Driveline

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Note

In keeping with its policy of continual product improvement, some material for this section may not have been available at time of publication. Supplemental documentation relating to "half-round" driveshaft connections and/or Series 1550 may be found at the Dana Spicer website, www.spicerdriveshaft.com. The publication series at this site is 3264. See publications 3119-5 SUJ 4/94 and IJ900-81 1/80.

Driveline

Safety

The purpose of this safety summary is twofold. First, it is to help ensure the safety and health of individuals performing service on, or operation of, the Blue Bird All American Series bus. Second, it is to help protect equipment. Before performing any service or operating procedure on the All American bus, individuals should read and adhere to the applicable warnings, cautions and notes located throughout this Blue Bird Service Manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, it not correctly adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure. Please note that on occasion, notes, too, may advise of potential safety issues.

Introduction

The purpose of this manual is to help you get the best value from your All American Series bus. This manual can help you decide what work must be done, and it provides for routine maintenance, as well as common service procedures. This manual has diagnostic and repair procedures to use when trouble occurs. We have tried to make this service manual as comprehensive as possible. However, in some cases, only the high volume options have been included.

Inspection

To keep a vehicle operating smoothly and economically, the driveshaft must be carefully inspected at regular intervals. Vibrations and U-joint and shaft support (center) bearing problems are caused by loose end yokes, excessive radial (side to side or up and down) looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke.

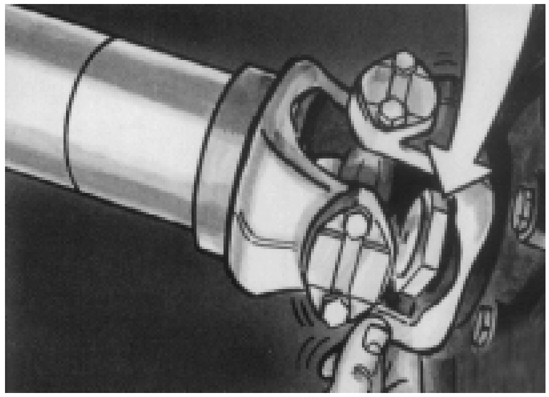

Figure 1—End Yoke Retaining Nut

Check the output and input end yokes on both the transmission and axle for looseness. If loose, disconnect the driveshaft and re-torque the end yoke retaining nut. **Figure 1.** If yoke replacement is required, check for manufacturer's recommendation regarding replacement frequency of the end yoke-retaining nut.

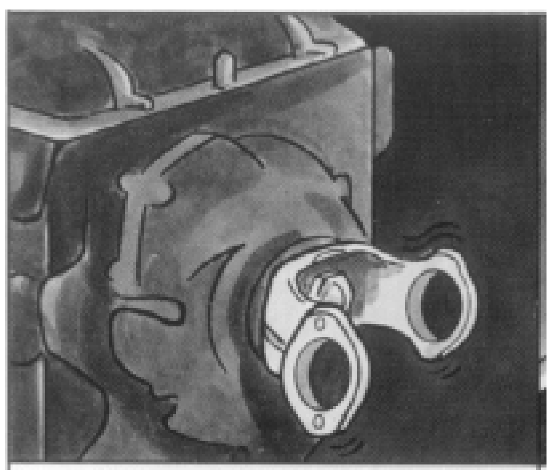

Figure 2—Transmission Output Shaft

If the end yokes are tight, check for excessive radial looseness of the transmission output shaft and axle input shafts in their respective bearings. **Figure 2.**

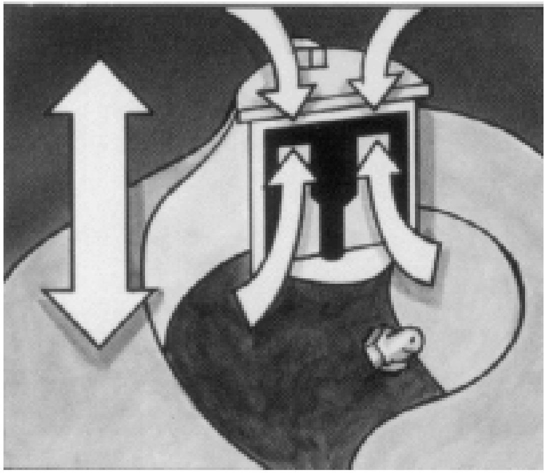

Figure 3—Bearing and Trunnion

Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed .006-inches maximum. **Figure 3**.

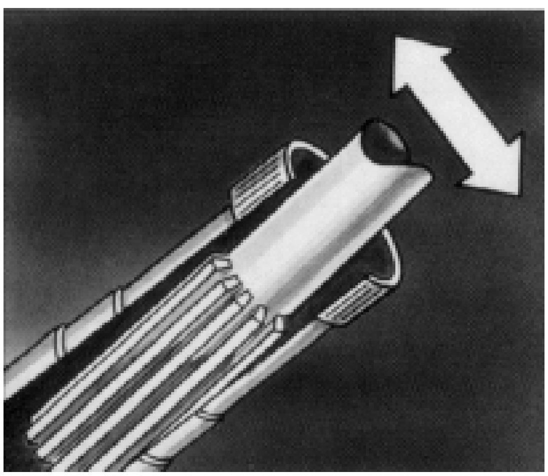

Figure 4—Slip Spline

Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .007-inches. **Figure 4.**

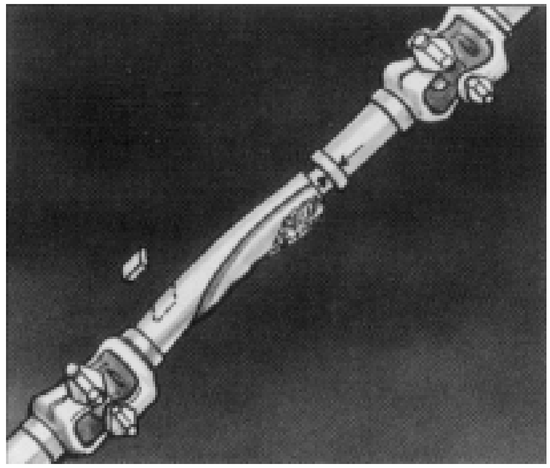

Figure 5—Driveshaft

Check the shaft for damaged, bent tubing or missing balance weights. **Figure 5**. Be sure there is no buildup of foreign material on the shaft, such as undercoat or concrete. If found, it should be removed.

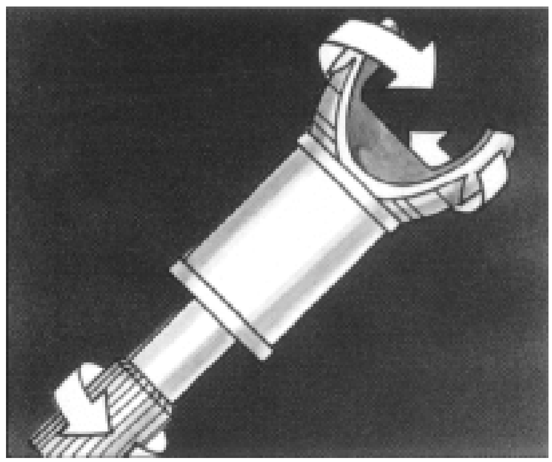

Figure 6—Run Out Reading of Driveshaft

If run out readings are required, they should be taken with the driveshaft mounted in the vehicle, with the transmission in neutral and the axle shafts pulled, or by jacking rear wheels off the ground and placing axles on the jack stands. **Figure 6**. This will allow rotating the driveshaft by hand to check indicator readings. The run out readings taken at the various locations should not exceed an additional 0.010 TIR (Total Indicator Reading) over the manufacturer's specified run out.

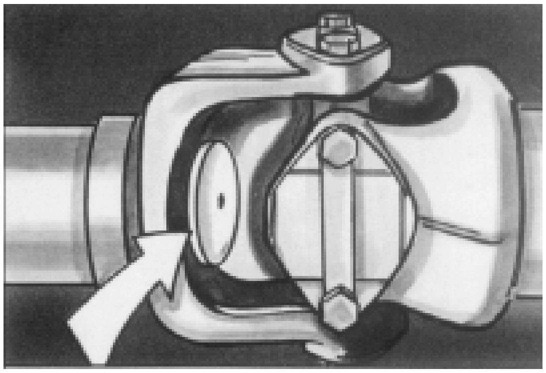

Figure 7—Slip Shaft Plug

For an inboard and outboard slip yoke assembly design, check to be sure the plug is not loose or missing. **Figure 7**. If it is loose or missing, repair or replace it. Not enough driveshaft slip movement commonly causes loose or missing plugs.

Lubrication

Among the most common causes of joint and slip problems is lack of proper lubrication. Properly sized Spicer U-joints that are adequately lubricated at recommended intervals will normally meet or exceed vehicle operation requirements. Lubrication flushes the joints, thus removing abrasive contaminants from the bearings.

Lubricants for Universal Joints

For a normal application, use a good quality lithium soap base extreme pressure (EP) grease meeting the NLGI Grades 1 or 2 specifications. Grades 3 and 4 are not recommended because of their greater thickness.

For a severe application, use a good quality lithium soap base or equivalent EP grease having an operating temperature range of –10° to +325° Fahrenheit. In addition, the grease should meet the NLGI Grades 1 or 2 specifications.

Consult your local lubricant source for greases that meet these specifications.

Initial Lubrication and Re-Lube Cycles

Spicer replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit before assembly into the yokes.

Each cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should be wiped with the same grease. You should fill all the cavities between the needle rollers and apply a liberal grease coating on the bottom of each bearing assembly.

Too much grease may cause hydraulic lock-up, make installation difficult. After the kits are installed into the yokes and before service, they should be lubricated, through the lube fitting, using the same grease. Lubricate every 10,000 miles or every month.

Lubrication Procedures for U-Joints

Warning

Rotating shafts can be dangerous. You can snag clothes, skin, hair and hands causing serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

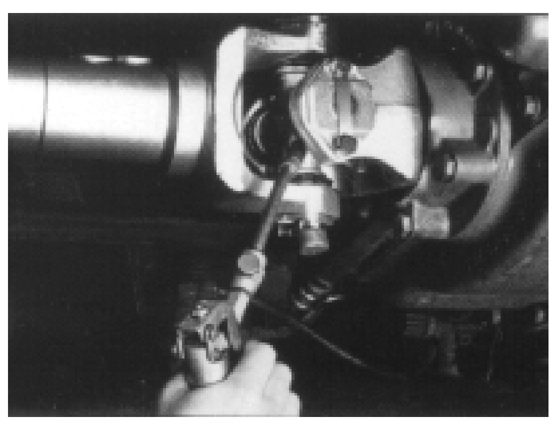

Figure 8—Lubrication of Four Seals

Note

Do not go under the vehicle when the engine is running.

Use the proper lubricant to purge all four seals of each U-joint. This flushes abrasive contaminants from each bearing assembly and ensures all four are filled. **Figure 8**. Pop the seals. Spicer seals are made to be popped.

If any seals fail to purge, move the driveshaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing end of the bearing assembly that is not purging. On two-zerk kits, try greasing from the opposite lube fitting. Check for a fully seated snap ring or burrs on the snap ring or snap ring groove.

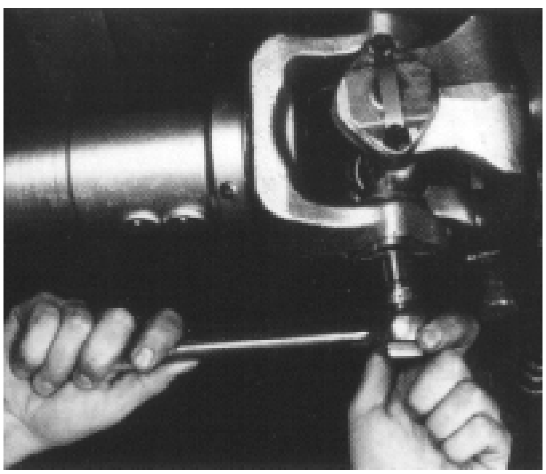

Figure 9—Seal Tension

Release seal tension by loosening the bolts holding the bearing assembly that does not purge. **Figure 9**. It may be necessary to loosen the bearing assembly approximately 1/16-inch minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage. Re-torque bolts to specification. **Table 1**.

Note

Half Round End Yoke self-locking retaining bolts should not be reused more than five (5) times. Follow instructions implicitly to prevent serious personal injury or death from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.

Lubrication for Slip Splines

The lubricant used for U-joints is satisfactory for slip splines. Glidecote and steel splines both use good EP grease meeting NGI Grade 1 or 2 specifications. Re-lube splines every 10,000 miles, or every month.

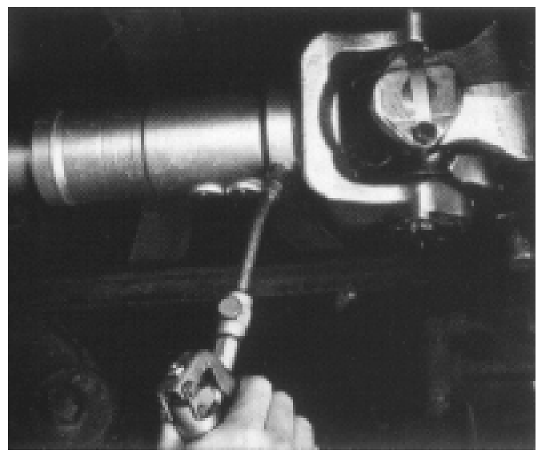

Figure 10—Pressure Relief Hole

Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke of the spline.

Figure 11—Slip Yoke Seal

Note

In cold temperatures, be sure to drive the vehicle immediately after lubricating. This activates the slip spline and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out.

Torque Specifications		
Yoke Round End Yoke		
Series	**Thread**	**Cap Screw Torque**
1610	5/16-24	17 to 24 foot-pounds (23 to 33 N•m)
1710	3/8-24	32 to 42 foot-pounds (43 to 57 N•m)
1760	3/8-24	32 to 42 foot-pounds (43 to 57 N•m)
1810	3/8-24	32 to 42 foot-pounds (43 to 57 N•m)
1880	7/16-24	50 to 66 foot-pounds (68 to 89 N•m)
Half Round End Yoke		
Series	**Thread**	**Cap Screw Torque**
1610	3/8-24	55 to 60 foot-pounds (68 to 89 N•m)
1710	1/2-20	130 to 135 foot-pounds (176 to 183 N•m)
1760	1/2-20	130 to 135 foot-pounds (176 to 183 N•m)
1810	1/2-20	130 to 135 foot-pounds (176 to 183 N•m)
Flange Yoke		
Series	**Thread**	**Cap Screw Torque**
1610	3/8-24	40 to 48 foot-pounds (54 to 65 N•m)
1710	3/8-24	40 to 48 foot-pounds (54 to 65 N•m)
1760	7/16-20	63 to 75 foot-pounds (85 to 102 N•m)
1810	7/16-20	130 to 135 foot-pounds (85 to 102 N•m)
1880	5/8-18	194 to 232 foot-pounds (263 to 314 N•m)

Table 1—Yoke Torque Specification

Light and Medium Duty Applications Specifications		
Part	**Bolt Size**	**Torque**
U-Bolt	5/16-24	14 to 17 foot-pounds (19 to 23 N•m)
---	3/8-24	20 to 24 foot-pounds (27 to 33 N•m)
---	7/16-20	32 to 37 foot-pounds (43 to 50 N•m)
Bearing Strap	1/4-28	13 to 18 foot-pounds (18 to 24 N•m)
---	5/16-24	25 to 30 foot-pounds (34 to 41 N•m)
Flange Bolts	5/16-24	22 to 26 foot-pounds (30 to 35 N•m)
---	3/8-24	40 to 48 foot-pounds (54 to 65 N•m)
--	7/16-20	63 to 75 foot-pounds (85 to 102 N•m)
---	1/2-20	97 to 116 foot-pounds (132 to 157 N•m)

Table 2—General Torque Specification

Torsion Vibration Dampers

There are two types of vibration encountered by designers and operators of engine-powered equipment—linear vibration and torsion vibration.

Linear vibration is caused by an out-of-balance condition, such as tires and wheels. Other causes might be an out-of-balance driveshaft or other rotating parts, as well as an out-of-round wheel coming in contact with the road.

Linear vibration, though possibly more intense at some rpms than others, can normally be felt and/or heard throughout the full speed range. Correcting linear vibration usually involves balancing the component or correcting the out-of-round condition, such as wheels or tires.

The type of vibration that has caused, and continues to cause, the most vibration is *torsion vibration.* Torsion vibrations are an inherent problem in all internal combustion engines.

The problem becomes one of severity and is a function of many factors, including engine design, cylinder pressures and firing sequences. There are several orders of vibrations within the operating range. In most conventional engine designs, such as in-line six-cylinder engines and V-8s, a critical order will excite the driveline, transmission and/or frame and cab at a frequency that is audible to the human ear.

Destructive torsion may also be present at frequencies above or below the threshold of human hearing, or are masked by other overall contributions, such as exhaust, air intake or other environmental noises.

Torsion in the audible range gives the opportunity to recognize their characteristics, to prevent failures of driveline components and to resolve the problem. As for inaudible torsions, without instrumentation a failure often has to occur before it is recognized. These types of failure are generally one of the following.

- Clutch drive plate-fatigue
- Failure of damping springs
- Retainers
- Transmission input shaft
- Worn splines
- Transmission gears
- Universal joints

A torsion-excited frame car or driveline will transient. It will occur in some given rpm range, but at engine speeds above or below this range, no noise will be heard.

This is an important key in differentiating between a linear and a torsion vibration. The noise generated by this torsion could be from one or several parts of the vehicle. Drivetrain noise is primarily caused by the separation of joints that can include gear teeth and/or splines, or even U-joints. Noise may also come from the frame, cab, shifters or any other component attached to the cab or frame.

The torsion vibration generated by the engine is changed to a linear type at the engine mounts. Any frame or component within the frame or cab that has a natural frequency that matches the frequency of the torsion being generated by the engine will be excited and will vibrate. **Figure 12**.

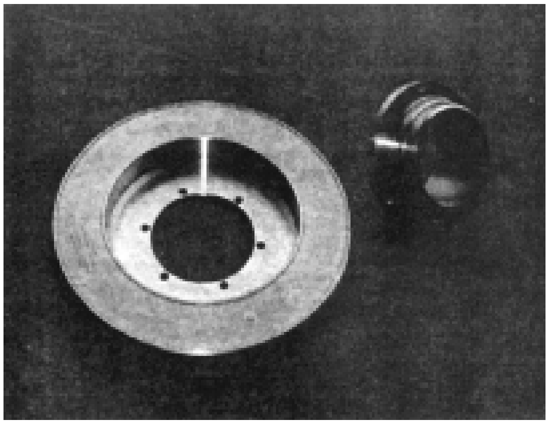

Figure 12—Vibration Damper

The noise or vibration caused by the resonant condition is evidence of destructive vibration energy. Gear and driveline noise is evidence of tooth, spline or joint separation.

When this occurs, there is multiplication of the static output torque of the engine. For example, in an engine rated at 1000 foot-pound of torque, the multiplication of this torque could be two to five times greater (or possibly more) when resonance occurs, depending on the degree of separation and other factors.

A vibration torque of 5000 foot-pound or greater far exceeds the design limits of gear teeth, splines and other joints. Once the separation occurs, the multiplication starts and the clearance increases, causing further multiplication leading to a catastrophic failure.

Figure 13—Transdamper

Installation of viscous type driveline dampers has accelerated over the past few years. Some manufacturers of mobile equipment, as well as a number of fleets, have been designing viscous type dampers into their equipment.

The Transdamper manufactured by Stahl International is one type of maintenance-free viscous type driveline damper. Two versions are manufactured. One version mounts by sandwiching the dampers between a companion flange and flanged adapters at the output shaft of the transmission. **Figure 13**.

Most vehicles are equipped with an end yoke at the output shaft and additional costs are incurred in replacing this yoke with a companion-flanged yoke.

Some drivelines incorporate a parking brake attached to the transmission output shaft companion flange. In this case, it is not possible to mount a damper at this location. **Figure 14.** Using a damper kit, it may be installed in the driveshaft.

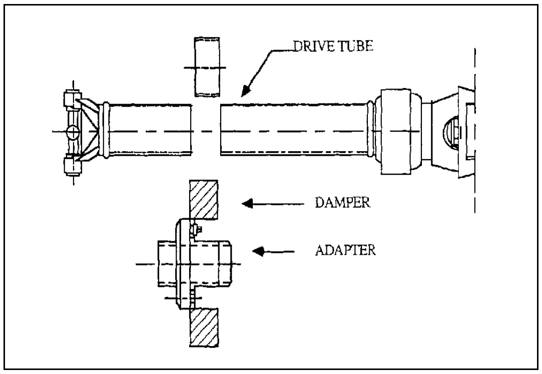

Figure 14—Transdamper Kit

Glossary of Vibration Definitions

Amplitude. The extent of the swing or degree of angle of a vibrating part on each side of a mean or center position.

Frequency (of vibratory motion). The number of vibrations per second.

Harmonic Motion. The acceleration of a vibrating part and the restoring force acting on it are proportional to its displacement from the mid-point of its path, and directed toward that point.

Hertz (Hz). Used to describe the frequency of the vibration in cycles per second; i.e., 100 Hz equals 100 cycles per second.

Linear Vibration. Vibration in a party or body causing it to move from one point to another and back in a straight line.

Natural Vibration. The point that resonance occurs.

Order. A quantity representing a number of events or cycles per revolution of a crankshaft.

Resonance. The property whereby any vibrating parts (system) responds with maximum amplitude to an applied force having a frequency equal or nearly equal to its own.

Torsion Vibration. A periodic force in a mechanism (engine or driven component) causes a body (i.e., shaft) to move from one point to another and back in an arc. This force is super-imposed on top of the normal shaft rotation.

Troubleshooting

Warning

Rotating shafts can be dangerous. Clothes, skin, hair and hands can snag. Serious or death can occur. Do not go under the vehicle when the engine is running.

Vibration Complaints

- Low gear shudder
- At certain speeds, under full drive or full coast
- Under light loaded conditions

Causes

- Secondary couple load reaction at shaft support bearing
- Improper phasing
- Incompatible driveshaft
- Driveshaft weight not compatible with engine-transmission mounting
- Driveshaft too long for speed
- Loose outside diameter fit on slip spline
- Excessively loose U-joint for speed
- Driveshaft out of balance; not straight
- Unequal U-joint angles
- U-joint angle too large for continuous running
- Worn U-joint
- Inadequate torque on bearing plate capscrews
- Torsion and/or inertial excitation

Corrections

- Reduce U-joint continuous running angle
- Replace U-joint
- Install two piece driveshaft with shaft support bearing
- Use larger diameter tube
- Shim drivetrain components to equalize U-joint angles
- Straighten and balance shaft
- Check with transmission or axle manufacturer-replace shaft bearing
- Inspect U-joint flex effort for looseness-torque to specification. **Table 2** or **Table 3.**
- Check driveshaft for correct yoke phasing

Premature Wear Complaints

- Low mileage U-joint wear
- Repeat U-joint wear
- End galling of cross trunnion and bearing assembly
- Needle rollers brinelled into bearing cup and cross trunnion
- Broken cross and bearing assemblies

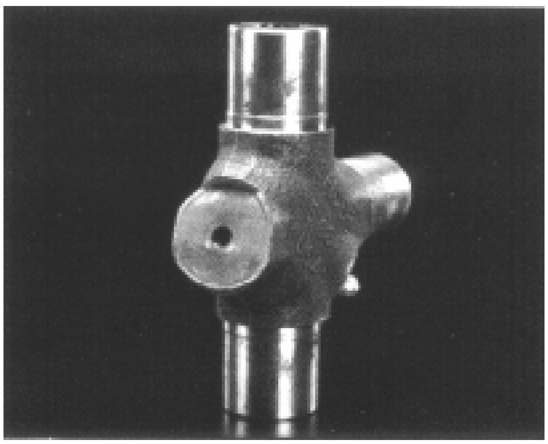

Figure 15—Premature Wear

Causes

- End yoke cross hole misalignment
- Excessive angularity
- Improper lubrication
- Excessive U-bolt torque on retaining nuts
- Excessive continuous running load
- Continuous operation at high angle/high speed
- Contamination and abrasion
- Worn or damaged seals
- Excessive torque load (shock loading) for U-joint and driveshaft size

Corrections

- Use Spicer alignment bar to check for end yoke cross hole misalignment. Replace end yoke if misaligned.
- Check U-joint operating angles with a spirit level protractor or Spicer Anglemaster Electronic Driveline Inclinometer. Reduce excessive U-joint operating angles.
- Lubricate according to Spicer specifications.
- Replace U-joint kit
- Reduce U-joint continuous running angle
- Replace with higher capacity U-joint and driveshaft
- Check U-joint flex effort. Replace joint or yoke, if necessary.
- Clean and lubricate U-joint
- Realign to proper running angle.
- Torque bearing retention bolts to specification **Table 2** or **Table 3**.

Slip Spline Wear Complaints

- Seizure
- Galling
- Outside diameter wear at extremities and at 180°
- Spline shaft or tube broken in torsion

Causes

- Improper lubrication
- Worn or damaged part
- Tube size inadequate
- Excessive torque load for U-joints and driveshaft size
- Male spline head engagement length too short for application
- Excessive loose outside diameter fit
- Slip member working in extreme extended or fully collapsed position
- Contamination

Corrections

- Lubricate slip spline according to Spicer specifications
- Replace with higher capacity U-joint and driveshaft (use caution here)
- Check U-joint flex effort. Replace joint or yoke if necessary.
- Clean and re-lubricate, according to Spicer specification
- Replace spline. Check design for application
- Use Spicer Glidecote slip spline
- Increase driveshaft assembly length to position slip spline head towards U-joint
- Check for male slip member with longer spline
- Use larger diameter tube

Shaft and/or Tube Complaints

- Shaft support bearing wear or fracture
- Shaft support rubber insulator wear or fracture. **Figure 16**.

Figure 16—Rubber Insulator Wear

Causes

- Balance weight located in apex of weld yoke lug area
- Balance weight too close to circle weld
- Improper circle weld
- Bending fatigue due to secondary couple loads
- Driveshaft too long for operating speeds
- Worn or damaged parts
- Excessive torque load (shock loading) for U-joint and driveshaft size
- Improper lubrication of bearings
- Shaft support bearing misaligned interferes with slinger.

Corrections

- Reduce U-joint continuous running angle
- Replace with higher capacity U-joint and driveshaft (use caution here)
- Install two piece driveshaft with shaft support bearing
- Use larger diameter tube
- Normal bearing wear. Replace.
- Realign mounting bracket to frame cross member to eliminate interference with slinger.

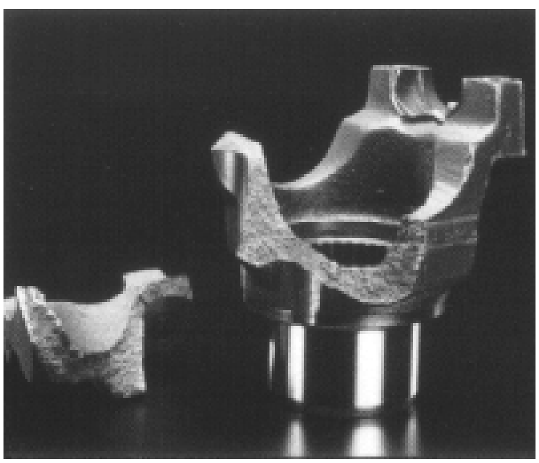

Figure 17—Broken Yoke

Yoke Fracture Complaints

- Yoke broken in hub
- Yoke broken at ear tip. **Figure 17**.

Causes

- Mating yoke lug interference at full jounce and rebound
- Excessive torque load for U-joint and driveshaft size
- Improper shaft length and slip
- Bending fatigue due to secondary couple loads

Corrections

- Reduce U-joint continuous running angles
- Replace with higher capacity U-joint and driveshaft (use caution here)
- Replace yoke; check design for application
- Use wide angle yokes
- Check installed lengths and adjust driveshaft length to provide proper slip conditions

Driveshaft Function

The basic function of a driveshaft is to transmit power from one point to another in a smooth and continuous action. The driveshaft is designed to send torque through an angle from the transmission to the axle (or auxiliary transmission).

The driveshaft must operate through constantly changing relative angles between the transmission and axle. The driveshaft must be capable of changing length while transmitting torque. The axle of a vehicle is not attached directly to the frame, but rides suspended by springs in an irregular, floating motion. **Figure 18**.

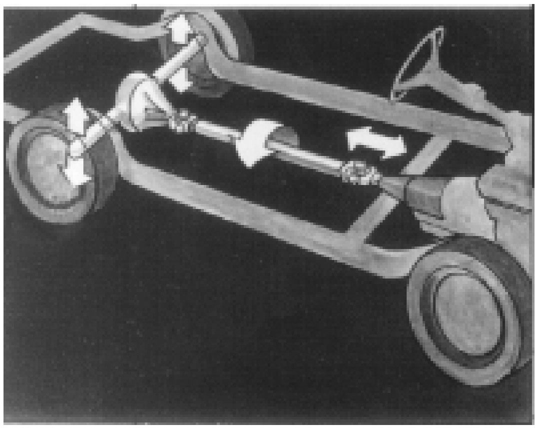

Figure 18-Axle

The driveshaft must be able to contract, expand and change operating angles when going over humps or depressions. This is accomplished through universal joints that permit the driveshaft to operate at different angles, and slip joints, that permit contraction or expansion to take place. **Figure 19** and **Figure 20**.

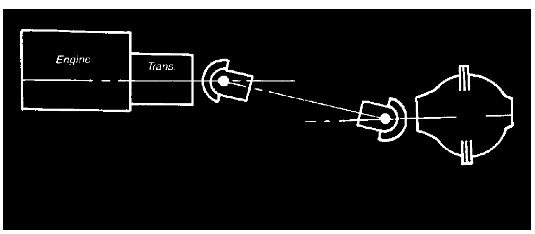

Figure 19—Universal Joint

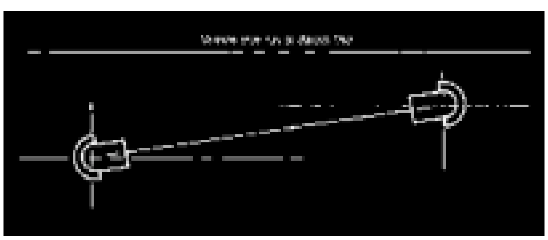

Figure 20—Universal Joint

Servicing the Driveshaft

Shaft Support Bearing Assemblies

Bearing manufacturers do the initial lubrication and all Spicer shaft support (center) bearings are lubricated for life. When replacing a shaft support bearing assembly, be sure to fill the entire cavity around the bearing with waterproof grease to shield the bearing from water and contaminants. **Figure 21**.

Enough grease must be used to fill the cavity to the edge of the slinger surrounding the bearing. Lubricants must be waterproof. Consult your grease supplier for recommendations.

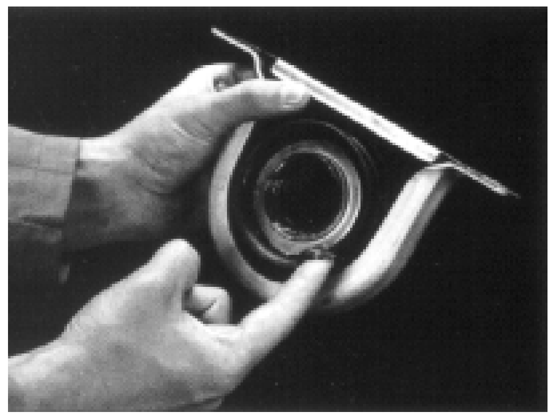

Figure 21—Bearing Cavity

Note

There are instances where special lubrication is required by vehicle specification or by customer request. The lubrication recommendations listed in this manual are what Spicer U-joint engineers suggest. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.

Heavy Duty Application

1. Cross and Bearing Kit Replacement
2. Bearing Plate Design

Full Round End Yoke Design

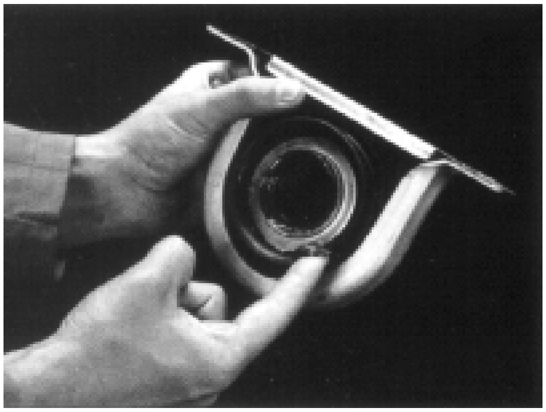

Figure 22—Full Round Tool Kit

Tools

See **Figure 22** and **Figure 23.**

- 3/8 inch square chisel
- Ball peen hammer
- 1/2-inch driver socket wrench
- Sockets, ½ inch, 9/16 inch, 5/8 inch
- Torque wrench (125 foot-pound)
- Alignment bar/No Go Wear Gauge; available only from Dana Corporation – Spicer Service Representatives
- Nylon support strap
- Owatonna tool kit (#7057) (Two-jaw Puller)
- Hydraulic floor jack

Half Round End Yoke Design

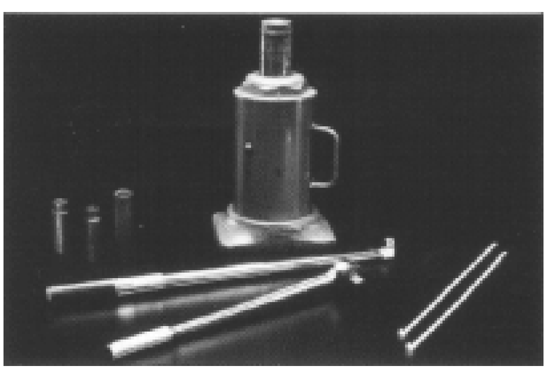

Figure 23—Half Round Tool Kit

Tools

See **Figure 22** and **Figure 23**.

- 1/2 inch drive socket wrench
- 1/2 inch, 9/16 inch, 3/4 inch socket
- Nylon support strap
- Alignment bar/No Go Wear Gauge, available only from Dana Corporation-Spicer Service Representatives

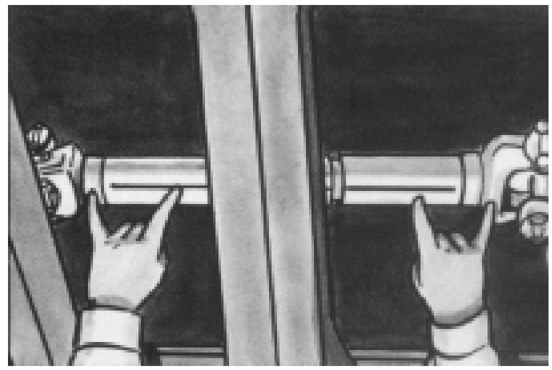

Figure 24—Driveshaft Removal

Note

Never heat components above normal operating temperatures when disassembling. Before removal of the driveshaft, mark the slip yoke assembly and tube shaft with a marking stick or paint to ensure proper alignment when reassembled.

Warning

Rotating shafts can be dangerous. Clothes, skin, hair and hands can snag, causing serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Removal Full Round End Yoke Style

The method of driveshaft removal should be one that ensures safety with ease of removal, without damage to the driveshaft, transmission or axle components. **Figure 24**. Suggested methods include use of a hydraulic jack, nylon strap and the two-jaw puller (Owatonna Tool Kit #7057).

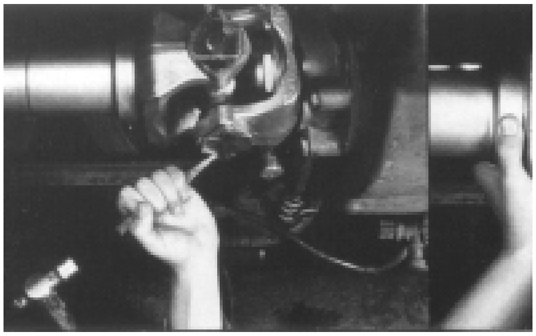

Figure 25—Lock Strap Tabs

Bend tabs of lock straps away from bolt heads with a chisel. **See Figure 25**.

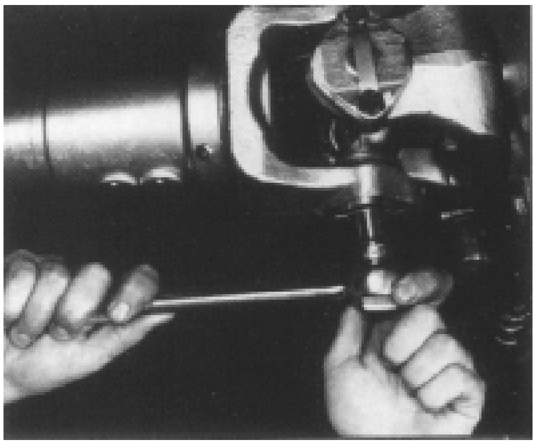

Figure 26—Four Bolts Bearing Assembly

Remove four bolts from each bearing assembly connected to the transmission and axle end yoke. See **Figure 26**.

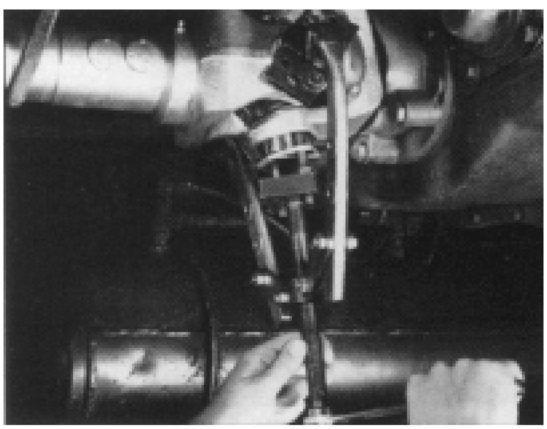

Figure 27—Yoke Cross-Holes

Release bearing assemblies from the yoke cross-holes using the Owatonna tool kit. See **Figure 27**.

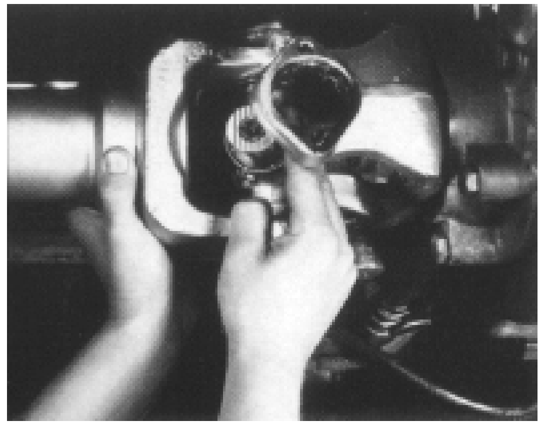

Figure 28—Trunnion and End Yoke

Free the trunnion from the end yoke by tilting the trunnion and collapsing the driveshaft. **Figure 28.**

If only one end of the driveshaft requires service, disconnect that end, unscrew the slip shaft seal (dustcap) from the slip yoke assembly, and then pull apart or slide off the assembly. When re-assembling, be sure that the arrows or marks on the shaft and slip joint are in line to keep the driveshaft yokes in phase.

Removal Half Round End Yoke Style

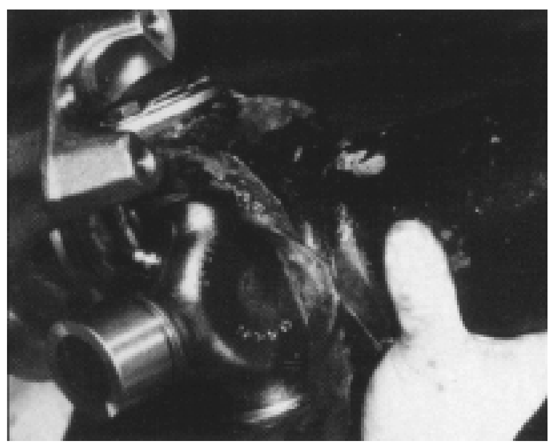

Figure 29—Half Round End Yoke

For half round end yoke disassembly, install a nylon support strap, remove the strap retaining bolts (one end at a time) and release the driveshaft. **Figure 29**.

Removal Flange Yoke Style

Install nylon support strap. Loosen and remove nuts and bolts from flange yoke to transmission or axle companion flange. Holding driveshaft firmly, tap loose, compress from one end and lower to floor. Repeat at other end.

Disassembly of Driveshaft

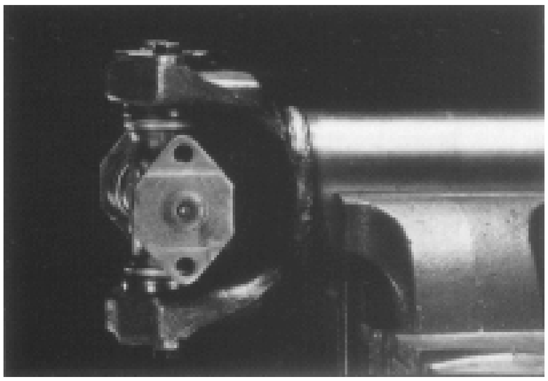

Figure 30—Bench Vise Clamping

Place the driveshaft in a bench vise, clamping on the tube adjacent to the cross and bearing assemblies being removed. **Figure 30**.

Caution

Do not distort the tube with excessive grip.

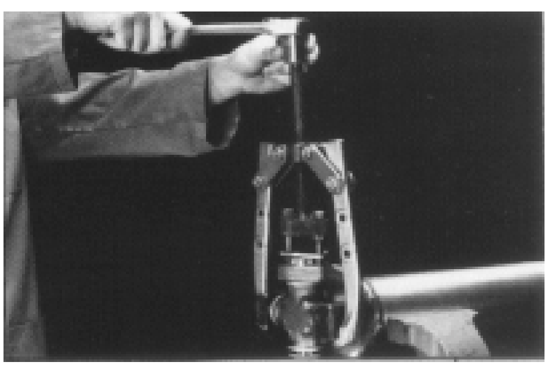

Figure 31—Owatonna Tool Kit

Completely remove the cross and bearings from both ends of the driveshaft.

Disassemble the bearing assemblies from the slip yoke and the tube yoke (and flange yoke where applicable) using the Owatonna tool kit. **Figure 31**.

Figure 32—Inspection of Cross Hole

Figure 33—Spicer Alignment Bar

Remove the cross and bearings, both ends.

Inspect the cross-hole surfaces for damage or raised metal. Raised metal can be removed with a rat tail or half round file or emery cloth. **Figure 32**.

Check the yoke lug cross-holes with a No-Go Wear Gauge.

The alignment bar will identify yoke lugs that have taken a set because of excessive torque. The raised metal or distorted lugs can be a cause of premature cross and bearing problems.

Caution

If the alignment bar will not pass through simultaneously, the yoke lugs are distorted. Replace yoke lugs.

Clean the cross-holes of the yokes on the transmission and axle.

Inspect using a Spicer alignment bar.

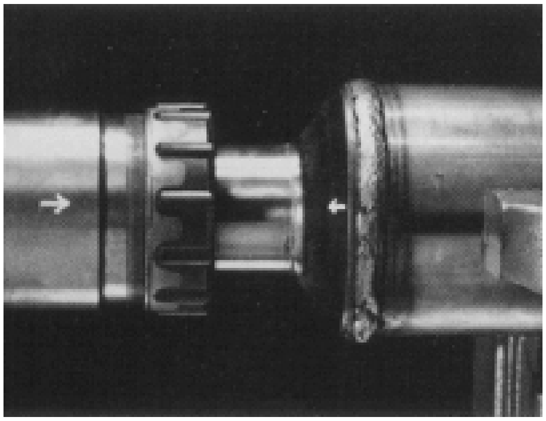

Figure 34—Paint Marking Tube and Slip Yoke

Check the paint marking placed on the tube and slip yoke assembly before removing from the vehicle to ensure paint marking is in line. **Figure 34**.

Place each end of the driveshaft, without cross and bearing kits, in a bench vise.

Figure 35—Remove Cross-Bearings

Remove the cross-bearings from the box and remove all four bearing assemblies. **Figure 35.**

Rotate the cross to inspect for presence of the one way check valve in each lube hole of all four trunnions.

Position the cross into the end yoke with lube fitting in line with the slip spline lube fitting. Keep the lube fitting on the inboard side.

Figure 36—Bearing Assembly

Apply an anti-seize compound to the outside diameter of four bearing assemblies.

Move one end of the cross to cause a trunnion to project through the cross-hole beyond the outer-machined face of the yoke lug.

Place a bearing assembly over the trunnion diameter and align it to the cross-hole. **Figure 36**.

Figure 37—Bearing Assembly Flush With Face of Yoke

Align the trunnion with the cross-hole.

Press bearing assembly flush to face of end yoke by hand.

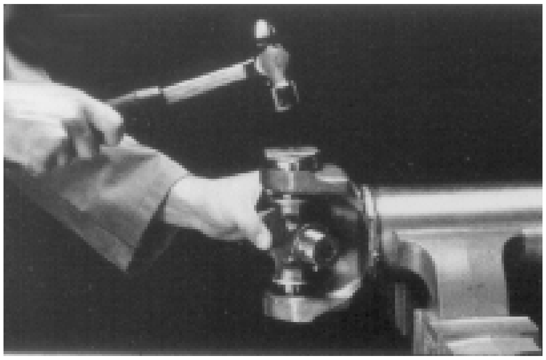

Figure 38—Correct Assembly

Note

Do not tap outer edges of bearing plate.

If bearing assembly binds in cross-hole, tap with ball peen hammer directly in center of bearing assembly plate. **Figure 38.**

Caution

Exact fit of all driveline components is extremely important. The correct parts and clean mating surfaces are essential for safe operation and good repair.

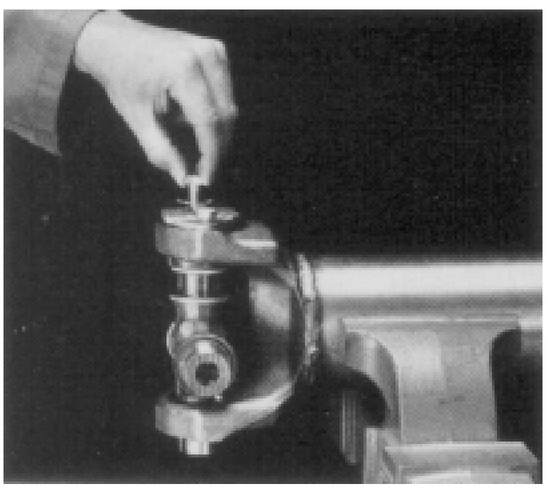

Figure 39—Lock Plate Tab

When the bearing assembly is seated, put lock plate tab in place. **Figure 39**.

Insert the Grade 8 capscrews that are furnished with the kit.

Note

Do not torque down bolts.

Insert capscrews through the cap screw holes in both the lock strap and bearing assembly. Thread with hand or wrench into tapped holes in yoke.

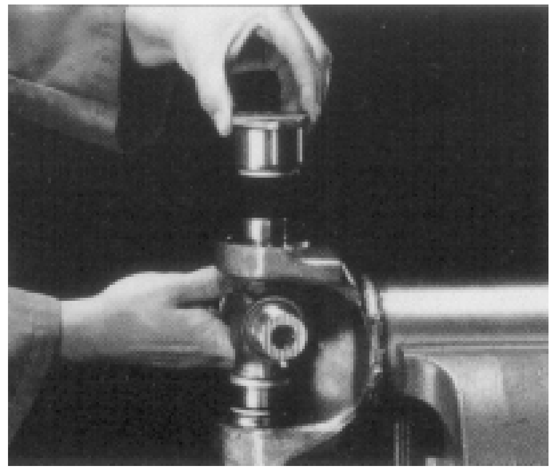

Figure 40—Seating the Plate to Face of Lug

Move the cross laterally to the opposite side and through the cross-hole beyond the machined surface of the yoke lug.

Place a bearing assembly over the cross trunnion and slide it into the cross-hole, seating the plate to the face of the lug. Put the lock plate tab in place and thread the bolts with hand or wrench into tapped holes in yoke. **Figure 40**.

Note

Projecting the trunnion through a cross-hole beyond the machined surface of the lug will provide a surface to help align the bearing assembly with the cross-hole. This method should be used when assembling driveshaft to yokes of vehicle at transmission and axle or axles.

Repeat the process of installation of cross and bearing kit at opposite end of the driveshaft. Make sure to position the cross in the yoke so that the lube fitting is in line with the lube fitting at the other end.

For flange yoke applications, install the flange yoke, bearing assemblies and bolts at this time.

Caution

Always replace the cross-four bearing assemblies and bolts as a unit.

Installation of Driveshaft

The installation of a driveshaft does not present any unusual mechanical difficulties. Before actual installation, the driveshaft should be checked for the following items.

- Damage or dents on the driveshaft tubing.
- Splines should slide freely with slight drag from slip shaft seal.
- Cross should flex and be free from excessive bind. A slight drag is the most desirable condition on a new cross and bearing kit.
- Excessive looseness is not desirable and will result in an unbalanced driveshaft.
- Mounting flanges and pilots should be free from burrs, paints and foreign substances that would not allow proper seating at assembly.

Warning

Rotating shafts can be dangerous. Clothes, skin, hair and hands can snag, causing serious injury or death. Do not go under the vehicle when the engine is running. To avoid becoming entangled, install power take-off and/or shaft behind the frame rail, tanks and battery box.

If power take-off and/or shaft are still exposed after installation, install a guard.

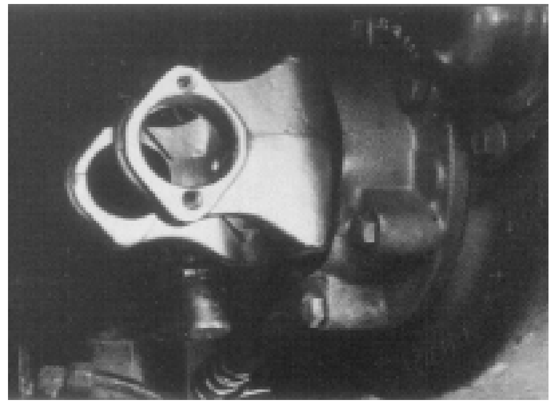

Figure 41—Transmission End Yoke

Rotate the transmission end yoke by putting the transmission in neutral and the axle end yoke by jacking up one rear wheel, so the cross holes are in a horizontal position. **Figure 41**.

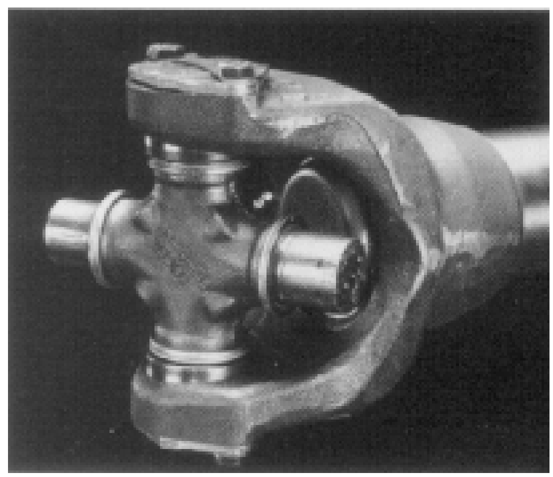

Figure 42—Cross Trunnion

Tilt the cross trunnions of the driveshaft, both ends, with trunnions points toward each other from end to end, one side. Install with the slip joints nearest the source of power. Use a nylon support strap to aid in handling the driveshaft. **Figure 42.**

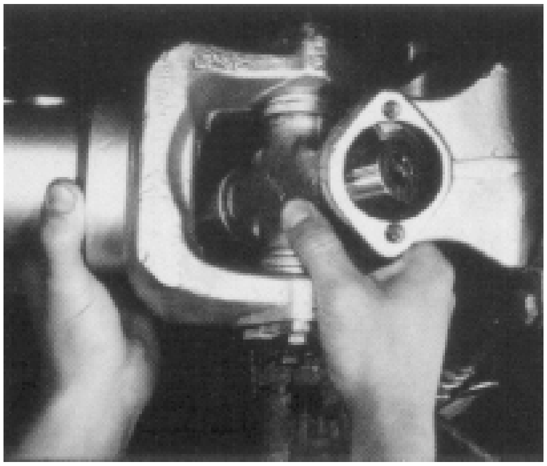

Figure 43—Drive Shaft, Trunnion and Yoke

Holding the driveshaft firmly, project a trunnion in an outward position between the lugs of either the axle or the transmission end yoke and through a cross-hole. Repeat at opposite end. **Figure 43.** The driveshaft is being supported at each end by one trunnion surface in a cross-hole and the nylon support strap.

Figure 44—Cross Trunnion

Tilt a cross trunnion until the opposite side can be inserted through a cross-hole. Repeat at opposite end. The driveshaft is now being supported at each end by two trunnion surfaces in the cross-holes and the nylon support strap. **Figure 44**.

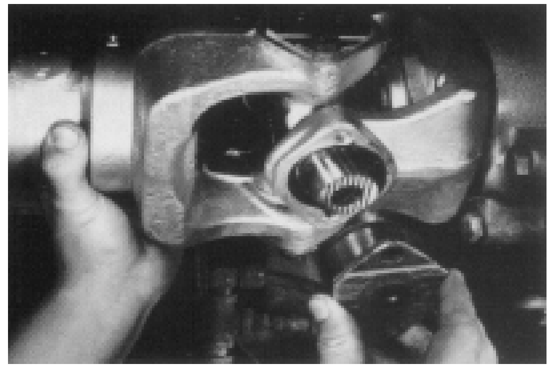

Figure 45—Bearing Assembly

Apply an anti-seize compound to the outside diameter of the remaining four bearing assemblies. Move one end of the shaft to cause a trunnion to project through the cross-hole beyond the outer-machine face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross-hole. **Figure 45**.

Figure 46—Bearing Assembly Flush to Face of Yoke

Holding the trunnion in alignment with the cross hole, press bearing flush to face of end yoke by hand. **Figure 46**.

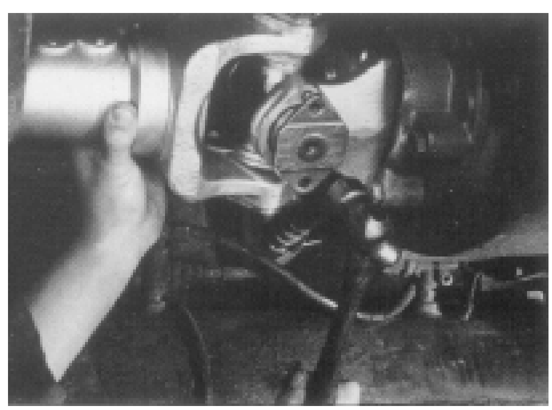

Figure 47—Binding Bearing Assembly

If bearing assembly binds in cross-hole, tap with ball peen hammer directly in center of bearing assembly plate. Do not tap outer edges of bearing plate. **Figure 47**.

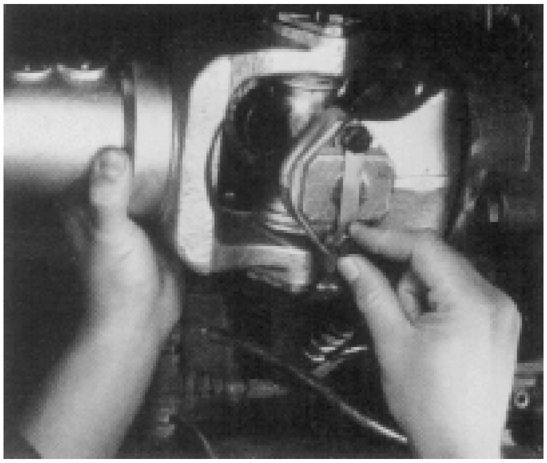

Figure 48—Lock Plate

Slide the shaft to project an opposite trunnion through the cross-hole beyond the face of the end yoke. Again, place a bearing assembly over the trunnion, align and place hands on opposite bearing assembly, and press both inward flush to yoke faces.

If assembly binds, tap with ball peen hammer as outlined above. Put the lock plate tab in place and insert the Grade 8 capscrews through the holes in the lock plates and bearing assemblies. **Figure 48**. Thread capscrews into end yokes. Tighten with wrench until plates are flush against end yoke faces.

Lubricate the cross and bearing assembly until lube appears at all four seals. If any seal fails to purge, see Lubrication Procedure for U-joints; also, Lubrication for Slip Splines.

Torque all eight bolts to specifications. **Table 1**. Bend lock plate tabs to flat of capscrew heads to lock in place.

Repeat at opposite end. Remove nylon support strap.

Assembly Half Round End Yoke Style

For half round end yokes, place the bearing assemblies on the cross trunnions and seat the bearing cups into the end yoke shoulders.

Place straps over the bearing assemblies, thread special self-locking capscrews into tapped holes and torque bolts to specification. See **Table 1**. Lubricate the cross and bearing assemblies.

Warning

Half round self-locking retaining bolts should not be reused more than five (5) times. Observe instruction to prevent serious injury or death from loss of driveshaft function.

Assembly Flange Yoke

With nylon support strap in place and holding the driveshaft firmly:

- Align the (permanent end) flange pilots of the driveshaft flange yoke and axle companion flange with each other.
- Align boltholes and install bolts, lock washers and nuts to temporarily secure driveshaft to axle.
- Compress the slip assembly to position the opposite end of the driveshaft to the transmission companion flange.
- Align boltholes and install bolts, lock washers and nuts.
- Torque bolts on both ends to specification. See **Table 1**.

Flange Yoke

Note

1650 Series Bearing Assemblies with Locking Flats.

When installing new bearing assemblies into cross holes, the locking flat on the bearing assembly must be aligned with the locking flat in the yoke cross hole. Proper location of locking flats will ensure that the bearing assembly will not rotate.

Light and Medium Duty Application

1. Cross and Bearing Kit Replacement
2. Inside and Outside Snap Ring
3. U-Bolt and Bearing Strap Design

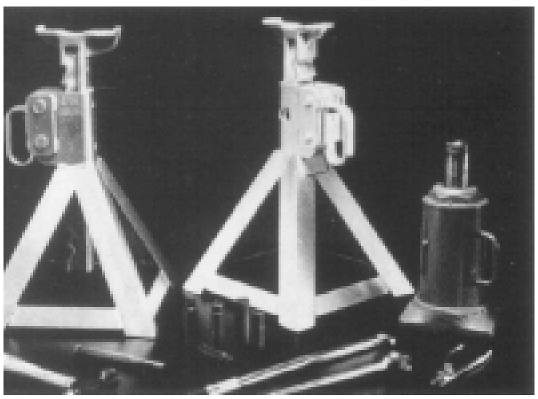

Figure 49—1000-1500 Series Tools

For 1000-1500 Series tools, see **Figure 49**.

- Pliers
- Soft Drift
- 3/8 inch Drive socket wrench
- Adaptor 3/8 inch to 1/2 inch
- Hydraulic floor jack
- Jackstands
- Arbor Press
- Torque wrench (150 foot-pound)
- Ball peen hammer
- Sockets – Hex 5/16, 1/2, 9/16, 5/8, 3/4 inch
- Sockets – 12 pt. 3/8, 1/2 inch

Removal Light Duty and Heavy Duty Driveshaft

Warning

Rotating shafts can be dangerous. Clothes, skin, hair and hands can snag, causing serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Procedures for removing the driveshaft from light and medium duty vehicles are nearly the same as for heavy-duty applications. One difference is that the cross and bearings vary in the method of attaching to the vehicle. **Figure 50**. Methods of attachment include U-bolt, bearing strap and flange yoke design.

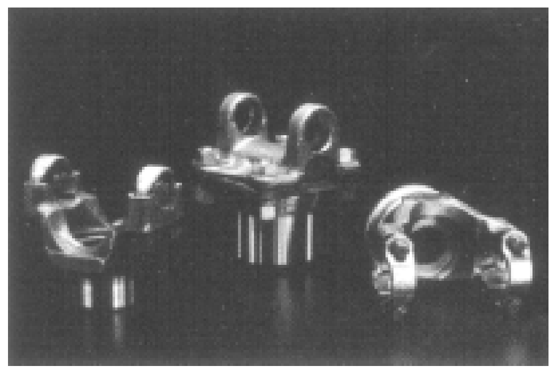

Figure 50—Driveshaft Removal Light Medium Vehicle

Remove the U-bolts or strap capscrews from the end yoke.

Slide the slip yoke toward the shaft to free the bearings from their seats between the shoulders in the end yokes.

Care should be taken to avoid dropping the bearing assemblies. Repeat at opposite end.

For double flange applications, disassemble as a complete assembly by removing the companion flange bolts.

Disassembly

Figure 51—Snap Ring

Using a soft drift, tap the outside of the bearing assembly to loosen snap ring. **Figure 51.** Tap bearing only hard enough to break assembly away from snap ring.

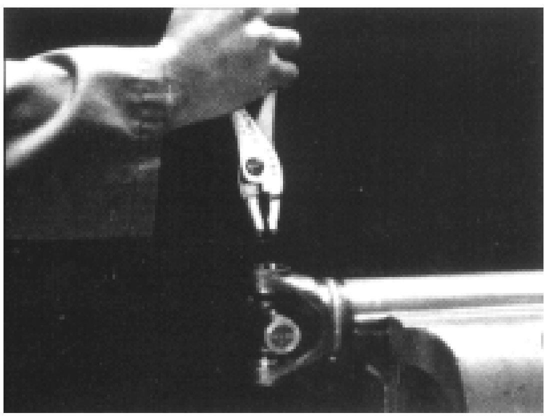

Figure 52—Remove Snap Ring

Remove snap ring from yoke. Turn part over and remove opposite snap ring.

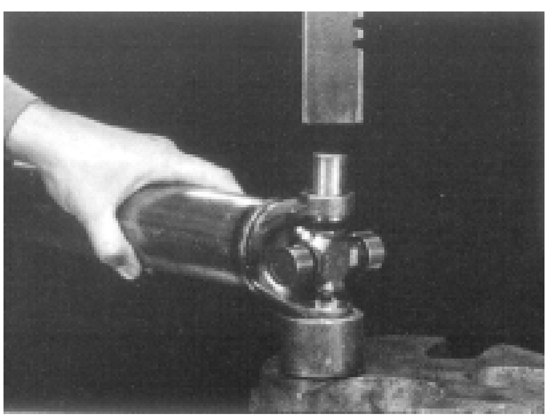

Figure 53—Yoke in Arbor Press

Set the yoke in the arbor press with a piece of tube stock beneath it. **Figure 53.**

Position the yoke with the lube fitting pointing up to prevent interference during disassembly.

Place a solid plug on the upper bearing assembly and press it through to release the lower bearing assembly.

If the bearing assembly will not pull out by hand after pressing, tap the base of the lug near the bearing assembly to dislodge it.

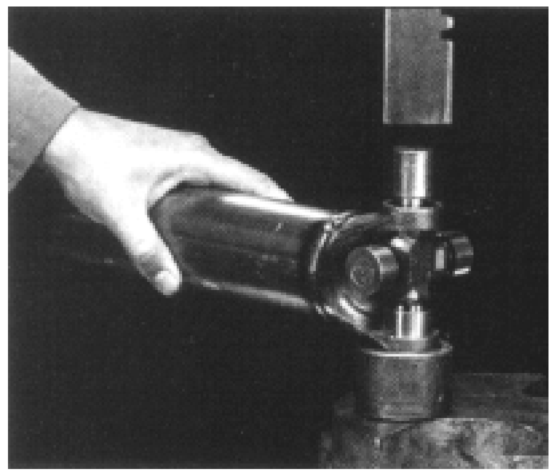

Figure 54—Cross and Open Cross-Hole

To remove the opposite bearing assembly, turn the yoke over and straighten the cross in the open cross-hole.
Then carefully press on the end of the cross so the remaining bearing assembly moves straight out of the veering cross-hole. **Figure 54**.

If the cross or bearing assembly is cocked, the bearing assembly will score the walls of the cross-hole and ruin the yoke.

Repeat this procedure on the remaining bearing assemblies to remove the cross from the yoke.

Assembly of Outside Snap Ring

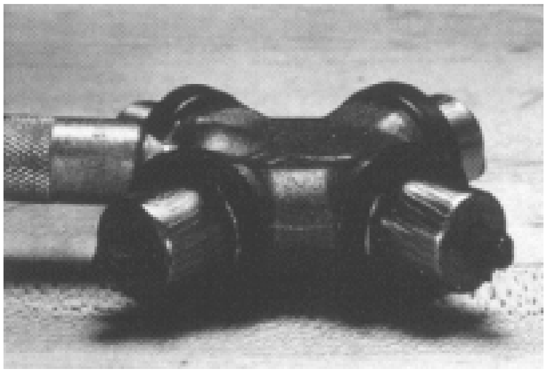

Figure 55—Four Grease Cavities

Pack the four grease cavities of the cross with a high quality extreme pressure NLGI Grade 1 or 2 grease. **Figure 55.**

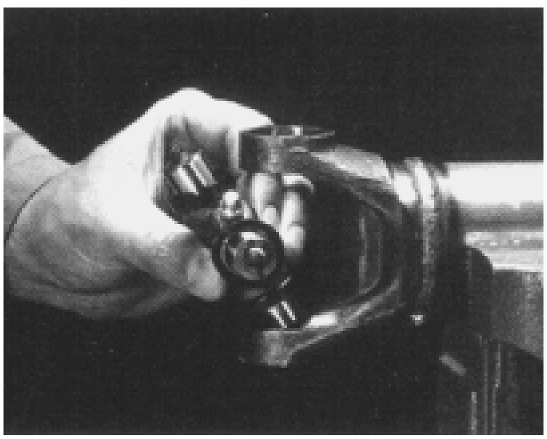

Figure 56—Cross Lube Fitting

Position the cross in the yoke with its lube fitting on the inboard side (toward driveshaft). **Figure 56**.

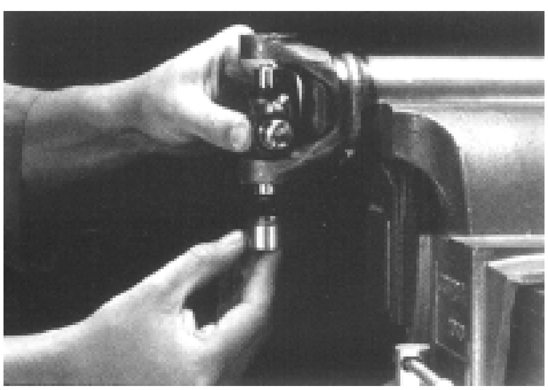

Figure 57—Trunnion Alignment

Move one end of the cross to cause a trunnion to project through the cross-hole beyond the outer machined face of the yoke lug. **Figure 57**.

Place a bearing assembly over the trunnion diameter and align it to the cross-hole.

Using an arbor press, hold the trunnion in alignment with the cross-hole and place a solid plug on the upper bearing assembly.

Press the bearing assembly into the cross-hole enough to install a snap ring.

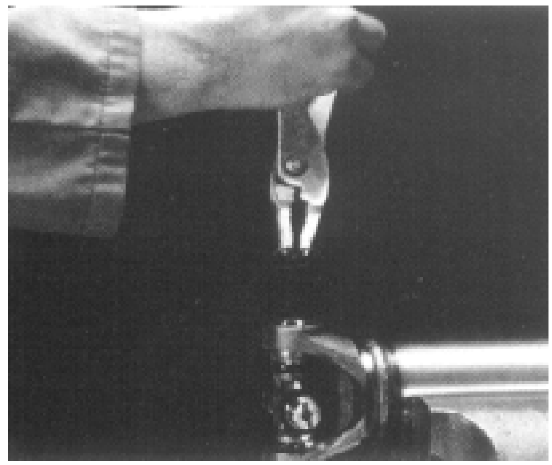

Figure 58—Snap Ring

Install a snap ring. **Figure 58**.

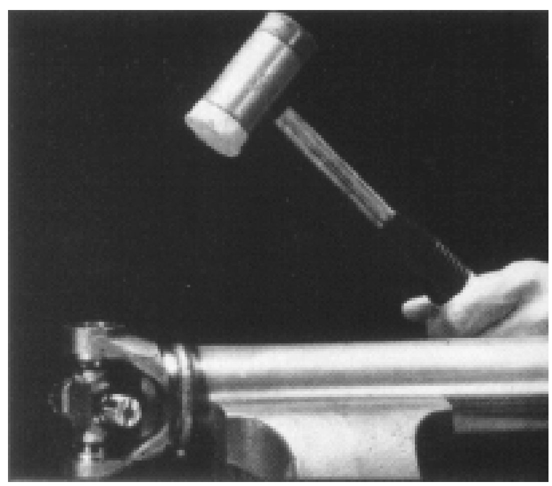

Figure 59—Seat Needle Bearing

Repeat steps to install the opposite bearing assembly. If the joint is stiff, strike the yoke ears with a ball peen hammer to seat the needle bearings. **Figure 59**.

Caution

Be sure snap rings are properly seated in grooves. Make sure to keep lube fittings at each end of the driveshaft in line.

Install the re-assembled driveshaft in the vehicle. If veering straps or U-bolts hold the shaft in vehicle, make sure the bearing assemblies are fully seated between bearing locating shoulders.

Torque bolts to specification. See **Table 2**.

Caution

Self-locking bolts used with bearing straps should not be reused more than five (5) times. Follow instructions to prevent danger of serious personal injury or death from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.

Apply more grease through the lube fitting until grease appears at all four bearing seals.

Inside Snap Ring Disassembly

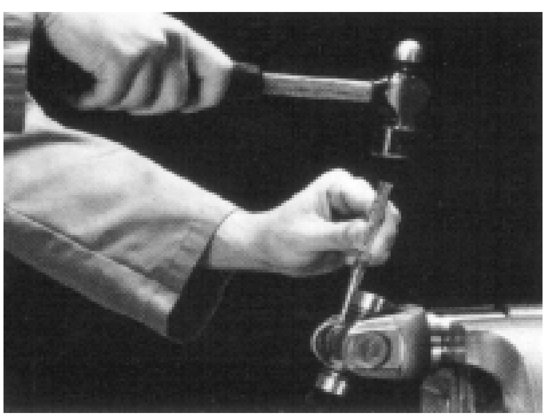

Figure 60—Disassembly Outside Snap Ring

Repeat outside snap design disassembly instructions.

Inside Snap Ring Assembly

Repeat outside snap ring design reassemble instructions.

Warning

Rotating shafts can be dangerous. Clothes, skin, hair and hands can snag, causing serious injury or death. Do not go under the vehicle when the engine is running. Avoid becoming entangled in power take-off and/or shaft behind the frame rail, tanks, and battery box.

Pre-Lube or Lube-for-Life Designs

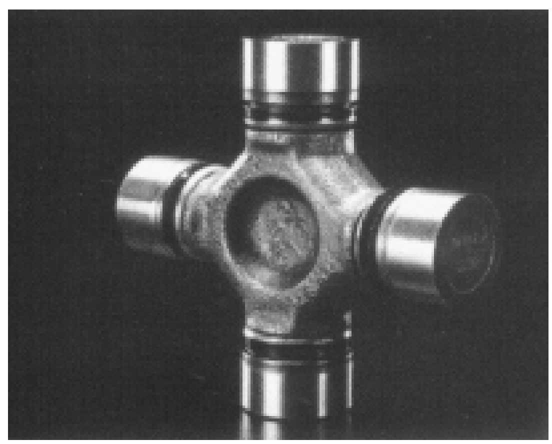

Figure 61—Spicer Crosses

Some Spicer crosses and bearings are pre-lube or lube-for-life designs and have no lube fittings. **Figure 61**.

Lubrication is critical and special seals are used to contain the lubricant in the cross/bearings.

Service instructions are nearly the same for re-lubrication and pre-lube or life-for-life design, whether it is inside or outside snap ring, U-bolt or bearing strap design.

The difference is that lifetime lubrication is done by Spicer at the time of manufacture and re-lubrication should not be necessary. Re-lubrication of these cross and bearing kits could be necessary because of high vehicle mileage or severe service off-highway in dirt, water, and extreme temperature conditions.

Only a qualified Spicer Service Representative should attempt to re-lubricate pre-lube designs. Replacement of the cross and bearing kit rather than re-lubrication is recommended.

Straightening and Balancing

The rebuilding of a driveshaft assembly usually consists of replacing worn cross and bearing assemblies with a new kit. These kits replace the part of a driveshaft most subject to wear in operation. The potential off-center condition present in the cross and bearing assemblies makes it desirable to balance every assembly after installing new cross and bearing kits.

When the tubing is bent or twisted or the tube fittings are distorted, it will be necessary to replace the damaged parts. Properly assemble the new components into the tube and straighten the shaft assembly before tack welding, to be sure the parts are on center. **Figure 62**.

This can be done by mounting the complete assembly in the appropriate tooling and straightening until the ends of the tube run concentric within .005 TIR. Recheck for run out.

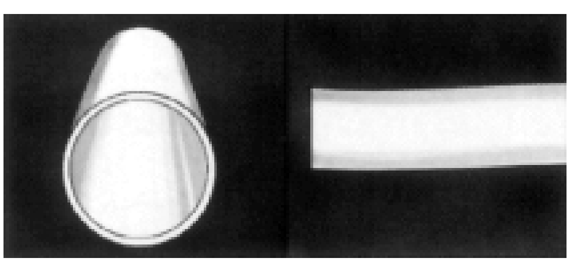

Figure 62—Shape of Tube

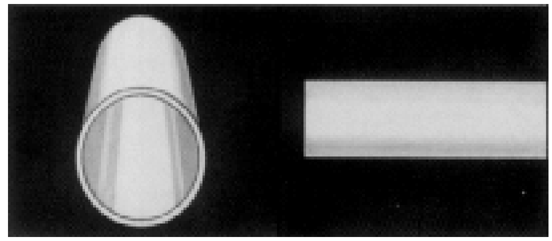

Figure 63—Shape of Tube

When checking for run out, it is important to distinguish between run out and oval shape.

Run out is when the tube is slightly bent but still maintains its circularity throughout the tube. During dynamic balancing, a dial indicator will show run out one per revolution.

Oval shape occurs when the tube is not circular but oval. During dynamic balancing, a dial indicator will display oval shape twice per revolution.

Total Indicator Reading (TIR)

Although a tube may be straight, oval shape will make it seem bent. A tube with oval shape may be used up to a .010 TIR run out reading. Beyond this limit, the tube must be discarded for driveshaft purposes.

After welding, the entire driveshaft should be straightened to the following limits. **Figure 64**.

Heavy Duty Driveshaft

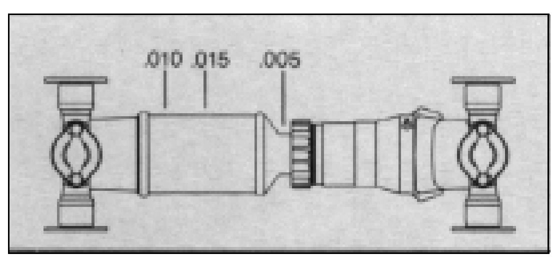

Figure 64—Heavy Duty Run Out Readings

0.005 TIR on the neck of the slip tube shaft. **Figure 64**.

0.010 TIR on ends of tubing three inches from welds

0.015 TIR at linear center of the tube

Light and Medium Duty Driveshaft

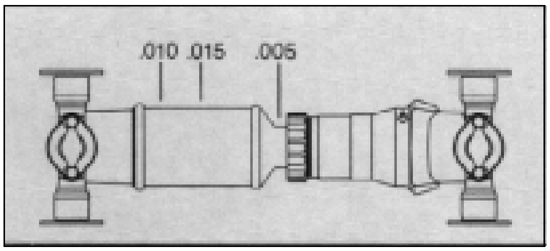

Figure 65—Light and Medium Duty

0.005 TIR on the neck of the slip tube shaft. **Figure 65**.

0.020 TIR on ends of tubing three inches from welds.

0.010 TIR at linear center of the tube.

0.020 TIR for full length of tube with 30 inches or less

Run-outs are done with entire driveshaft assembly mounted on master tooling. Reading location is on the outboard bearing assemblies of the U-joint kit (light and medium duty), or the trunnions of the outboard U-joint kit (heavy duty) or on selected flange yokes or yokes.

All flange yokes should be selected for dynamic balance to eliminate as much unbalance as possible.

During balancing, the driveshaft should be mounted on the same master tooling or selected flanges or yokes.

After straightening, balance the entire assembly to Original Equipment Manufacturer specifications.

Angles and Phasing (All Types)

Proper driveshaft angles and correct phasing of the yokes are very important in maintaining long life and quiet running shafts.

When in phase, the slip yoke lugs (ears) and tube yoke lugs (ears) are in line.

Normally, this is the ideal condition and gives the smoothest running shaft. There should be an alignment arrow stamped on the slip yoke and on the tube shaft to ensure proper phasing when assembling these components.

If there are no alignment marks, they should be added before disassembly of the shaft to ensure proper reassembly.

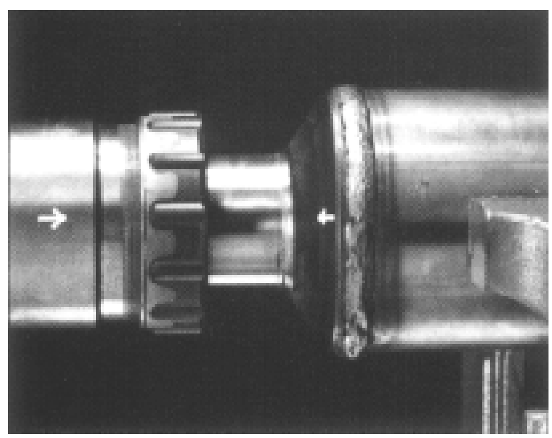

Figure 66—Slip Yoke Lugs and Tube Yoke Lugs

Phasing is relatively simple on a two-joint set. Make sure that the slip yoke lugs and tube yoke lugs are in line. **Figure 66.**

The U-joint operating angle is the angle formed by two yokes connected by a cross and bearing kit. There are two kinds of U-joint angles.

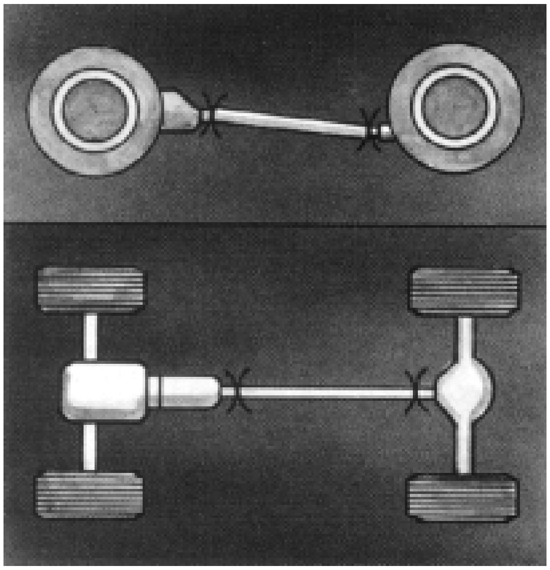
Figure 67—One Plane Angle

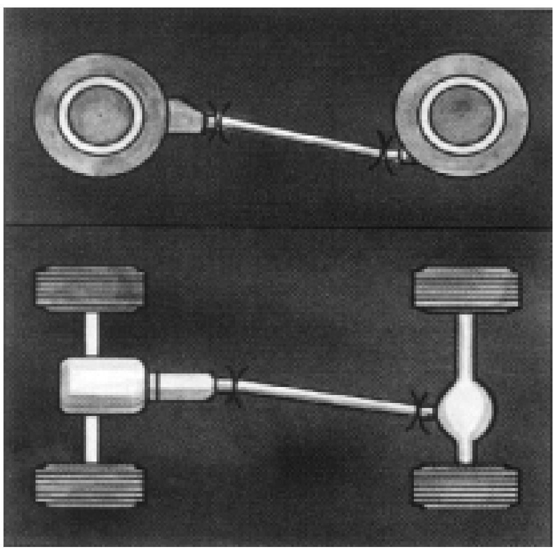
Figure 68—Compound Angle

The one plane angle found in most installations has all driveline slope confined to one plane, usually the vertical plane. **Figure 67**.

The other type of driveline angle is the compound angle is two planes. **Figure 68**.

This is in driveline designs where offset exists in both the vertical and horizontal planes. For detailed information on troubleshooting compound angles, contact your Spicer Service Representative.

High angles combined with high R.P.M. are the worst combination, resulting in reduced U-joint life. Too large and unequal U-joint angles can cause vibrations and contribute to U-joint, transmission and differential problems. The improper U-joint angles must be corrected.

Ideally, the operating angles on each end of the driveshaft should be equal to or within 1 degree of each other, have a 3 degree maximum operating angle and have at least 1/2 degree continuous operating angle.

Revolution is the main factor, though, in determining maximum allowable operating angles. As a guide to maximum normal operating angles, refer to the chart listed.

Driveshaft RPM	**Maximum Normal Operating Angles**	
5000	3°	15°
4500	3°	40°
4000	4°	15°
3500	5°	0°
3000	5°	50°
2500	7°	0°
2000	8°	40°
1500	11°	30°

Table 3—Operating Angles

Tube diameter and normal operating RPM determine maximum allowable tube length. If critical length is reached, a three joint driveshaft with center support or a Spicer Graph-Lite driveshaft must be used. Refer to the Spicer Driveshaft Speed Calculator Form M3-11 TRNG.

When the transmission output shaft centerline and axle input shaft centerline are parallel, the U-joint operating angle permissible is length of driveshaft divided by five.

Example—A short-coupled driveshaft with a 15-inch length would be limited to 3° maximum operating angle. A 30-inch shaft would be limited to 6°.

When the transmission output shaft centerline and axle input shaft centerline intersect midway of the driveshaft, the joint angles are equal.

However, due to the change to unequal joint angles during up and down axle movement, this is a more undesirable condition than parallel centerlines.

In this case, the maximum joint operating angle is determined by dividing length of driveshaft by ten. For example, a 30-inch driveshaft with intersecting angles would have a 3-degree permissible operating angle.

Checking Driveshaft Angles in the Vertical or Horizontal Plane

Warning

Rotating shafts can be dangerous. Clothes, skin, hair and hands can snag, causing serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Use the following procedure to check driveshaft angles for proper U-joint operating angles.

Inflate all tires to the pressure normally operated. Park the vehicle on a surface that is as nearly level as possible both from front-to-rear and from side-to-side.

Do not attempt to level the vehicle by jacking up the front or rear axles.

Shift the transmission to neutral and block the front tires. Jack up a rear wheel.

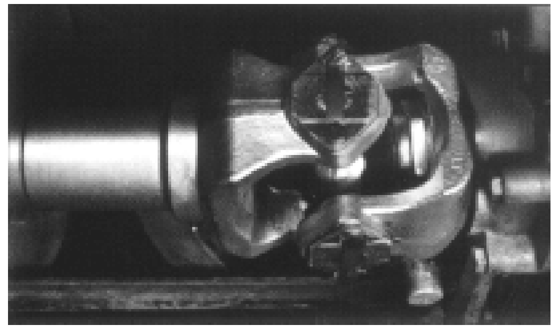

Figure 69—Rotate the Wheel

Rotate the wheel by hand until the output yoke on the transmission is vertical. **Figure 69**.

Check the driveshaft angles in the same loaded or unloaded condition as when the vibrations or noise occurred.

Always try to check driveline angles in both loaded and unloaded conditions.

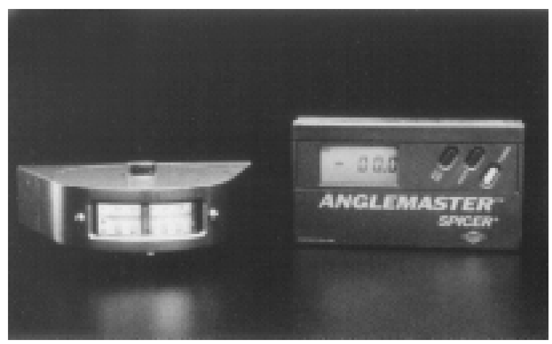

Figure 70—Tools Required to Determine Angles

To determine driveshaft angles, a spirit level protractor, or Spicer Anglemaster Electronic Driveline Inclinometer is required. **Figure 70**.

On a protractor, when angles are read from the 0 degree mark (horizontally on the driveshaft) record and use the angle shown. When angles are read from either of the 90 degree marks (vertically-on the flange) do not record the angle shown on the protractor since the 90 degree marks must be understood to be the same as 0 degrees on the horizontal plane.

Thus, if a vertical reading is 85 degrees, the angle being measured is 5 degrees (90 degrees – 85 degrees = 5 degrees).

To use the Spicer Anglemaster Electronic Driveline Inclinometer, simply place the sensor on the component to be measured. A displayed module will show what the angle is and in which direction it slopes. (Available only from Dana Corporation and your Spicer Service Representative.))

If using a protractor, all angles should be read within ¼ degree and they should be measured with the protractor held plumb on a clean flat surface. The Spicer Anglemaster Electronic Driveline Inclinometer is automatically accurate to within 1/10 of 1 degree.

Measure the slope of the drivetrain going from front to rear. A component slopes downward if it is lower at the rear than the front. A component slopes upward when it is higher at the rear than it is in front.

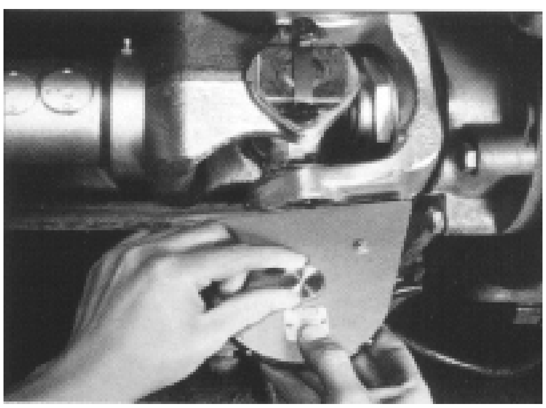

Figure 71—Main Transmission Angle

Figure 72—Location of Correct Angles

Check and record the angle on the main transmission. **Figure 71**.

The reading can be taken on the end yoke lug, with the bearing assembly removed or on a flat surface of the main transmission parallel or perpendicular to the output yoke lug plane. **Figure 71**.

Warning

The self-locking bolts should not be reused more than five (5) times. Observe instructions to prevent serious personal injury or death from loss of driveshaft function. If in doubt, use new bolts.

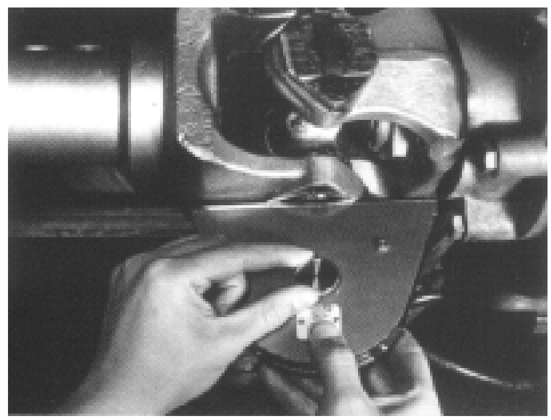

Figure 73—Driveshaft Angle

Check the driveshaft angle between the transmission and axle or forward axle. **Figure 73.**

On short tube length driveshafts, check the angle of the driveshaft on either the tube or slip yoke lug with the bearing assembly removed.

On long tube length driveshafts, measure the angle on the tube at least 3-inches from the circle welds or at least 1-inch any from any balance weights. Be sure to remove any rust, scale or sound deadening compounds from the tube to obtain an accurate measurement.

With all of the angles recorded, complete a drawing as shown. **Figure 74**.

There are no U-joint operating angles in your drawing at this time, just the slope of the components and their direction. To determine U-joint operating angles, simply find the difference in the slopes of the components.

Check the forward axle input yoke angle by removing a bearing assembly and measuring the angle on the yoke lugs or on a flat surface of the angle housing parallel or perpendicular to the input yoke lug plane. **Figure 75** and **Figure 76**.

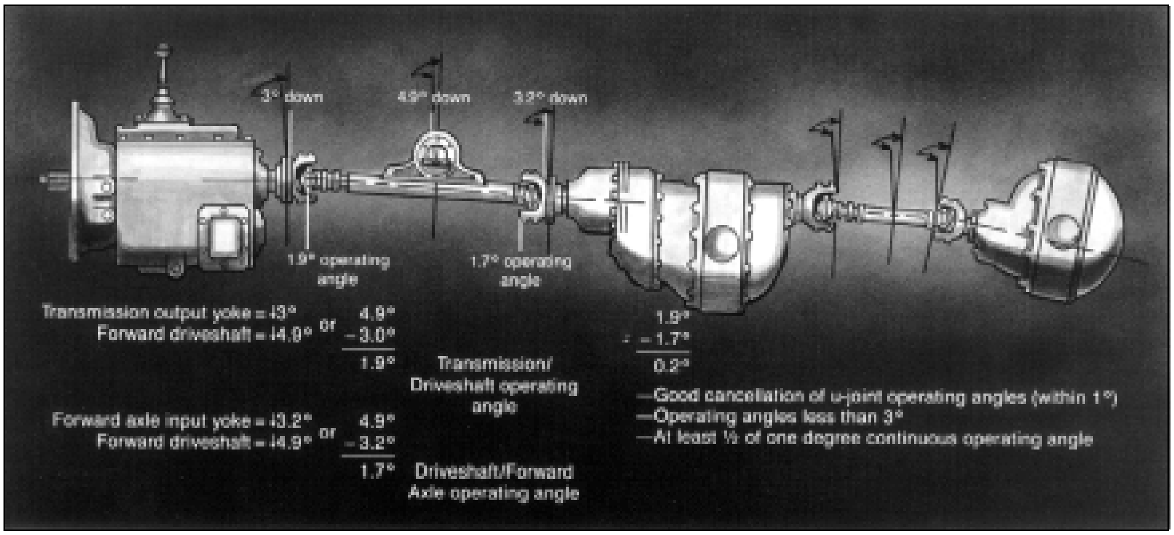

Figure 74—U-Joint Operating Angles

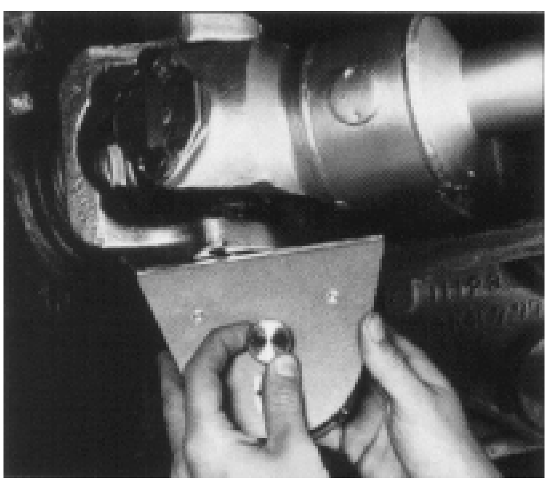

Figure 75—Forward Axle Input Yoke Angle

Figure 76—Perpendicular Input Yoke Lug Plane

If applicable, measure the output yoke angle of the forward axle, the angle of the tandem driveshaft between the forward input yoke angle.

When the slopes are in the same direction on two connected components, subtract the smaller number from the larger to find the U-joint operating angle.

When the slopes are in the opposite direction on two connected components, add the measurements to find the U-joint operating angle.

Now compare the U-joint operating angles on your drawing to the rules for ideal operating angles mentioned above.

Correcting U-Joint Operating Angles

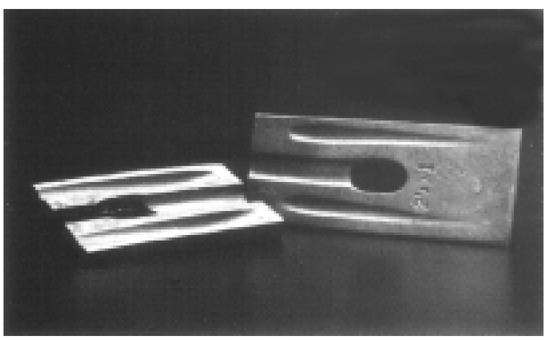

Figure 77—Axle Shims

The recommended method for correcting severe U-joint operating angles depends on the vehicle suspension or driveline design.

On vehicles with leaf spring suspension, thin wedges, can be installed under the leaf springs of single axle vehicles to tilt the axle and correct U-joint operating angles. Wedges are available in a range of sizes to change pinion angles.

On vehicles with tandem axles, the torque rods can be shimmed. Torque rod shims rotate the axle pinion to change the U-joint operating angle. A longer or shorter torque rod may be available from the manufacturer if shimming is not practical. Some torque rods are adjustable.

The addition or removal of a ¼-inch shim from the rear torque arm will change the axle angle approximately ¾ of a degree. A ¾ of a degree change in the pinion angle will change the U-joint operating angle about ¼ of a degree.

Always take the time to call the vehicle manufacturer if there are unusual U-joint operating angle problems. For detailed information on troubleshooting three U-joint or multiple-shaft driveline arrangements, contact your Spicer Service Representative.

What Causes U-Joint Operating Angles to Change

- Suspension changes caused by:
  - Worn bushings in the spring hangers
  - Worn bushings in the torque rods
  - Incorrect airbag height
- Revisions in components of the driveline
- Stretching or shortening the chassis
- Adding an auxiliary transmission or transfer case in the main driveline
- Worn engine mounts

Driveshaft Brake

When a driveshaft brake is used, care must be taken to see that the brake drum is properly piloted, runs true, and is in balance.

Field Problem Analysis (All Types)

U-joint problems, as a rule, are a progressive nature. They generally accelerate rapidly and result in ruined components.

Some recognizable signs of U-joint deterioration are:

- Vibration
- U-joint looseness
- U-joint discoloration due to excessive heat buildup
- Inability to purge all four trunnion seals
- An audible noise or squeal from the driveline

Lubrication Related Problems

The most common reasons for U-joint wear is lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough. **Figure 78**.

To avoid lubrication-related problems:

- Lube all fittings, including those that are often overlooked, out-of-sight, dirt-covered or difficult to reach.
- Know how some lube fittings appear different from regular chassis lube fittings and require a needle nose attachment for the grease gun.
- Lubricated slip yoke lubrication.

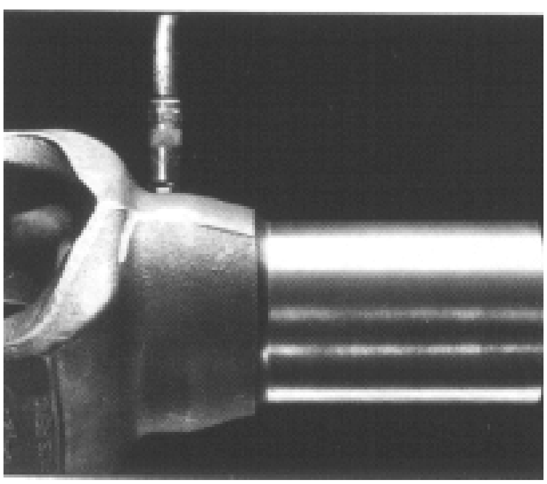

Figure 78—Slip Yoke

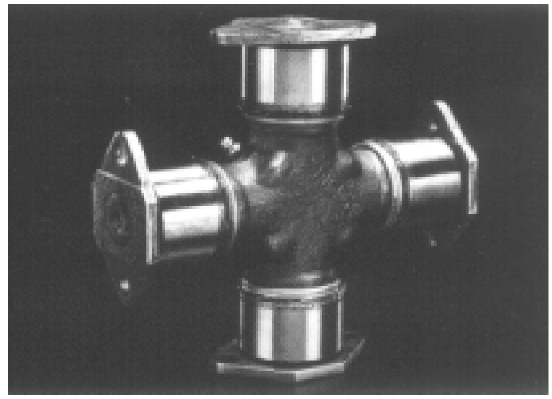

Figure 79—Correct Lubrication

- Use correct lube technique. New lube must flow from all four bearing seals. **Figure 79**.
- Use correct lubricant. It should be a recommended type, such as NLGI Grade 1 or 2 with EP additives and high temperature resistance.
- New U-joints must be lubricated when assembled into the driveshaft yokes.
- Observe recommended lubrication cycle.

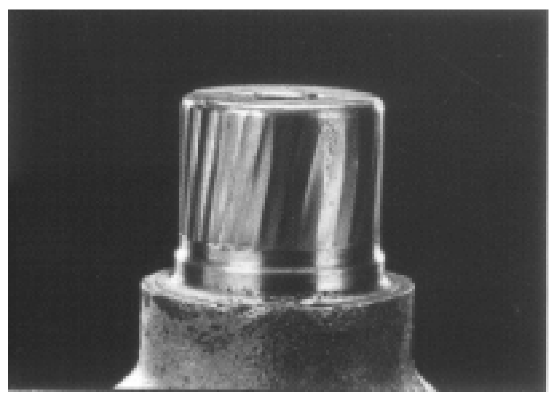

Figure 80—Over Torque

Figure 81—Bending

Generally, a lubrication problem is one of two types — brinelling or end galling. The grooves made by the needle roller bearings on the trunnion of the cross are known as brinelling.

Brinelling can also be caused by too much torque for the capacity or the U-joint used.

End galling is a displacement of metal at the end of the trunnion and can be related to angularity problems. Both of the problems can be caused by lack of lubrication.

Problems that are not a result of lubrication are associated with the installation, angles and speed of the driveshaft.

Fractured parts caused by torque, fatigue and bending are associated with overload, excessively high U-joint angles and driveshaft lengths exceeding critical speed limitations.

Vibration Related Problems

Vibration is a drive problem that can be either transverse or torsion. **Figure 82**.

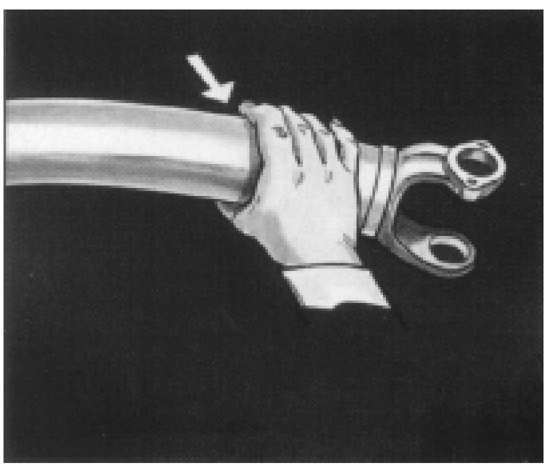

Figure 82-Vibration

Transverse vibration is the result of non-balance acting on the supporting shafts as the driveshaft rotates. When a part having an out-of-balance, or heavy side, is rotated an unbalanced force is created that increases with the square of the speed. The faster the shaft turns, the greater the unbalanced force acting on the shaft.

The force produced by this out-of-balance condition tends to bend the supporting members. As the supporting members have a natural frequency of vibration similar to a swinging pendulum, a violent vibration may exist at certain periods when the speed of rotation and natural frequency of supports coincide.

Each end of the shaft must be balanced individually, as each support is responsive to an out-of-balance condition in the portion of the shaft it supports. Out-of-balance affects operating conditions only when rotating.

Transverse vibration caused by a driveshaft out-of-balance will usually emit sound waves that you can hear and mechanical shaking you can feel.

The force from out-of-balance increases with speeds, not torque load. The driveshaft speed is determined by vehicle speed and the vibration is demonstrated best by road testing the vehicle to operating speed, disengaging engine, and checking vibration while coasting with engine noises eliminated.

Torsion vibration, although similar in effect to transverse vibration, is en entirely different motion. The transverse vibration is a bending movement whereas torsion vibration is a twisting motion. **Figure 83**.

The energy to produce torsion vibration can occur from the power impulses of the engine or from improper U-joint angles. This type of vibration is difficult to identify in road testing but certain characteristics do exist. It causes a noticeable sound disturbance and can occasionally transmit mechanical shaking.

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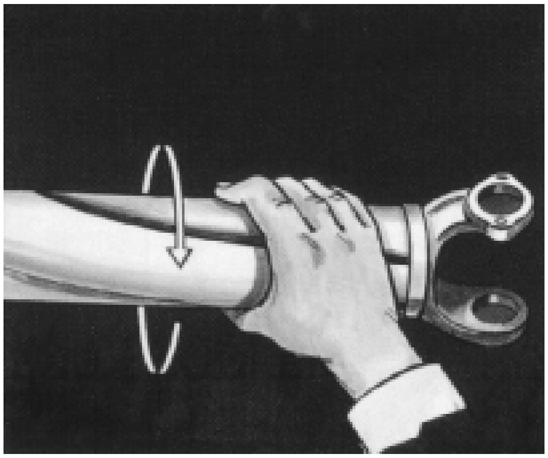

Figure 83—Torsion Vibration

Torsion vibrations can exist at one or more periods any place in the operating range and tend to be more severe at lower speeds. Changes in torque load (part-to-full throttle) usually effect the vibration.

The non-uniform velocity obtained when a U-joint operates at an angle produces torsion vibration.

In a driveline having two or more joints in series, it is desirable to have the individual joint angles arranged such that the net result minimized non-uniform velocity characteristics over the system.

It is practically impossible to maintain the desired joint angles throughout the operating range. Therefore, it is necessary to determine some maximum limit of torsion excitation that can be considered as generally acceptable.

The amount of torsion excitation that can be accepted without causing excessive disturbance depends upon operating speed and characteristics of supporting structures.

Other vibration problems in a driveshaft could be caused by worn or damaged U-joint. These joints must be constantly maintained according to manufacturer's lubrication specifications.