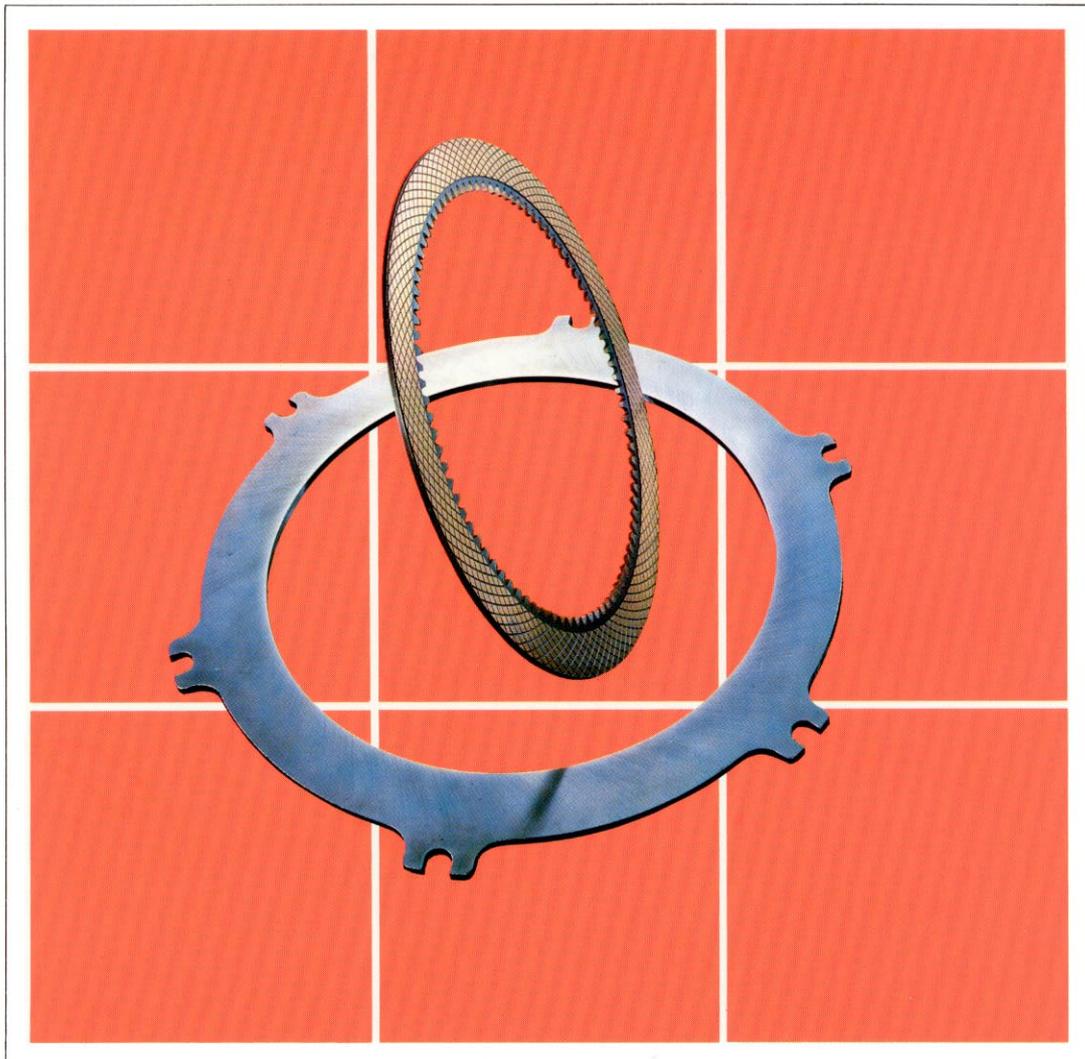


SHOP MANUAL



GUIDANCE FOR REUSABLE PARTS

CLUTCH PLATES AND DISCS



GUIDANCE FOR REUSABLE PARTS
KOMATSU

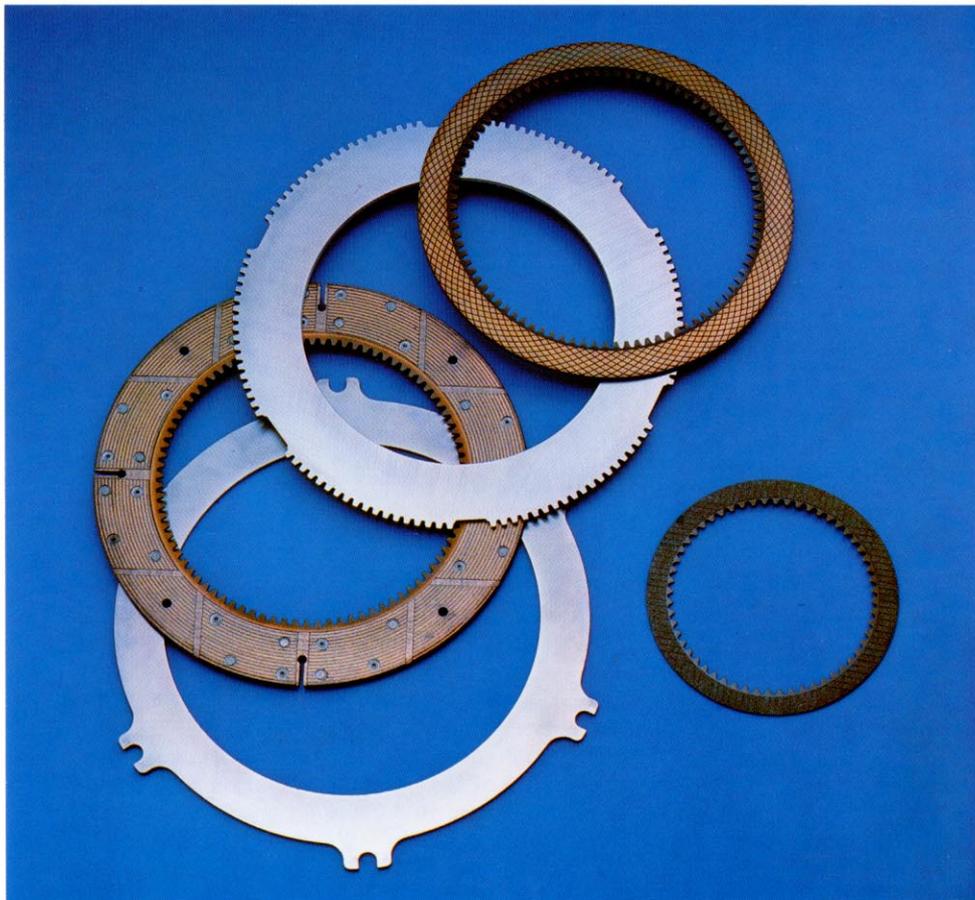
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INTRODUCTION

As an aid for disassembly, assembly, and repair of construction machines, this GUIDANCE FOR REUSABLE PARTS, "CLUTCH DISCS AND PLATES", is intended to describe the failure diagnosis of clutch discs and plates and indicate criteria for their reusability. In addition, this GUIDANCE describes the fundamentals of clutch plates and discs as well as their failure causes.

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.

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	<ul style="list-style-type: none"> ● Chipped, eroded friction disc ● Broken surface groove on friction disc ● Deformation ● Amount of wear on the friction surface ● Damaged or discolored surface ● Worn or cracked teeth
Plate	<ul style="list-style-type: none"> ● Discolored, seized or scored friction surface ● Deformation ● Amount of wear on the friction surface ● Worn teeth ● Cracked tooth roots and friction surface

Standards for Failure Determination

Rank	Failure degree
Use again	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 after reconditioning	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.
Do not use again	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.

*For the criteria of ordinary wear on clutch discs and plates, refer to the maintenance standard given in applicable shop manuals.

Discs : Determination for Reusage

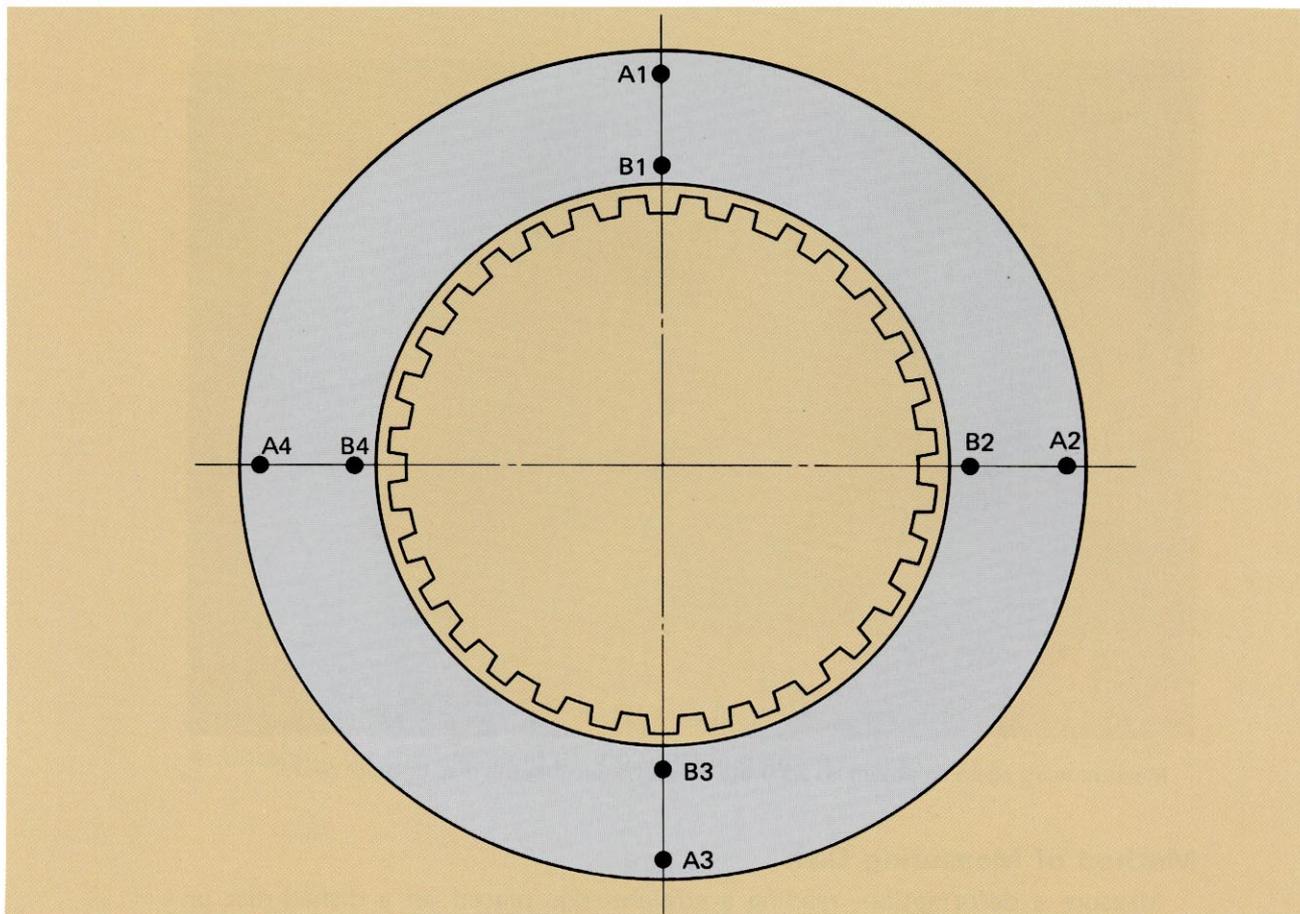
Failure	Rank	Failure degree
Wear	Use again	<ul style="list-style-type: none"> • The plate thickness is within the allowable range specified in an applicable shop Manual. • Lack of uniformity of the radial plate thickness ranges from 0.01 to 0.02mm and that of the overall thickness is 0.04mm maximum.
	Do not use again	<ul style="list-style-type: none"> • Worn more than discribed above.
Chipping	Use again	<ul style="list-style-type: none"> • 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.
	Do not use again	<ul style="list-style-type: none"> • Chipped more than discribed above.
Erosion	Use again	<ul style="list-style-type: none"> • Light erosion.
	Do not use again	<ul style="list-style-type: none"> • Heavy erosion.
Plastic flow of surface	Use again	<ul style="list-style-type: none"> • No plastic flow of metal in the surface layer.
	Do not use again	<ul style="list-style-type: none"> • Plastic flow of metal is observed.
Deformation	Use again	<ul style="list-style-type: none"> • In warp <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> 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
	Do not use again	<ul style="list-style-type: none"> • Deformed more than discribed above.
Damage on teeth	Use again	<ul style="list-style-type: none"> • No excessive wear or cracks on teeth.
	Do not use again	<ul style="list-style-type: none"> • Badly worn or cracked.

Plates : Determination for Reusage

Failure	Rank	Failure degree
Wear	Use again	<ul style="list-style-type: none"> The plate thickness is within the allowable range specified in an applicable Shop Manual and lack of uniformity of the radial thickness is less than 0.05mm without the rugged surface.
	Use after reconditioning	<ul style="list-style-type: none"> A plate in the same conditions as described above and having the rugged surface.
	Do not use again	<ul style="list-style-type: none"> Those plates which have worn more than described above.
Blue Temper	Use again	<ul style="list-style-type: none"> No blue temper is observed at all.
	Do not use again	<ul style="list-style-type: none"> Blue temper is observed. The plate is annealed, resulting in the low hardness.
Heat spot	Use again	<ul style="list-style-type: none"> No "heat spot" is observed.
	Use after reconditioning	<ul style="list-style-type: none"> When the occurrence rate of heat spots is less than 10%.
	Do not use again	<ul style="list-style-type: none"> When the occurrence rate of heat spots exceeds 10%.
Smearing	Use again	<ul style="list-style-type: none"> When the occurrence rate of smearing is less than 5%.
	Use after reconditioning	<ul style="list-style-type: none"> When the occurrence rate of smearing ranges from 5% to 30%.
	Do not use again	<ul style="list-style-type: none"> When the occurrence rate of smearing exceeds 30%.
In circumferential grooves	Use again	<ul style="list-style-type: none"> No circumferential grooves.
	Use after reconditioning	<ul style="list-style-type: none"> Plate thickness is within the specified allowable limit.
	Do not use again	<ul style="list-style-type: none"> Plate thickness is out of the specified limit.
Deformation	Use again	<ul style="list-style-type: none"> In warp <ol style="list-style-type: none"> Plate of 400mm or more in O.D. Less than 0.6mm Plate of less than 400mm in O.D. Less than 0.3mm In dish <ol style="list-style-type: none"> Plate of 400mm or more in O.D. Less than 0.2mm Plate of less than 400mm in O.D. Less than 0.1mm
	Do not use again	<ul style="list-style-type: none"> Deformed more than described above.

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 or plate on a surface plate and measure warp along the outside and inside diameters, using a thickness gauge.



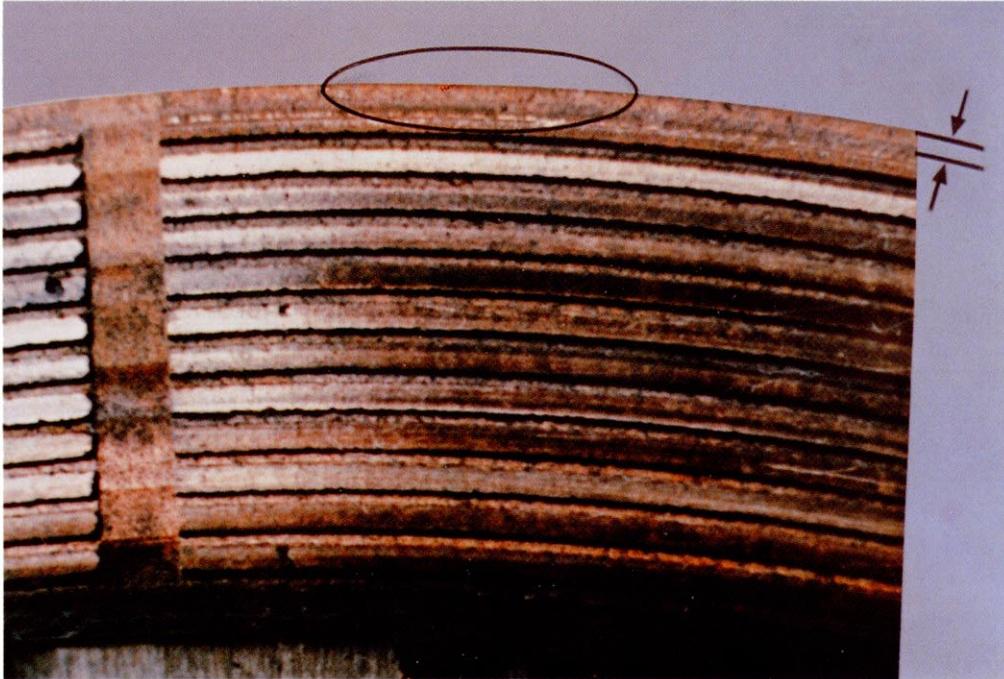
* Measure warp again to obtain an accurate value, by turning the disc or plate over.

Method of Measuring Dish

Measure a deformation, reading a straight-edge placed on a dished disc or plate along its diameter.



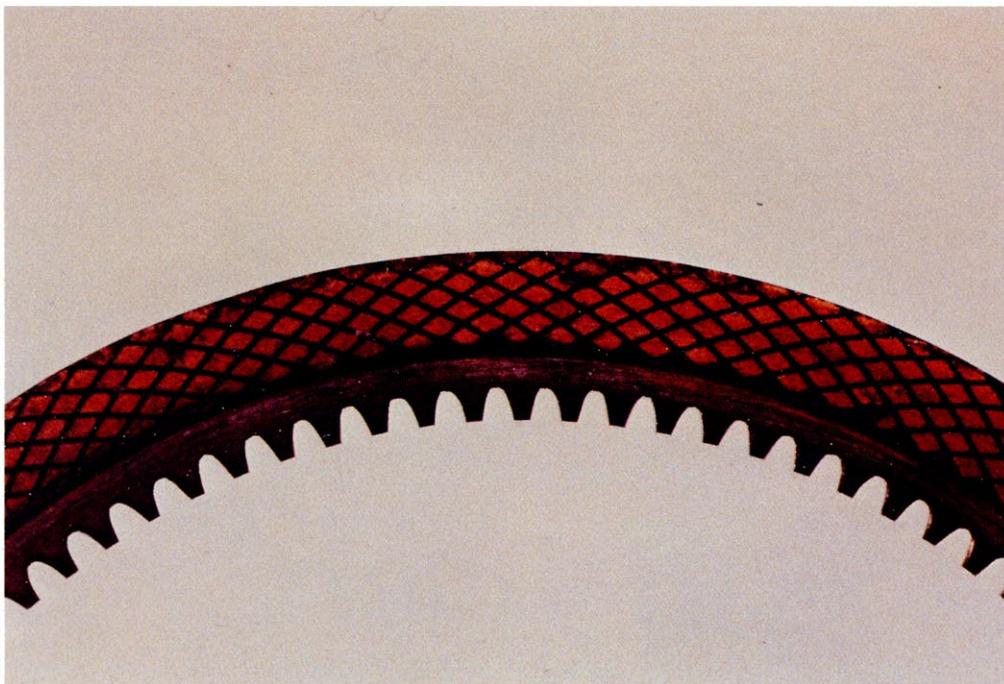
Clutch Disc



USE AGAIN

Failure Signs

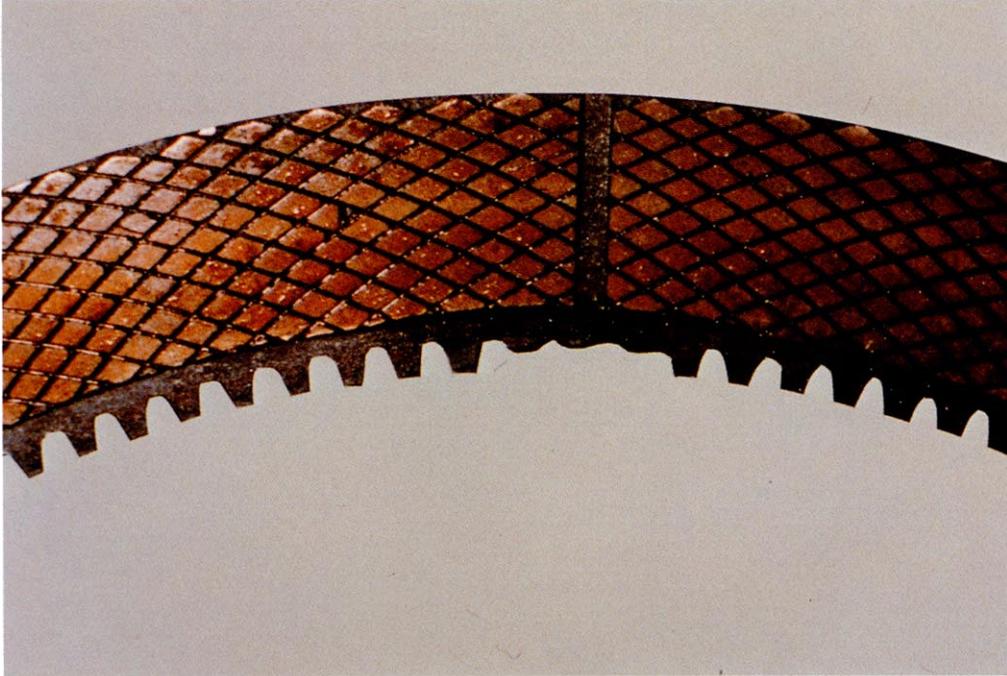
- Chipping on the first land of the outside diameter.



USE AGAIN

Failure Signs

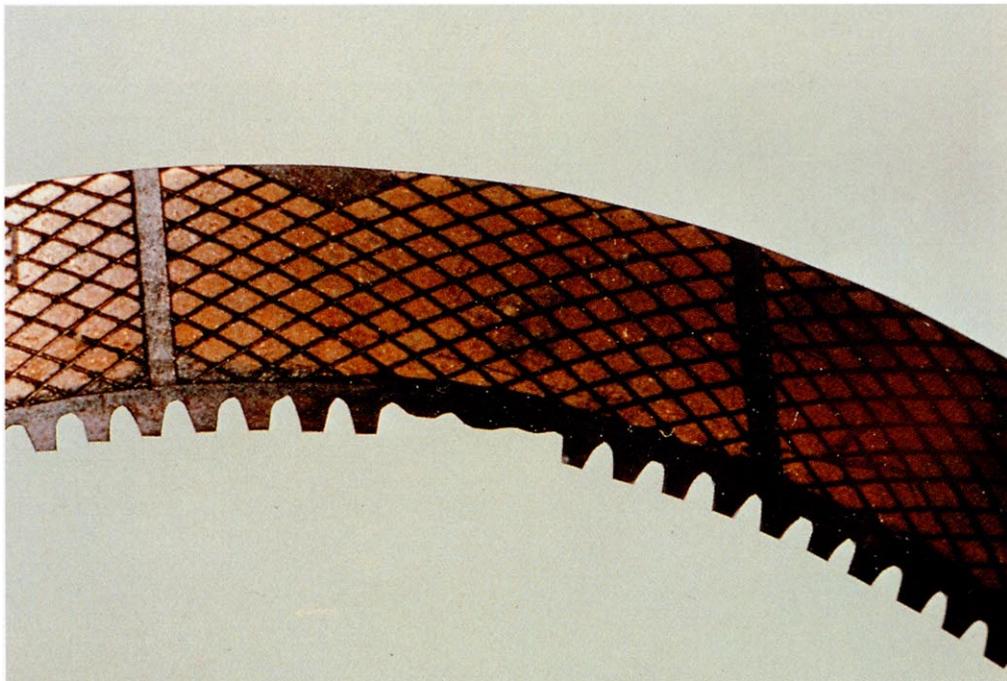
- Chipping on the triangular land of the inside diameter.



USE AGAIN

Failure Signs

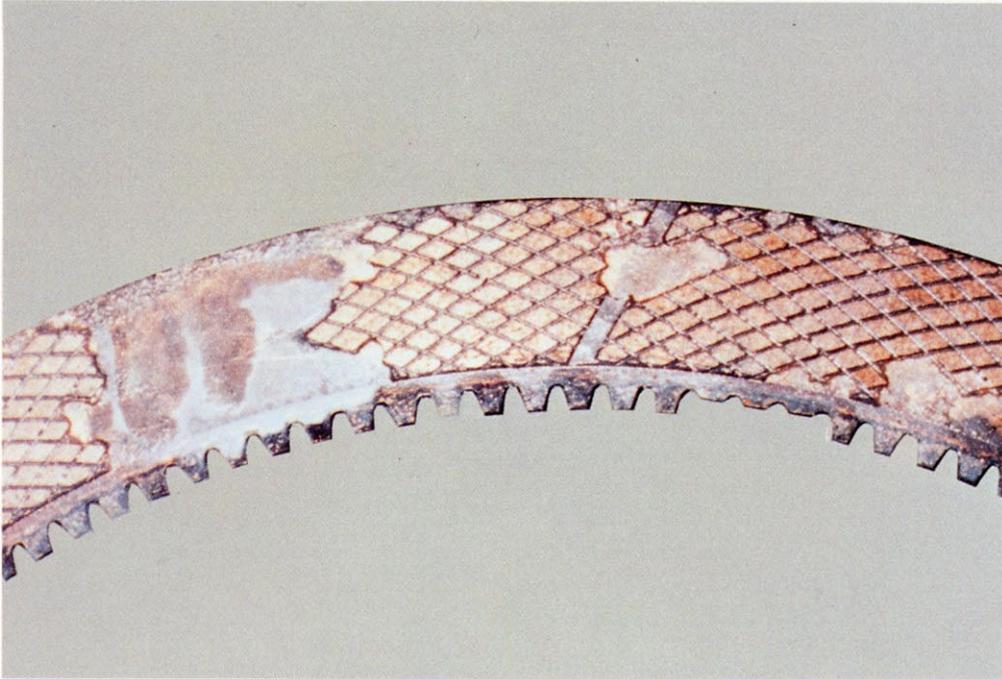
- Chipping on the triangular land of the outside diameter.



DO NOT USE AGAIN

Failure Signs

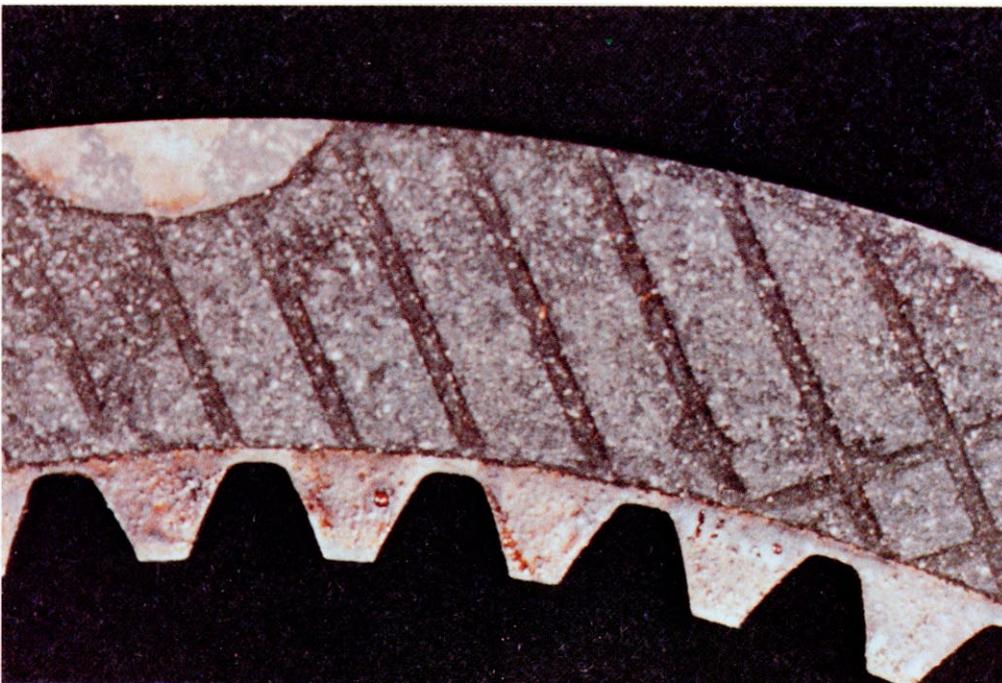
- Chipping reaching a diamond-shaped portion.



DO NOT USE AGAIN

Failure Signs

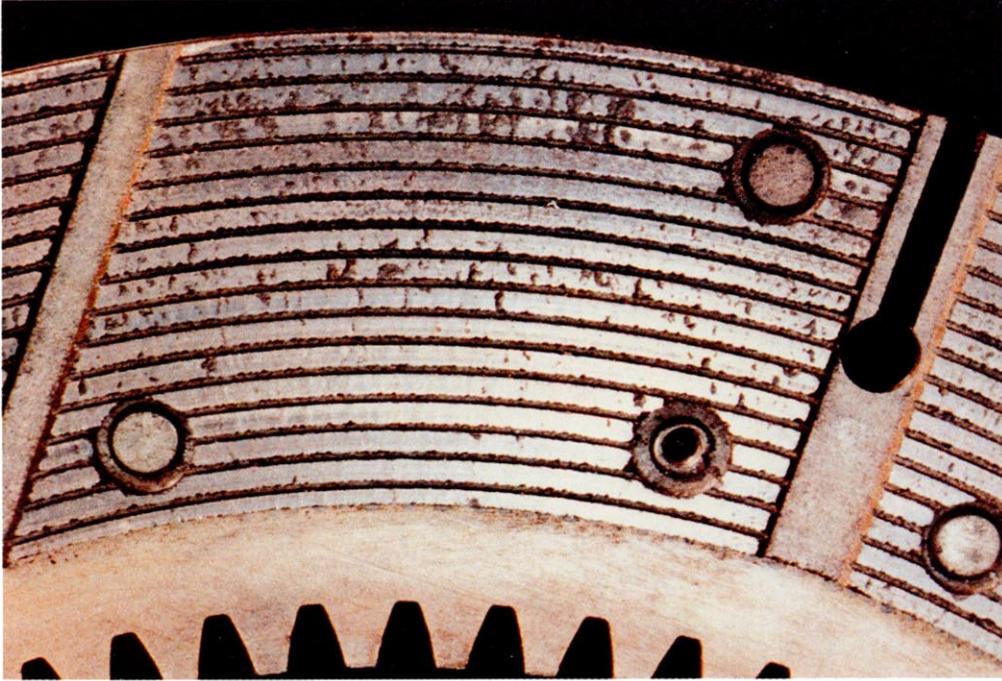
- Friction material is thoroughly chipped off, extending from the inside to the outside diameter.



DO NOT USE AGAIN

Failure Signs

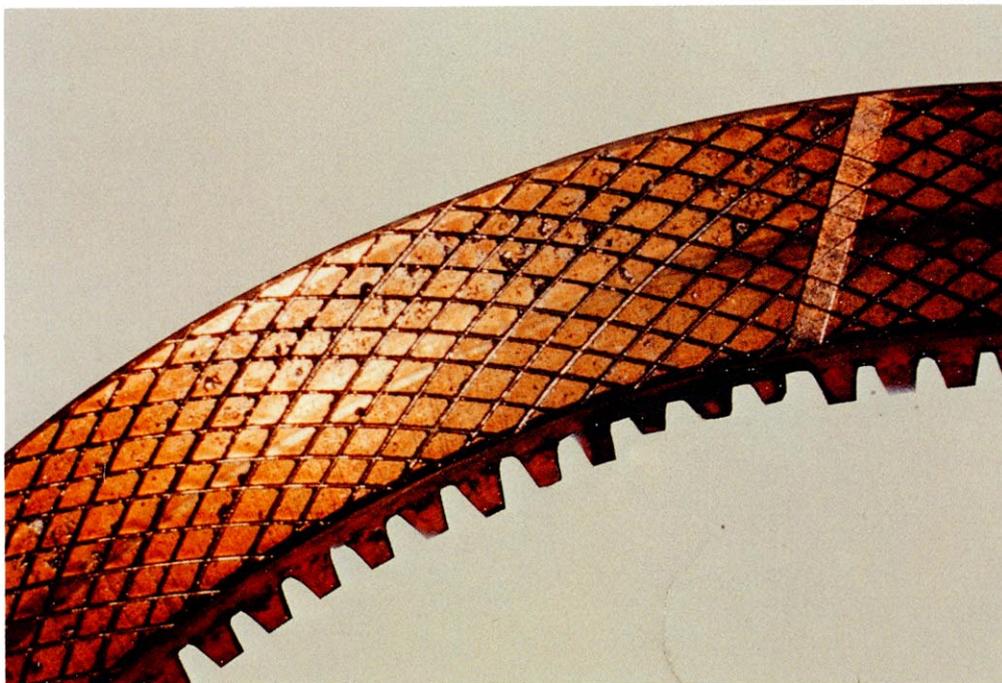
- Friction material is thoroughly chipped off on this paper disc.



DO NOT USE AGAIN

Failure Signs

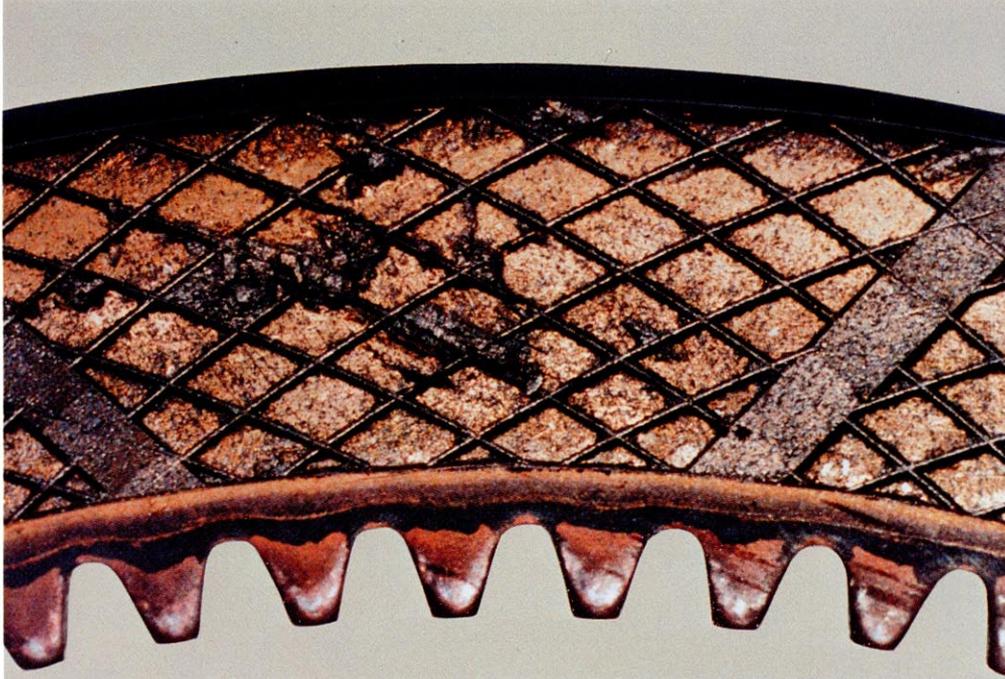
- Erosion on spiral grooves.



DO NOT USE AGAIN

Failure Signs

- Erosion on grooves of diamond-pattern.



DO NOT USE AGAIN

Failure Signs

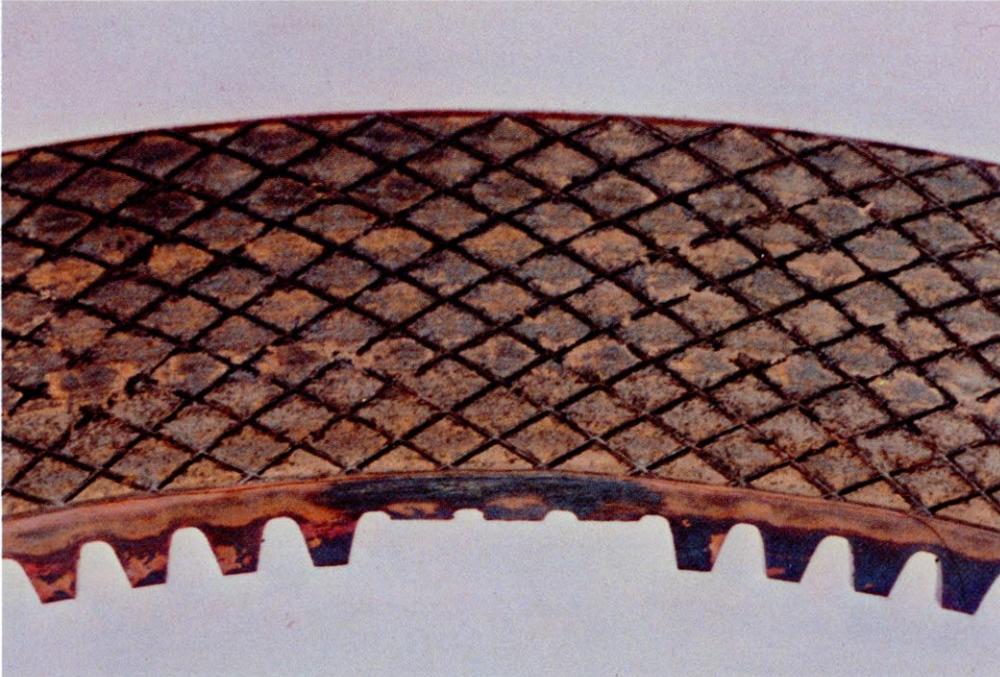
- Erosion developed to the size of one complete diamond-space.



DO NOT USE AGAIN

Failure Signs

- Erosion on paper disc surface.



DO NOT USE AGAIN

Failure Signs

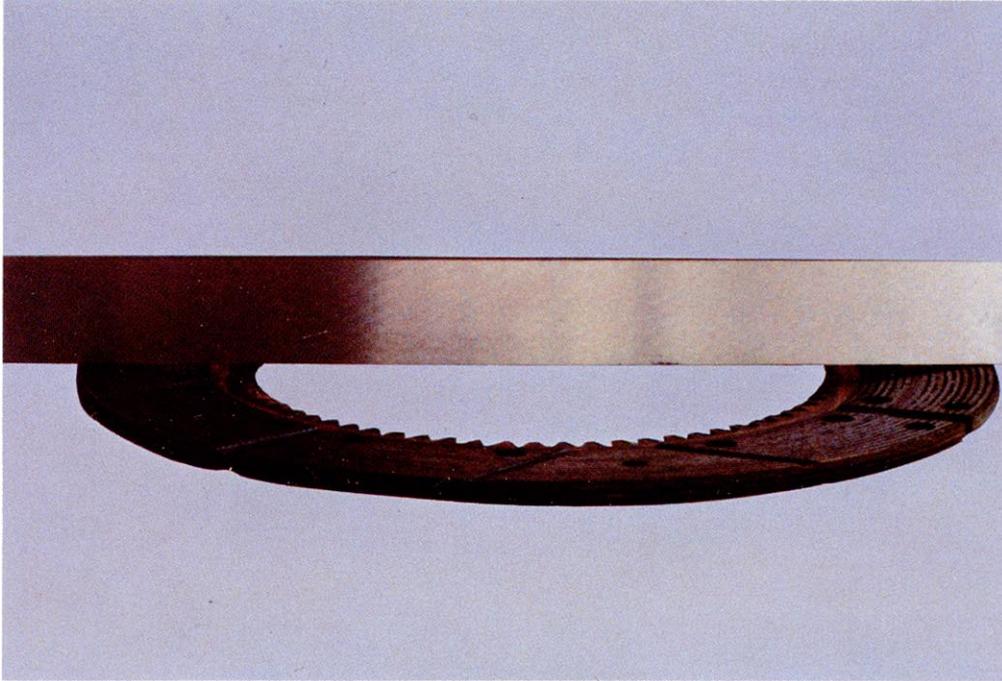
- Plastic flow showing crushed grooves dimly.



DO NOT USE AGAIN

Failure Signs

- Plastic flow showing crushed grooves distinctly.



DO NOT USE AGAIN

Failure Signs

- Dish visible clearly.

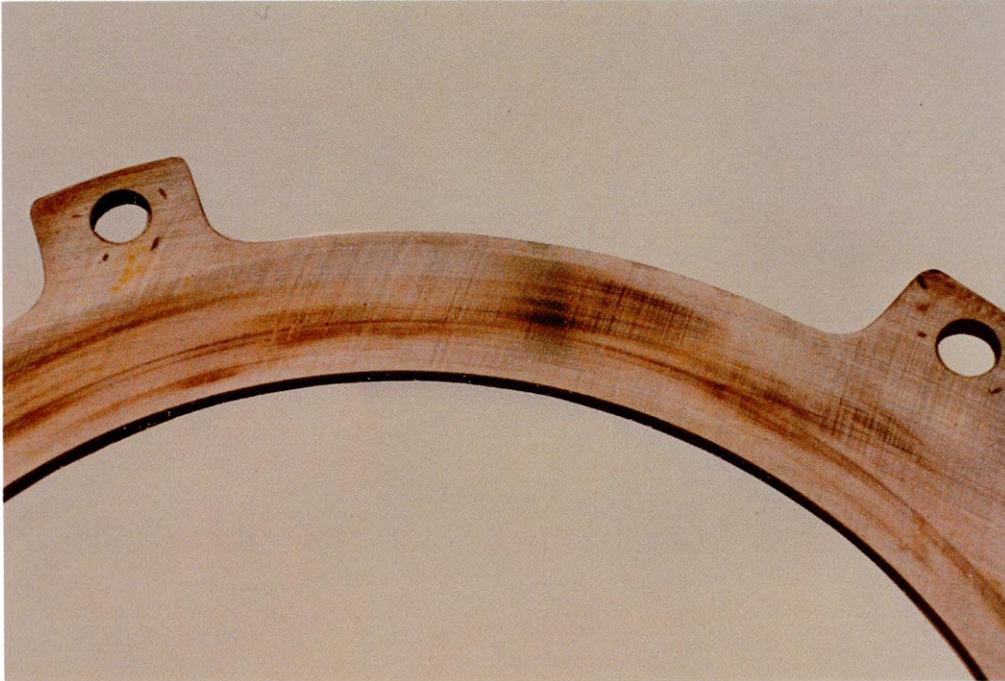


DO NOT USE AGAIN

Failure Signs

- Scratches on paper disc surface caused by foreign particles.

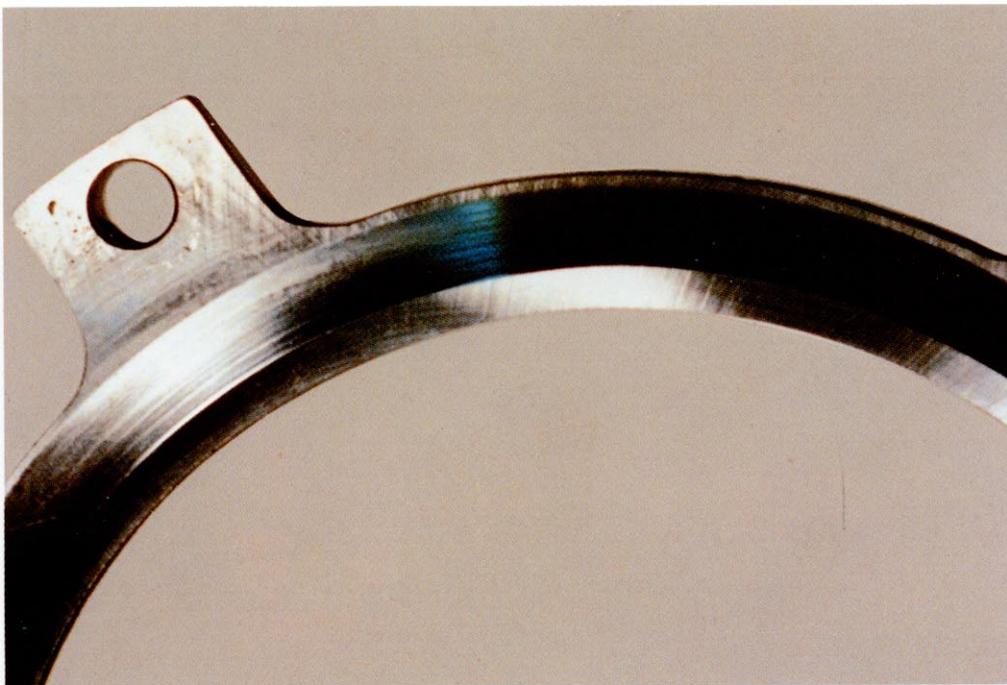
Clutch Plate



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

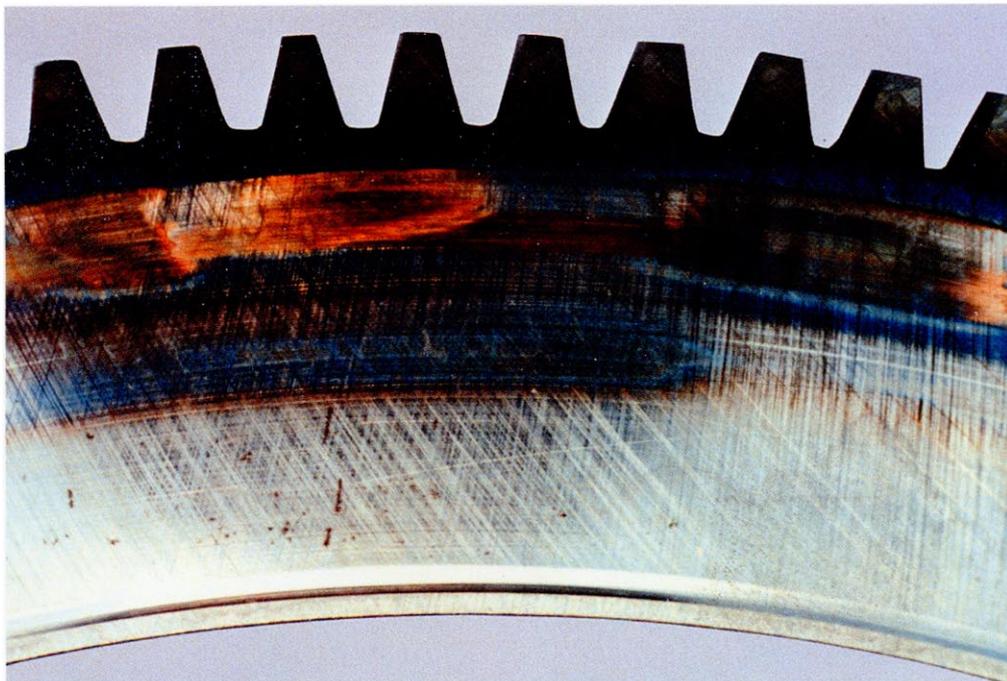
- Wear is uniform all over the surface but the plate thickness is within the specified allowable limit. This is an example of roughed surface.



DO NOT USE AGAIN

Failure Signs

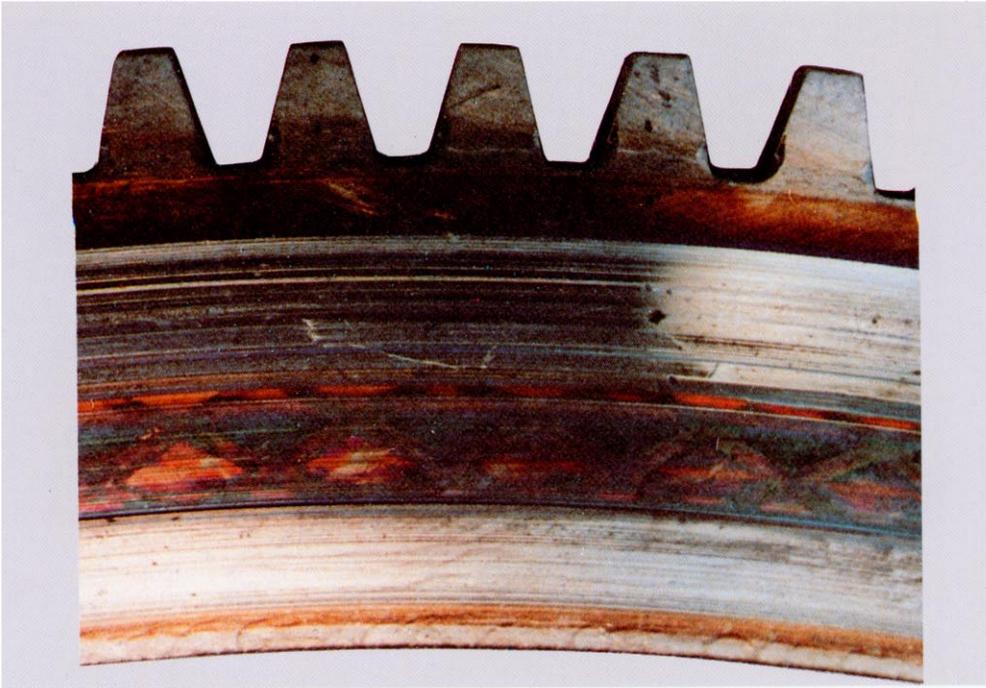
- The surface has been worn out like the surface of gramophone record because of radial spiral grooves on disc. Smear has also occurred.



DO NOT USE AGAIN

Failure Signs

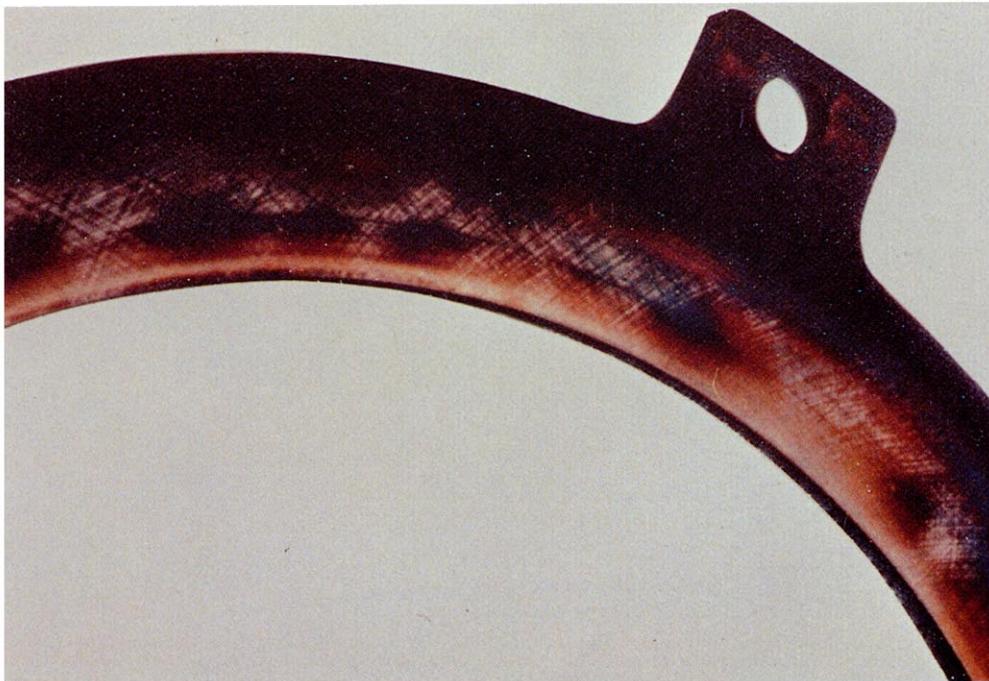
- Blue temper on clutch plate.



DO NOT USE AGAIN

Failure Signs

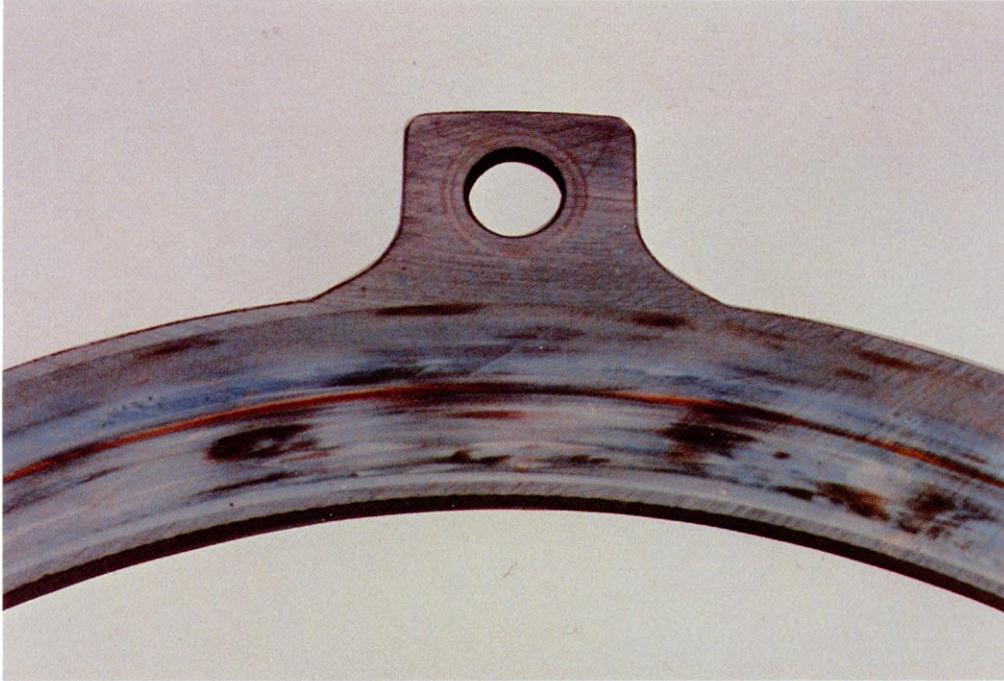
- The plate friction surface has been worn out. This blue temper is caused by uneven contact with disc or by a chipped disc.



DO NOT USE AGAIN

Failure Signs

- Clutch plate shows blue-black color.



USE AFTER RECONDITIONING

Failure Signs

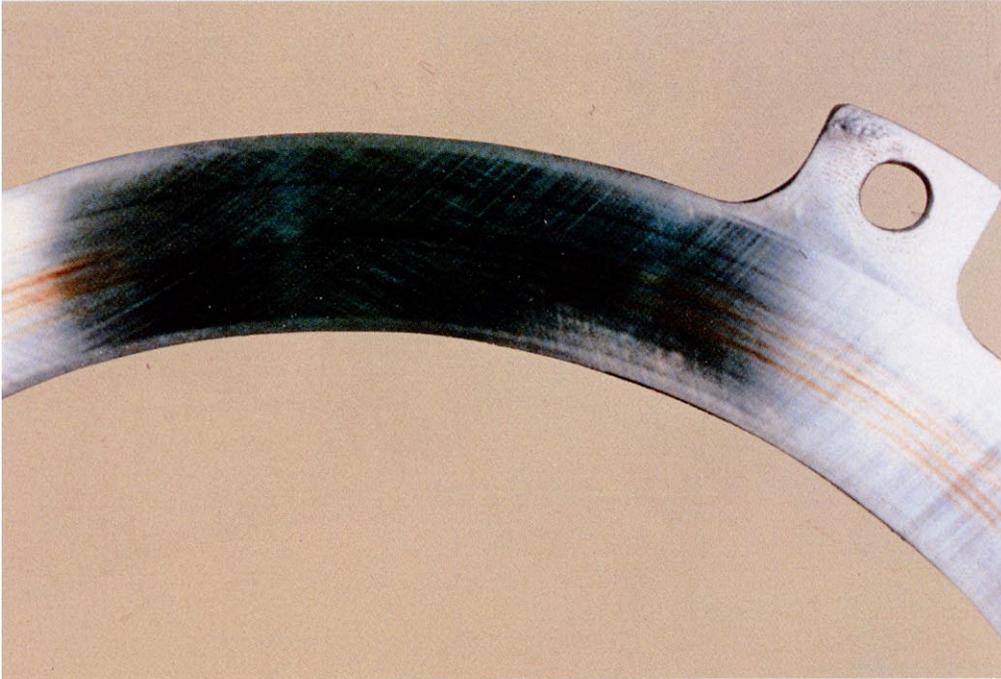
- The occurrence rate of heat spots is less than 10%.



DO NOT USE AGAIN

Failure Signs

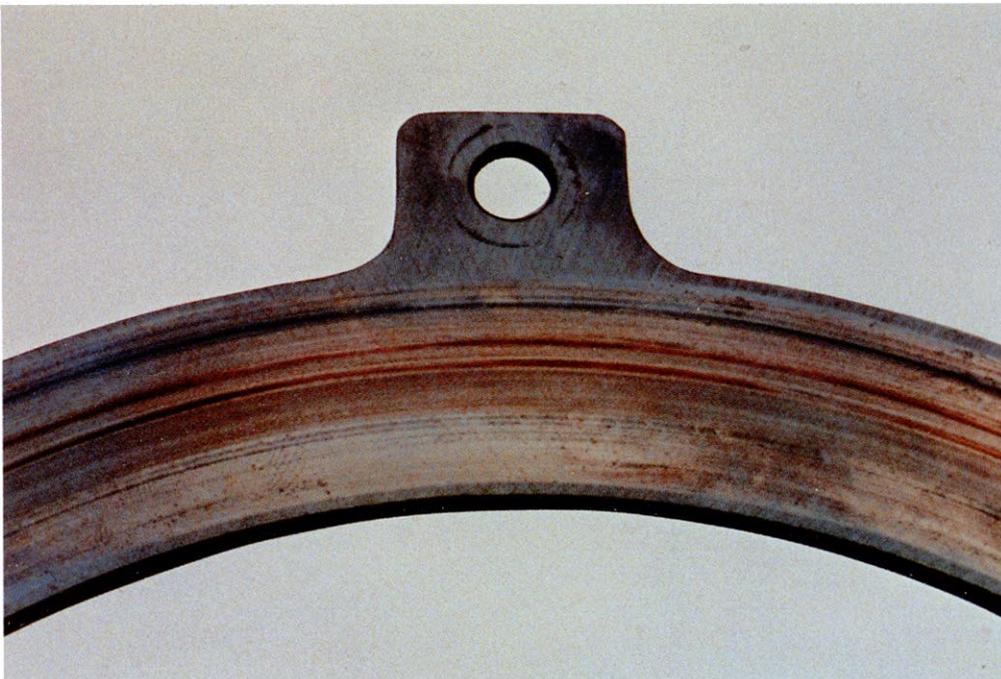
- The occurrence rate of heat spots is 70%.



USE AGAIN

Failure Signs

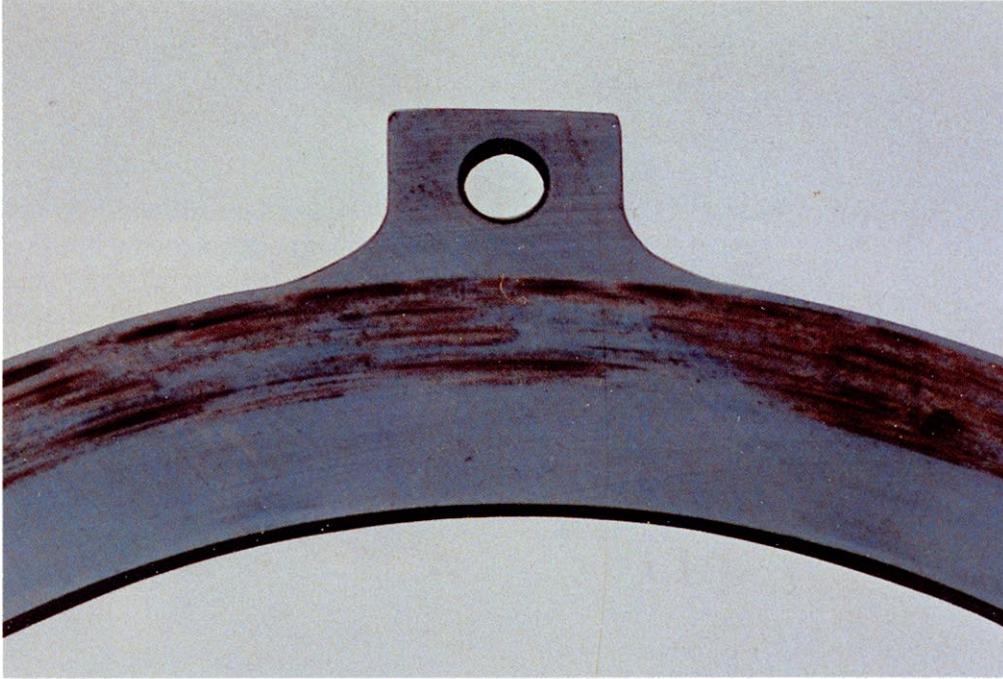
- The occurrence rate of smear is less than 5%.



USE AFTER RECONDITIONING

Failure Signs

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



USE AFTER RECONDITIONING

Failure Signs

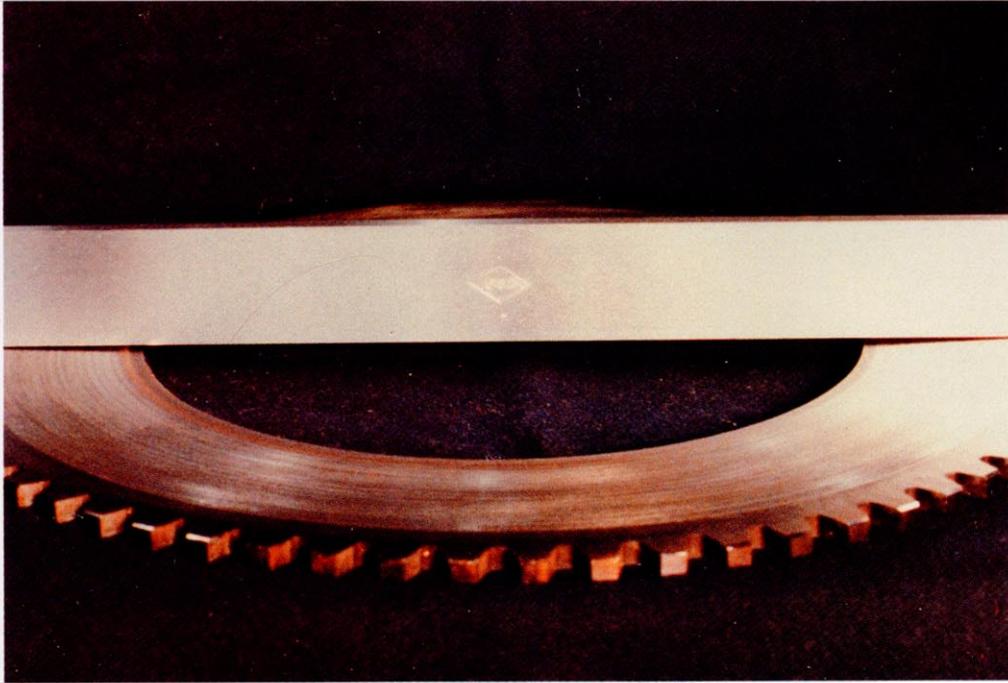
- The occurrence rate of smear is less than 30%.



DO NOT USE AGAIN

Failure Signs

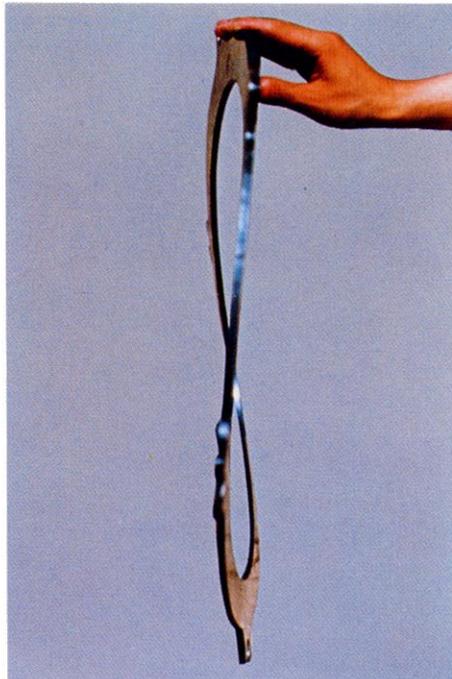
- The occurrence rate of smear is 60%.



DO NOT USE AGAIN

Failure Signs

- Dish visible clearly.



DO NOT USE AGAIN

Failure Signs

- Wavy deformation.

FAILURE ANALYSIS

Failure Causes

Discs and plates, component parts of clutches, are repeatedly engaged with or disengaged from each other. When engaging them, the frictional force and heat are generated.

Disc teeth, plate flanges and teeth are subjected to the reaction force of clutch torque due to the frictional force. Consequently, failures of discs and plates are classified into mechanical failures caused by the frictional force on friction surfaces, thermal failures caused by the frictional heat, and mechanical failures of disc teeth, plate flanges and teeth. The latter mechanical failures frequently occur the secondary failures of the other types of failures. In short, failures of discs and plates occur mainly in their frictional surfaces.

This GUIDANCE describes the failures mainly in the friction surfaces of 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 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 or seized discs or plates.

Lubricating Oil

Clutches are cooled with lube oil. If the oil temperature is elevated due to the over-heating, the clutch cooling effect will be deteriorated, causing the discs and plates to be smeared, seized or distorted.

Use of any other oils than those recommended and those different in viscosity as well as negligence of periodic oil changes cause such failures as seizure, chipping etc. to discs and plates.

Speed Change Control

The larger a variation in traveling speeds before and after a speed change control, the larger the heat to be generated will be. Consequently, frequent abrupt gearshifting causes discs and plates to be defective prematurely.

Half-Clutching Control

In a clutch mechanism, a half-clutching control can be made. Keeping a clutch in a half-engaged condition for many hours or frequently allows the clutch temperature to be elevated by the heat generated due to the clutch slippage, which in turn causes such failures as smear, seizure, deformation, excessive wear, etc. to discs and plates.

Infiltration of Dust, Water, etc.

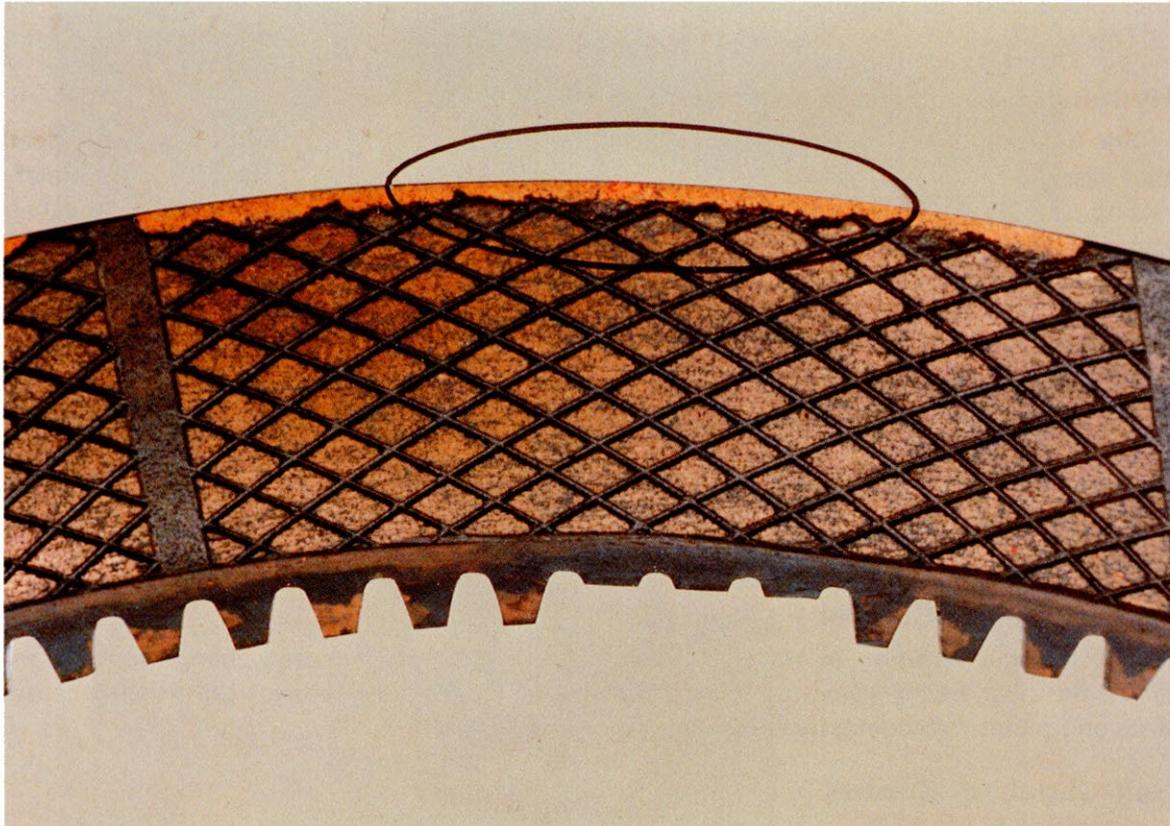
If dust, sand, or water infiltrates into clutches during oil level checking or oil change, it causes premature wear on their discs and plates.

TYPICAL EXAMPLES OF FAILURES

Disc Failures

Chipping

Chipping occurs frequently due to excessive heating in clutches, that is, the disc friction material is chipped off from the contacting surface with the core plate because of the high temperature.



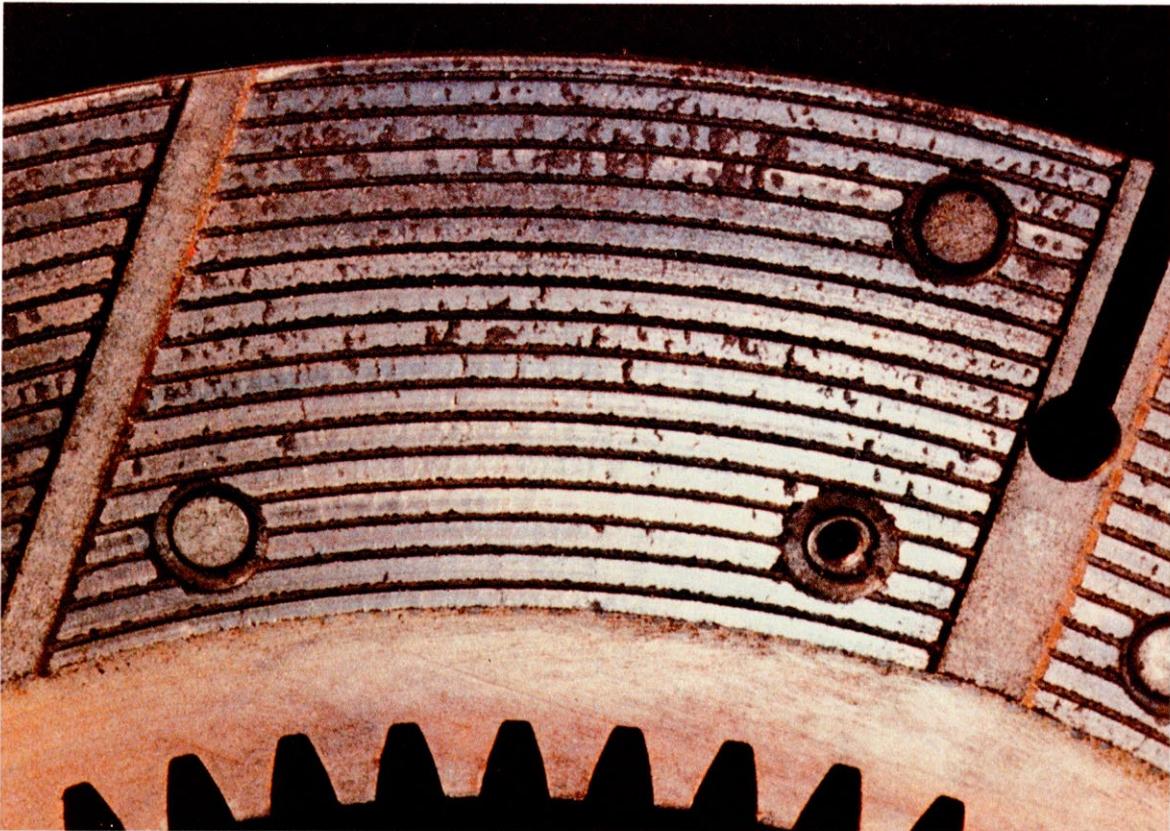
*In general, chipping occurs mostly along the outside diameter subject to friction.

Causes

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

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.

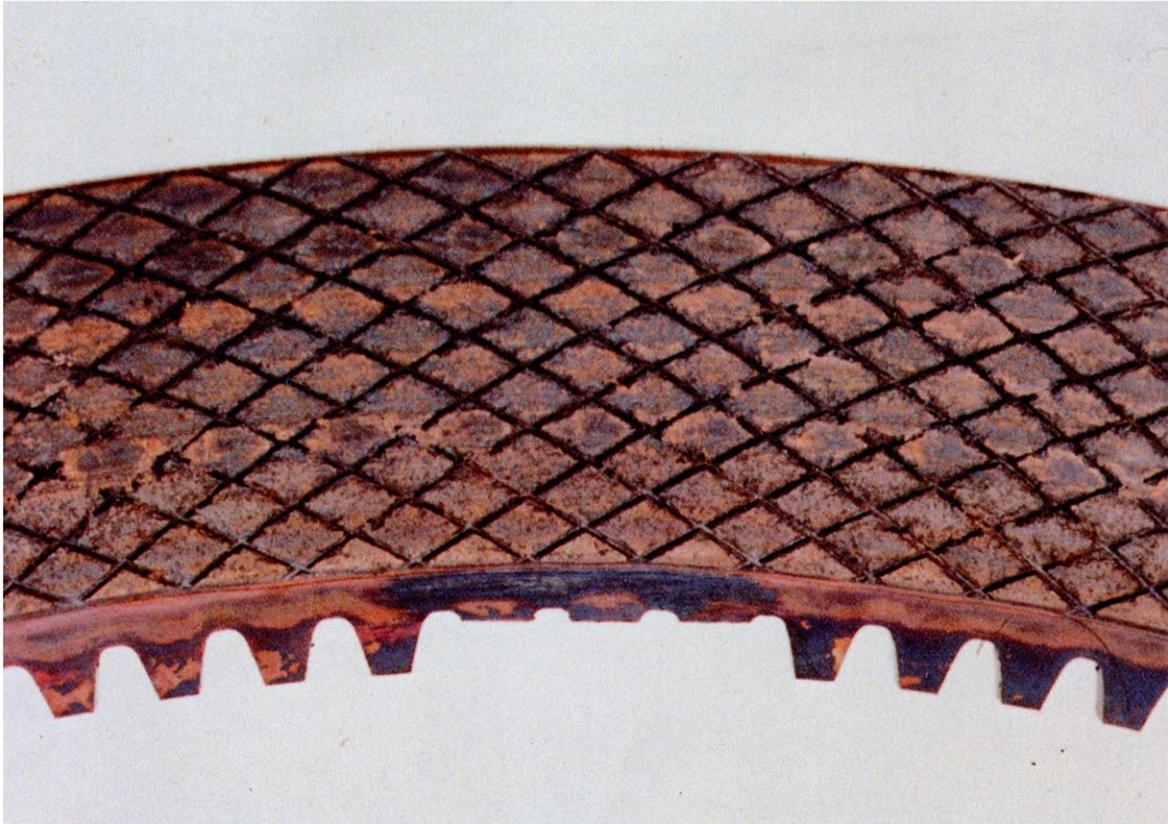


Causes

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

Plastic Flow of Metal in Surface Layer

The surface metal of friction material flows, if overheated in consequence of unsatisfactory lubrication, resulting in the grooves embedded with the metal.



Causes

- Slipping due to the oil pressure drop
- Poor lubrication
- Overheating
- Too frequent half-engagement of clutch
- Use of an improper type 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.



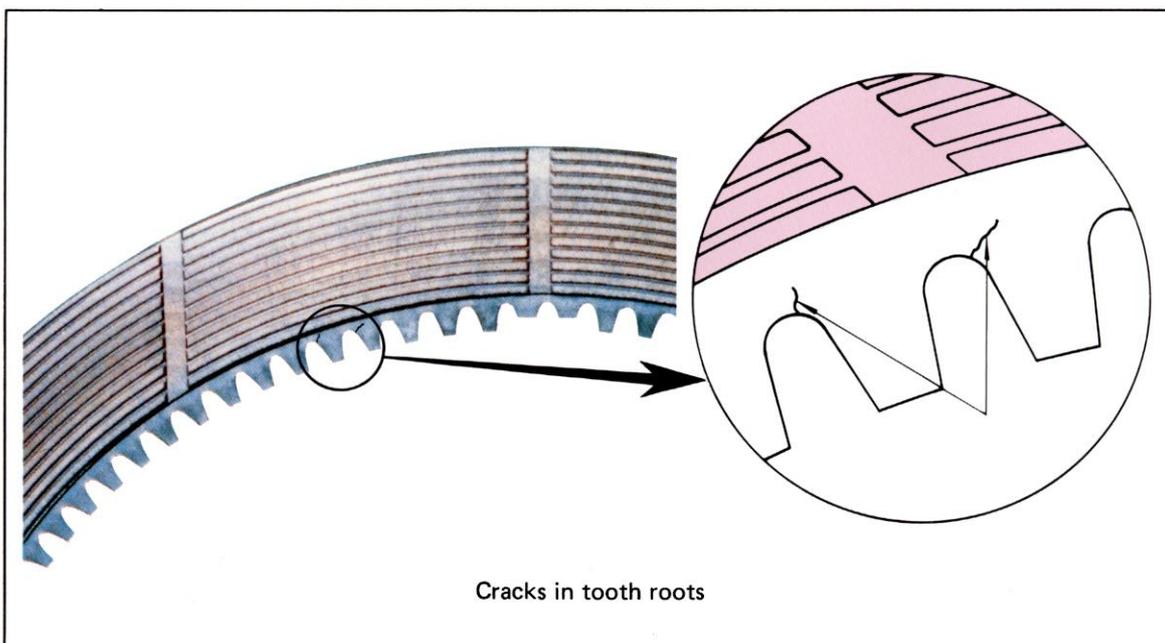
*Whenever discs are deformed, the mating plates should be checked for deformation.

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.

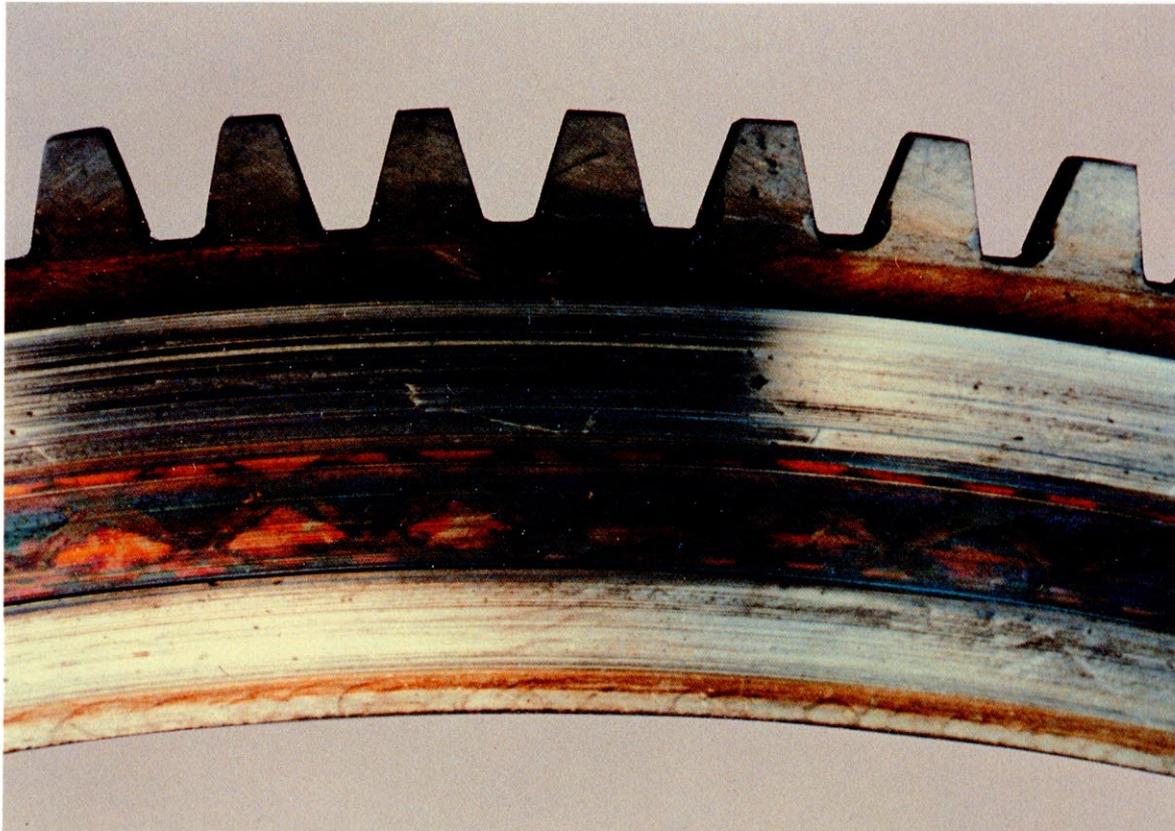


* Where the disc teeth have been worn out or cracked, the mating teeth should be checked for wear, cracks, etc. Cracks at the tooth roots are mostly caused by unsatisfactory operational control of clutches.

Plate Failures

Blue Temper

The temperature of plate surface is abruptly elevated by the heat generated in the frictional surfaces of the disc friction material and plates. As the result, the plates are tempered with the surfaces changed in color to blue.

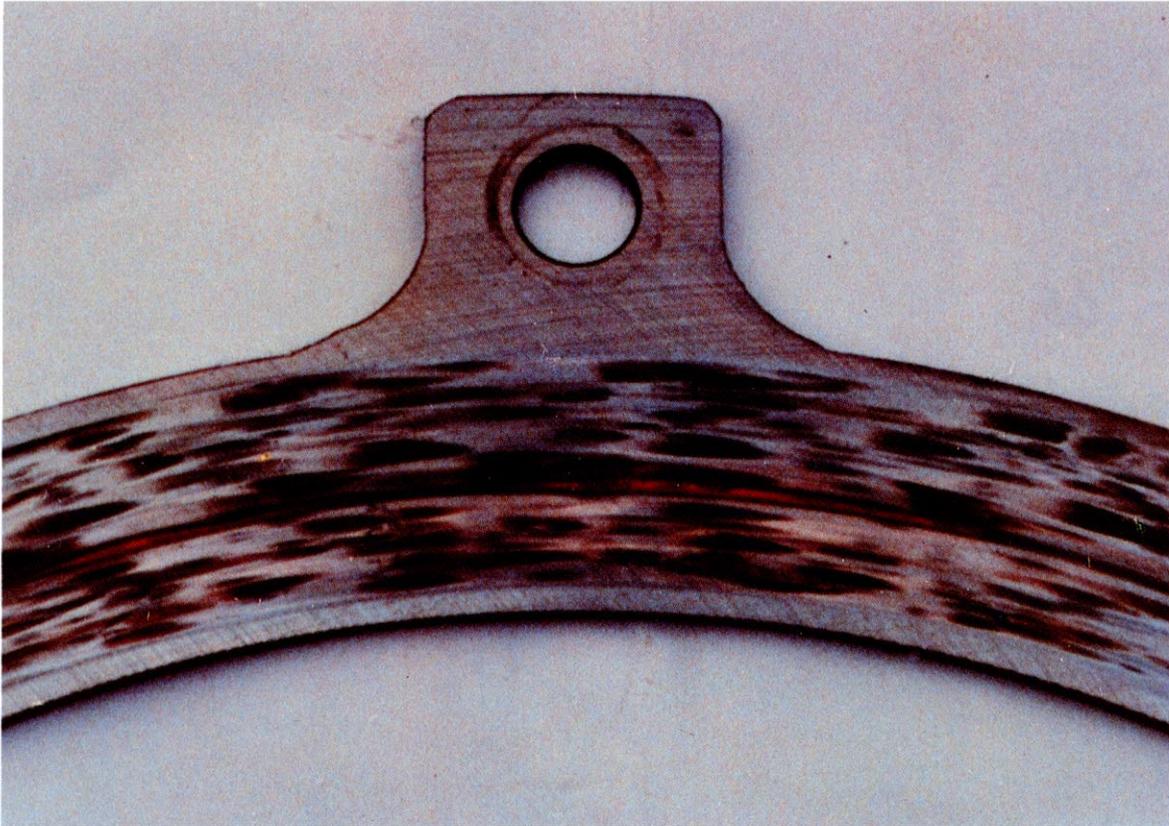


Causes

- Poor lubrication
- Oil pressure drop

Heat Spot

Such portions of the plate friction surface where the heat is generated locally are changed in the structure, leaving black spots.



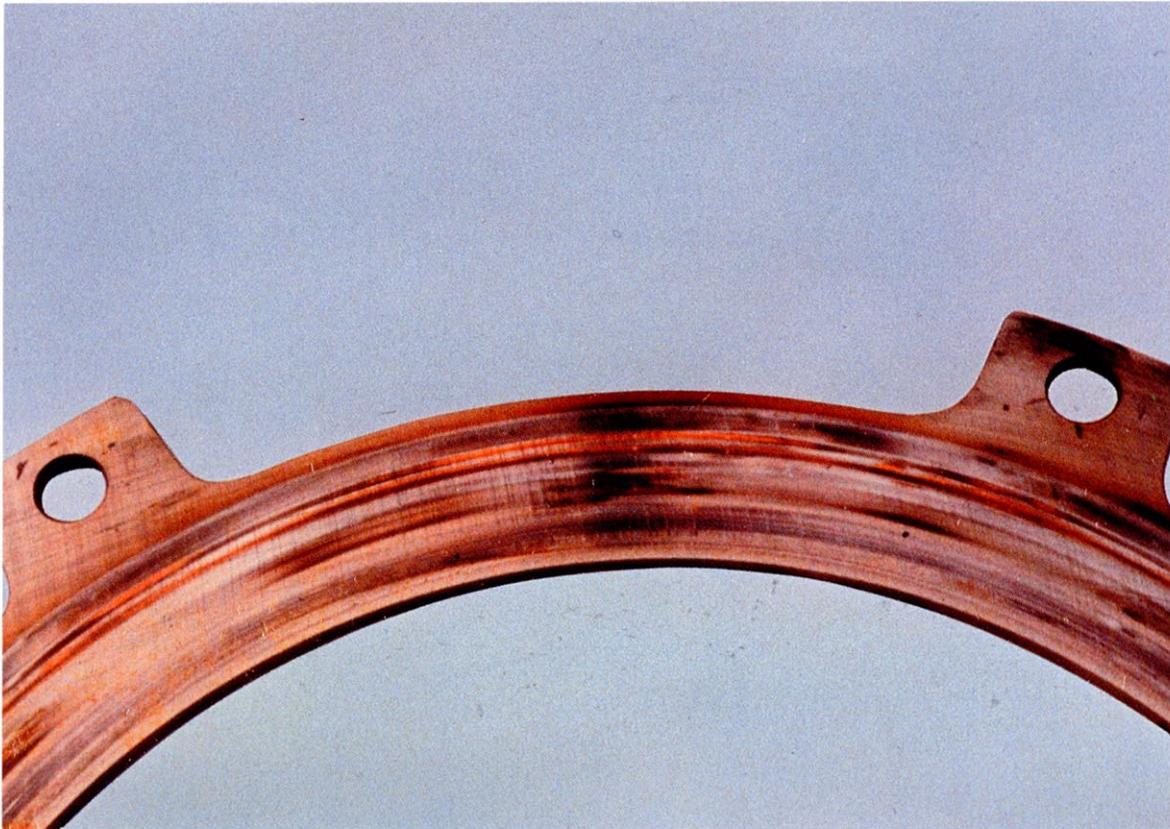
Causes

- Poor lubrication
- Unsatisfactory modulating function (the modulating time is too short.)

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".

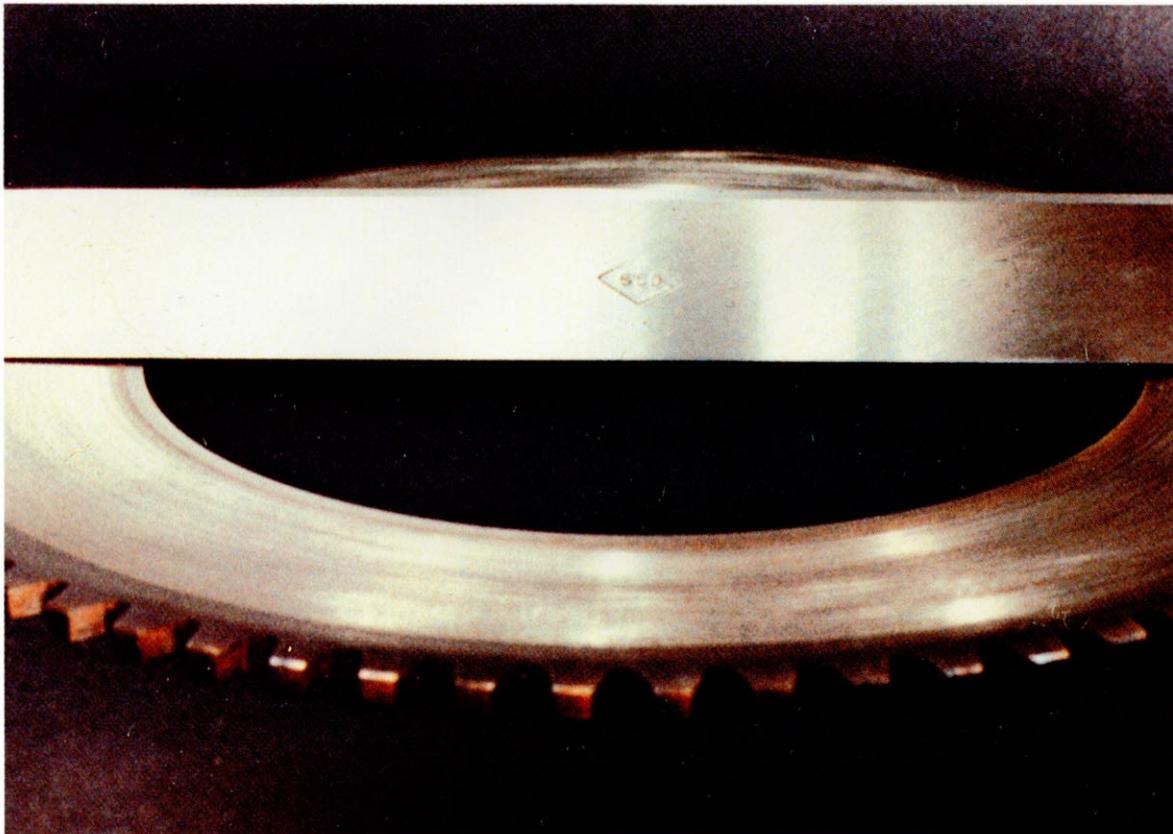


Causes

- 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.

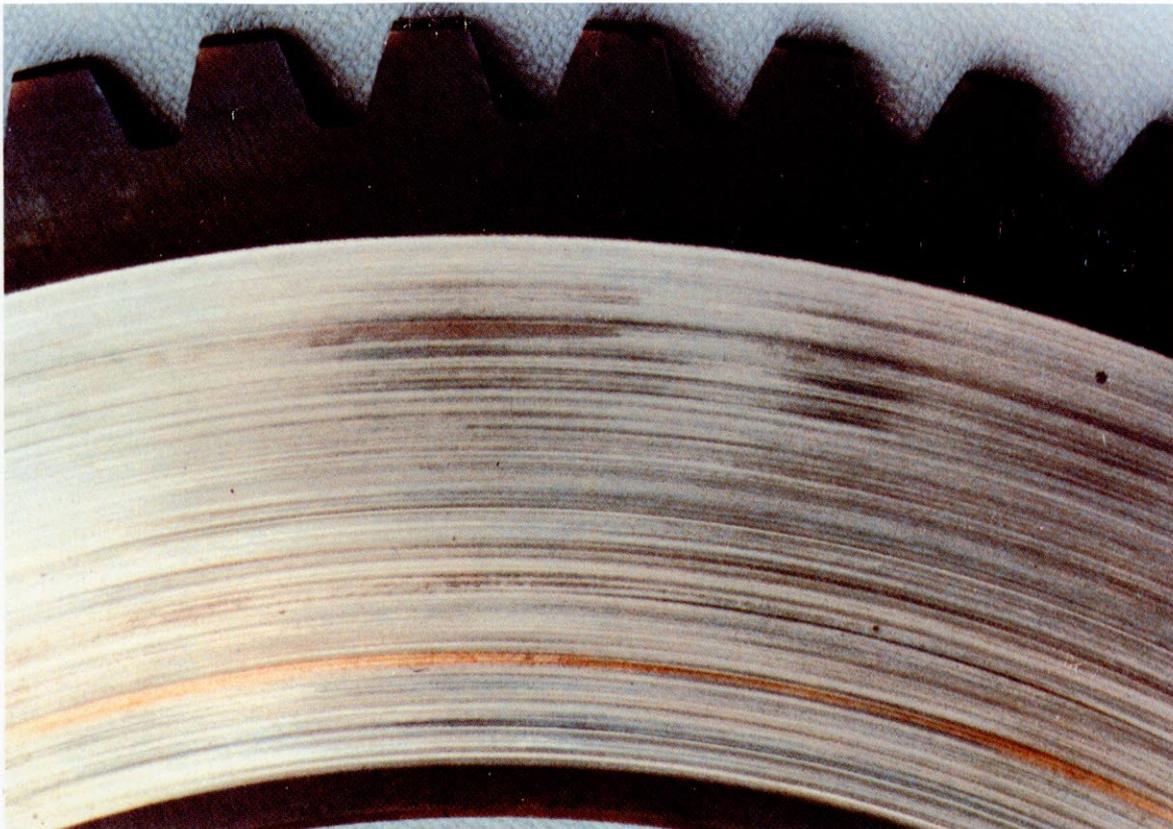


* Whenever plates are deformed, the mating discs should be checked for deformation.

Causes

- Poor lubrication
- Slipping due to oil pressure drop.

Circumferential Grooves on Clutch Plates



*Circumferential grooves on the plates may accelerate wear on the discs.

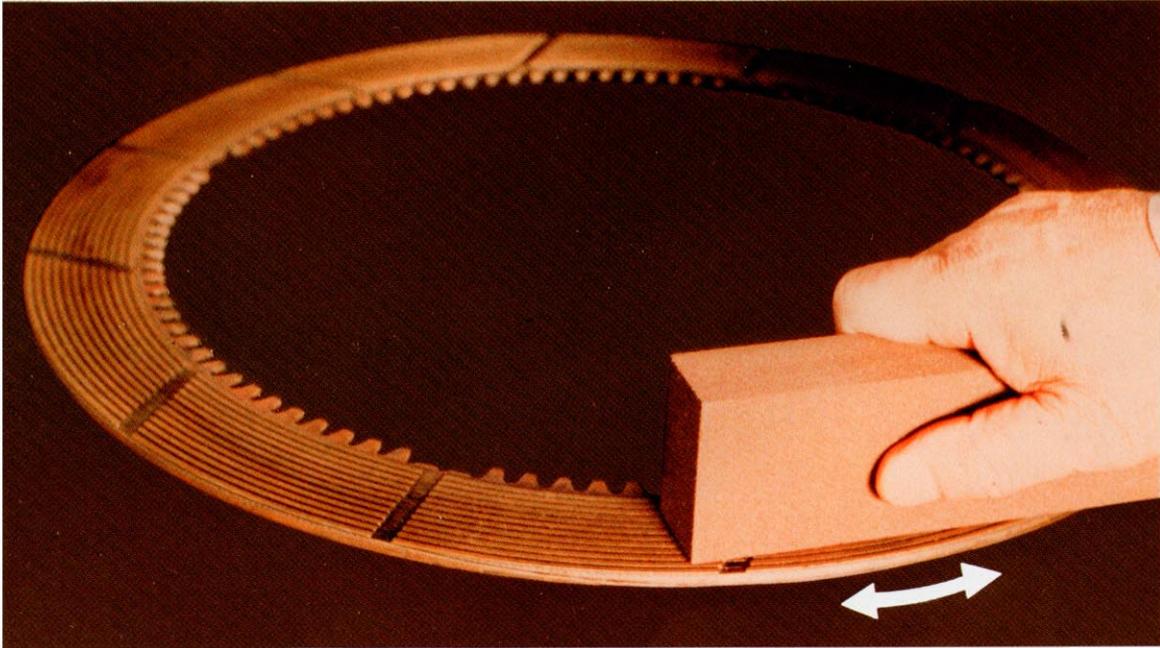
Cause

- Foreign particles in the lubricating oil.

PROCEDURES FOR RECONDITIONING DISCS AND PLATES

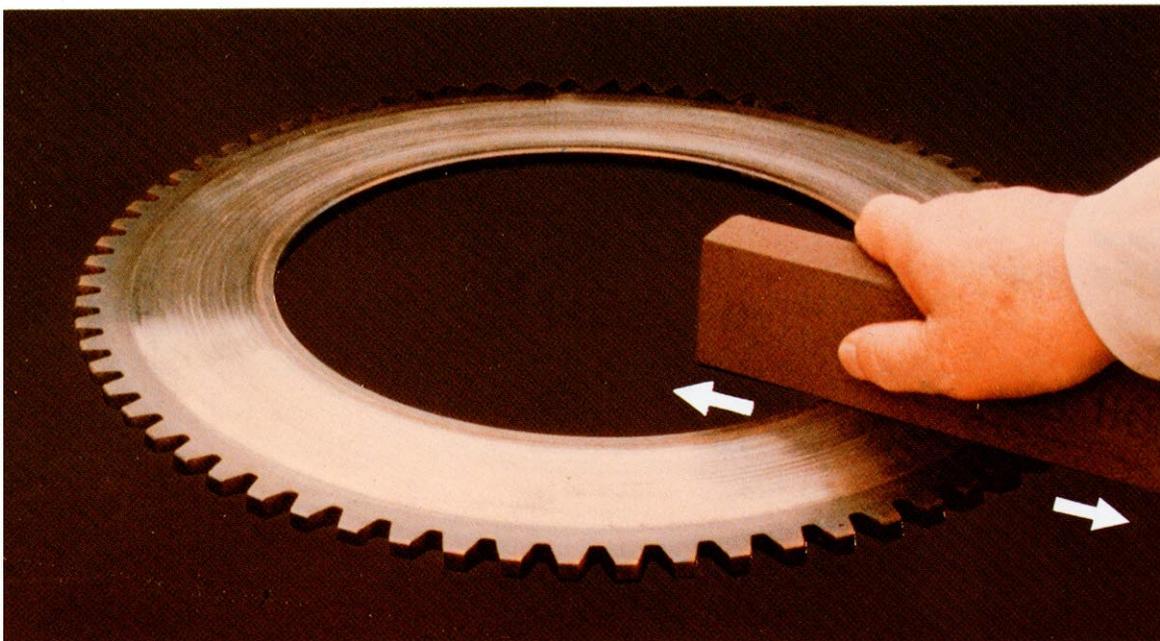
Discs

Even in the normal operating conditions, discs will sometimes become glazed and show some discoloration. Such surface conditions are caused by the heat generated during operation and the lube oil used. These surfaces can be reconditioned by grinding them in the "circumferential direction", using a #180 oil stone.



Plates

Plates can be reconditioned grinding them in the plate "radial direction", using a #180 oil stone.



* Emery paper should not be used because it is difficult to recondition the surface uniformly.

* A flat oil stone so large as shown in the above photo should be used.

CONSTRUCTION AND FUNCTION OF CLUTCHES

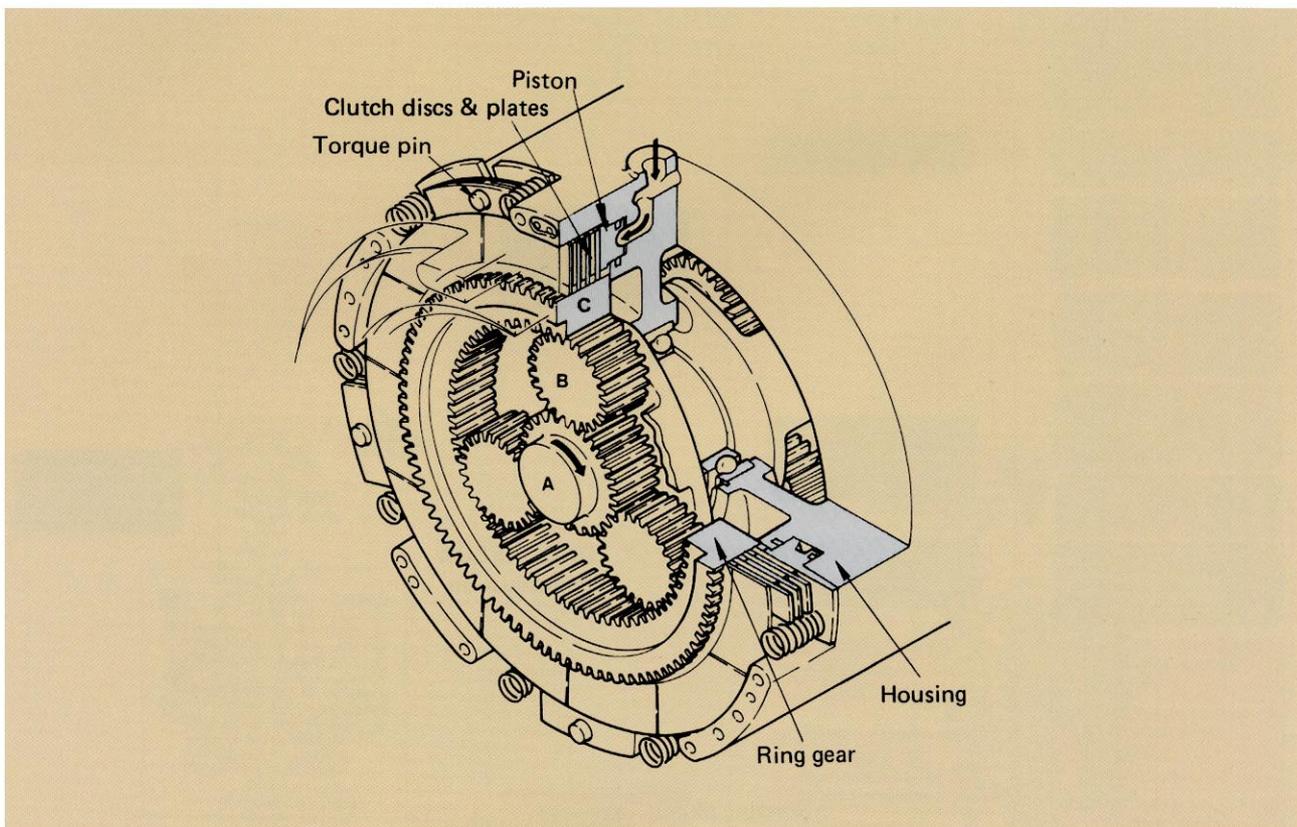
Construction of Clutches and their Classification by Applications

Clutches used in construction machines are classified by construction 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.

Construction of Planetary Gear Type Transmission

As an example, the construction and function of a clutch in the planetary transmission (TORQ-FLOW 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.

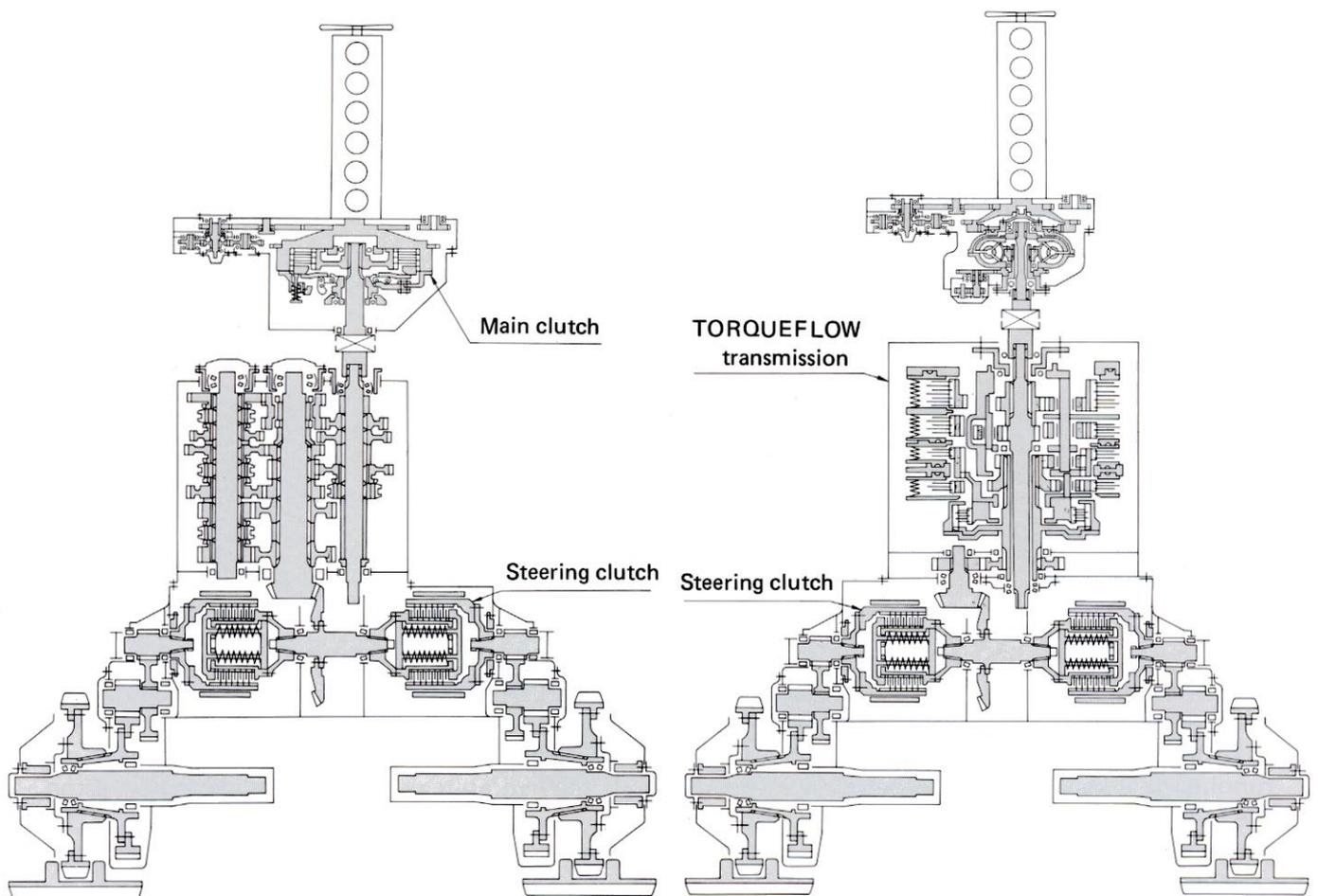
While the hydraulic oil from control valve does not work on clutch piston, discs and plates are running idle, keeping clearances between themselves. If the hydraulic pressure is applied to the piston, the discs and plates are pushed to each other by the piston. Thus, the clutch is actuated by the frictional 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.

Classification of Clutches by Application

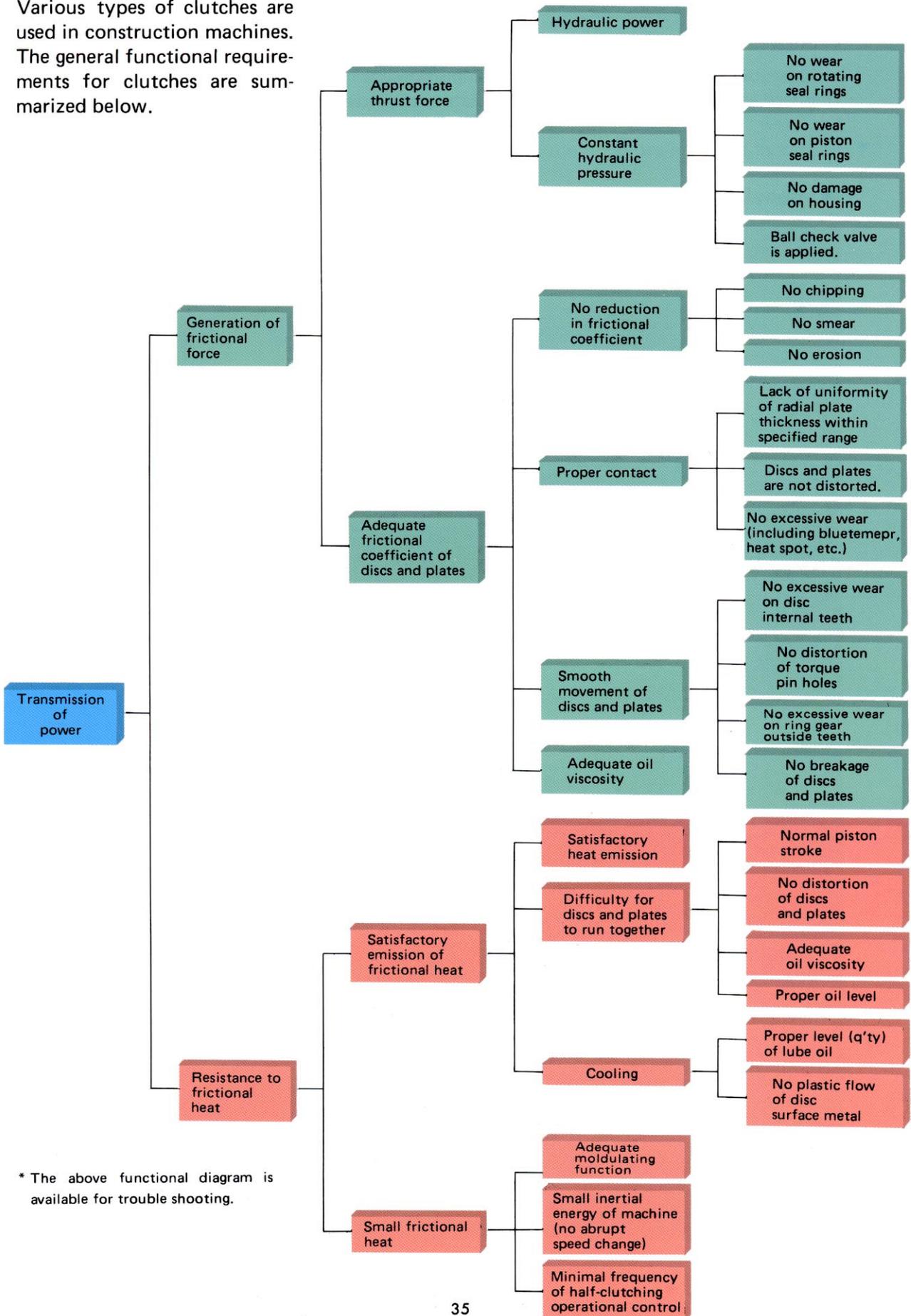
Clutches are classified by their major applications in construction machines as indicated below.

Classification	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
Main clutch	○	○	○	○	○	○	
Steering clutch	○	○			○	○	
TORQFLOW transmission (includ. hydroshift transmission)		○			○		○
Brake system		○			○		○



Clutch Functional Diagram

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

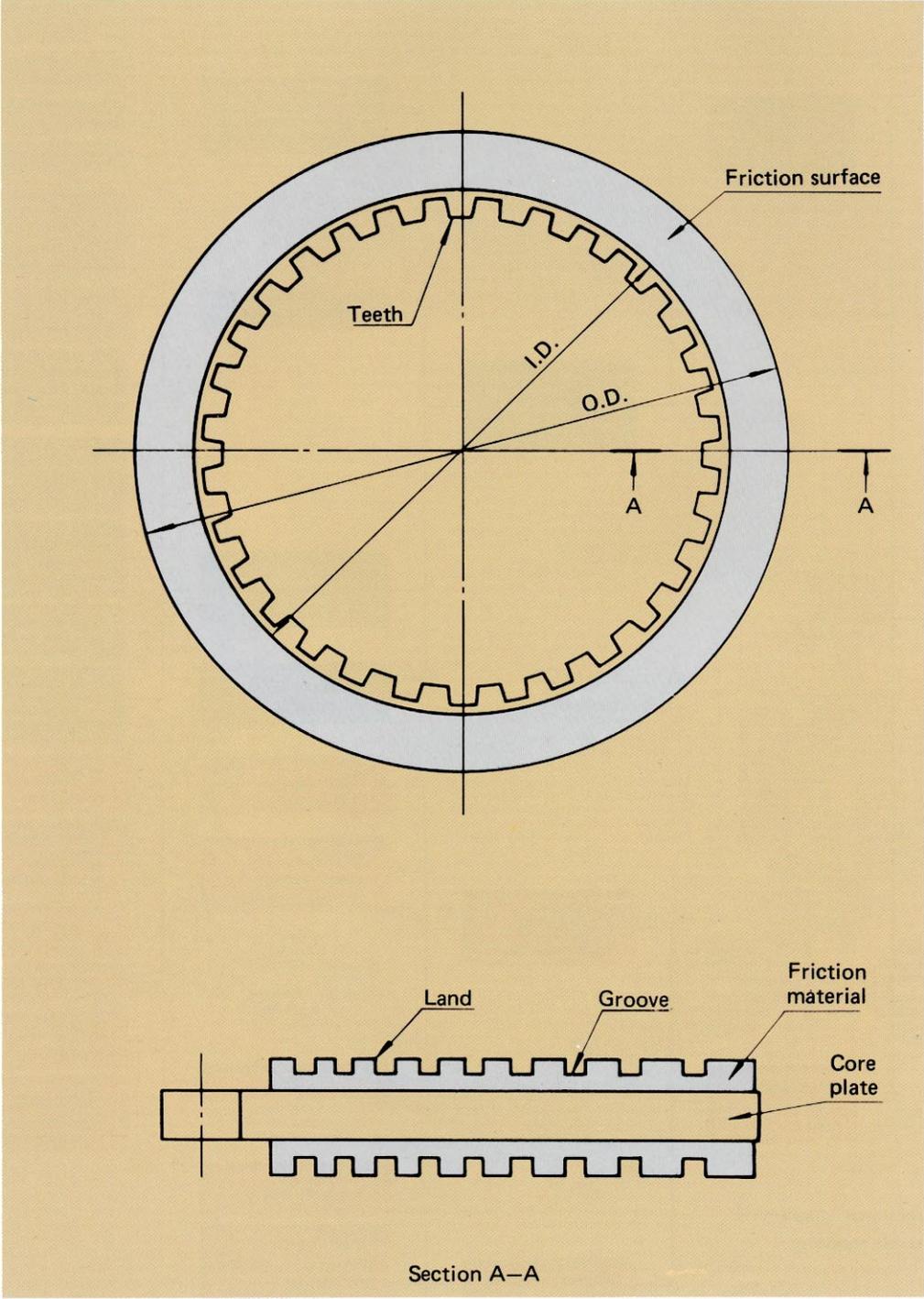


* The above functional diagram is available for trouble shooting.

Discs

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

Nomenclature of Disc

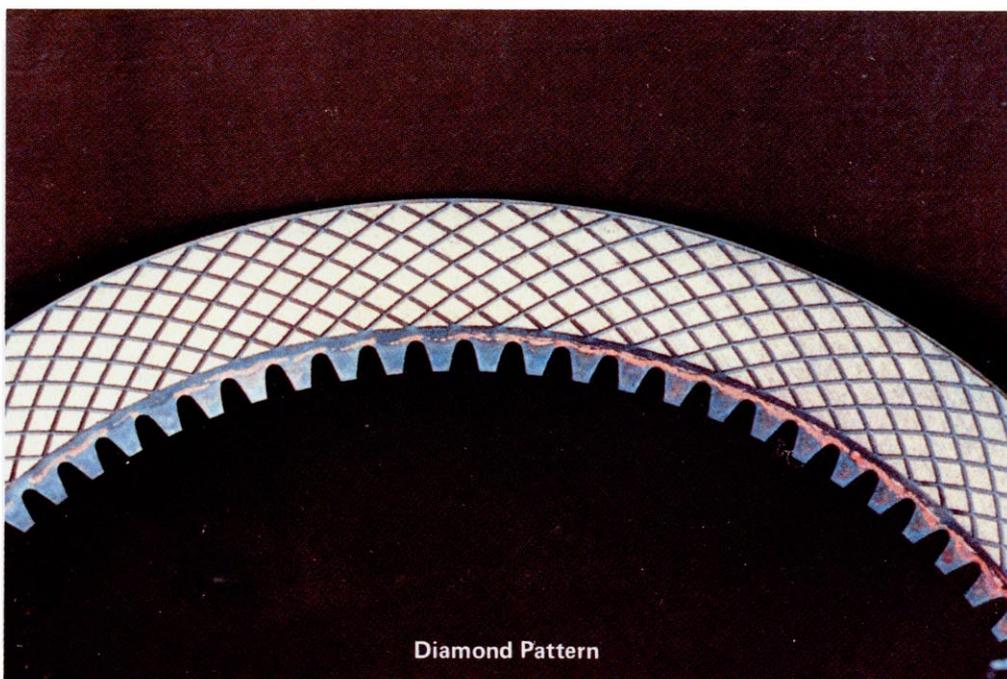
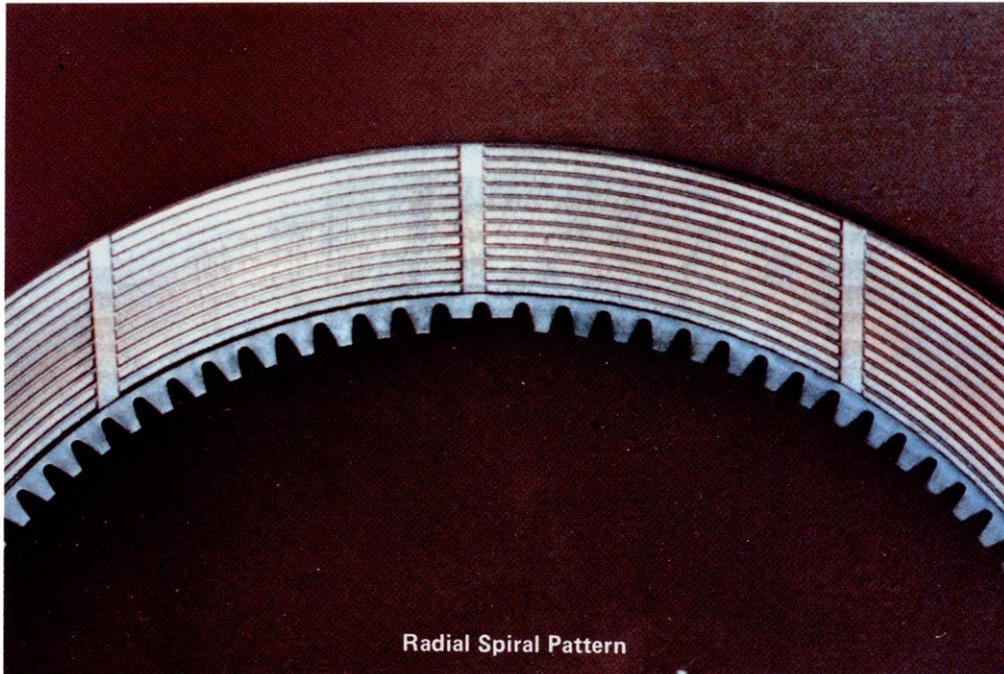


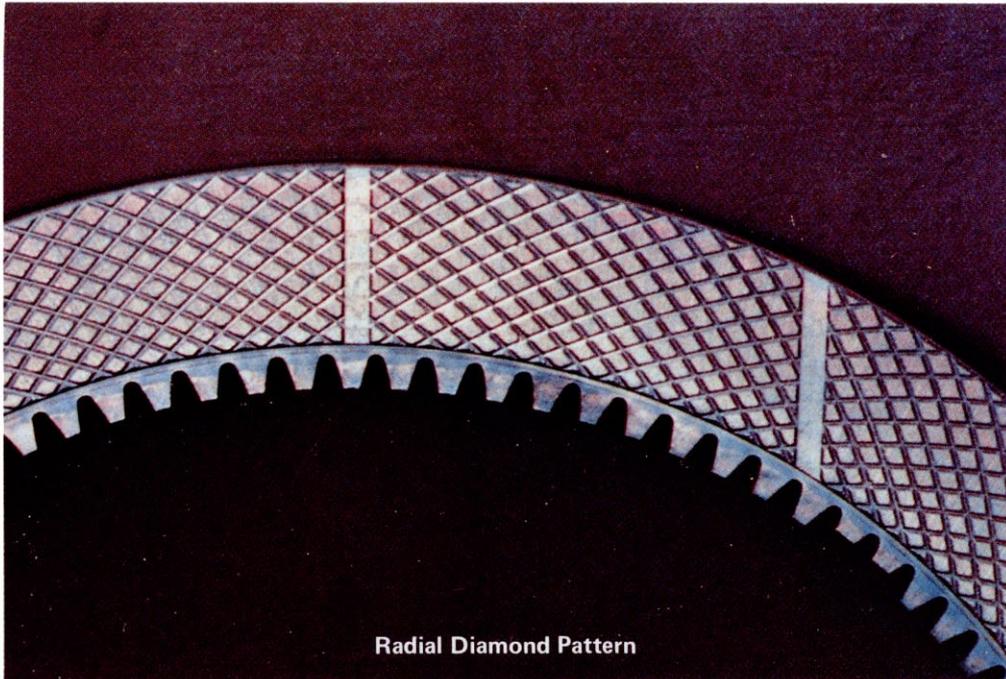
Disc Groove Patterns

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

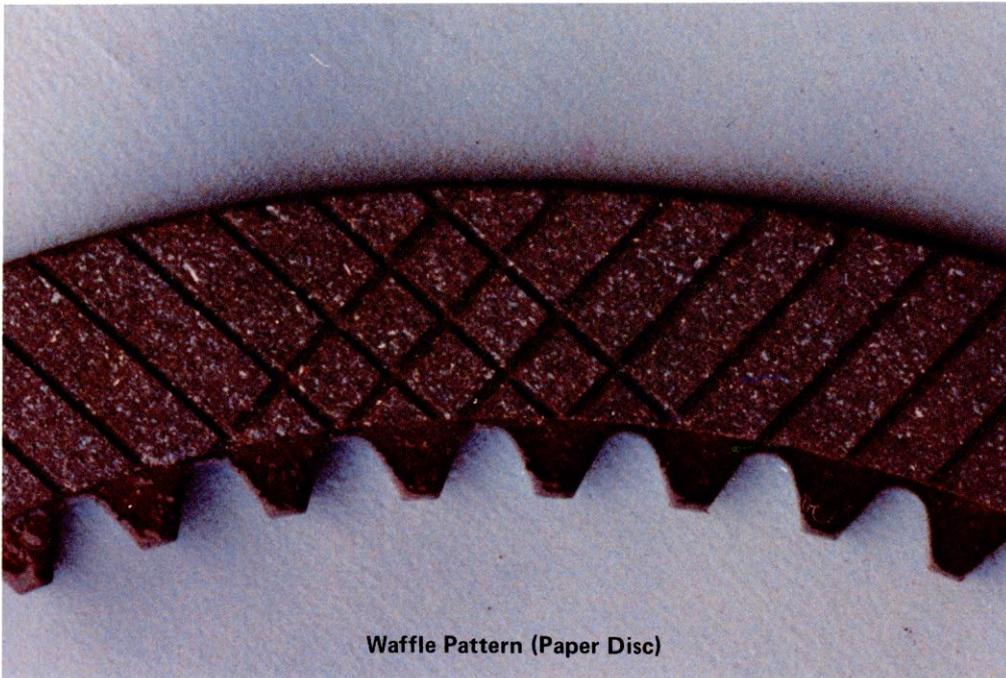
Groove patterns are featured for the resistance of discs to heat, wear and friction. Thus, discs having grooves of the optimum types are used in various devices and machines.

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





Radial Diamond Pattern



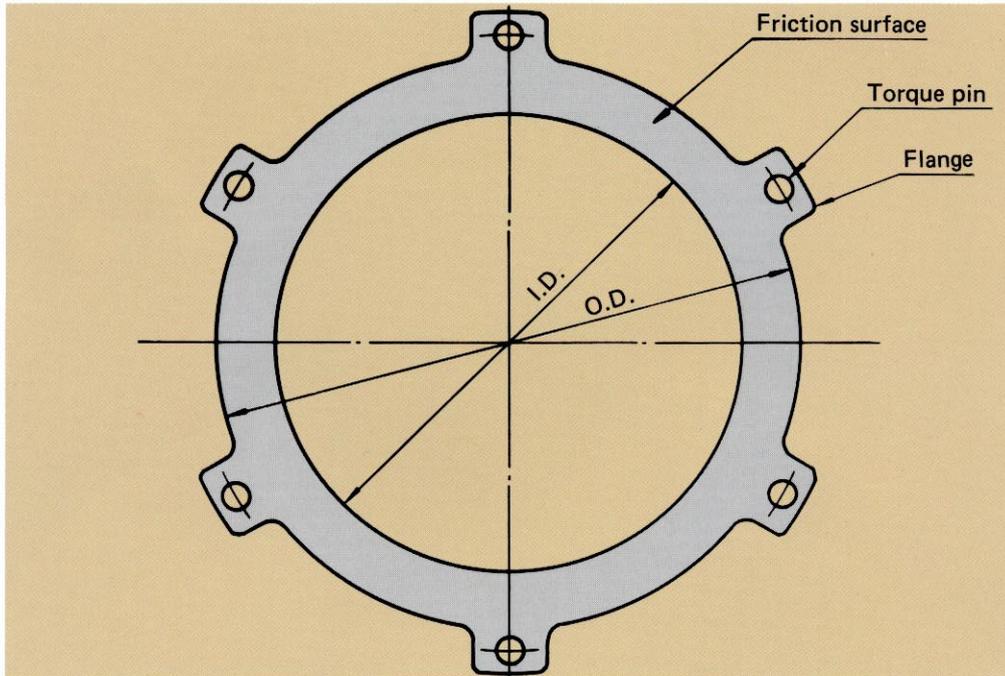
Waffle Pattern (Paper Disc)

Plates

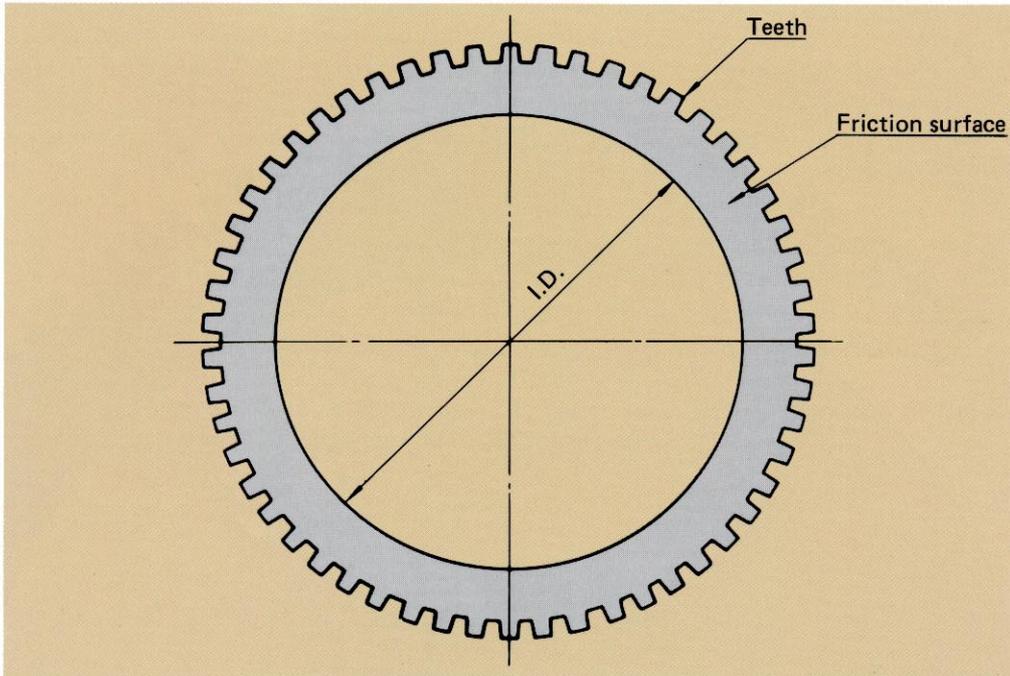
Types and shapes of plates vary with purposes of clutch applications. The standard shape and plate nomenclature are indicated below.

Nomenclature of Plates

For Fixed Clutch



For Rotating Clutch

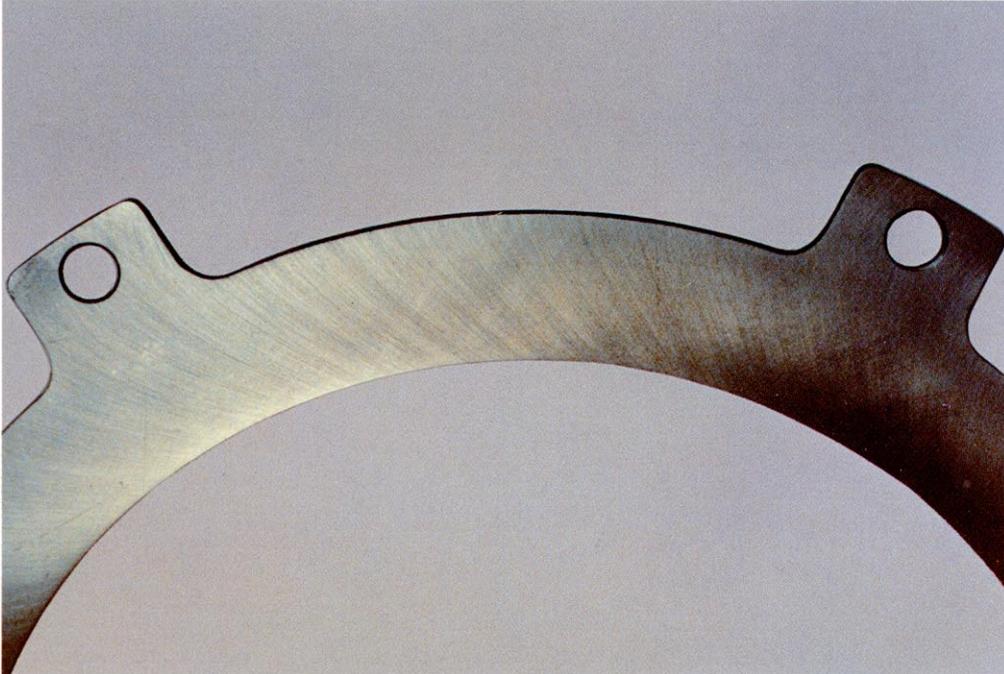


Types of Plates

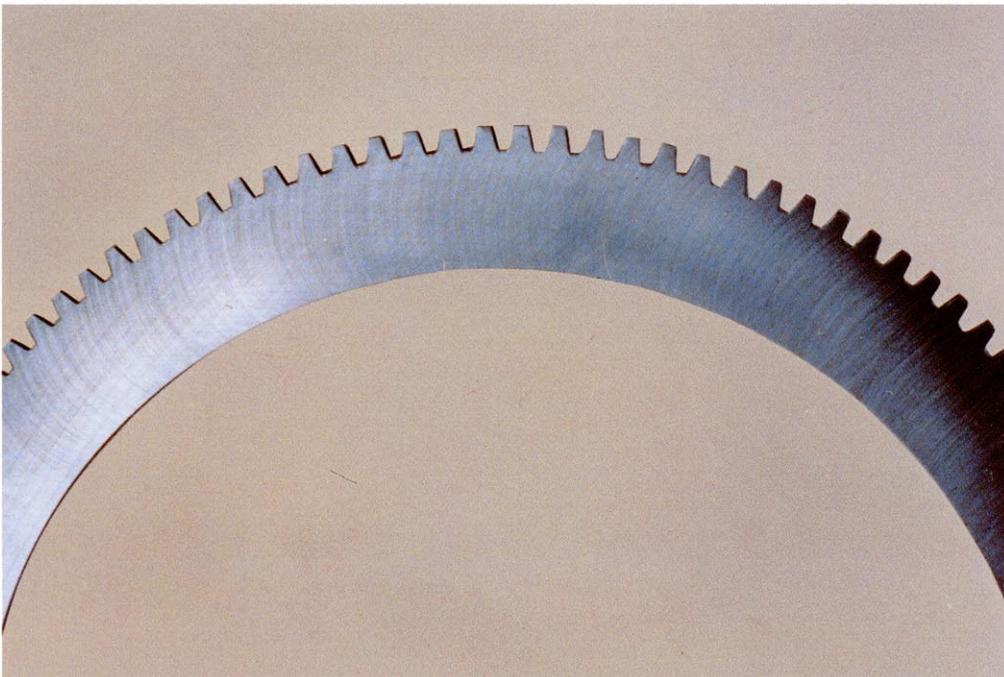
Plates are heat treated for the max. function and their friction surfaces are finished to the specified surface roughness.

Two types of plates and the finished surfaces of new plates are shown below.

For Fixed Clutch



For Rotating Clutch



Materials and Applicable Heat Treatments of Discs and Plates

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

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 paper	Paper friction material (facing) is bonded to the carbon steel plate.	Teeth are induction-hardened to prevent wear	—
Plate		Carbon steel	Blank plate is heat treated.	Finishing by grinding

PREVENTIVE MAINTENANCE

In order for operating machines to the full by preventing machine troubles, be careful about the machine conditions at all times, particularly about the oil pressure, oil temperature, oil consumption, unusual sound, and other symptoms.

Most machine troubles and failures can be prevented by carrying out the servicing items positively, referring to the Operation and Maintenance Manuals. Above all, users shall be advised to observe the following matters faithfully in operating and servicing their machines.

- Use the KOMATSU's specified lubricating oils and determine their types depending on the varying ambient temperatures. Change oils at the specified interval.
- Warm up engines thoroughly before operating machines. Abrupt operation under overload, abrupt acceleration and stopping should be avoided wherever possible.
- Frequent abrupt speed changing operational control should be avoided wherever possible.
- Carry out oil level checks, replenishment, oil change, and oil analysis periodically.

* Whenever any unusual condition is felt or found in clutch or in its related system or components, examine and isolate the cause(s), applying P.M inspection program.

