage caused by the frictional force on the friction surface, heat damage caused by the frictional heat.

The mechanical damage occurs frequently as secondary damage caused by other failures. Damage to the discs and plates occurs mainly to the friction surface. In particular, the problems described below cause damage to the discs and plates.

Hydraulic Modulating Function

For high durability of clutches and power transmitting parts, such a function is provided that discs and plates are engaged with each other in a given period of time of time by gradually raising the hydraulic oil pressure. If this modulating function is out of order, their engagement will be made too fast or too late. This will, in turn, cause the frictional heat to be generated, resulting in the smeared, seized or worn discs or plates.

Lubricating Oil

The clutches and brakes are cooled by lubricating oil, but if the oil temperature rises because of overheating, the cooling effect is lost, and this may cause carbonization, deterioration, or plastic flow on the disc surface, or smearing, seizure, and deformation of the discs and plates.

In addition, use of any other oils than those recommended, or use of oils of a viscosity suited for a different temperature, or failure to change the oil at the specified intervals will also cause damage such as smearing or peeling of the discs and plates.

Operation

The greater the difference in speed before and after shifting gear, the greater the amount of heat generated will be. Therefore, frequent sudden gear shifting, or operating frequently or for long periods with the clutch partially engaged will cause overheating due to the heat generated by the clutch slipping. This will cause carbonization and deterioration of the disc surface, plastic flow, smearing, seizure, warping and wear of the disc plate.

In addition, going downhill too fast, or overload will cause overheating of the brakes. This will result in the same kind of damage to the brake discs and plates.

Infiltration of Dirt or Water

If sand or water infiltrates when the oil is checked or changed, this will cause premature wear or peeling of the discs and plates.

Handling Procedures

If the discs or plates are scratched during disassembly or assembly operations, this will cause premature wear. With fiber discs, and rubber discs washing with a volatile solvent will cause peeling.

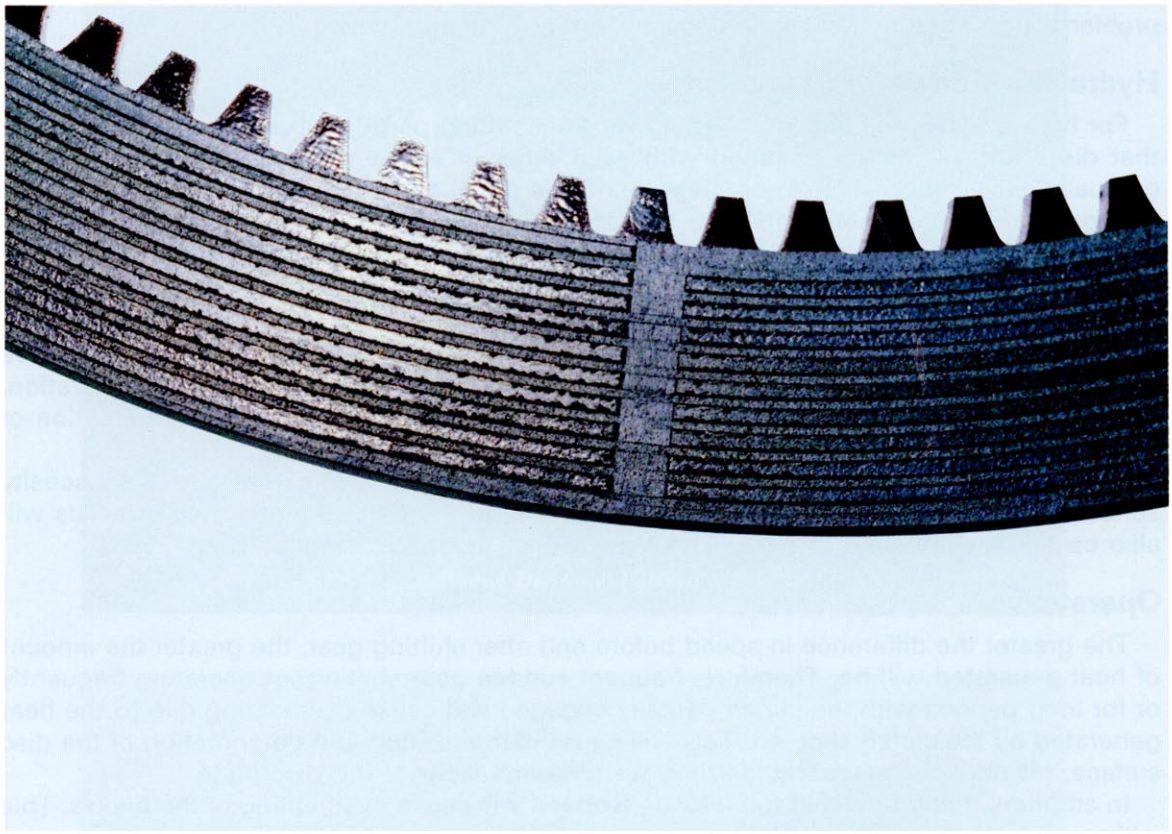
Storage procedure

If discs and plates are affected by rain during storage, this will cause rust and premature wear. With fiber discs and rubber discs, it will cause peeling.

TYPICAL EXAMPLES OF FAILURES

Chipping

This happens in cases where overheating is caused by overload or defective lubrication.

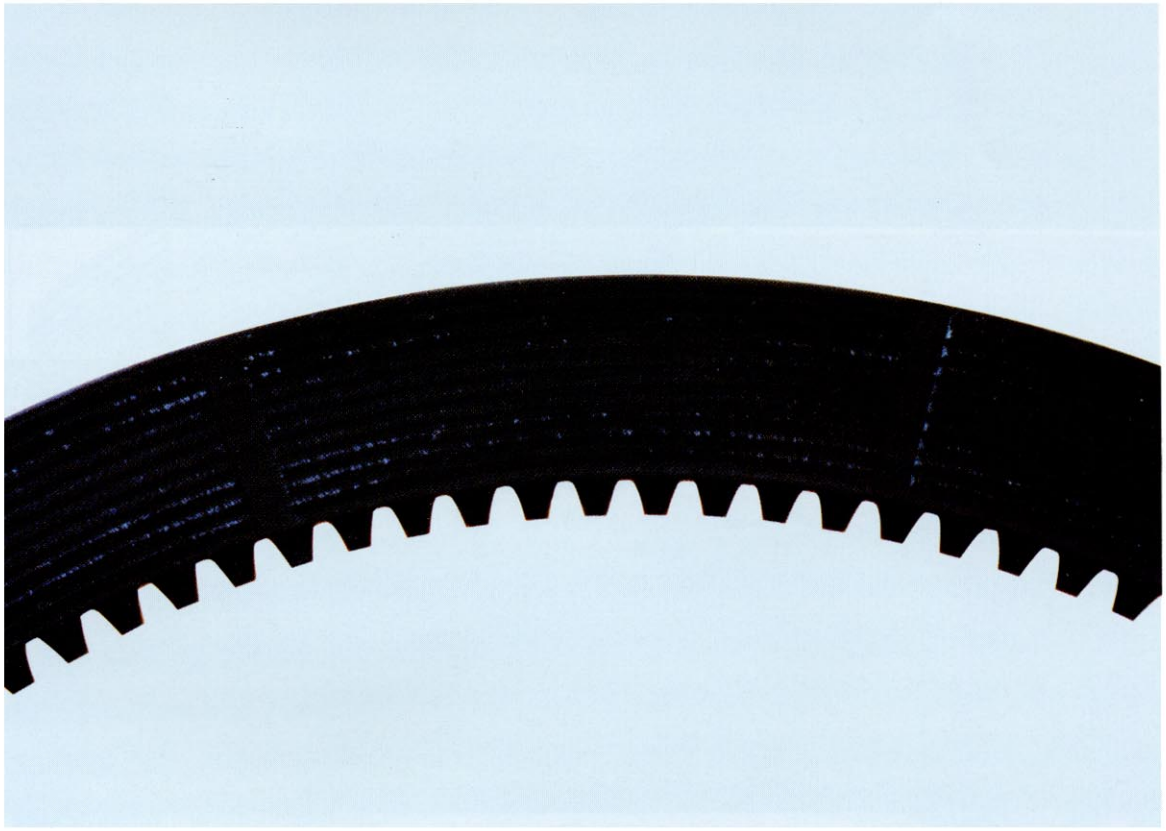


Causes

- Modurating function is out of order
  (Engagement is made too fast or too late)
- Overload
- Defective lubrication
- Low quality oil used

Erosion

Erosion occurs frequently whenever the excessive heat is generated in clutches. The disc friction material comes off from the friction surface, the eroded disc surface looks as if the surface were eaten by moths.

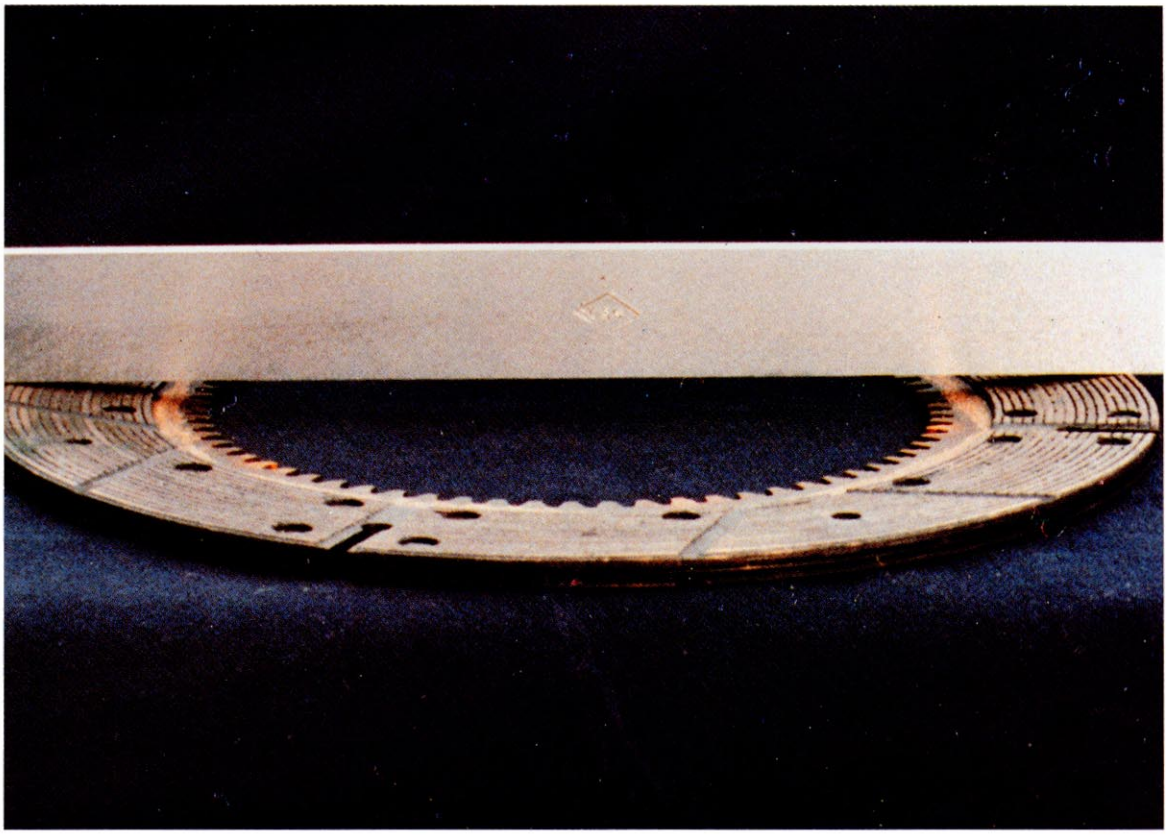


Causes

- Poor lubrication
- Overheating
- Use of low viscosity oil.

Deformation

Deformation is caused mainly by slippage between discs and plates, unsatisfactory lubrication of clutches, etc. The disc temperature is elevated excessively by the frictional heat generated by clutch engagement, causing a dished or wavy deformation to discs.



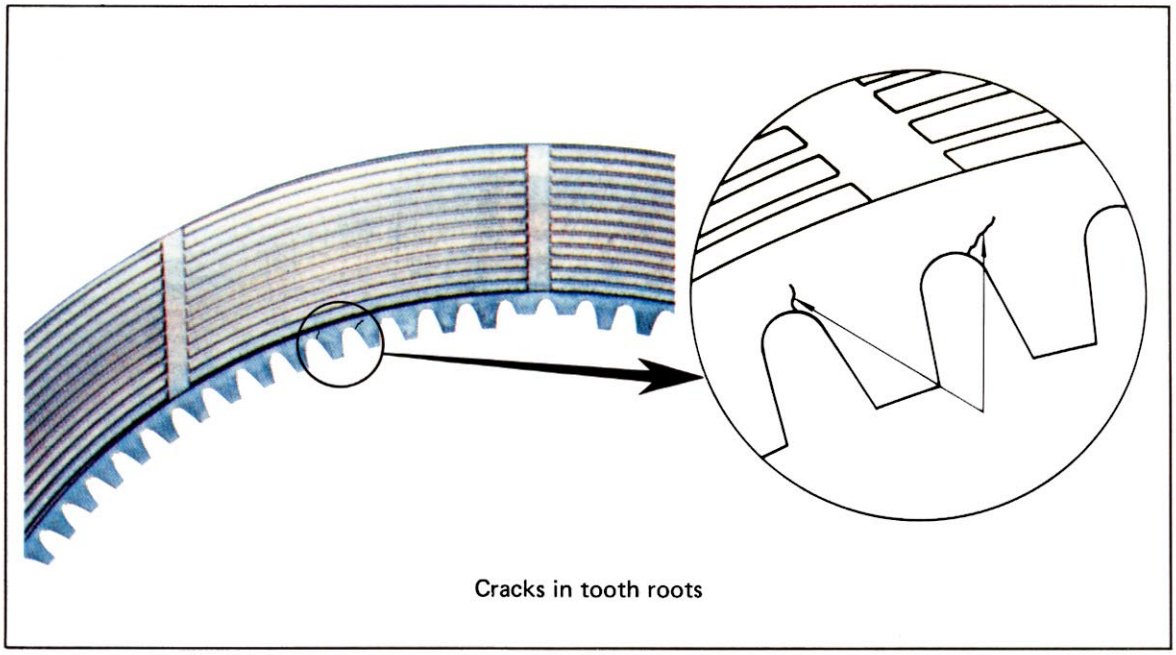
*Whenever discs are deformed, the mating plates should be checked for deformation.

Causes

- Poor lubrication
- Slipping due to the oil pressure drop.

Tooth Failures

If severe shock loads are imposed on a clutch, cracks will occur in its tooth roots. Foreign particles which has infiltrated into a clutch cause the tooth to be worn excessively.



Cracks in tooth roots

Excessive tooth wear

*Where the disc teeth have been worn out or cracked, the mating teeth should be checked for wear, cracks, etc. Cracks at the tooth roots are mostly caused by unsatisfactory operational control of clutches.

FAILURE SIGNS AND DIAGNOSIS FOR REUSAGE

Although the scale of damages is one of the important items to be considered in determining to reusability of defective parts, illeffects given by damages to the clutch assembly should also be considered thoroughly depending on the locations and types of damages.

Before determining the reusability of a defective part, the cause of a damage should be examined, considering the daily maintenance and operating conditions and referring to the know-how resulted from the accumulated experience in operation and servicing of construction machines. Then, the reusability should be determined, referring to photos classified into 3 ranks of criteria.

Check Points of Parts for Reusability

In order to evaluate a defective part accurately, wash or clean and check the parts for the following items.

Part	Check points
Disc	● Chipped, eroded friction disc ● Plastic flow in the friction disc surface ● Deformation ● Amount of wear on the friction surface ● Damaged, discolored or surface roughness ● Worn or cracked teeth

Standards for Failure Determination

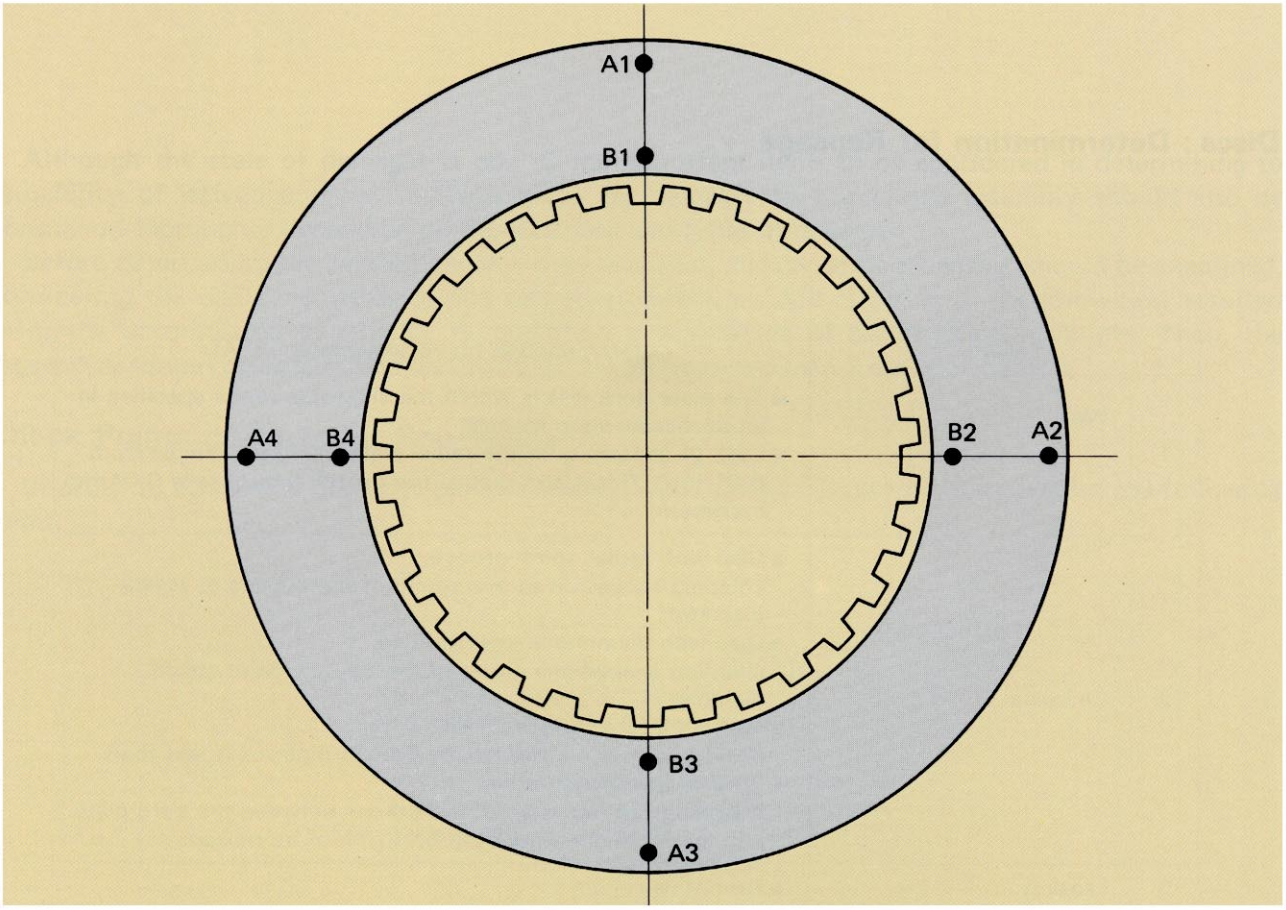
Category	Failure degree	Action
A	A defective part remains almost the same as a new one and its damage is so slight as causing no functional problem or no secondary damage to a machine.	Use again
B	If a defective part is continuously used, its damage will be extended, causing a possibility of the secondary damage. In this case, the inherent machine function can be maintained by its reconditioning or repair.	Use after reconditioning
C	A defect positively determined to be detrimental to the function of a machine cannot be corrected. The continued use of such a part causes a serious damage to the machine.	Do not use again
* For the criteria of ordinary wear on clutch discs, refer to the maintenance standard given in applicable shop manuals.		

Discs : Determination for Reusage

Failure		Determination for reusage(category A)
1	Wear	● The plate thickness is within the allowable range specified in an applicable shop Manual. ● Lack of uniformity of the radial plate thickness ranges from 0.01 to 0.02mm and that of the overall thickness is 0.04mm maximum.
2	Chipping	● Disc with radial, spiral groove. chipping ranges up to one round of the outside or inside diameter. ● Disc with diamond-shaped groove. chipping shaped like diamond on the outside or inside diameter. ● Waffle pattern groove disc (fiber disc) peeling from the inside of the friction material is less than 10% of the friction area. If peeling has occurred at the border between the core plate and the friction material, the part cannot be reused.
3	Erosion	● Do not use again
4	Plastic flow of surface	● Do not use again
5	Deformation	● In warp 1) discs of 400mm or more in O.D. Less than 0.6mm 2) discs of less than 400mm in O.D. Less than 0.3mm ● In dish 1) discs of 400mm or more in O.D. Less than 0.2mm 2) discs of less than 400mm in O.D. Less than 0.1mm
6	Damage on teeth	● Do not use again
7	Discoloration	● Discoloration Parts which are blackened and the smooth surface cannot be reused (see the photograph of discoloration among the examples of failure)

MEASURING METHODS

Method of Measuring Radial and Overall Disc Thickness



Measuring Disc Thickness

Disc thickness is measured at eight points in total, four equidistant points on the outside diameter (A_1 to A_4) and the other four equidistant points on the inside diameter (B_1 to B_4) using a micrometer.

- Lack of uniformity of radial thickness
  (Mean value of thicknesses at four points on the outside diameter) – (Mean value of thicknesses at four points on the inside diameter)
- Lack of uniformity of overall thickness
  (Max. value of thicknesses at all measuring points) – (Min. value of thicknesses at all measuring points)

* Plate thickness should be measured in the same manner as described in measuring the disc thicknesses.

Method of Measuring Warp

Rest a disc on a surface block and measure warp along the outside and inside diameters, using a thickness gauge.

* Measure warp again to obtain an accurate value, by turning the disc over.

Method of Measuring Dish

Meassure a deformation, reading a straight-edge placed on a dished disc along its diameter.

EXAMPLES OF FAILURES

Wear

1

Category: C DO NOT USE AGAIN

Failure Signs

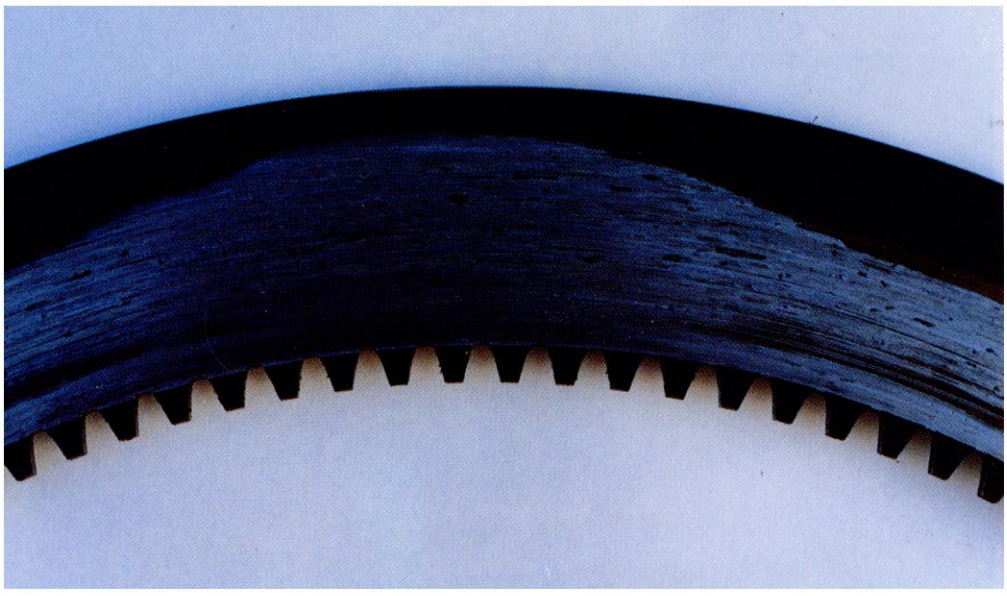
- There is no groove because of wear.

* The mating plate may also have smears.

Causes

- End of life
- Dirt

2



Category: C DO NOT USE AGAIN

Failure Signs

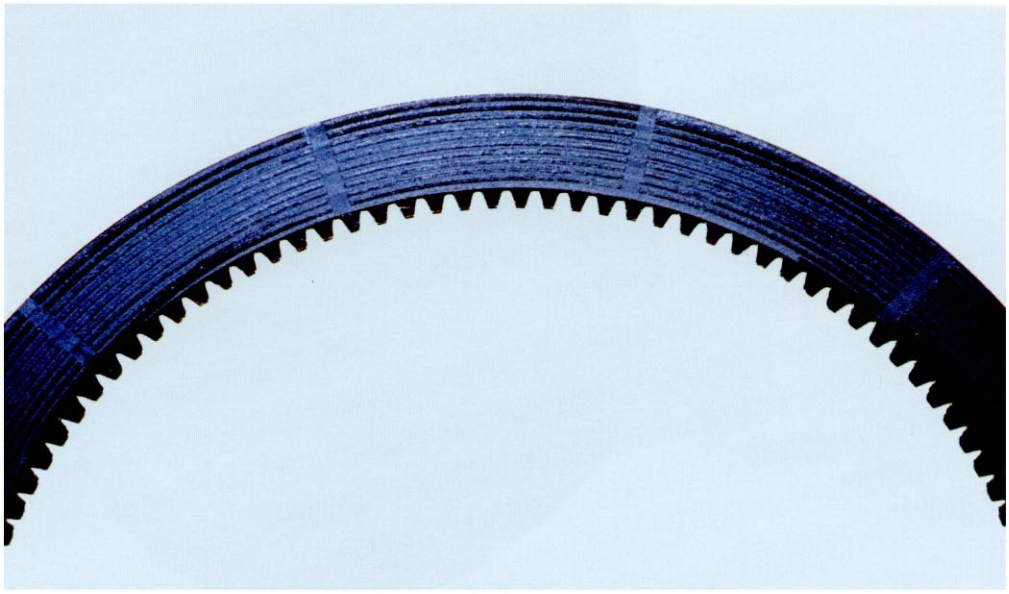
- Facing is worn out and core plate is exposed.

Causes

- Overload
- Overheat
- End of life
- Biased abrasion by heat strain

Chipping

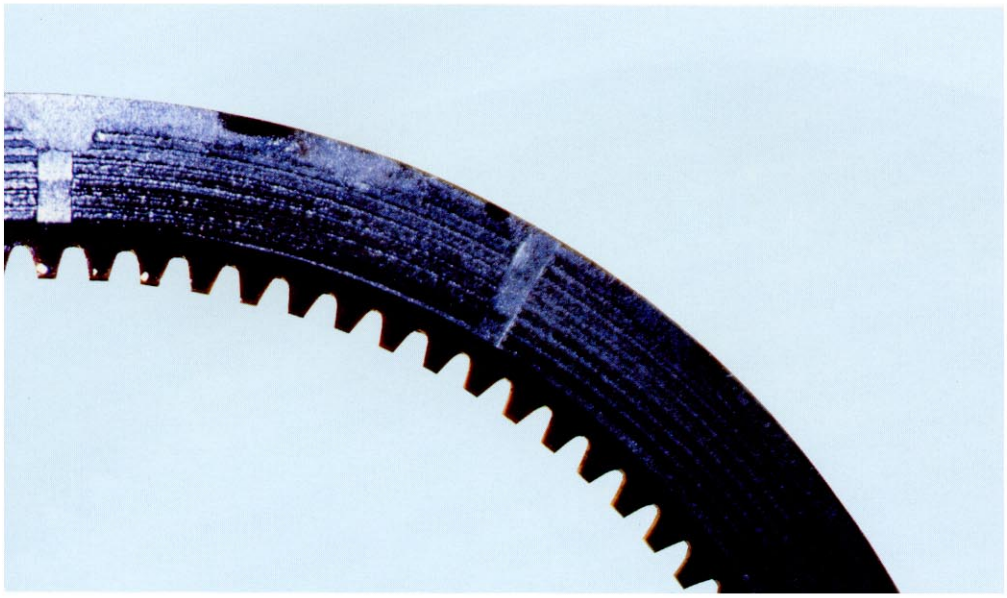
3



Category: C DO NOT USE AGAIN

Failure Signs

- Friction material is thoroughly chipped off on disc.



Category: C DO NOT USE AGAIN

Failure Signs

- The disc facing is carbonized or worn, or is peeling in parts.

Causes

- Wear
- Overheat

5

Category: C DO NOT USE AGAIN

Failure Signs

- There is water in the lubricating oil and the adhesive is chemically attacked.

Causes

- Water or fuel in oil
- Overheat

6

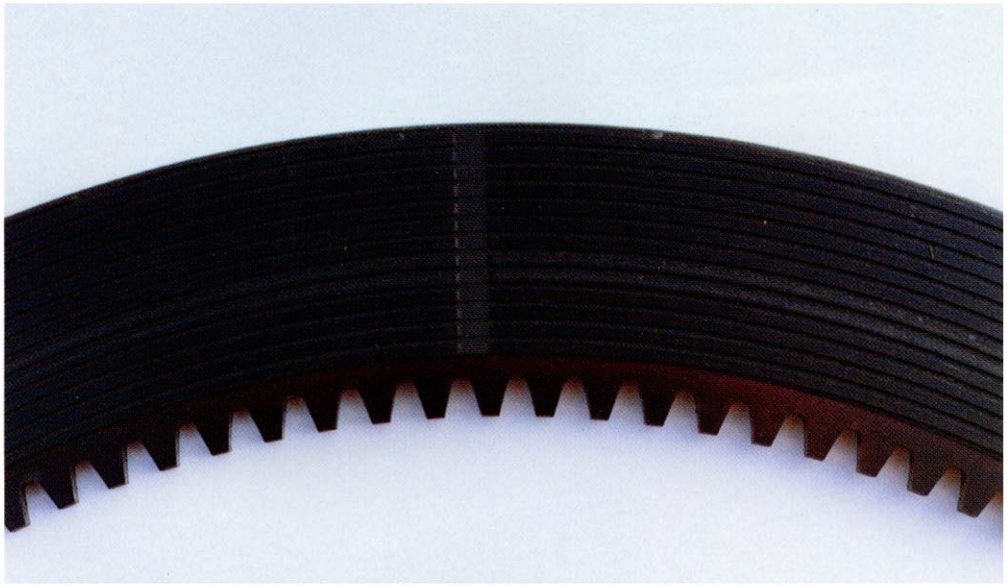
Category: C DO NOT USE AGAIN

Failure Signs

- The disc facing is completely worn or damagmed.

Erosion

7

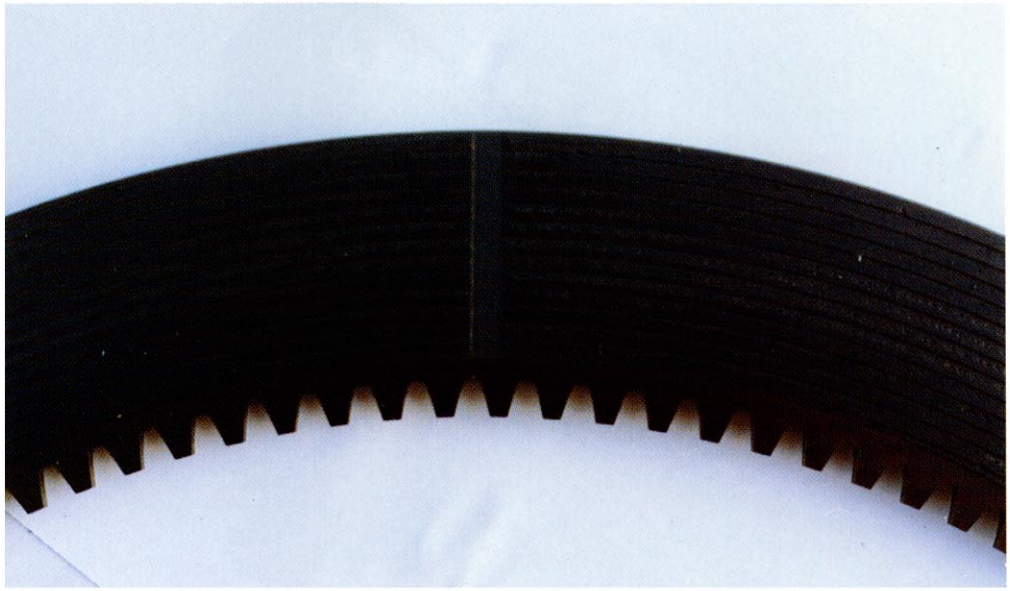


Category: C DO NOT USE AGAIN

Failure Signs

- Erosion developed to the size of two complete spiral bands.

8



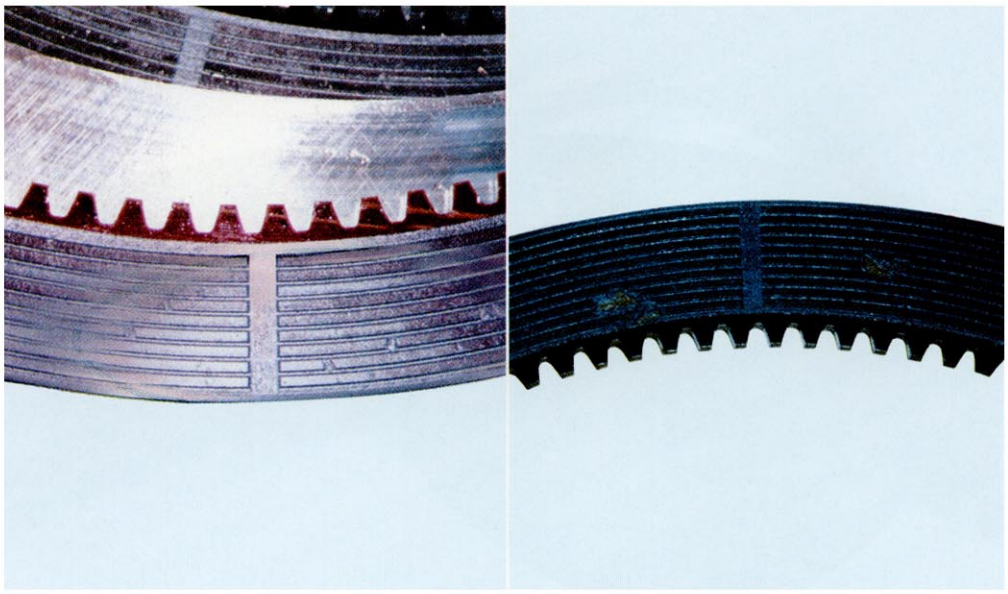
Category: C DO NOT USE AGAIN

Failure Signs

- Erosion on disc surface.

Scratches on Disc

9

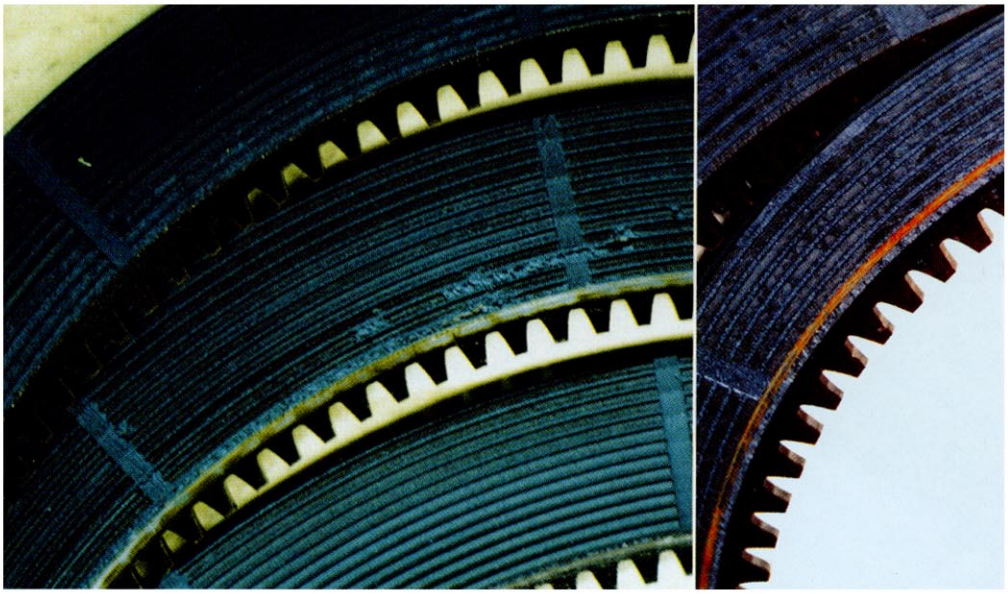


Category: C DO NOT USE AGAIN

Failure Signs

- Scratches on disc surface casued by forein particles.

10



Category: C DO NOT USE AGAIN

Failure Signs

- Dirt has rubbed off the disc facing.

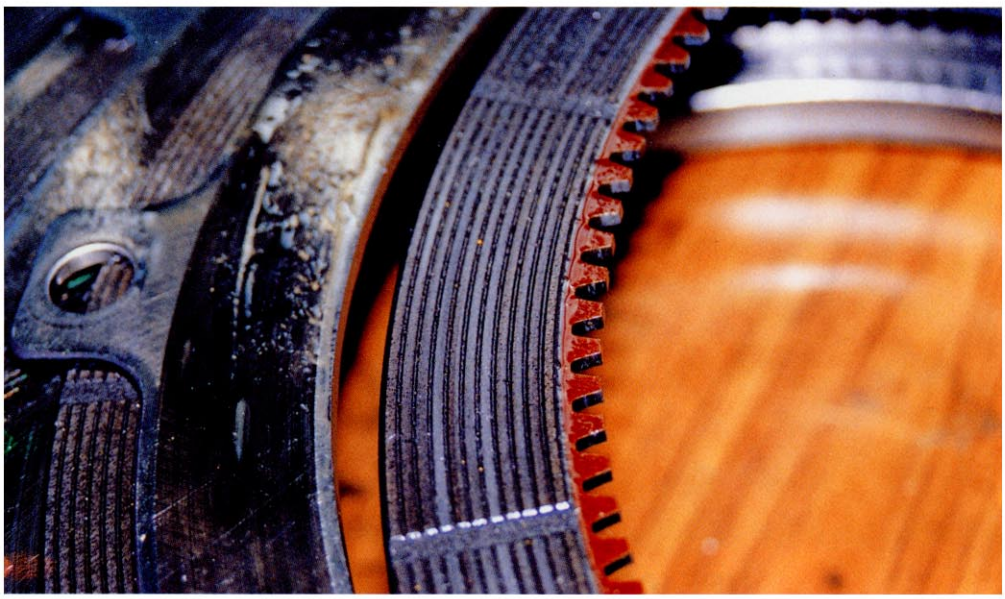
* The cooling circuit must also be flushed out to clean it.

Causes

- Dirt

Discoloration

11

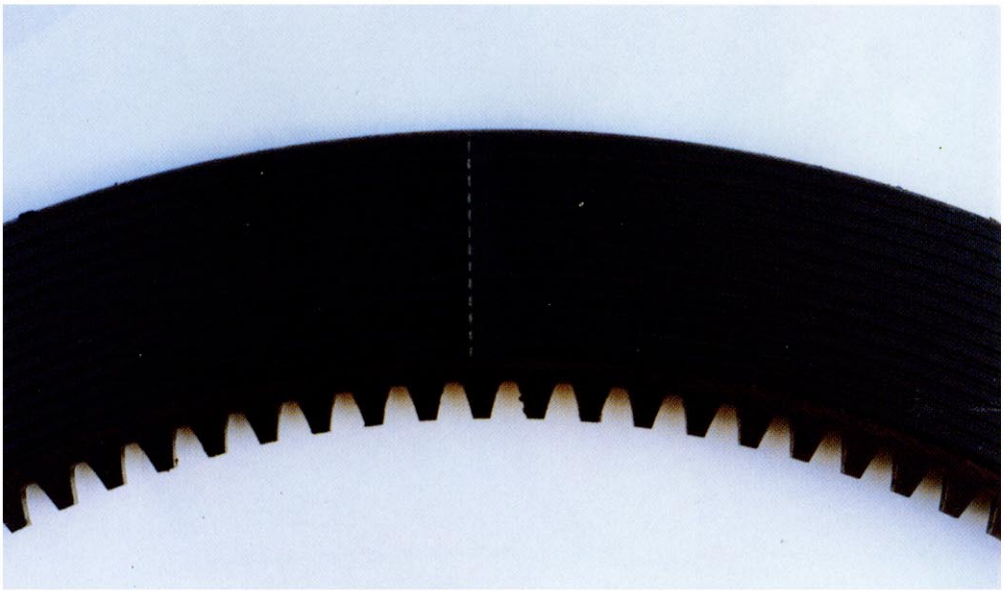


Category: C DO NOT USE AGAIN

Failure Signs

- Erosion developed to the size of two complete spiral bands.

12

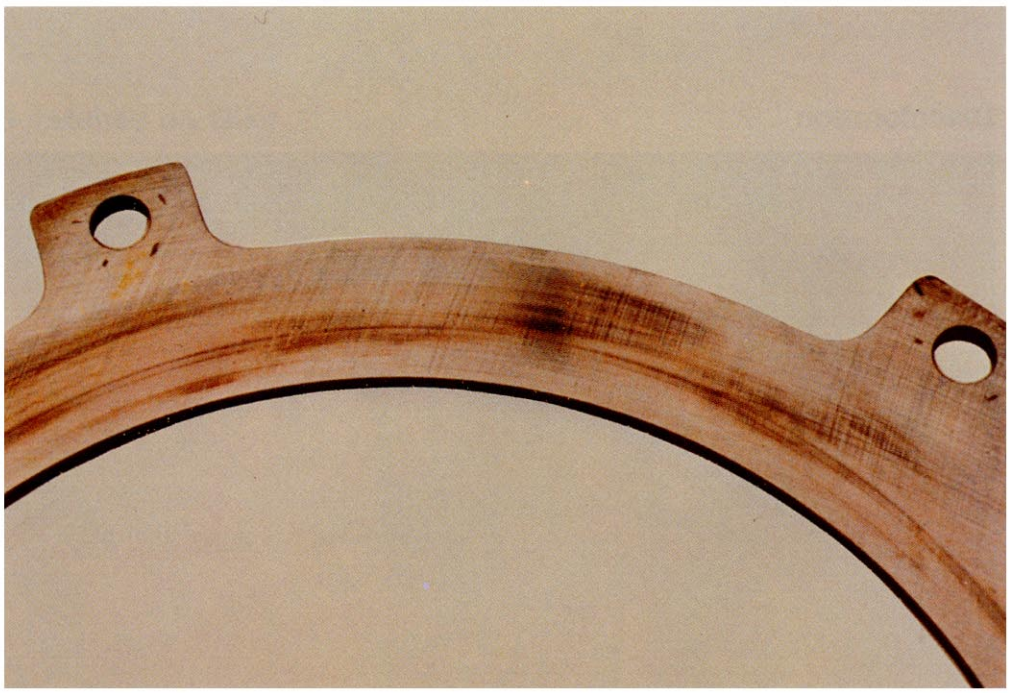


Category: A USE AGAIN

Failure Signs

- Normal oil temperature.

Clutch Plate

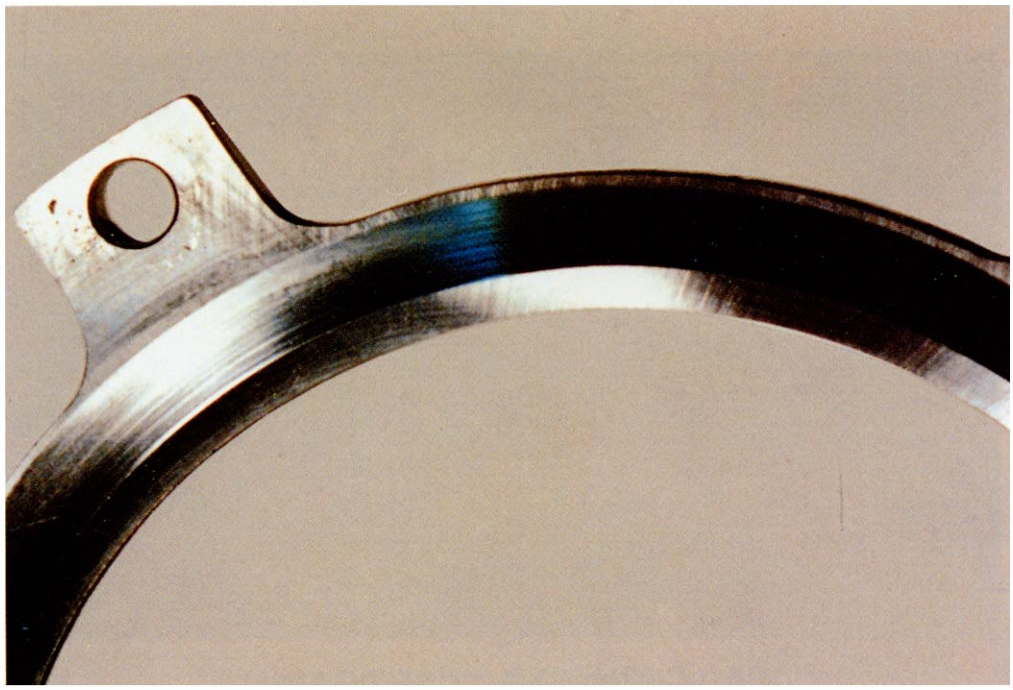


USE AFTER RECONDITIONING

Failure Signs

- Wear leaving original grind marks on the friction surface.

*This plate should be reused after regrinding the smeared areas with an oil stone.



USE AFTER RECONDITIONING

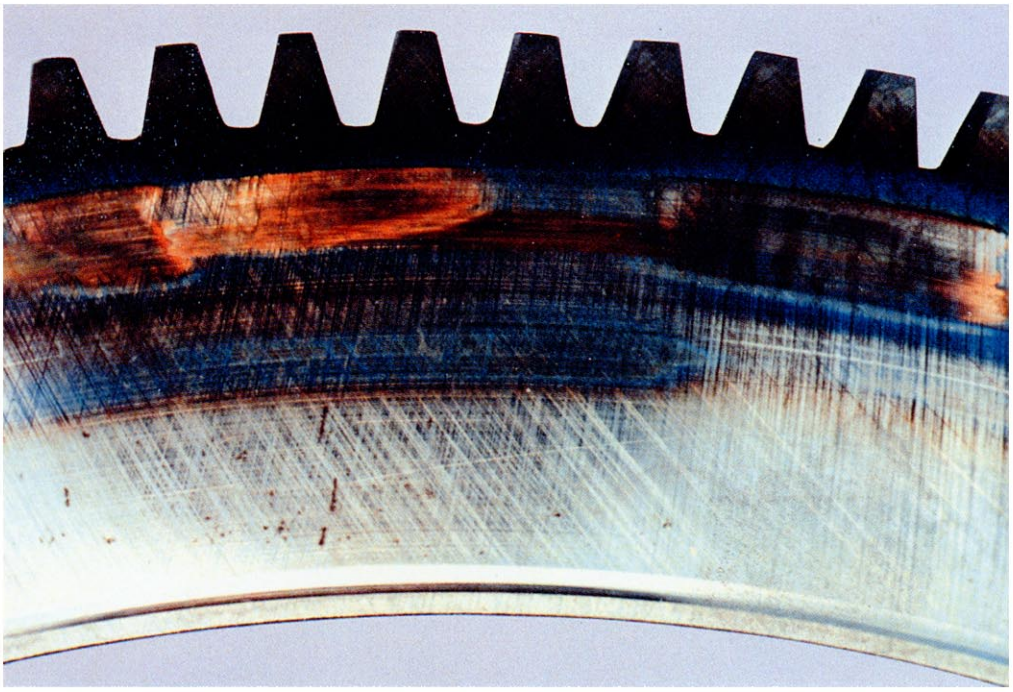
Failure Signs

- Wear is uniform all over the surface but the plate thickness is within the specified allowable limit. This is an example of roughed surface.

DO NOT USE AGAIN

Failure Signs

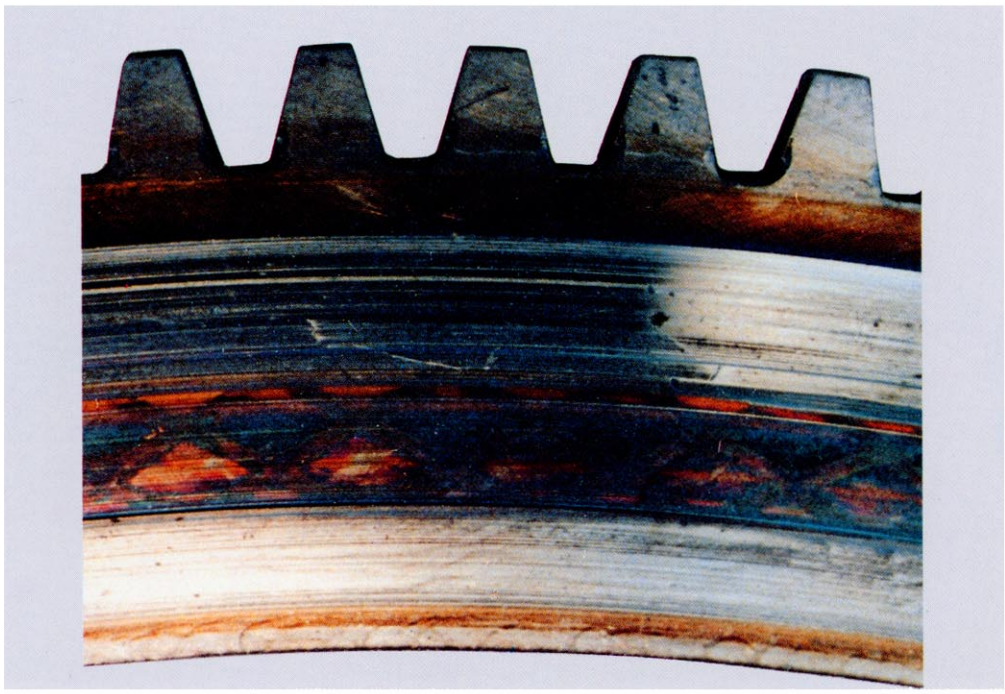
- The surface has been worn out like the surface of gramophone record because of radial spiral grooves on disc. Smear has also occurred.



DO NOT USE AGAIN

Failure Signs

- Blue temper on clutch plate.



DO NOT USE AGAIN

Failure Signs

- The plate friction surface has been worn out. This blue temper is caused by uneven contact with disc or by a chipped disc.

DO NOT USE AGAIN

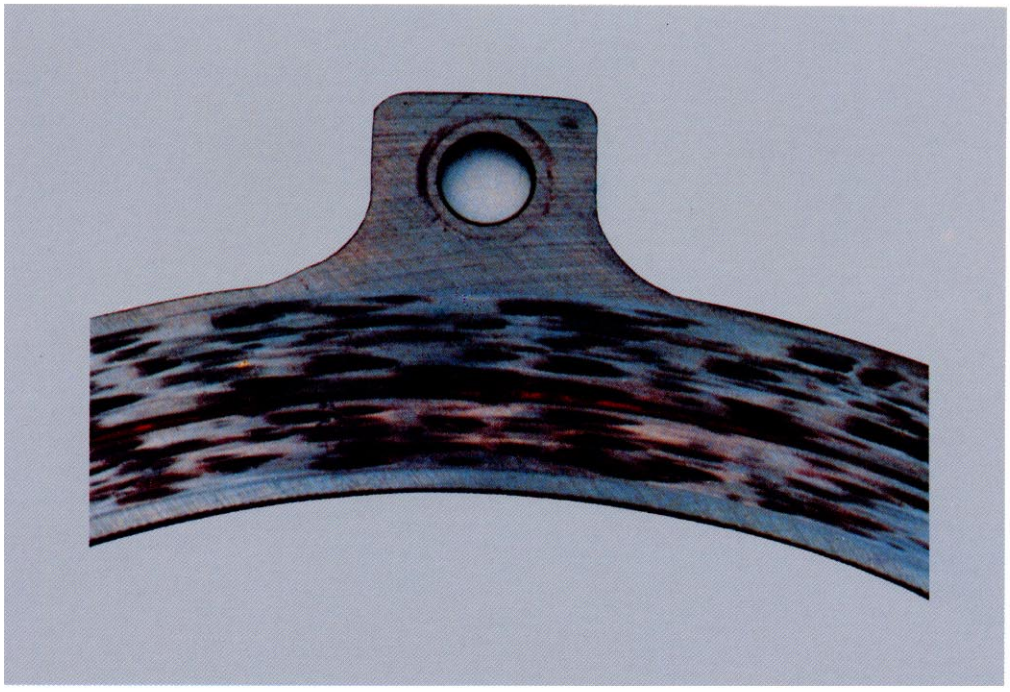
Failure Signs

- Clutch plate shows blue-black color.

USE AFTER RECONDITIONING

Failure Signs

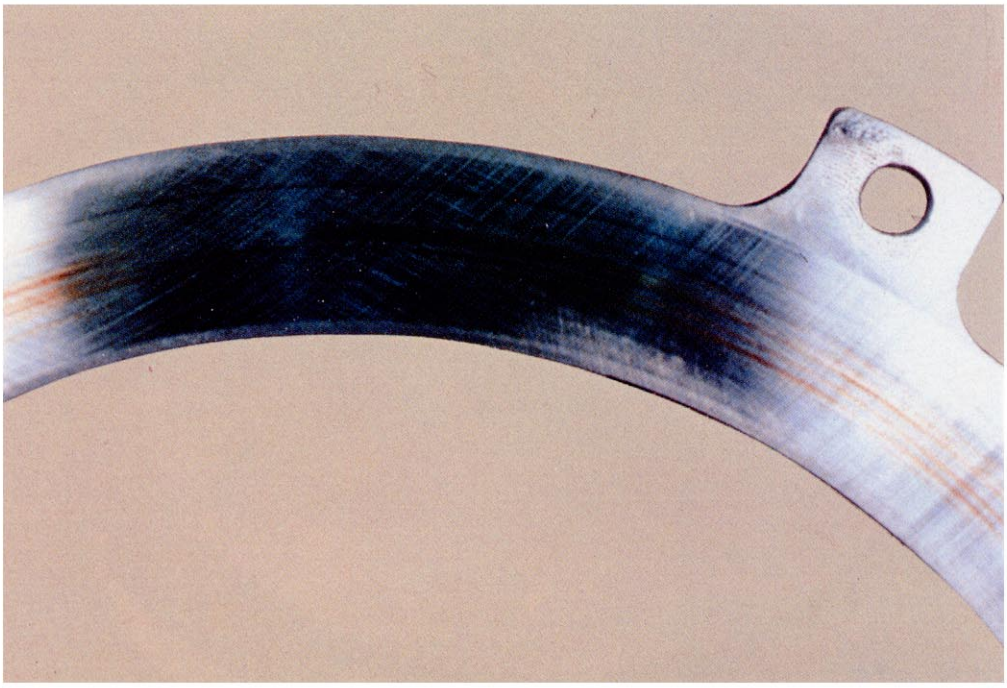
- The occurrence rate of heat spots is less than 10%.



DO NOT USE AGAIN

Failure Signs

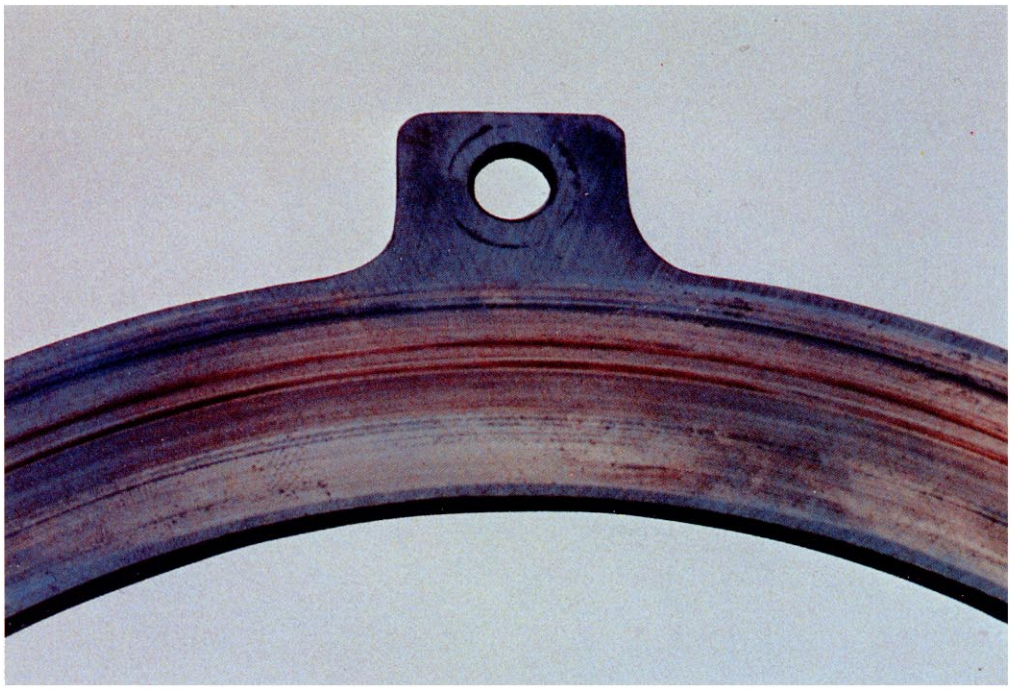
- The occurrence rate of heat spots is 70%.



USE AGAIN

Failure Signs

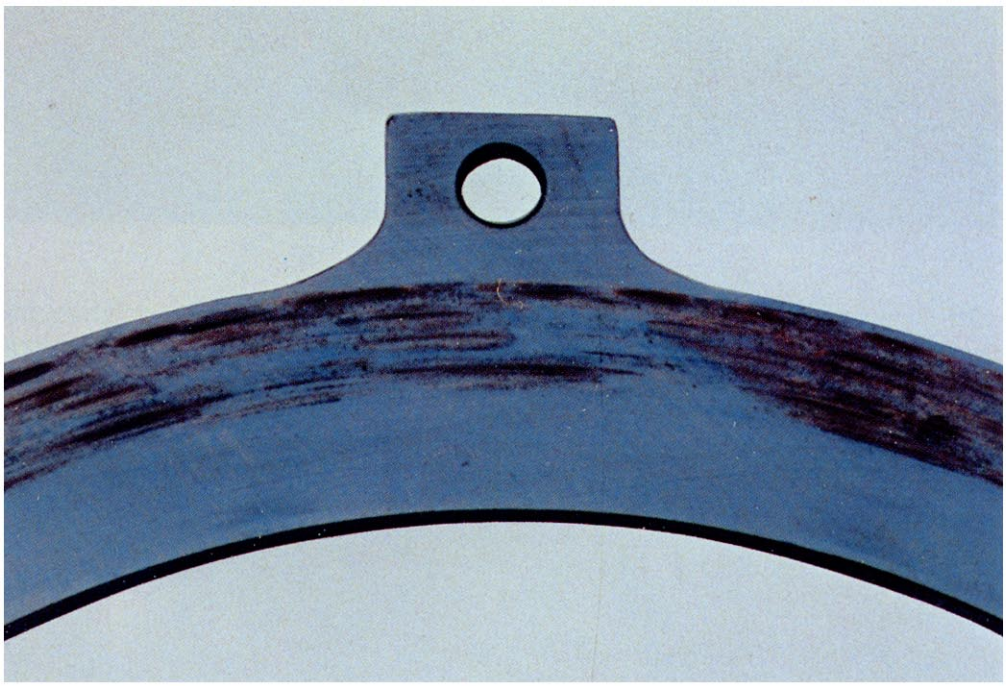
- The occurrence rate of smear is less than 5%.



USE AFTER RECONDITIONING

Failure Signs

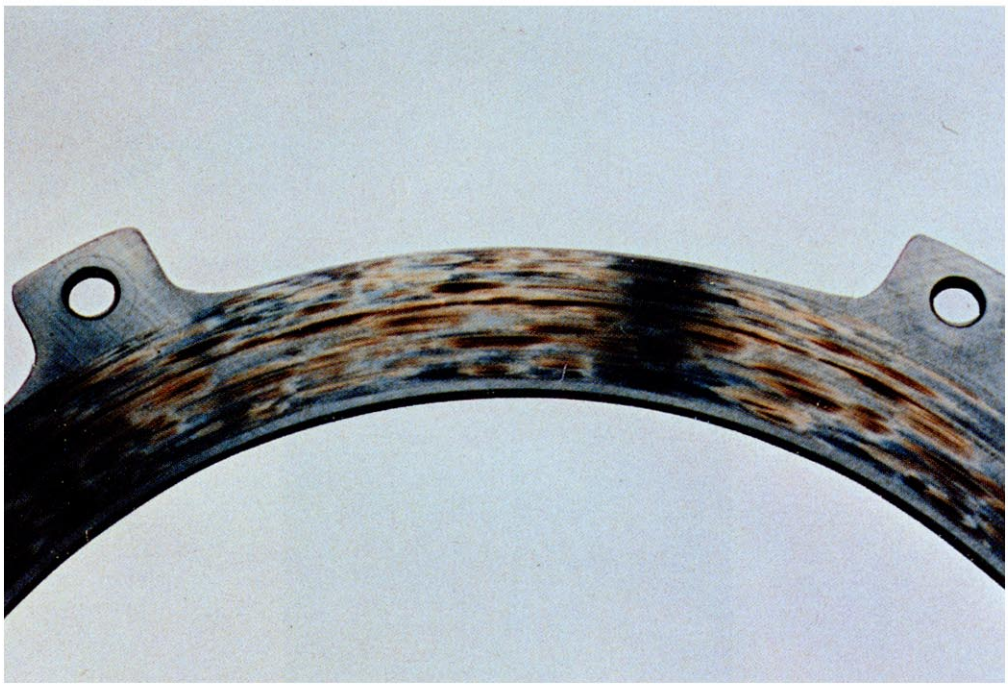
- The occurrence rate of smear is less than 30%.



USE AFTER RECONDITIONING

Failure Signs

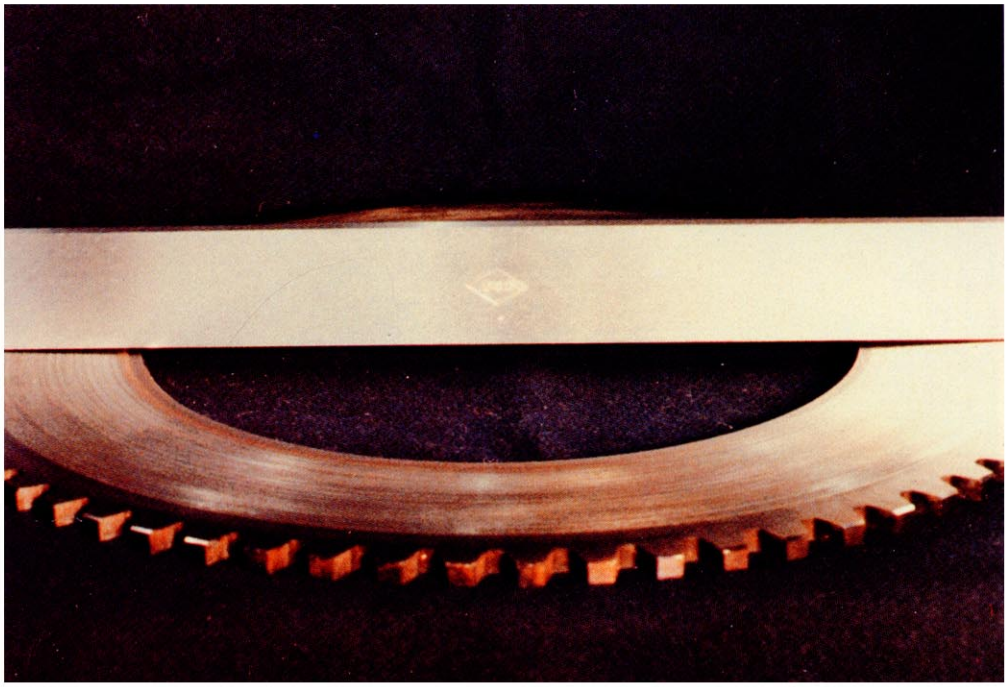
- The occurrence rate of smear is less than 30%.



DO NOT USE AGAIN

Failure Signs

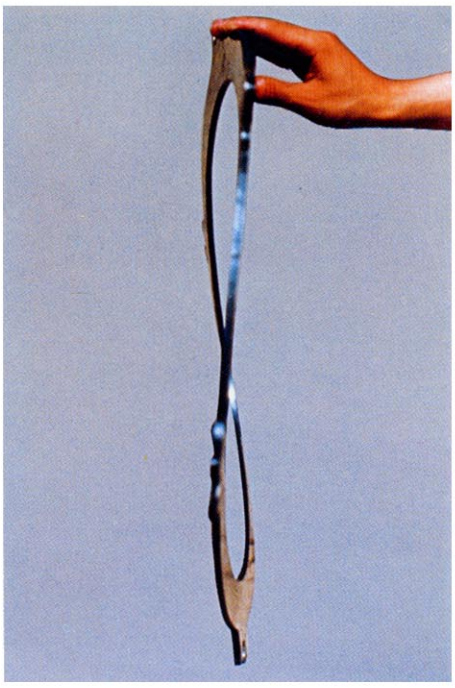
- The occurrence rate of smear is 60%.



DO NOT USE AGAIN

Failure Signs

- Dish visible clearly.



DO NOT USE AGAIN

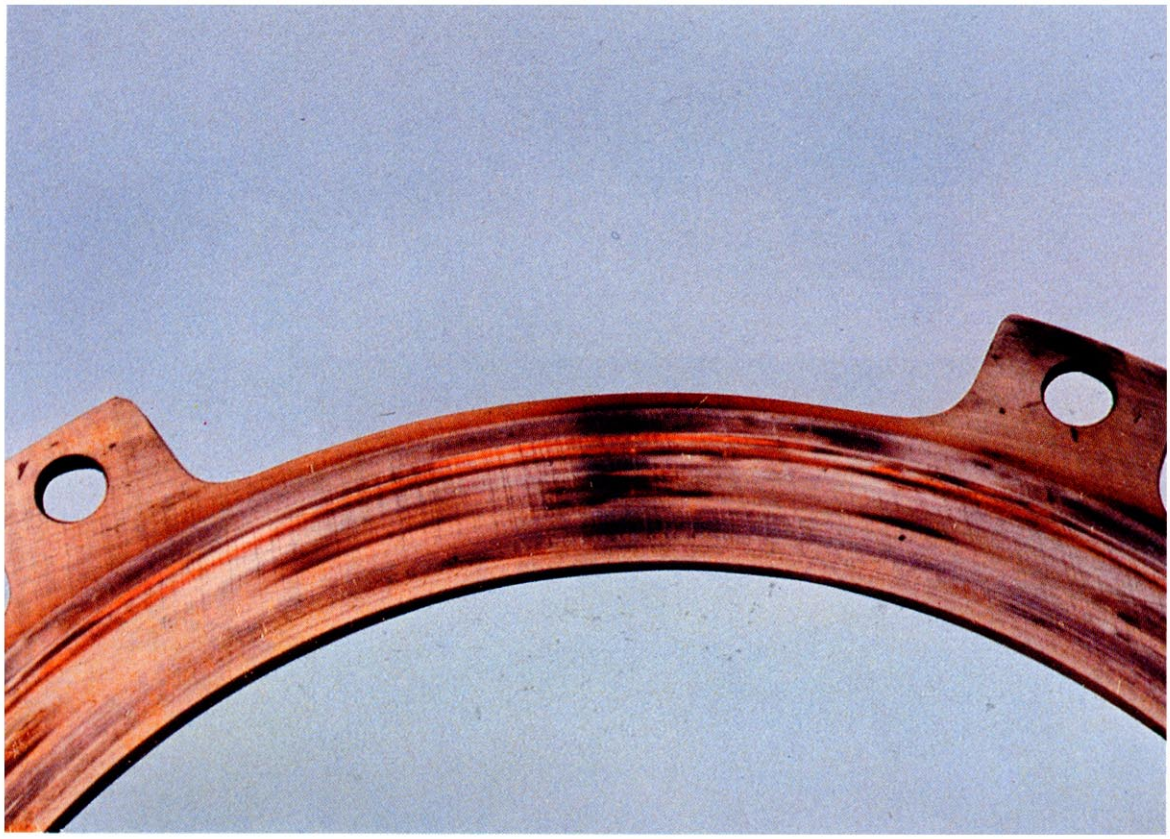
Failure Signs

- Wavy deformation.

Smear

Sintered metal particles rubbed from the disc friction surface are stuck to the plate surface due to the frictional heat.

Such a symptom is called "smear".

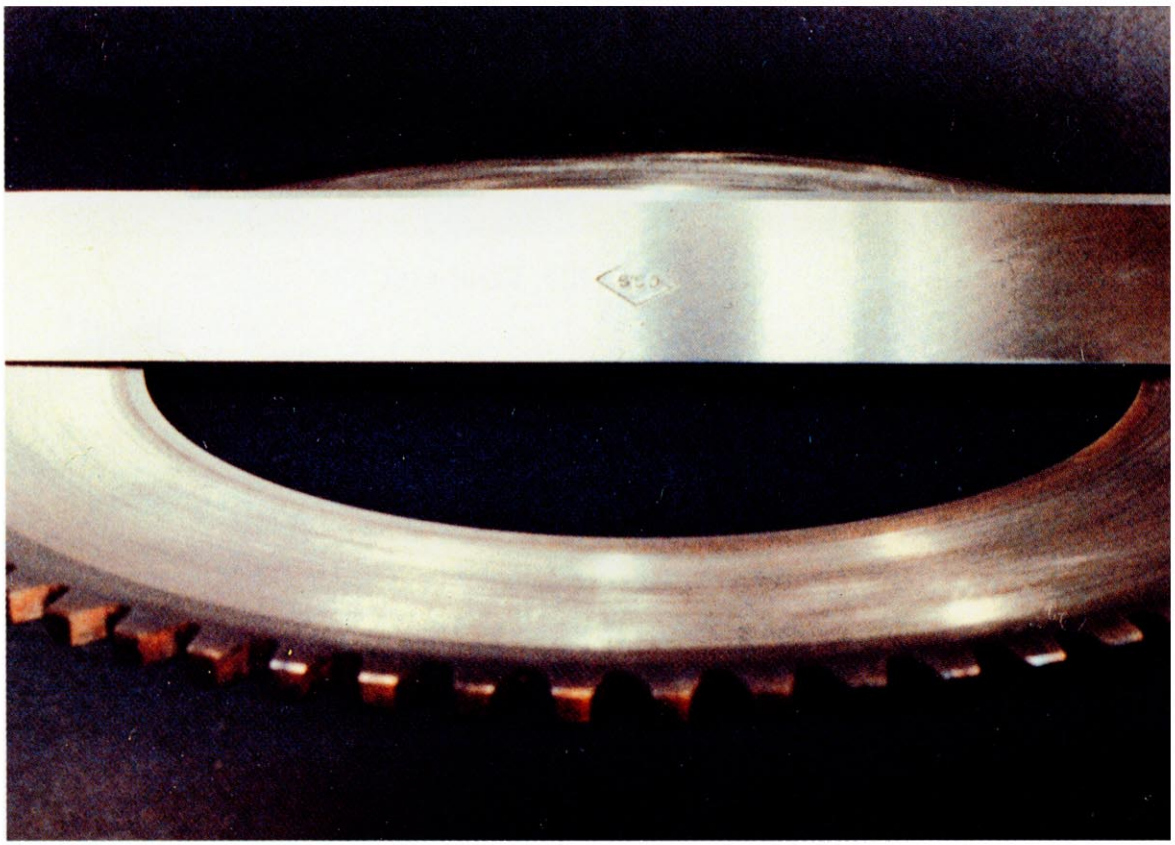


Causes

- Poor lubrication
- Oil pressure drop

Deformation

Dished or wavy plate deformation occurs when the plate temperature is elevated excessively by the frictional heat. This frictional heat is generated by the extreme slippage between discs and plates during their frequent engagement and disengagement.



* Whenever plates are deformed, the mating discs should be checked for deformation.

Causes

- Poor lubrication
- Slipping due to oil pressure drop.

THICKNESS CRITERIA

Unit : mm

Parts No.	Standard size	Tolerance	Repair limit	Remedy
22X-15-22710	3.0	±0.1	2.5	Replace
23S-15-12730	5.0		4.5	
23S-15-12740	3.0		2.5	
561-15-42711	5.4		4.9	
561-15-42721	5.4		4.9	
561-15-42811	5.4		4.9	
566-15-62721	5.0		4.5	
569-15-32721	5.0		4.5	
569-15-32811	5.4		4.9	

FORM NO. SEBG4220-01

KOMATSU

Printed in Japan