SERVICE MANUAL SECTION

DRIVETRAIN FAILURE ANALYSIS

s10008, Formerly CTS-5198

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Table of Contents

1. INTRODUCTION

It is the intent of this publication to help the user identify the cause of component failures. When a failure occurs, we need to understand what happened so that it can be prevented in the future. In general there are three reasons for component failure: misapplication, improper vehicle operation and lack of maintenance.

Misapplication. Components fail because the design limits have been exceeded. The engine horsepower, GCW and duty cycle are some of the criteria used when selecting drivetrain components. To deviate to a lesser design will result in a shorter service life or an immediate failure.

Improper vehicle operation. Components that are within design limits will fail due to improper or abusive operation. It is important that the driver understands how to operate the vehicle correctly. Failures from abuse may not occur immediately but many miles later.

Lack of maintenance. Lack of maintenance or improper maintenance will result in premature component failure regardless of how well the vehicle is operated or the design strength of the component. It is important to follow the adjustment and lubrication recommendations in the CTS-5000 Master Service Manual.

Before making repairs, talk with the driver about the failure. Review the service history of the vehicle to find out if this failure occurred before. Do not clean the component before carefully examining it. Use the illustrations in this publication as a guide for the probable cause of the failure.

2. TRANSMISSION COMPLAINTS

2.1. VIBRATION

Vibration is a condition which can be difficult to trace and isolate. The effects of vibration will cause transmission problems, even though it originates somewhere else in the system. Intermittent vibration can be isolated under specific conditions of engine idle, RPM, gear selection, load and speed. Constant vibration should vary with engine RPM, load and speed to provide clues to its source.

Causes of vibration:

1. A loose output shaft nut. Examine the splines of the output shaft for shiny areas which indicate end yoke movement.
2. A rough idling engine. This will produce pulsation and gear train vibration as mainshaft gears mesh with mating gears. This condition is referred to as noise in neutral or while idling.
3. Loose or broken engine mounts. Loose or broken mounts will produce a vibration that appears to be in the transmission.
4. Incorrect U-joint working angles, out of phase propeller shafts or shafts that are out of balance and excessive shaft length. These will contribute to a vibration complaint.
5. Worn or failed suspension components.

2.2. HARD SHIFTING

The effort required to move the gear shift lever from one position to another varies. If too great an effort is required, it will be a constant cause of complaint from the driver. When hard shifting is reported, the first component to be inspected is the clutch. Verify that the clutch adjustment is within specification and the disks are free to slide on the input shaft.

If the clutch is released and the input shaft continues to turn, the flywheel pilot bearing has failed. Remove the remote control and shift the transmission into gear with a prybar. If the shift rods move readily into position, the problem is somewhere in the external linkage. If not, the transmission will have to be inspected for the following:

1. Lack of lubricant or wrong lubricant used, causing a build up of varnish and sludge deposits on the splines of shafts and gears.
2. Worn or bent shift bars.
3. Improper adjustment on shift linkage.
4. Clutch gears tight on shaft splines.
5. Clutch teeth burred over or chipped due to improper shifting.
6. Lack of lubricant on swivels or U-joints of the remote control.
7. Free running gears seized on the thrust face or the diameter.
8. Broken thrust washers.
9. Excessive end play.
10. Loose mainshaft nut.

2.3. GEAR JUMPOUT

Jumpout can be caused by interference in the shifting mechanism or some other malfunction which results in the clutch gear or shift bar moving out of its selected position.

Inspect the shift lever to verify it moves freely and completely into position. Visually check the floorboard opening, drivers seat or anything that could interfere with the shift lever. If the cause cannot be identified, check the following:

1. Heavy shift lever extensions.
2. Broken poppet springs.
3. Worn shift bar detents.
4. Bent or sprung shift bars or forks.
5. Worn clutch teeth on shift collars.
6. Cracked thrust washers.
7. Broken snap rings.
8. Worn corners on mainshaft gear locks.

2.4. STICKING IN GEAR

Inspect for the following:

1. Clutch not releasing.
2. Sliding clutch gears tight on splines.
3. Improper adjustment, excessive wear or lost motion in shifter linkage.
4. Contaminants wedged between the splines of the shaft and gear.

2.5. NOISE

There will always be a certain level of noise due to normal transmission operation. However, excessive noise or unusual noise such as a whine, growl or squeal indicates some kind of problem.

The transmission can be the source of excessive noise or the noise can originate elsewhere in the vehicle and appear to be coming from the transmission. The following are examples of noise originating in the transmission:

1. Knocking or Thudding.
   a. Gears - Bumps or swells on gear teeth. These can be identified as highly polished spots on the face of the gear tooth. This noise is more prominent when the gear is loaded which helps locate the source at a specific gear position. Bumps or swells can be removed with a hone or small hand grinder.
   b. Bearings - Noise comes in at low shaft speeds in any position. It is caused by bearings with damaged balls or rollers, or with pitted and spalled raceways.
   c. Cracked Gear - A cracked gear or broken shock loading or by pressing on the shaft during installation will produce this sound at low speeds. At high speeds, a howl will be present.
2. High Pitch Whine or Squeal.
   a. Gear Wear - This noise will develop from normal gear wear including tooth pitting from excessive use. In advanced deterioration, a howl will result.
   b. Mismatched Gear Set - The wear pattern on the face of the gear teeth will be uneven.
   c. Bearings - Pinched bearings, having inadequate radial or axial clearance.
3. Growling.

   Timing Error - Incorrect timing of the transmission during assembly or due to a gear turning on the countershaft.
4. Jarring.

   Bearings - Countershaft and mainshaft bearings with excessive axial and radial clearances. Excessive radial clearance in countershaft bearings increases the center distance between shafts and results in loading the tips of the gear teeth. This can result in tooth fracture.

3. TRANSMISSION COMPONENTS

3.1. GEARS

Gear wear is a constant process. Normal wear takes place over a long period of time and shows an unbroken pitch line. Gear tooth life can be shortened by various conditions.

1. Impact fractures result from a severe shock load or after running under a heavy load (Figure 1).

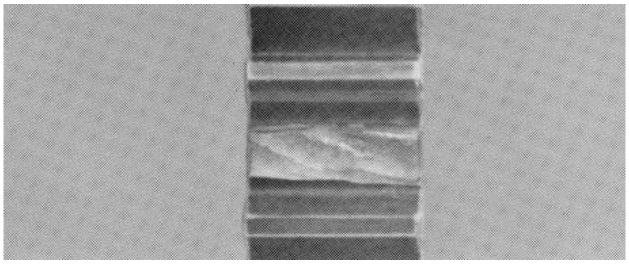

Figure 1 Impact Fracture

2. Fatigue fractures occur when running many cycles under light to moderate overload or after several minor shock loads. This type of fracture is identified by the presence of beach marks in the fractured area (Figure 2).

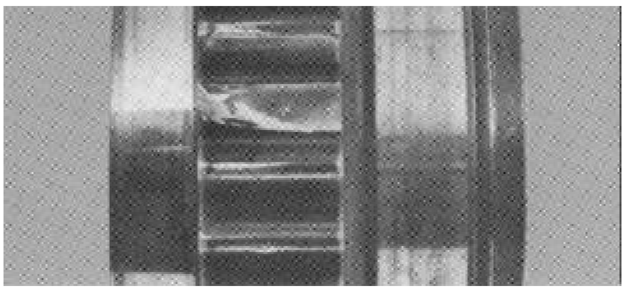

Figure 2 Fatigue Fractures

3. Pitting and spalling occurs when gears are run under excessive loads for long periods of time or using the wrong type of lubricant. Contaminated lube will also cause this type of failure (Figure 3).

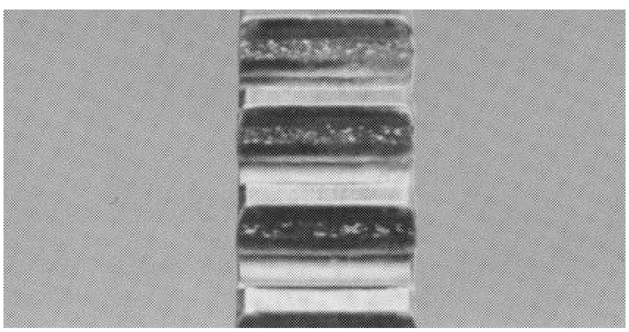

Figure 3 Pitting and Spalling

Scoring and galling are caused by metal to metal contact. Poor lubricant quality or lack of lubricant creates high temperatures. The metal surface softens and smears as the teeth slide against each other. Scoring is identified by scratches or ridges directed up and down the tooth (Left, Figure 4). Galling is an advanced form of scoring (Right, Figure 4).

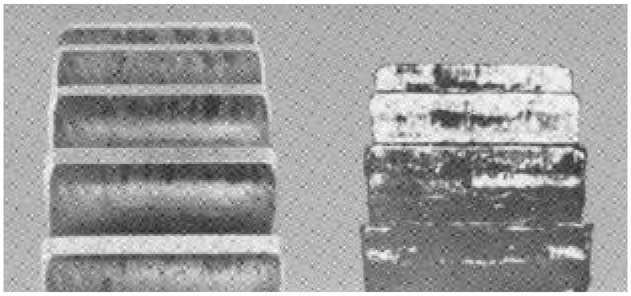

Figure 4 Scoring and Galling

3.2. SHAFTS

Transmission shafts can twist or fracture when stresses are applied which are greater than the design limit. The main causes for this type of failure are:

1. Improper clutch use.
2. Starting in the wrong gear.
3. Lugging.
4. Incorrect transmission application.
5. Bumping the dock while backing.

3.3. BEARINGS

Under normal conditions the service life of a transmission is determined by the life of the bearings. Premature bearing failure falls into the following categories:

1. Torsional vibration can cause the bearing cage to fail, allowing the balls to move and not carry the load evenly. The inner race will have a sharp edge along the edge (Figure 5).

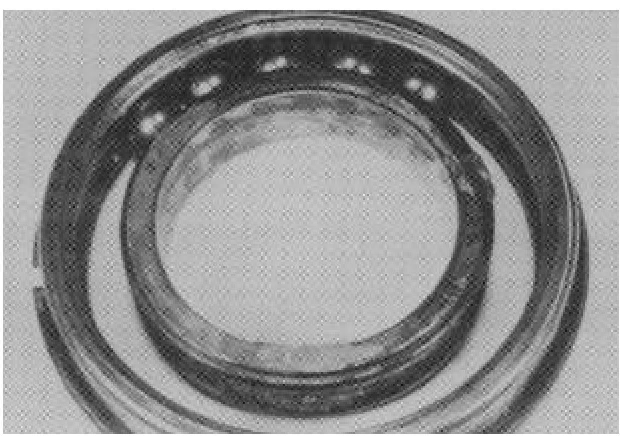

Figure 5 Sharp Edge Along Inner Race

2. Contaminated lubricant will cause inner race spalling (Figure 6).

Figure 6 Inner Race Spalling

Fatigue is characterized by flaking or spalling of the bearing raceway (Figure 7). Spalling is a granular weakening of the bearing steel which causes it to flake away from the raceway. The rough surface of spalled bearings will produce noise and vibration.

Figure 7 Flaking or Spalling of Bearing Raceway

3. Lack of lubricant is characterized by discoloration of the bearing parts and spalling of the raceway (Figure 8).

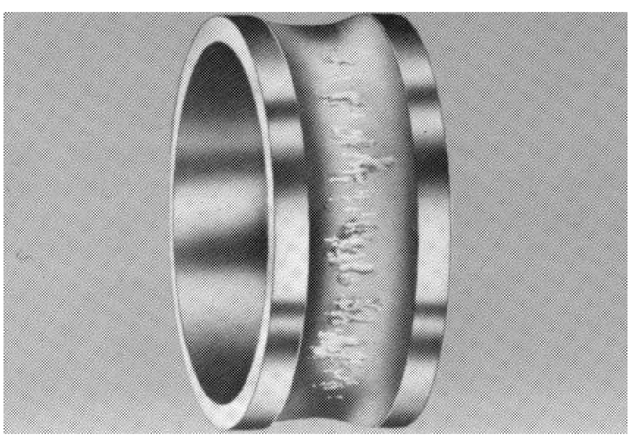

Figure 8 Spalling of Raceway

4. Improper assembly can cause brinelling (Figure 9). Driving or pressing on one race while supporting the other is the primary cause.

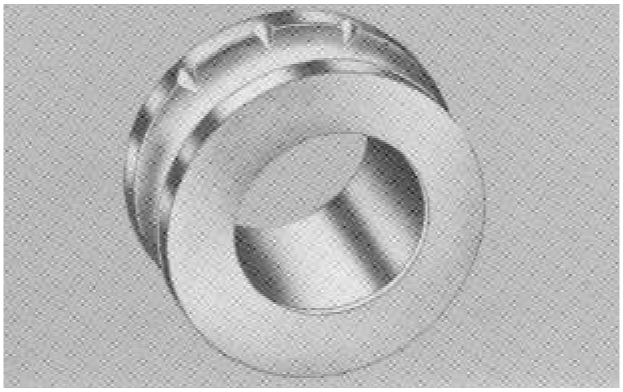

Figure 9 Brinelling

5. Overloading will appear as shown in Figure 7.

6. Misalignment is indicated by offset spalling (Figure 10) or an angular ball path (Figure 11).

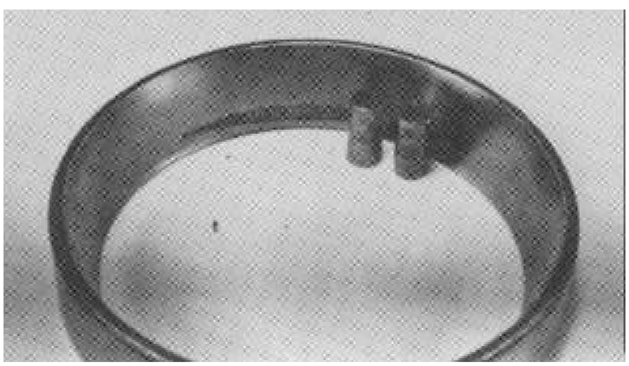

Figure 10 Offset Spalling

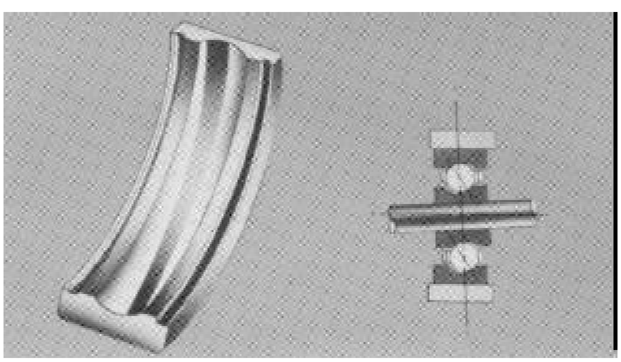

Figure 11 Angular Ball Path

3.4. CLUTCH COLLARS

Clashing gears while shifting is a common abuse in unsynchronized transmissions. Significant damage can occur by a hard clash shift when gears and collars are forced to engage but the speeds are not synchronized (Figure 12).

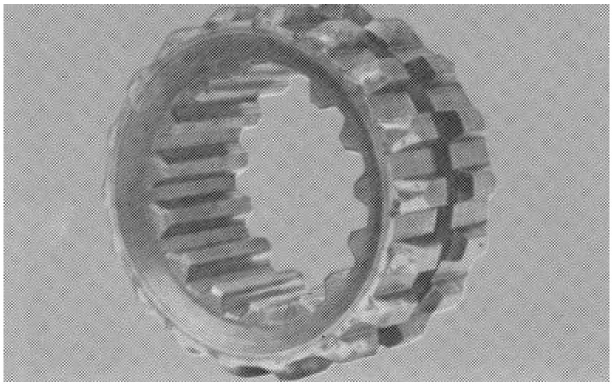

Figure 12 Damage From Clashing Gears

The probable causes of clashing gears are:

1. Improper shifting by drivers who are not familiar with the shift pattern or who have not learned the RPM spread between shifts.

2. Poor clutch release or a dragging clutch will make shifting difficult and will result in damage to gears and collars.

3. The inertial force of rotating gears requires a few seconds to slow down. Forcing a quick shift will result in noise and premature damage to gears and collars.

4. Clashing can also occur in air shifted transmissions. Verify that the correct shift points are being used or the pressure regulator setting is correct.

3.5. SYNCHRONIZED TRANSMISSIONS

These transmissions are designed for first gear starts. The correct shifting procedure requires moving the shift lever in one smooth motion until the shift is completed. Failure to follow this practice can result in the blocking action of the synchronizer to become ineffective and gear clashing will result.

Failures Due to Improper Shifting

Examples of failures due to improper shifting:

1. Rounded corners on synchronizer clutching teeth (Figure 13).

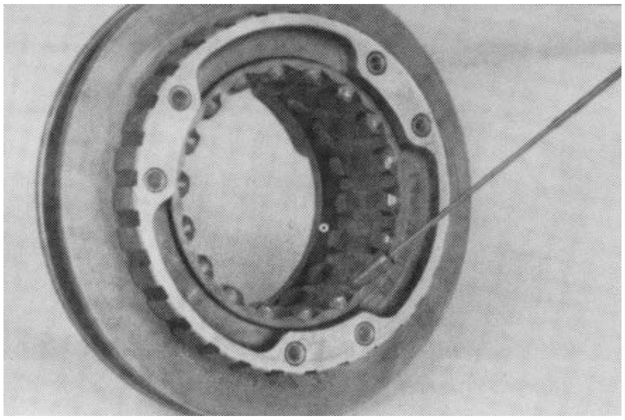

Figure 13 Rounded Corners on Synchronizer Clutching Teeth

2. Clutch teeth on gears will become worn or chipped (Figure 14).

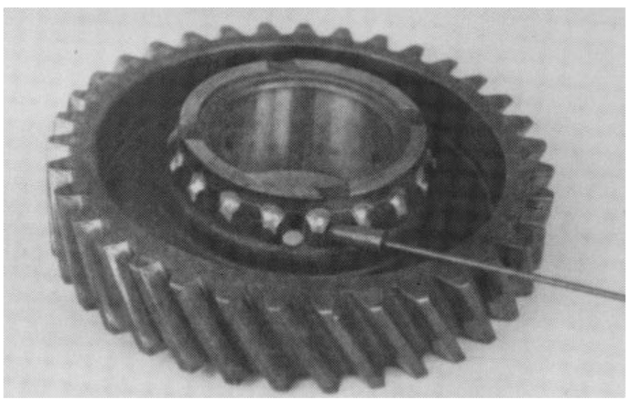

Figure 14 Worn or Chipped Clutch Teeth

3. Rounded teeth at the gear I.D. result in gear jumping (Figure 15).

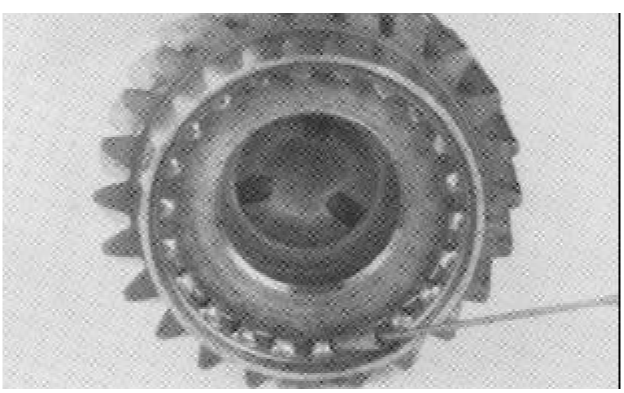

Figure 15 Rounded Teeth at Gear I.D.

4. The soft brass synchronizer rings will become imbedded with metal chips from the clutching teeth (Figure 16).

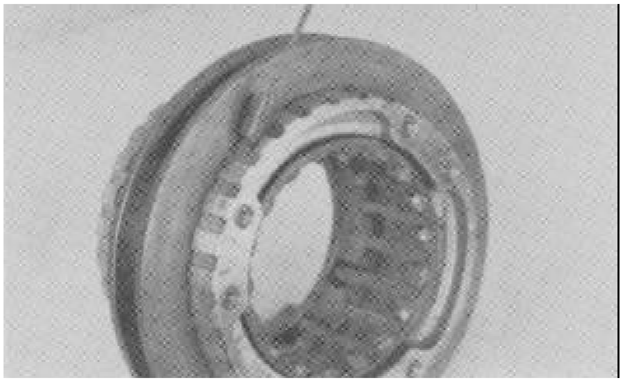

Figure 16 Synchronizer Rings Imbedded With Metal Chips

Vibration Failures

For vibration complaints in synchronized transmissions, refer to VIBRATION(See VIBRATION, page 1). Examples of vibration failures follow:

1. Mainshaft seizure of the fourth speed fluted diameter (Figure 17).

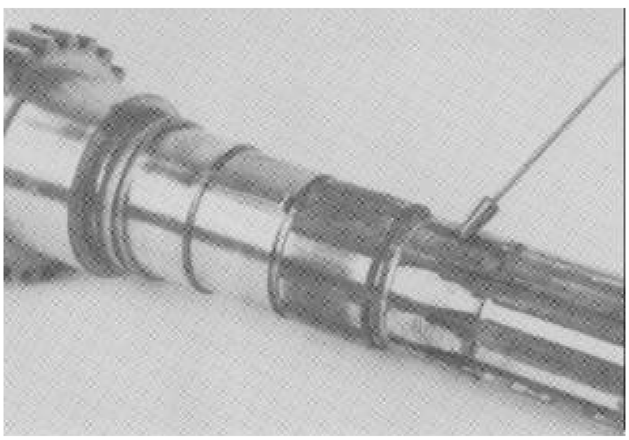

Figure 17 Mainshaft Seizure of Fourth Speed Fluted Diameter

2. Severe seizure of both the third and fourth gear area (Figure 18).

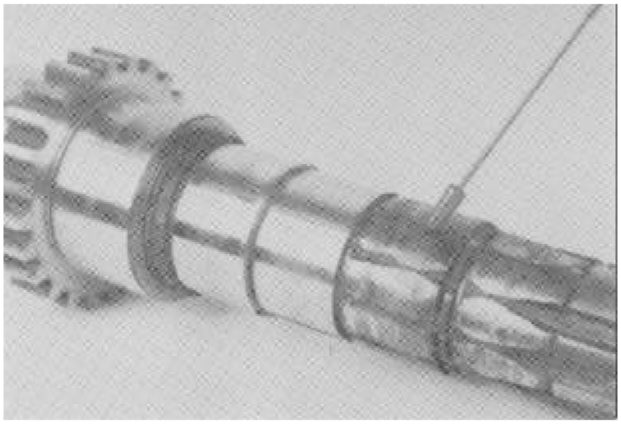

Figure 18 Seizure of Third and Fourth Gear Area

3. High heat welded the hub to the mainshaft (Figure 19).

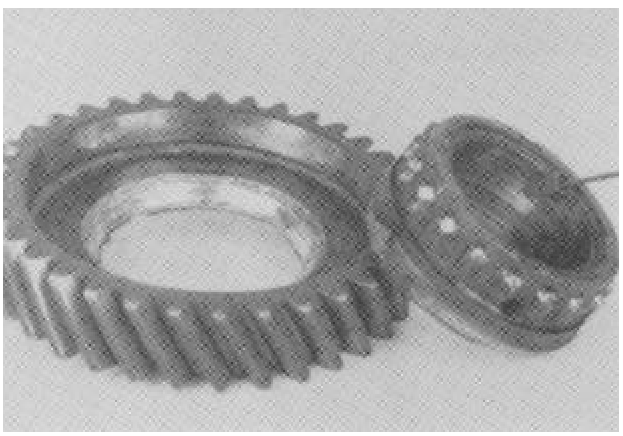

Figure 19 High Heat Welded Hub to Mainshaft

4. Washer seized to the thrust face of its gear (Figure 20).

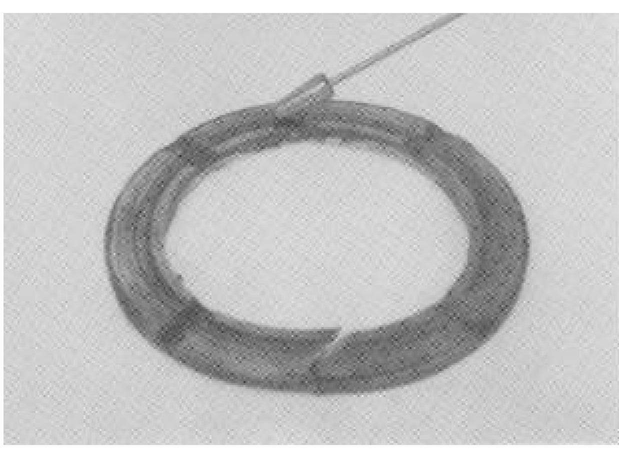

Figure 20 Washer Seized to Thrust Face of Gear

5. Broken synchronizer pins (Figure 21).

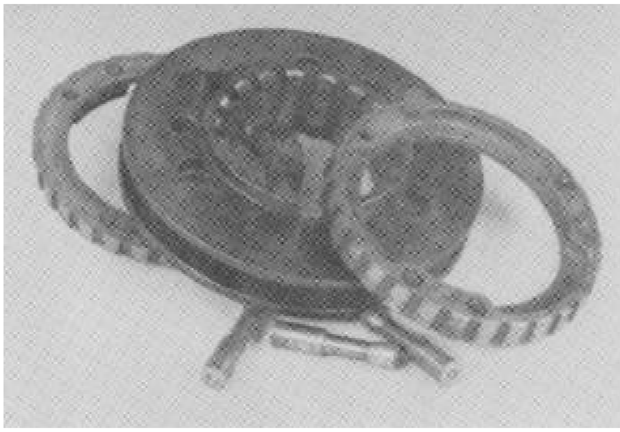

Figure 21 Broken Synchronizer Pins

4. CLUTCH COMPONENTS

4.1. CLUTCH COVER

If there is wear on the outer surface (Figure 22), inspect for the following:

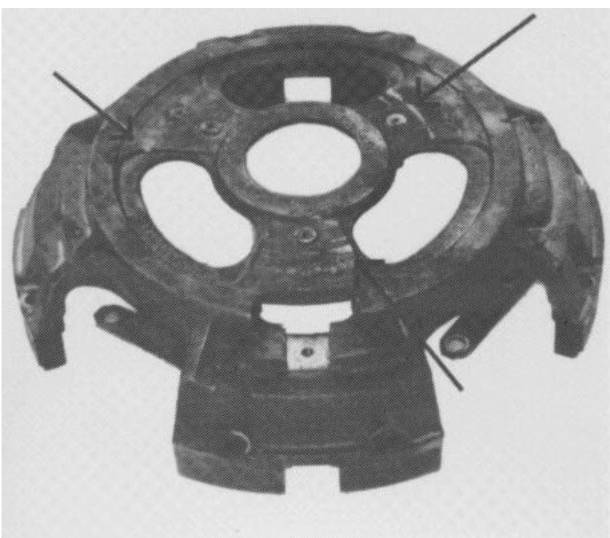

Figure 22 Outer Surface Wear

1. Linkage adjustment.
2. Worn transmission input bearing cap.
3. Worn or missing clutch brake.
4. Worn wear pads on release bearing housing.
5. Worn release forks tips.
6. Too much material removed from flywheel.

4.2. CENTER PLATE/PRESSURE PLATE

1. Cracked or heat checked caused by thermo stress due to slippage (Figure 23and Figure 24). Check the following:

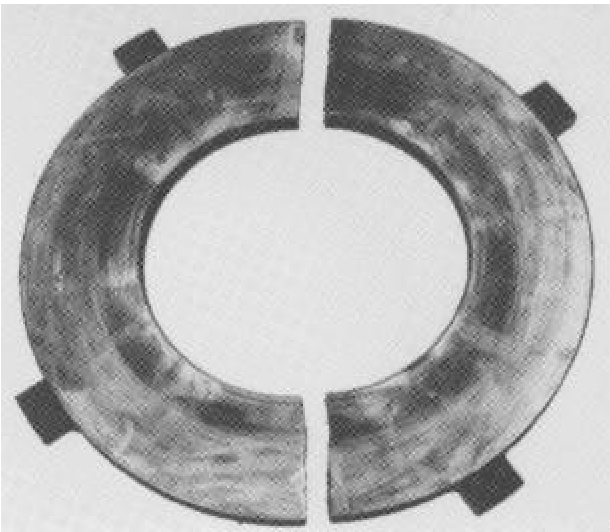

Figure 23 Cracked Plate

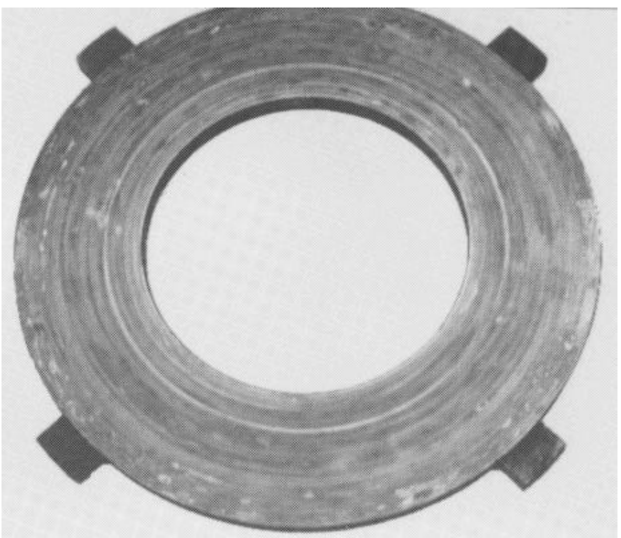

Figure 24 Heat Checked Plate

   a. Clutch adjustment.
   b. Drive pins not square to the flywheel (14").
   c. Center plate lug clearance (15-1/2").

2. Scored center plate or pressure plate (Figure 25). Small scratches and grooves are normal wear. Large scratches and grooves are due to slippage. Refer to page 13Step 1 above.

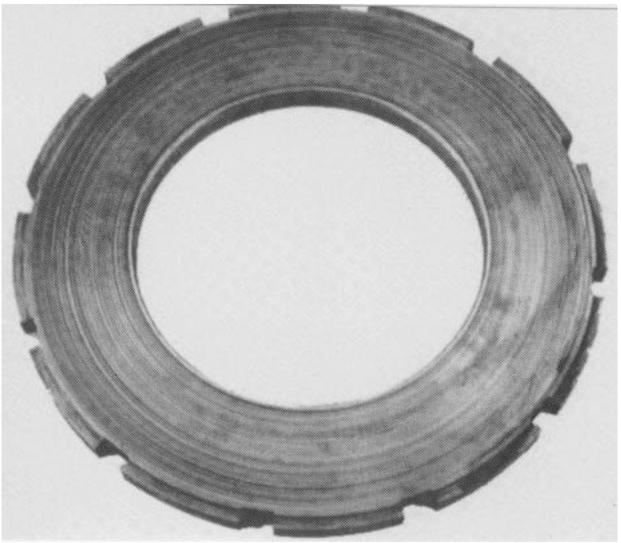

Figure 25 Scored Plate

3. Excessive center plate lug wear or damage is caused by drivetrain vibration.

4. Broken drive pins.
   a. Failure to use anti rattle springs supplied with super duty clutch.
   b. Misapplication of the clutch.
   c. Unequal loading on the drive pins as a result of filing the drive slots.

4.3. CLUTCH RELEASE RETAINER

1. Broken lever groove or guide pin tabs is caused by allowing the transmission to hang unsupported in the driven disc during transmission installation.

2. Worn retainer splines.
   a. Misalignment between the engine housing and the transmission clutch housing.
   b. Excessive runout of the flywheel.

4.4. DRIVEN DISCS

1. Grease/oil contaminated facings.
   a. Leakage at transmission bearing cap or engine rear main seal.
   b. Failure to remove rust preventative from the flywheel.
   c. The transmission input shaft was greased.

   NOTE – Greasing the transmission input shaft is NOT recommended. This practice can lead to clutch release problems.

   d. Leaking flywheel pilot bearing.

2. Warped driven discs result when the transmission is hung unsupported during installation.

3. Burnt driven discs are a result of excessive heat due to slippage. Ceramic facing material will flow and eventually separate from the disc. Organic material will separate from the disc due to bonding agent failure. Burnt discs can result from:
   a. Lack of free pedal.
   b. Constantly riding the clutch pedal.
   c. Partial unloading of a clutch due to a binding linkage system.
   d. Worn driven discs.
4. Driven disc to release retainer interference is the result of incorrect adjustment. The linkage was adjusted to compensate for wear rather than the internal adjusting ring. This can cause cracked hubs in the rear disc and a cracked pressure plate from the heat generated (Figure 26).

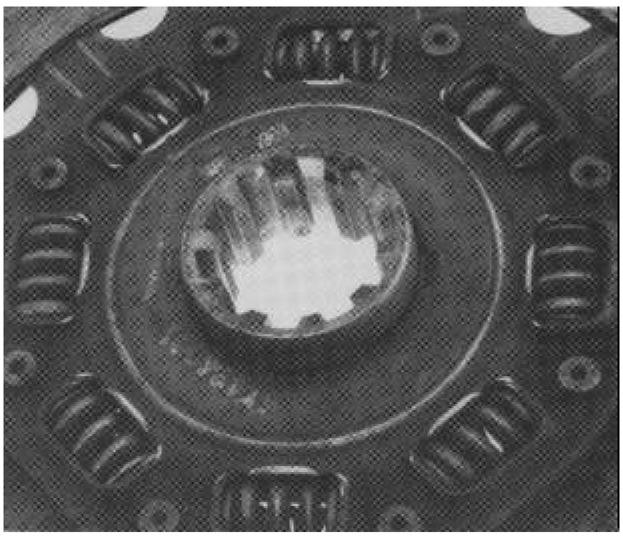

Figure 26 Cracked Hub

5. Rigid disc splines excessively worn or disc cracked. The cause of worn splines is usually due to torsional vibration or misapplication (Figure 27). A cracked disc hub (Figure 28) can be caused by the following:

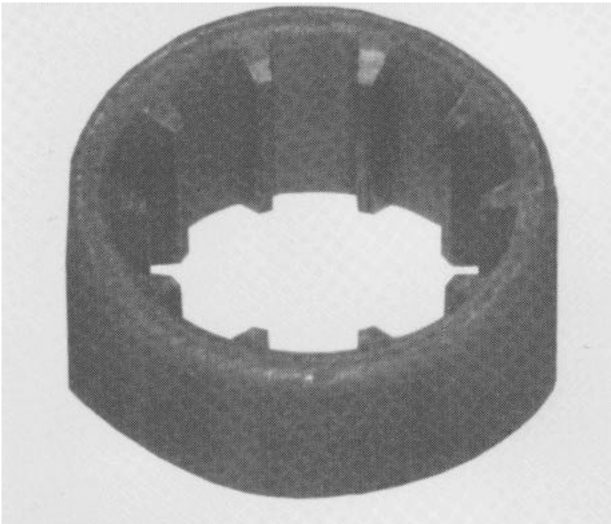

Figure 27 Worn Splines

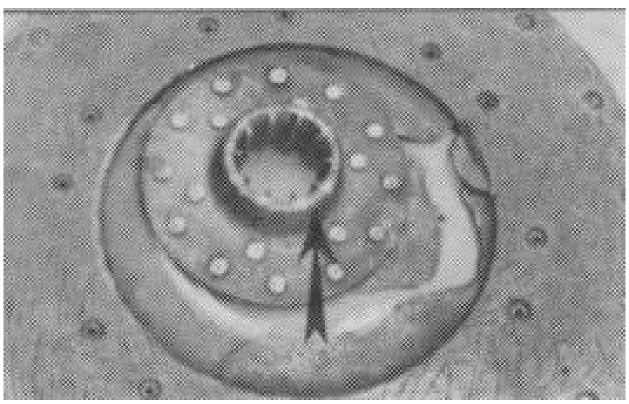

Figure 28 Cracked Disc Hub

a. A severe shock load.

b. Misalignment between the transmission clutch housing and the engine housing.

c. Misapplication - a rigid disc should not have been used.

d. Torsional vibration from the engine.

e. Excessive flywheel runout.

f. The transmission was hung in the disc unsupported during installation.

6. Cracked damper cover (Figure 29) can result from:

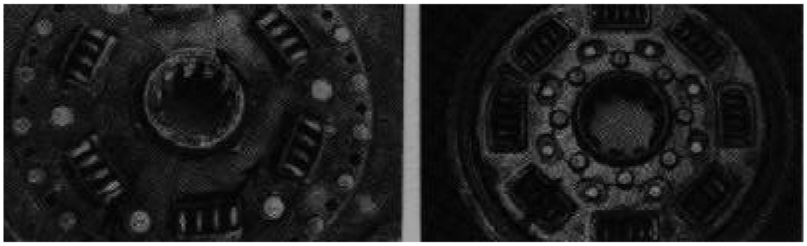

Figure 29 Cracked Damper Cover

a. Forcing the transmission input shaft into the driven disc hub during installation.

b. Allowing the transmission to hang unsupported in the driven disc hub during installation.

c. Misalignment between the engine housing and the transmission clutch housing.

7. Broken or missing damper springs may result from severe shock loads or excessive torsional vibration from the engine over the design limit of the damper (Figure 30).

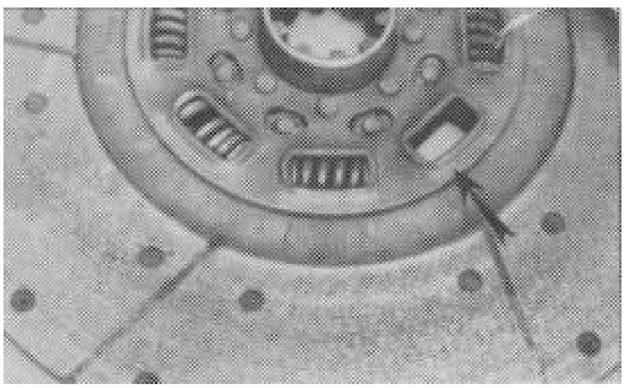

Figure 30 Broken and Missing Damper Springs

8. Driven disc damper hub cracked due to severe shock load or powertrain torsional vibration (Figure 31).

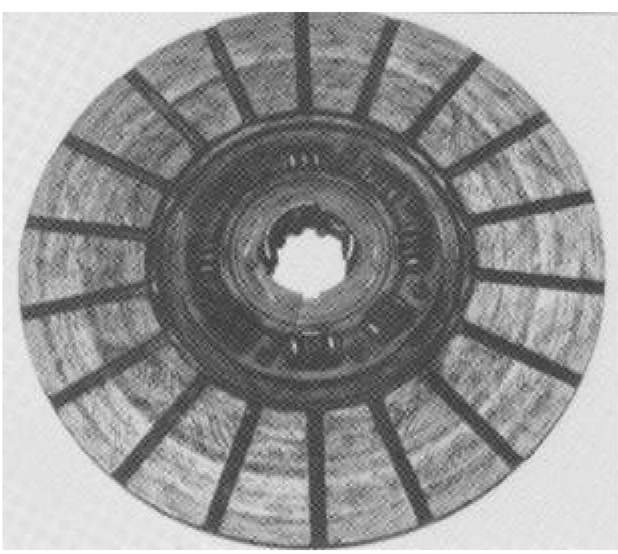

Figure 31 Cracked Driven Disc Damper Hub

9. Cracked or broken driven disc due to a severe shock load (Figure 32).

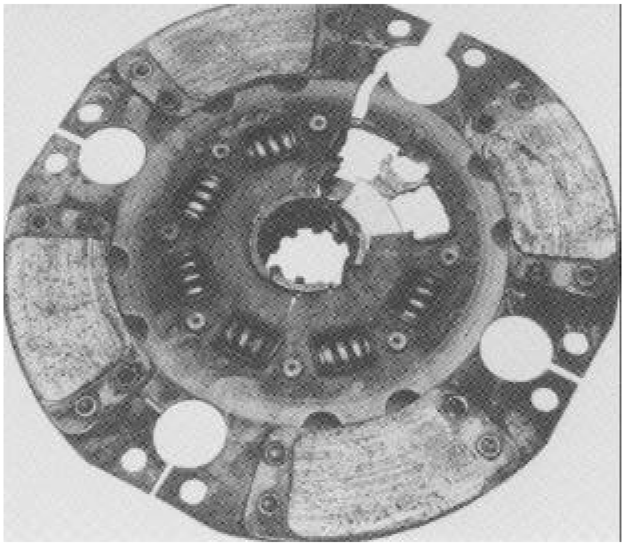

Figure 32 Cracked or Broken Driven Disc

10. Facings separate from the driven disc and the pressure plate, center plate and flywheel show severe damage caused by excessive slippage (Figure 33).

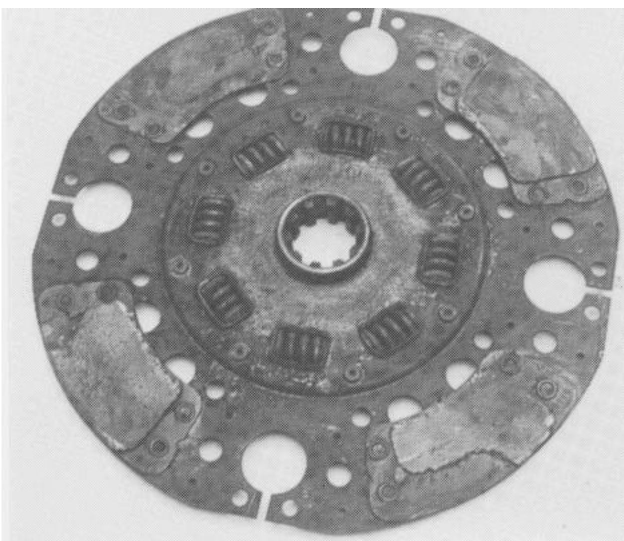

Figure 33 Damaged Facings

a. Clutch out of adjustment.

b. Insufficient clutch torque capacity for the application.

4.5. RELEASE BEARING ASSEMBLY

1. A release bearing will fail (Figure 34) for one or more of the following reasons:

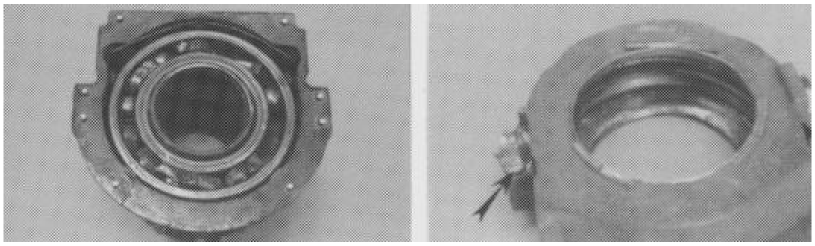

Figure 34 Release Bearing Failure

a. Lack of periodic lubrication (does not apply to sealed bearings).

b. Failure to fully release or riding the clutch pedal.

c. Failure to use the recommended lubricant.

2. Uneven wear on housing wear pads is caused by worn or damaged cross shaft bushings or cross shaft (Figure 35).

Figure 35 Uneven Wear on Housing Wear Pads

3. Excessive housing cover wear can be caused by a linkage system out of adjustment or driver shift technique (Figure 36).

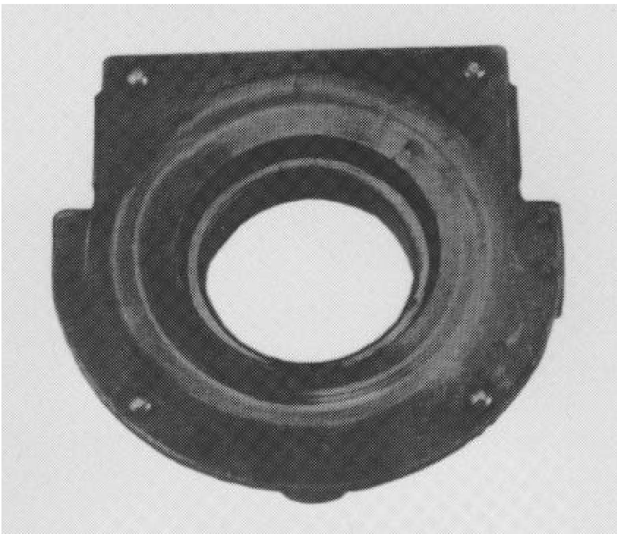

Figure 36 Excessive Housing Cover Wear

4.6. RELEASE FORK

1. Release fork bridge contacting the cover assembly (Figure 37). Inspect for the following causes:

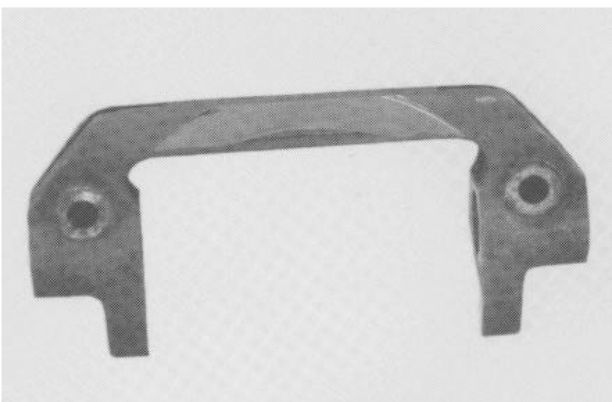

Figure 37 Release Fork Bridge Contacting Cover Assembly

   a. Worn clutch brake.
   b. Broken or missing clutch brake.
   c. Worn or incorrect transmission bearing cap.
   d. Excessive wear on release bearing housing wear pads.
   e. Excessive wear on release fork fingers.
   f. Incorrect linkage adjustment.
   g. Incorrect release fork.
   h. Machined too much material from the flywheel.

2. Worn fork fingers (Figure 38).

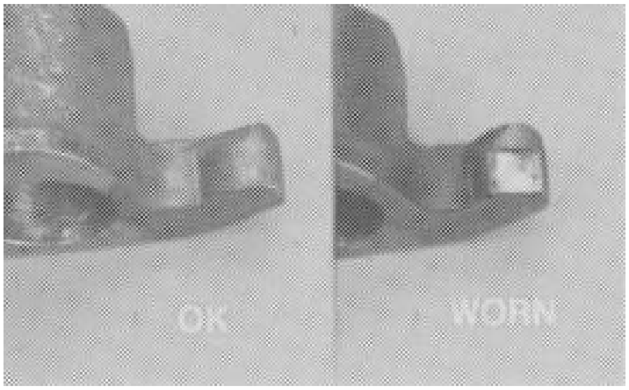

Figure 38 Worn Fork Fingers

a. Failure to maintain free pedal.

b. Driver abuse by riding the clutch pedal.

4.7. CLUTCH BRAKE

Clutch brake failure is usually attributed to the following:

1. Hitting or engaging the clutch brake while the vehicle is in motion.
2. The clutch brake was set too high.
3. A worn or rough transmission bearing cap.

5. AXLE COMPONENTS

5.1. RING AND PINION SETS

1. Gear teeth surface fused. A charred appearance indicates an overheated condition. Metal lifted off the pinion and fused to the ring gear teeth (Figure 39). This is due to lack of lubricant.

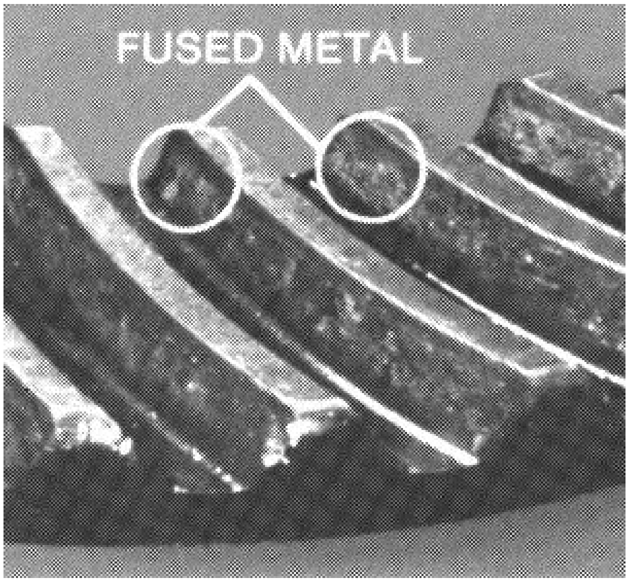

Figure 39 Gear Teeth Surface Fused

2. Shock load. Teeth as shown in Figure 40were in mesh with the pinion and were subjected to an instantaneous shock load. The fracture is rough and looks crystalline.

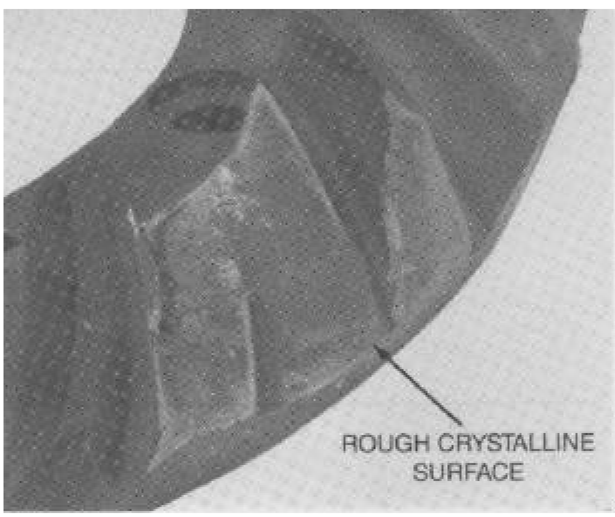

Figure 40 Shock Load

3. Spalling and pitting. Flakes of metal have broken off the tooth surface to create a spalled condition (Figure 41). This failure started with pitting at the tooth root and advanced to spalling at the tooth working surface. It is usually caused by continuous overloading.

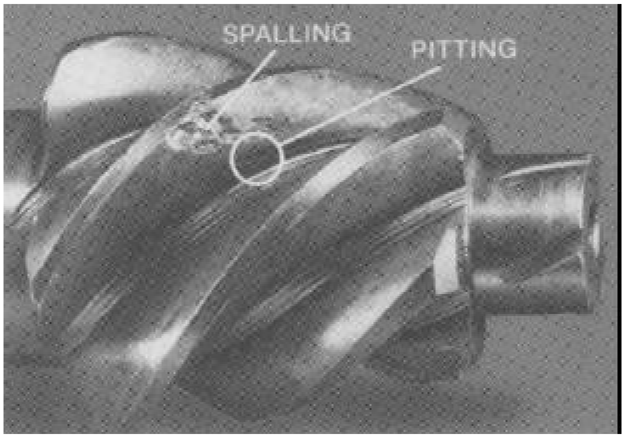

Figure 41 Spalling and Pitting

4. Flank cracking. This type of fatigue failure will first develop cracks that run the length of the tooth face. Once the cracks appear, the metal between them begins to flake away and failure occurs rapidly (Figure 42).

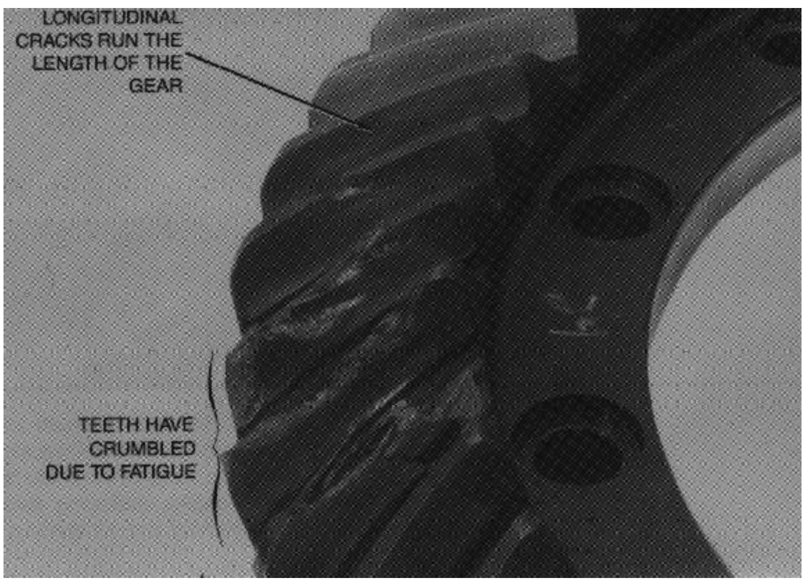

Figure 42 Flank Cracking

5. Drive pinion fatigue failure. A torsional and bending force caused the pinion inFigure 43to fail. The failure was probably due to operational overloads or a shock load.

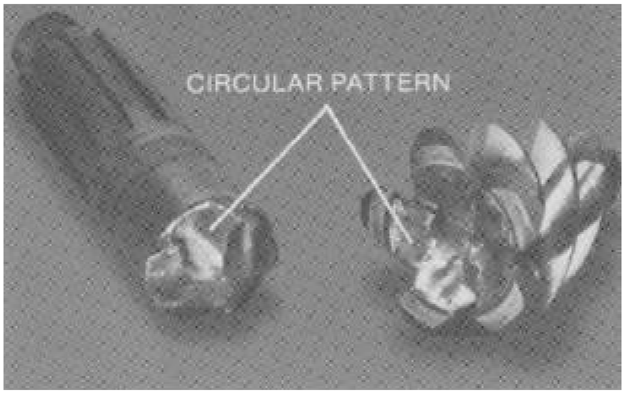

Figure 43 Drive Pinion Fatigue Failure

6. Root beam fatigue. Figure 44shows typical root beam bending fatigue beach marks at the roots of all damaged teeth. If the remaining teeth are in good condition, the probable cause was a shock load.

Figure 44 Root Beam Fatigue

7. Crows foot pattern. This pattern on gear teeth is characteristic of wear caused by improper lubricants or lubricants with depleted additives (Figure 45).

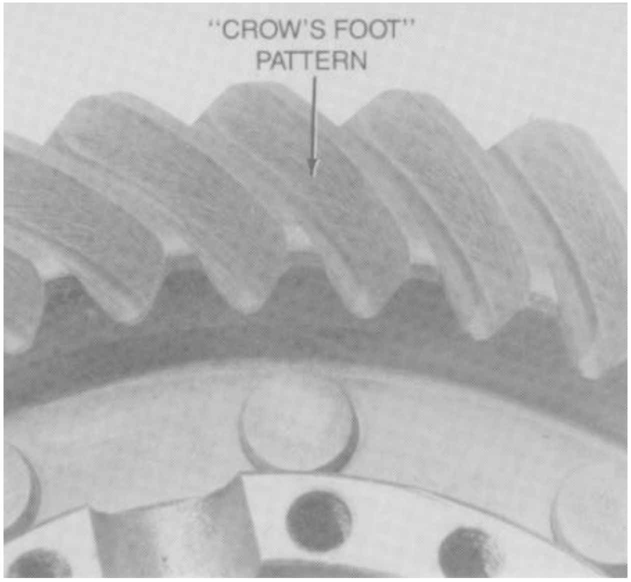

Figure 45 Crows Foot Pattern

5.2. WHEEL DIFFERENTIAL

1. Spinout failure. This type of failure is caused by excessive wheel spinning. Heat developed by the excessive speed of the differential gears will break down the lubricant film and metal to metal contact occurs. The pinion can weld to the cross and the cross will break (Figure 46).

Figure 46 Spinout Failure

2. Differential case worn and scored. Excessive spinout or low lubricant level can cause scoring and wear at case surface which contacts the thrust washers (Figure 47).

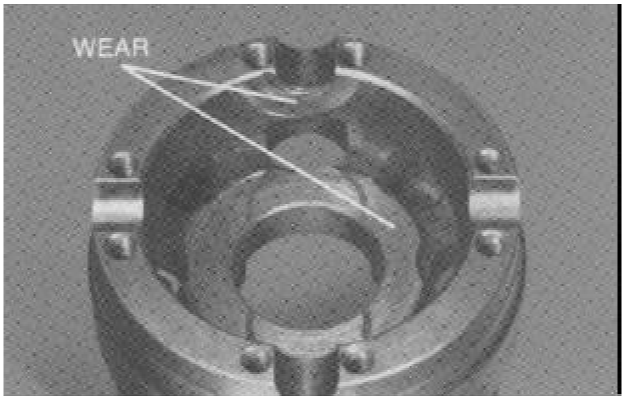

Figure 47 Differential Case Worn and Scored

3. Teeth on side gear broken and worn. This failure is caused by contaminated lubricant. A part failed, contaminated the lubricant, then caused tooth wear and fracture (Figure 48).

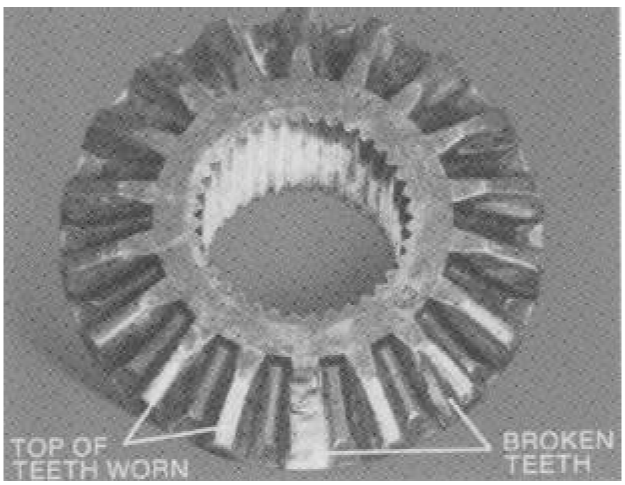

Figure 48 Broken and Worn Teeth on Side Gear

4. Differential shock failure.
   a. A severe shock load fractured the cross and pinion gears. Continued operation damaged the side gear teeth (Figure 49).

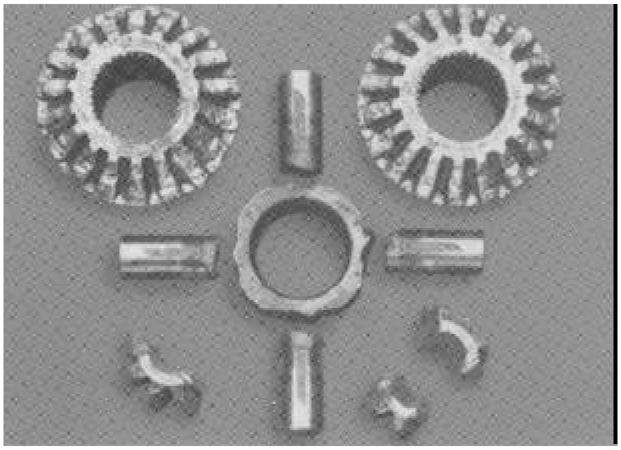

Figure 49 Differential Shock Failure

b. Inspection of the inner case shows the side gear with its teeth missing (Figure 50). The gear teeth are extremely marred from the metal ground into them. The fractures show a rough crystalline appearance typical of an instantaneous shock load failure.

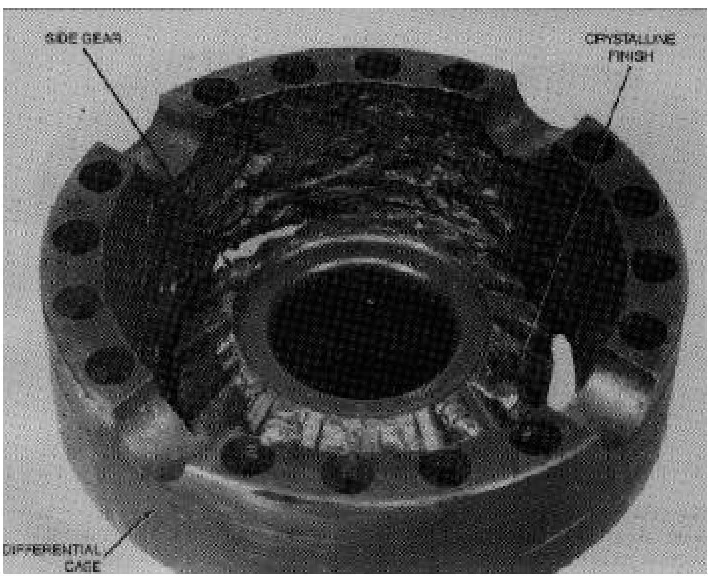

Figure 50 Teeth Missing in Side Gear

5.3. INTER-AXLE DIFFERENTIAL

1. Spinout.

   a. The components in Figure 51show the effect of excessive differentiation. The cross is worn and scored, bushings are scored and thrust washers are worn. The side pinion teeth are worn and chipped and the cross shows irregular shaped splines.

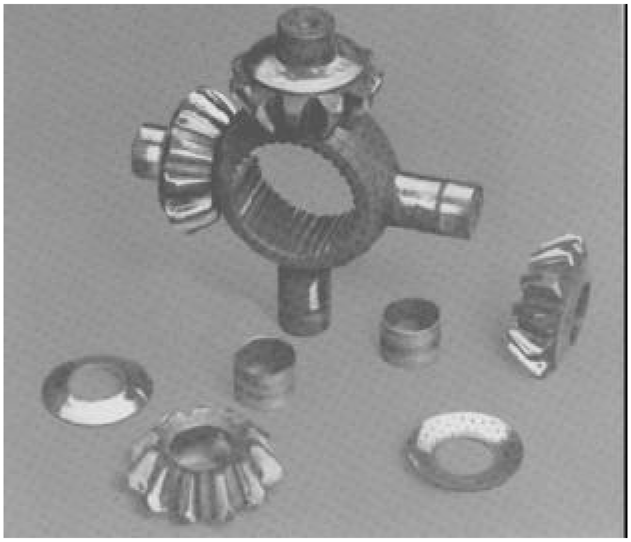

Figure 51 Excessive Differentiation

b. Case thrust washer surface worn (Figure 52). Metal to metal contact caused this wear pattern in the case wall. The deep ridges at the edge of the pattern requires case replacement.

Figure 52 Worn Case Thrust Washer Surface

5.4. POWER DIVIDER

1. Damaged teeth due to shock impact. One sudden shock impact fractured the engaged teeth of these two gears. The adjacent teeth were damaged by metal pieces (Figure 53).

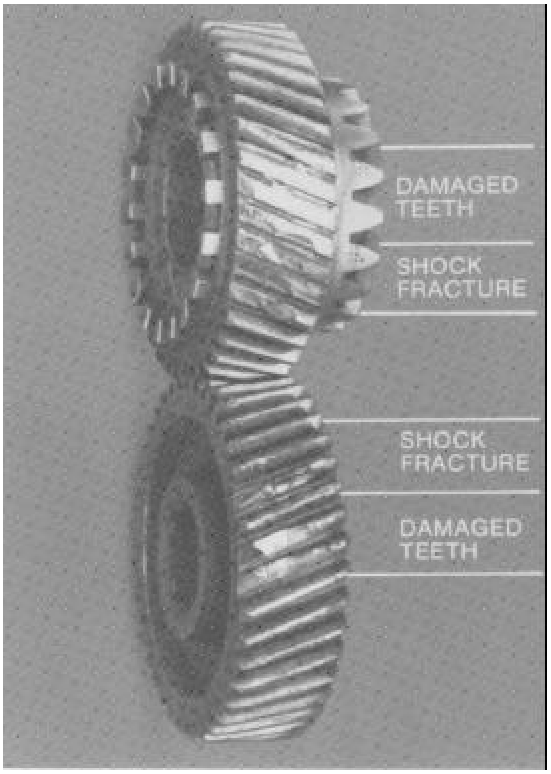

Figure 53 Damaged Teeth Due to Shock Impact

2. Broken gear teeth from fatigue failure. A shock load to the gear teeth in mesh produced cracking of the case hardened tooth surface. Continued loading resulted in a progression of fractures as evidenced by beach marks (Figure 54).

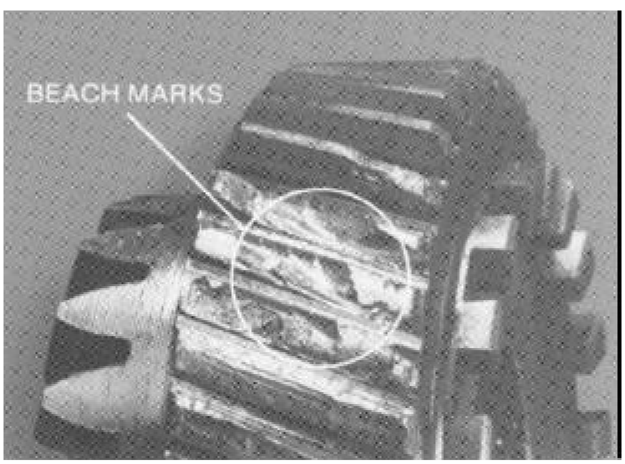

Figure 54 Broken Gear Teeth From Fatigue Failure

3. Broken sliding clutch. An instantaneous shock load created the rough surface pattern on the fracture (Figure 55). This can be caused by trying to engage the inter-axle differential lockout while the wheels are spinning.

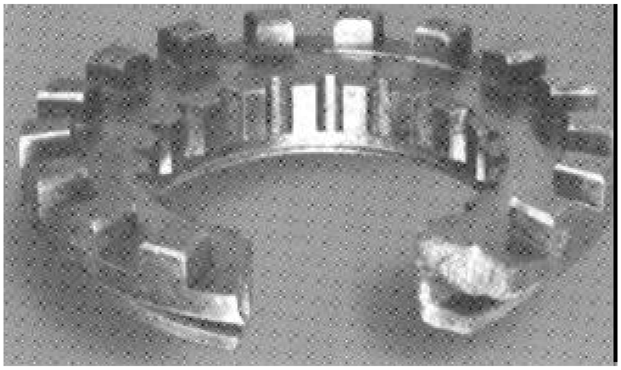

Figure 55 Broken Sliding Clutch

4. Gear bushing scored. Contaminated lubricant with fine particles caused scoring. Some pitting and scoring has occurred on the gear thrust washer surface (Figure 56).

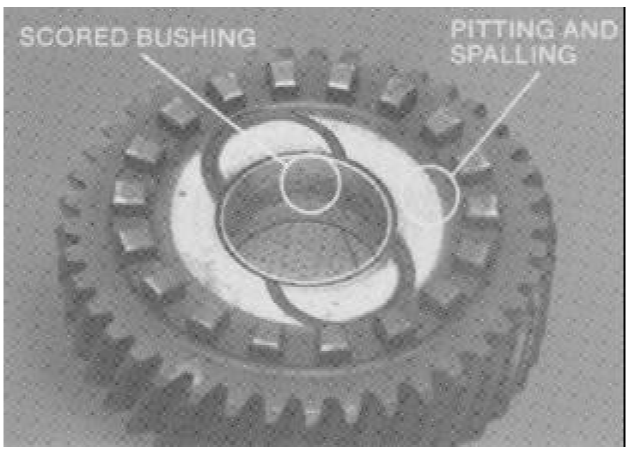

Figure 56 Gear Bushing Scored

5. Input shaft broken. Multiple shock loads produced the flat, rough break of this input shaft (Figure 57). It can be caused by abusive truck operation, incorrect use of inter-axle differential lockout or abusive clutch operation.

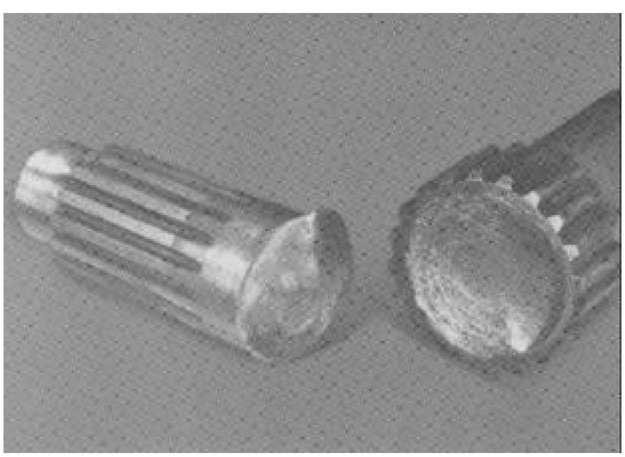

Figure 57 Input Shaft Broken

6. Input shaft torsional fatigue failure. The shaft surface initially cracks from an extremely high load. The cracks progress to the center of the core under normal operation until the shaft fails (Figure 58).

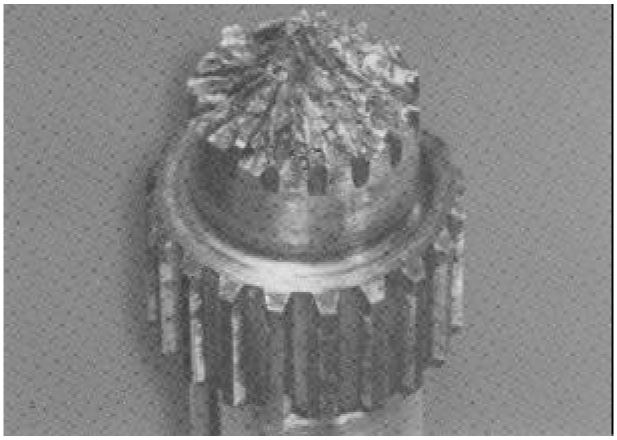

Figure 58 Input Shaft Torsional Fatigue Failure

7. Output shaft torsional shock failure. This is the result of a shock load and can occur in a single impact (Figure 59). The direction of spline twist will indicate whether the vehicle was moving forward or in reverse.

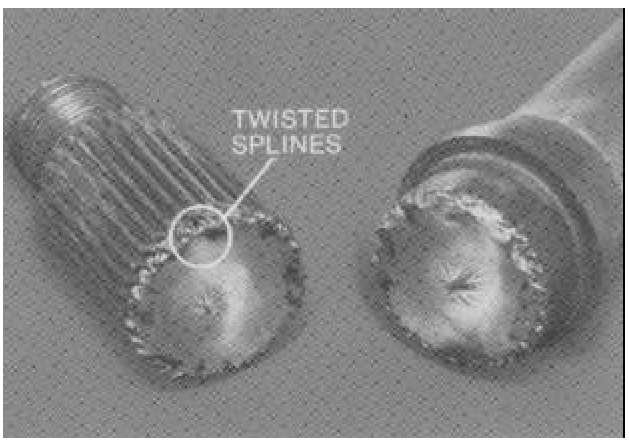

Figure 59 Output Shaft Torsional Shock Failure

5.5. AXLE HOUSING

1. Worn and scored spindle. Lack of lubricant is the cause of scored or worn spindles. Contamination will create a combination of metal to metal abrasive action. The bearing can seize and the inner cone will turn on the spindle causing a scored condition (Figure 60).

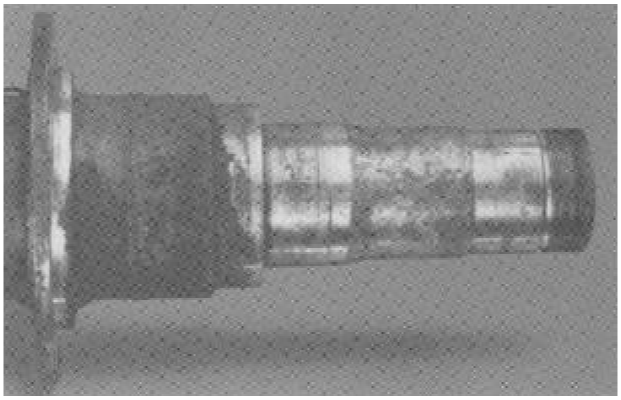

Figure 60 Worn and Scored Spindle

2. Cracks at the spring pad area. Clamping hardware which is loose could cause cracks at the top and/or bottom of the axle housing. Wear spots in the spring pad area would indicate loose hardware (Figure 61).

Figure 61 Cracks at Spring Pad Area

3. Axle housing crushed in the spring pad area. Clamping hardware was overtightened to cause this condition (Figure 62). Inspect for cracks and replace hardware. If the new hardware does not fit correctly, replace the housing.

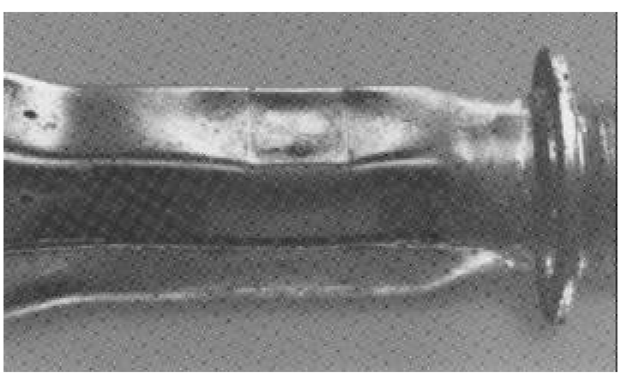

Figure 62 Axle Housing Crushed in Spring Pad Area

4. Axle fatigue cracks at a weld. Fatigue cracks start at the suspension bracket. The failure is caused by repetitive loads at the bracket mounting surface and could be due to misapplication, material or a weld problem (Figure 63).

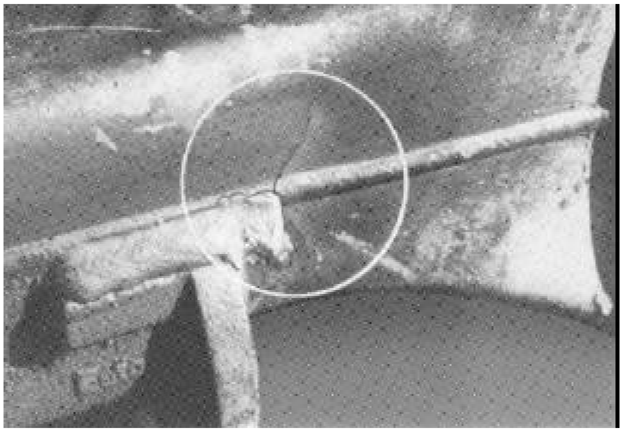

Figure 63 Axle Fatigue Cracks at Weld

5.6. AXLE SHAFT

Axle shaft failure is caused by a torsional shock load (Figure 64). Ramming during trailer hookup, spinning wheel hitting dry pavement, engaging the inter-axle differential lockout with wheels spinning could produce this shock load.

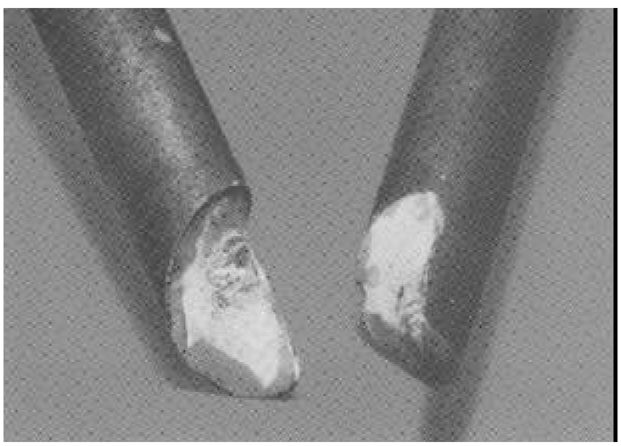

Figure 64 Axle Shaft Failure

5.7. PLANETARY UNIT

1. Gear and pinion teeth pitted and spalled. This is generally caused by continuous overloading which breaks down the lubrication film and pitting occurs or contaminated lube. The pitting starts below the tooth centerline then works its way above the centerline. Continued operation causes flakes of metal to break off until spalling occurs (Figure 65and Figure 66).

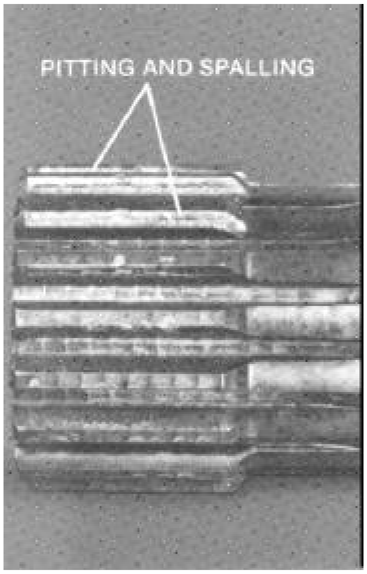

Figure 65 Pitting and Spalling

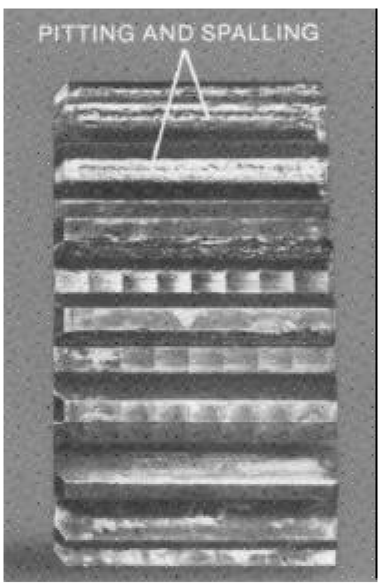

Figure 66 Pitting and Spalling

2. Broken teeth on sliding clutch gear (Figure 67). A severe shock load caused four teeth to fracture that were in mesh with the idler pinions. This occurred when the vehicle was started in high range under heavy load.

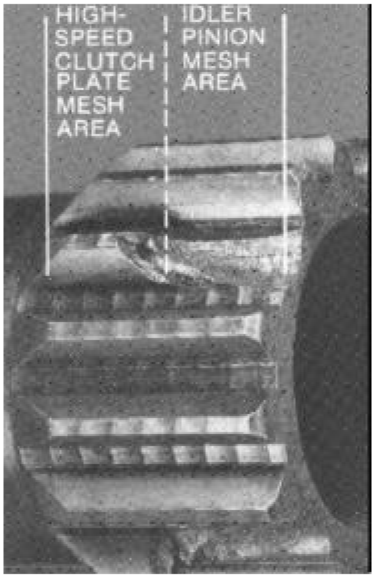

Figure 67 Broken Teeth on Sliding Clutch Gear

3. Excessively worn clutch plates and gear. Incorrect shifting caused excessive wear to the sliding clutch gear (Figure 68) and the sliding shifting plates (Figure 69).

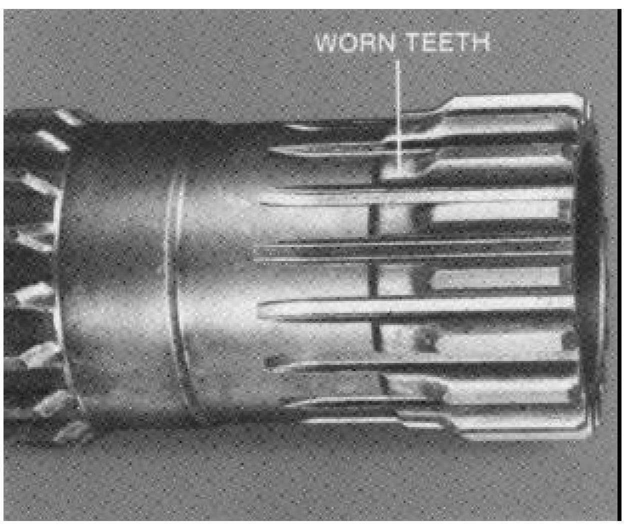

Figure 68 Excessive Wear to Sliding Clutch Gear

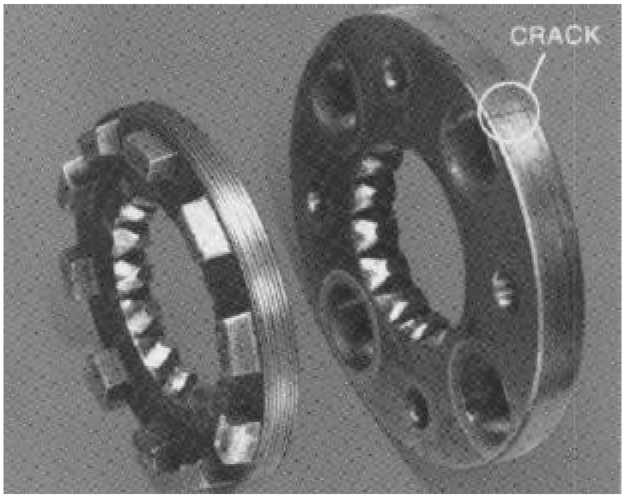

Figure 69 Excessive Wear to Sliding Shifting Plates

4. Normal and excessive wear on the idler pin (Figure 70). The area labeled normal wear is acceptable for reuse. A idler pin appearing as that labeled excessive wear must be replaced.

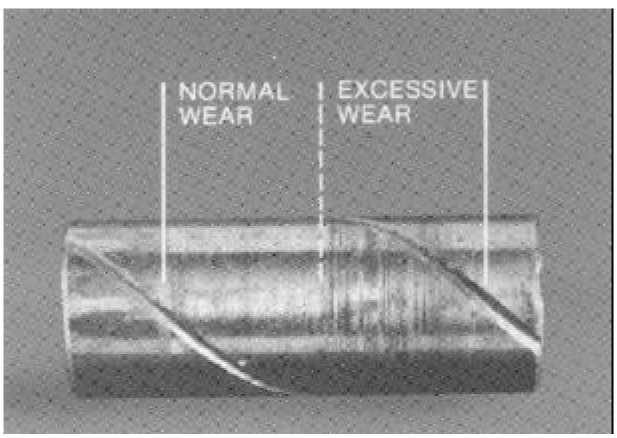

Figure 70 Normal and Excessive Wear on Idler Pin

5. Scored and worn idler pin (Figure 71). This condition could be from normal wear or contaminated lubricant. The discoloration could also indicate overheating or a low lubricant level.

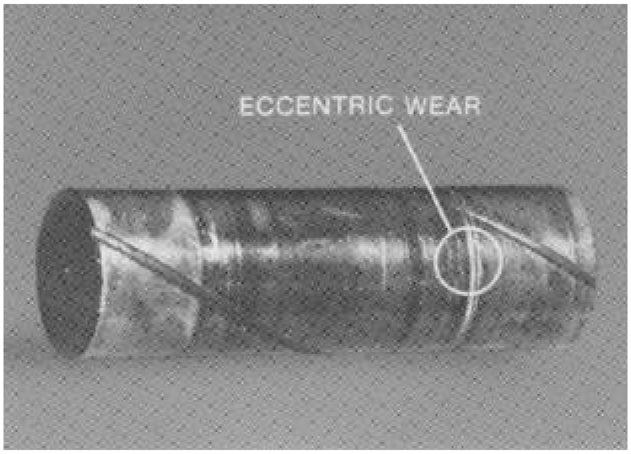

Figure 71 Scored and Worn Idler Pin

6. DRIVELINE

6.1. UNIVERSAL JOINTS

1. Burned U-joint cross (Figure 72):

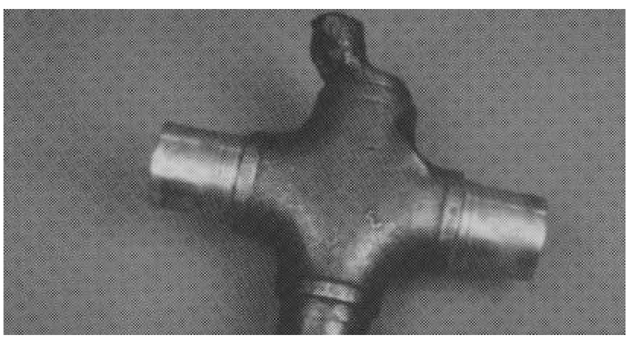

Figure 72 Burned U-Joint Cross

   a. Lack of lubrication (improper maintenance).
   b. Missing or improperly installed check valves.
   c. Wrong lubricant.
   d. Improper application.
   e. Improper assembly procedure.

2. Fractured U-joint (Figure 73):

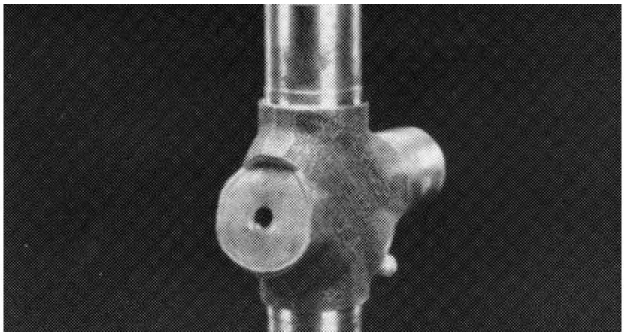

Figure 73 Fractured U-Joint

a. Excessive torque loads.

b. Shock loads.

c. Improper application.

3. End galling (Figure 74):

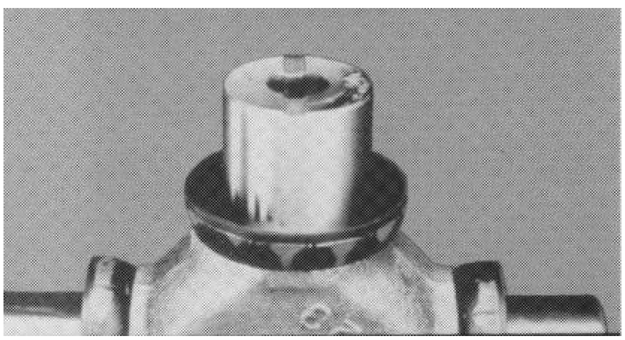

Figure 74 End Galling

a. Excessive driveline angles.

b. Improper assembly procedures.

c. Sprung or bent yoke.

4. Brinelling (Figure 75):

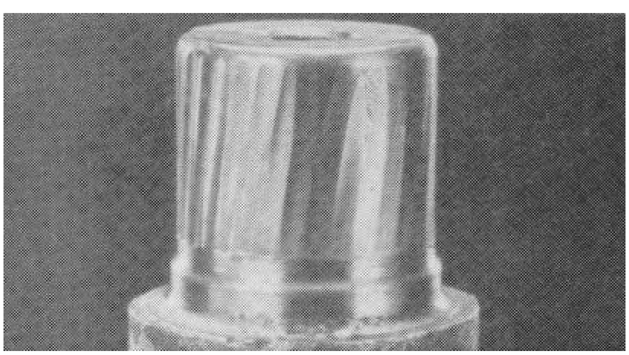

Figure 75 Brinelling

a. Excessive continuous torque loads.

   b. Seized slip yoke splines.
   c. Excessive driveline angles.
   d. Sprung or bent yoke.

5. Spalling (Figure 76):

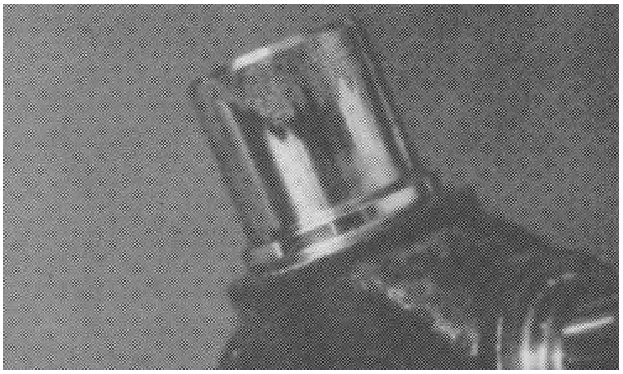

Figure 76 Spalling

   a. Water contamination.
   b. Wrong lubricant.

6.2. END YOKES

1. Fractured yoke (Figure 77):

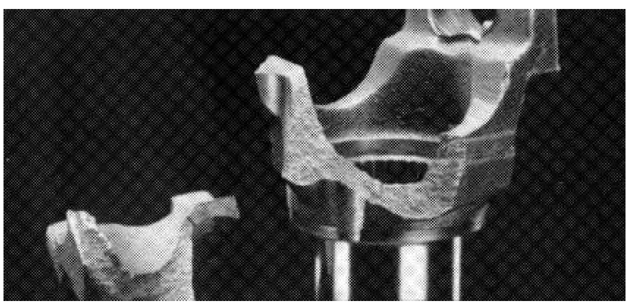

Figure 77 Fractured Yoke

   a. Excessive torque loads.
   b. Shock loads.
   c. Improper application.

2. Broken tang half round (Figure 78):

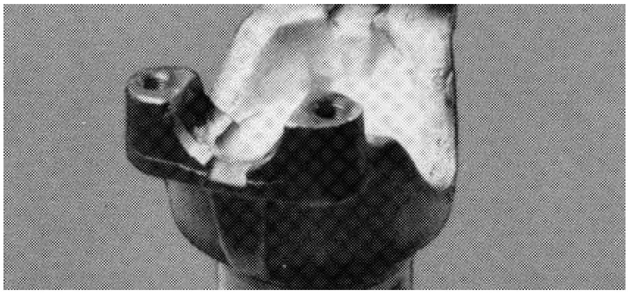

Figure 78 Broken Tang Half Round

a. Improper strap bolt torque.

b. Improper installation.

3. Bent yoke (Figure 79):

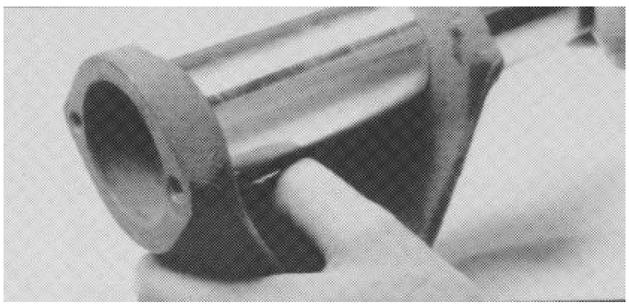

Figure 79 Bent Yoke

a. Excessive torque.

b. Improper application.

c. Improper U-joint removal.

6.3. DRIVESHAFT TUBING

1. Bent tubing (Figure 80):

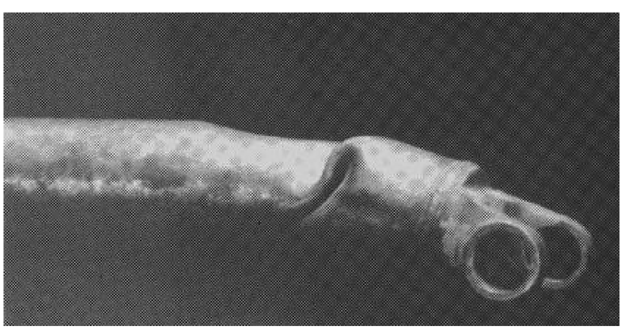

Figure 80 Bent Tubing

a. Excessive torque.

b. Axial shock load.

c. Improper service procedures.

2. Broken weld (Figure 81):

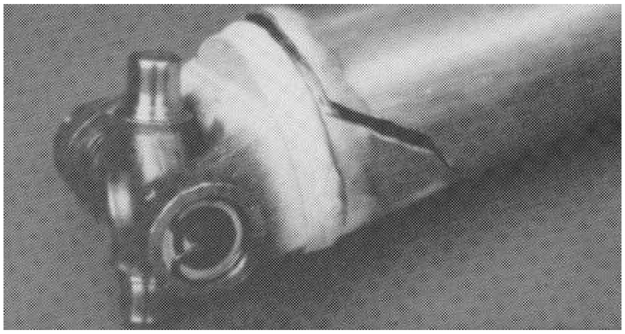

Figure 81 Broken Weld

a. Shock loads.

b. Excessive vibration.

3. Split tube seam (Figure 82):

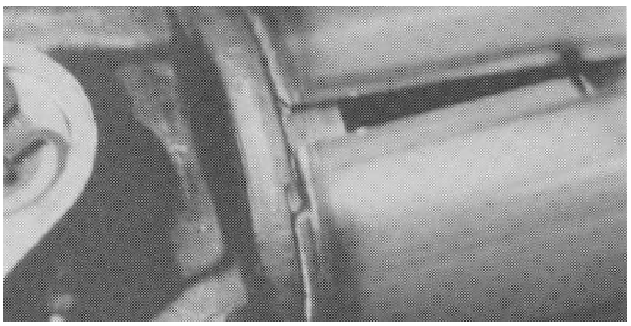

Figure 82 Split Tube Seam

a. Shock loads.

b. Improper straightening procedure.

6.4. CENTER BEARING SUPPORT

1. Damaged support (Figure 83):

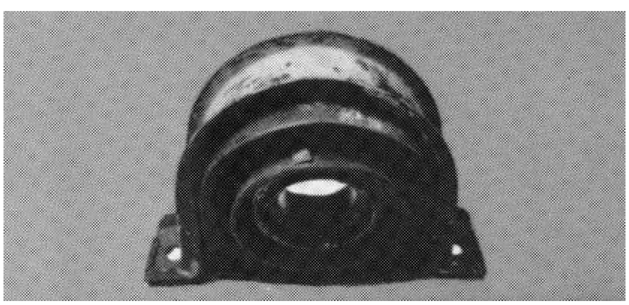

Figure 83 Damaged Support

a. Improper bracket installation angle.

b. Improper application.

c. Off road abuse.

6.5. TUBE SHAFTS

1. Fractured spline (Figure 84):

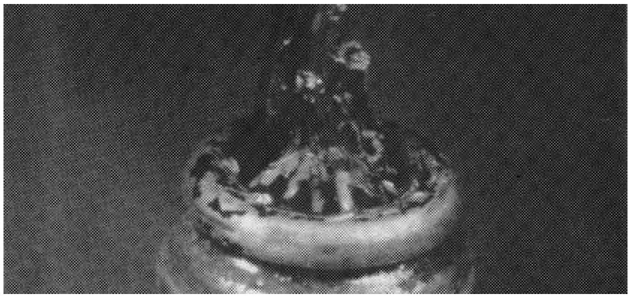

Figure 84 Fractured Spline

a. Excessive torque loads.

b. Shock loads.

c. Improper application.

2. Twisted spline (Figure 85):

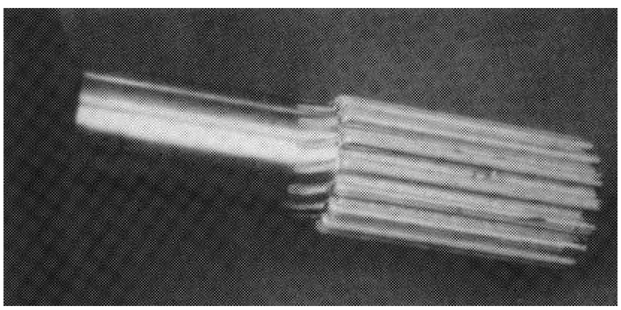

Figure 85 Twisted Spline

a. Excessive torque loads.

b. Shock loads.

c. Improper application.