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Common Causes of Grid Coupling Failures

Informational Bulletin

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Abstract

This Informational Bulletin presents recommendations for identifying common causes of grid coupling wear and failures.

Copyright Statement

Foreword

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Scope

This Informational Bulletin contains information for use to the industry but are not standards. These Bulletins are made available to the public via the MPTA website.

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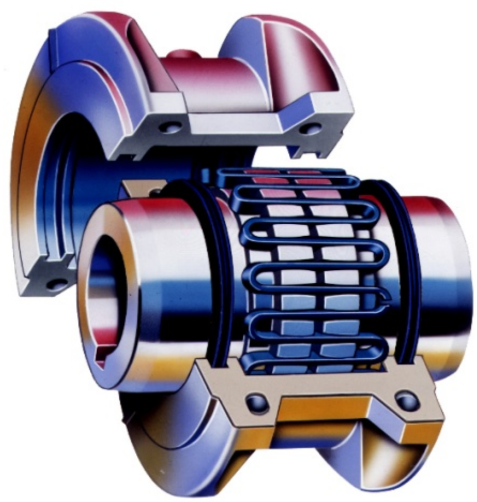

1. INTRODUCTION

The grid coupling uses a serpentine spring steel flexible member that connects two hubs that are mounted on the connected pieces of rotating equipment. In the event of a coupling failure, a thorough investigation should be made to determine the cause. The most common causes of failure in a grid coupling are usually related to improper coupling selection, improper assembly, improper or inadequate lubrication and excessive misalignment. We will describe below the major types of grid coupling wear and failure modes, their causes and remedial recommendations.

2. GRID FAILURE MODES

2.1 GRID WEAR- Normal

A Grid coupling accommodates misalignment by the sliding and flexing of the grid in the hub tooth slots; this action, provided with proper lubrication, develops a polished surface on the grid to hub contacting surfaces. An example of normal grid wear is shown (Fig 1).

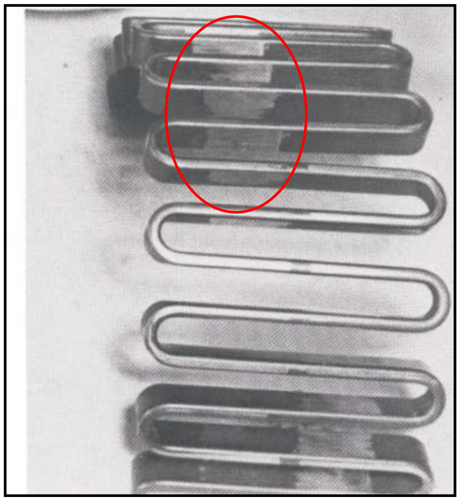

Fig 1

2.2 GRID WEAR- Lack of lubrication

With inadequate lubrication, grid wear will be accelerated in the following stages:

Early stage:	Contact area of grid will appear scuffed
Middle stage:	Deeper grid wear areas with fretting corrosion (red powder)
Late stage:	Cross section of grid worn to point of grid breakage (Fig 2).

Grid wear is accelerated further with increasing misalignment which serves to increase the sliding action and loading of the grid.

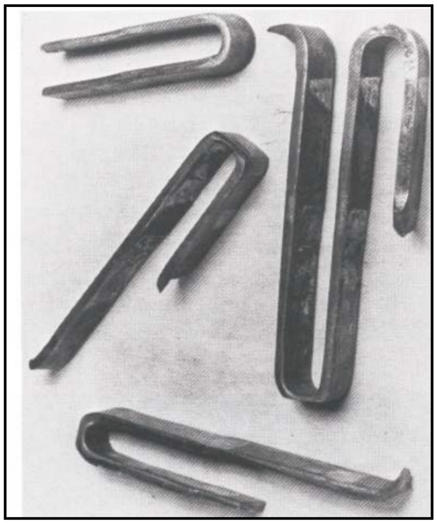

Fig 2

2.3 GRID WEAR- Misalignment

A combination of grid end wear and wear on radially outer edge of grid where it strikes the inside of cover are indications of excessive shaft misalignment (Fig 3). Higher speeds will increase the severity of wear. In general, excessive grid wear conditions can be minimized with good alignment and proper lubrication.

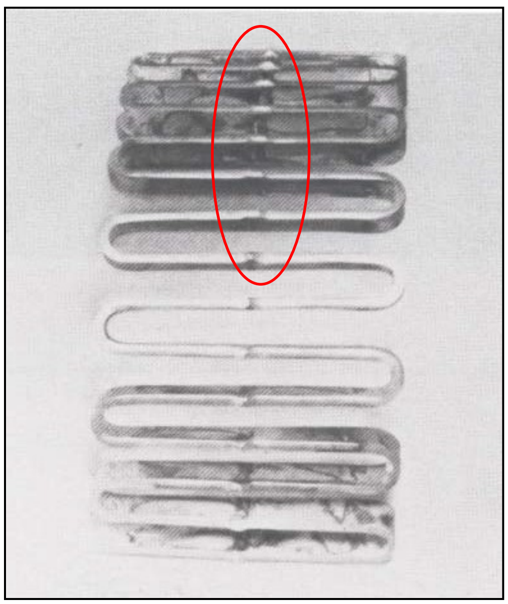

Fig 3

2.4 GRID FRACTURE – High Cycle Fatigue

The flexible grid member flexes to transmit torque and accommodate misalignment. In this cyclic type loading, if the allowable bending fatigue stress of the grid is exceeded, a fatigue type failure will occur. These cyclic load changes may consist of a complete or partial reversal of torque (+ to -) or may vary within the same load direction (0 to +).

The location of the grid fracture on the grid along with the number of load cycles before failure can help determine the failure load. Load cycles could be the frequency of a vibratory load, the number of starts, speed changes, or in the case of misalignment, the RPM of the coupling.

A grid failure occurring between the hub tooth contact point and grid loop or in the loop of the grid generally indicates a high cycle low load fatigue failure (Fig. 4).

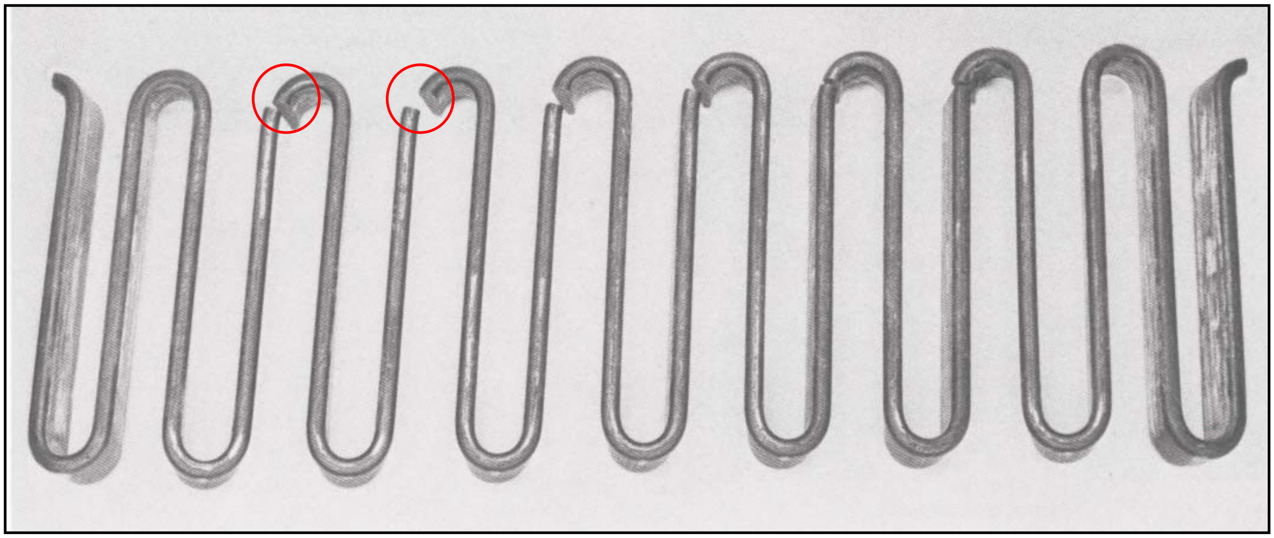

Fig 4

2.5 GRID FRACTURE – Low Cycle Fatigue

Grid failures caused by low cycle fatigue are a result of excessive torque, misalignment, or a combination of the two. Examples of excessive torque situations are high inertia starts, high braking torque or high shock loads. Grid failures can be prevented by improving the coupling alignment, removing the overload condition or selecting a coupling size which has the capacity to handle these loads. When grid failure occurs between tooth contact point and the coupling hub gap this generally indicates a low cycle high load fatigue failure (Fig 5).

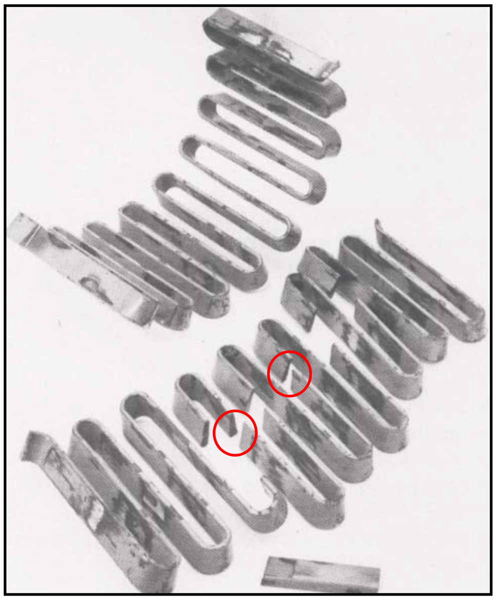

Fig 5

2.6 GRID FRACTURE- Ultimate Failure

Under extremely high peak loads, the grid section may fracture in the gap portion of the coupling and be accompanied by broken and deformed hub teeth. This type of grid coupling failure is very infrequent (Fig 6).

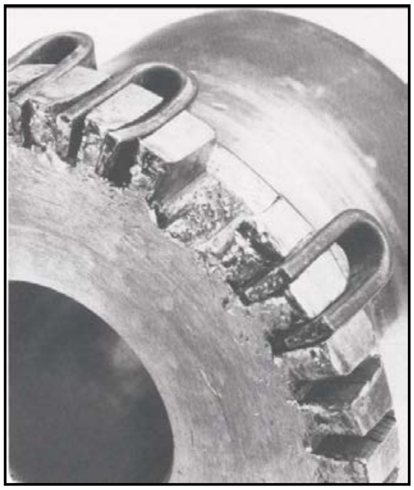

Fig 6

2.7 GRID FAILURE- Yield without Fracture

A grid yield failure without fracture can also occur in the gap area of grid (Fig 7).Grid yielding in the coupling gap area can be prevented by removing system overloads and realigning equipment.

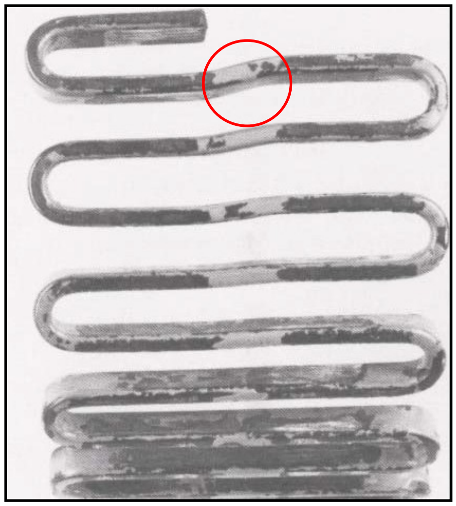

Fig 7

3. HUB FAILURE MODES

3.1 HUB TOOTH FAILURES

Grid coupling hub teeth are designed to have much higher fatigue strength then the grid; as a result, hub tooth fatigue failures are rare with grid couplings. In very extreme shock or high peak conditions, it is possible deform and break teeth along with the grid segments. As a result of overload and misalignment the hub teeth may break at the root diameter (Fig 8).

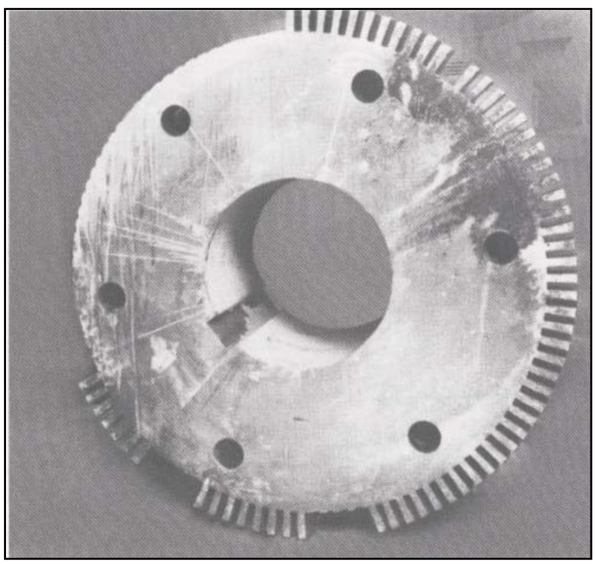

Fig 8

3.2 HUB SHOULDER FAILURES- Material Interference

Occasionally a grid coupling hub shoulder failure is encountered. These failures generally consist of cracks extending through the hub shoulder at a keyway corner or through the set screw hole (Fig 9 & Fig10). Grid hub failures can usually be traced to poor installation

Practices, such as hubs forced onto shaft radii, keys oversize for hub or shaft keyways, setscrews being tightened on hot hubs used for interference fits, or excessive interference fit between shaft and hub.

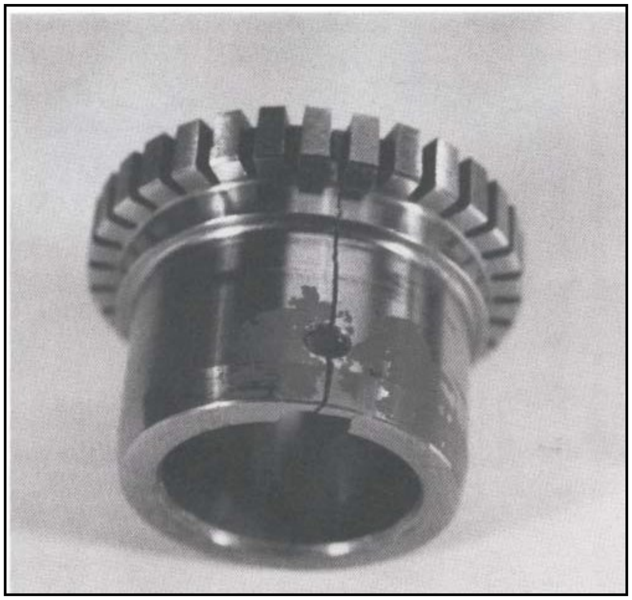

Fig 9

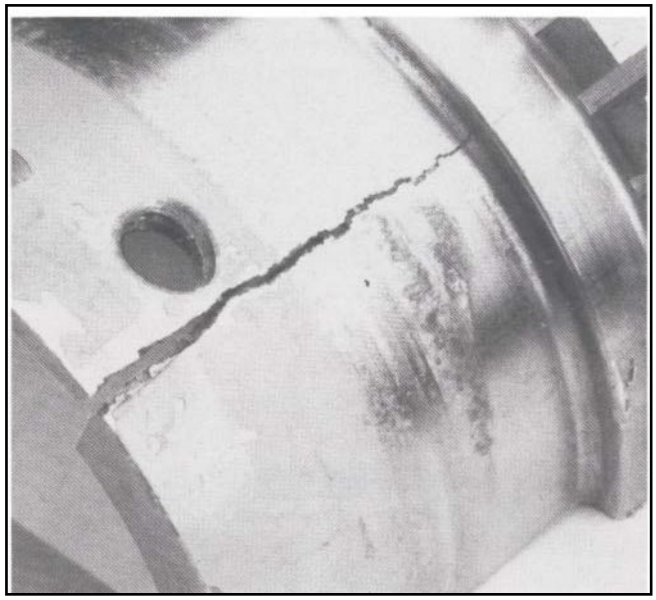

Fig 10

3.3 HUB SHOULDER FAILURES- Short Key Engagement

Sometimes a short length of key engagement into the hub may cause local yielding in the keyway (Fig 11). The resulting loose key may initiate hub failure due to high loading stresses. This is most commonly seen in smaller size couplings where clearance fit hubs are preferred by most customers.

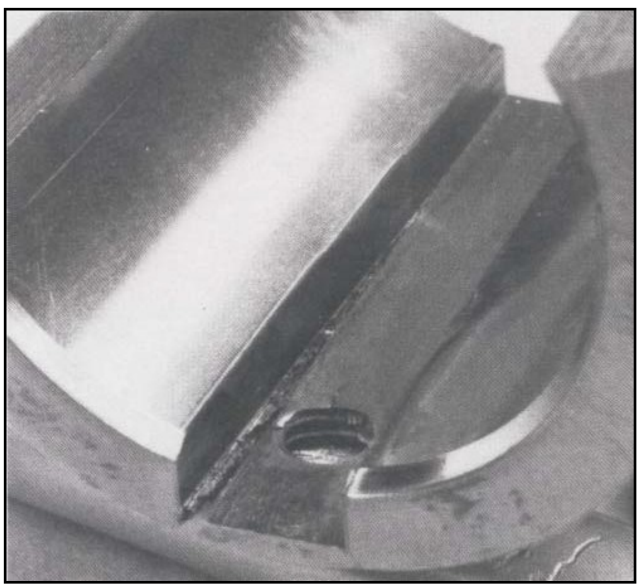

Fig 11

3.4 HUB BORE WEAR AND FRETTING CORROSION

The cause of hub bore wear and fretting is usually from clearance between the hub and the shaft which permits axial or planetary motion (Fig 12). Clearance fit hubs having loose setscrews may also permit sliding or rocking of hubs; in these cases, the hub tooth face and the contacting grid surface of loose hub will often show excessive wear. Hub movements are related to external forces such as increased bearing clearances, flexible foundations, loose equipment, or excess shaft deflection. Hub failures can frequently be prevented with good maintenance practices. The bore, key, hub and shaft keyway fits need to be correct, setscrews properly torqued and external components such as bearings and supporting foundations must be operating within acceptable limits.

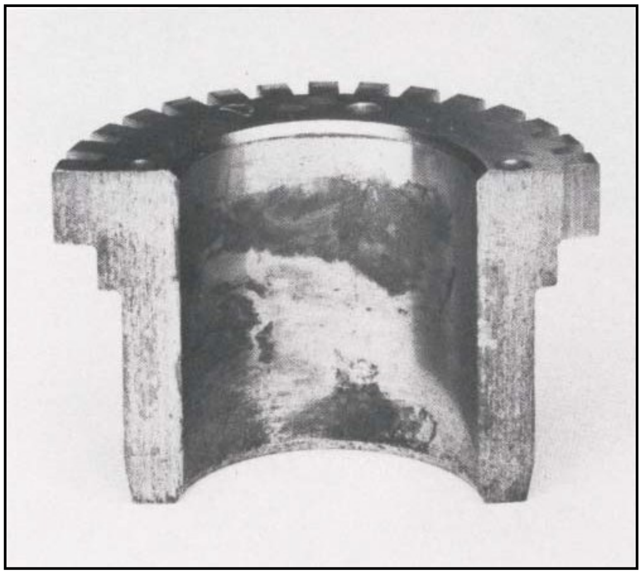

Fig 12

3.5 HUB TOOTH WEAR

Hub teeth will wear from the sliding action induced by misalignment that is combined with the tooth loading from torque transmission. This wear is greatly accelerated by lack of or improper lubrication (Fig 13). Improvements in alignment and lubrication practices, will reduce hub tooth (and grid) wear.

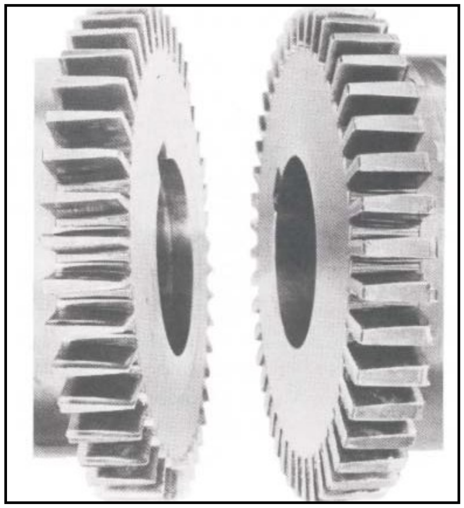

Fig 13

4. SEAL FAILURE MODES

4.1 SEAL WEAR- General

All seals will experience some wear as a result of movement between the hub shoulder and the seal. As misalignment or axial end float increase, the seal wear will also increase. The grid couplings using horizontally split grid covers have lugs cast into the cover to prevent cover rotation independent of hub (and seal); therefore seal wear is not greatly affected by frequent starts and stops. "O" ring type seals used on larger size grid couplings are totally enclosed by a seal cage which minimizes any seal roll out. Any cuts or flat spots observed on the "O" ring seals promote lubricant leakage and should be replaced. Where necessary to minimize maintenance labor, a replacement "O" ring seal may be cut, wrapped around the hub and then cemented together.

4.2 SEAL FAILURE- Horizontally split covers

The seal used with the horizontal split cover design, is placed into position on the hub before the cover is placed on the coupling (Fig 14). If the hub barrel outer surface is dry, rusted, or scratched, this seal may roll over in assembly of the cover and create an unsealed condition. Lightly lubricating the hub barrel and seal before assembly helps improve seal performance, eases coupling assembly and helps prevent seal failure.

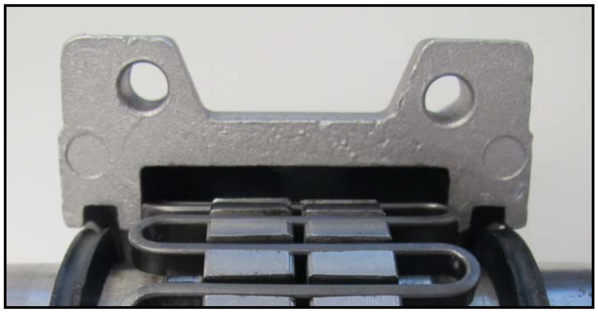

Fig 14

4.3 SEAL FAILURE- Vertically split cover

Grid couplings that use a vertically split cover design have seals that fits over the inside diameter of the cover seal flange (Fig 15 & Fig 16). If the hub barrel outer surface is dry, rusted, or scratched, this seal may roll over in assembly of the cover and cause the seal to come off the cover flange. To minimize seal roll over, lightly lubricate the seal and hub shoulder to permit the seal to slide freely until the half cover is assembled in place. The seal may also be cut due to excessive misalignment (Fig 17). Improving equipment alignment will eliminate this problem.

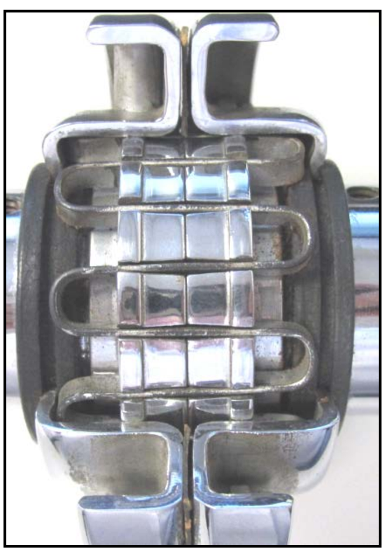

Fig. 15

Fig. 16

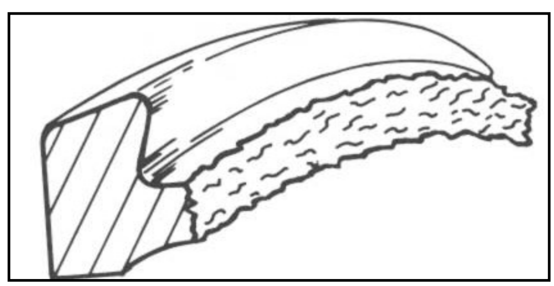

Fig. 17

5. COVER FAILURE MODES

5.1 COVER FLANGE GASKET FAILURE

To avoid gasket leakage of grease, the fasteners holding the gasket joint must be properly tightened. Torn gaskets should be replaced, and the contacting cover surfaces should be free from burrs and scratches that would either damage the gasket or provide a path for the grease to escape.

5.2 COVER WEAR

The function of the cover is to contain the grid axially, radially and to retain the lubricant. Two styles of covers are used with the Grid style coupling; horizontally and vertically split. The axial split cover is generally made of aluminum while the vertical split cover is generally made of steel.

Since the cover must retain the grid both axially and radially, it is normal to find markings or shallow grooves in the inside of cover. Deep grooves (Fig 18) indicate coupling is operating with excessive parallel misalignment. Since the cover carries no loads, such markings on the inside of cover will not affect the torque transmitting ability of the coupling. Correcting the misalignment will extend the life of the load carrying components.

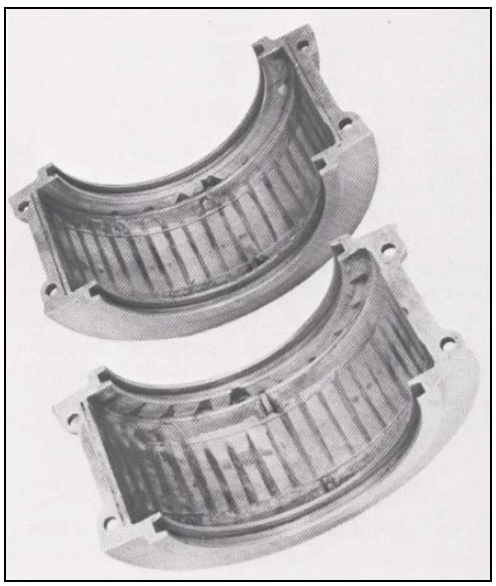

Fig 18

The inside end faces of the covers may have indentations from grid loop contact. These markings are normal and only a concern if their depth approaches one-half of the side wall thickness (Fig 19).

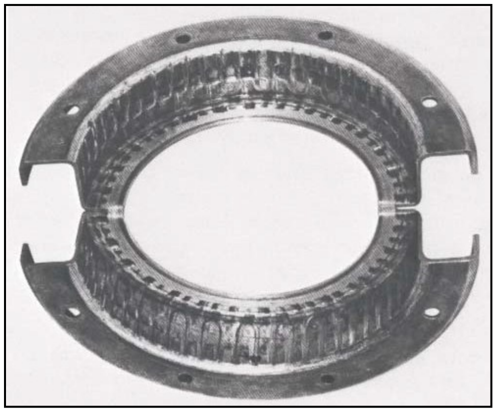

Fig 19

5.3 COVER FAILURE

On rare occasions, covers can fracture. If the coupling is subjected to repeated high loads that result in grid failures of every rung near the gap, this allows the driving hub to turn independent of driven hub and the cover rotates with the driving hub until grid pieces became wedged between the stationary hub and rotating cover, resulting in destruction of the cover (Fig. 20).

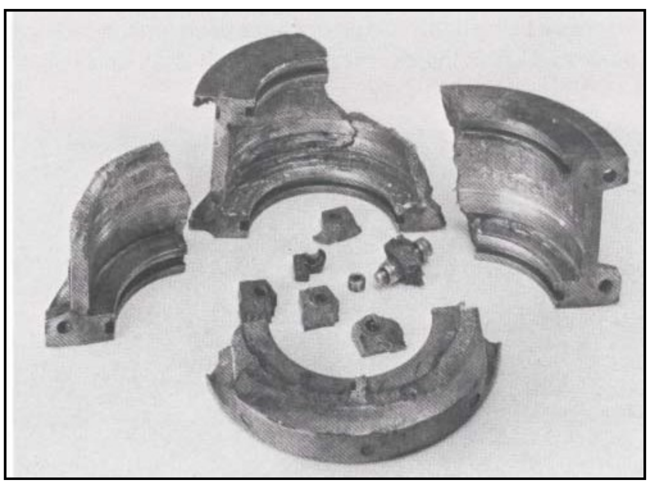

Fig 20

6. TEMPERATURE RELATED FAILURES

High and low temperatures can affect both the seals and the lubricant. When the temperature limits of the seal are exceeded, the seal material will become brittle and fracture. This will allow the grease to escape and/or allow external contaminants to enter the coupling. The result will be excessive wear on the mating grid, tooth and cover components.
Temperature effects on the lubricant cause the viscosity to change. High temperature results in a reduction of the viscosity and a loss in the lubricating quality of the grease and an increased rate of the separation of the grease. Low temperature results in a loss of mobility of the grease causing metal-to-metal contact between mating parts; both conditions will result in increased wear between mating components. Extreme temperature lubricants or alternative seals to allow for operation under these conditions are available, consult coupling manufacturer.

7. LUBRICANT SEPARATION

Grease used in lubricating grid couplings is comprised primarily of an oil and a thickener (soap/lithium base), they are together in a “suspension” but and are not truly *combined*. In the event of temperatures or speeds beyond the coupling rating, the oil and thickener may separate. In this separated condition, the loss of lubrication results in increased wear between the grid and hub teeth and will ultimately shorten the coupling life. Under these conditions, consult coupling manufacture for lubrication alternatives. In general, there is no adjustment to the viscosity of grease (NLGI rating) used in a grid coupling within the manufacturers published operating speed range. Always use coupling grease, never use bearing grease.

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