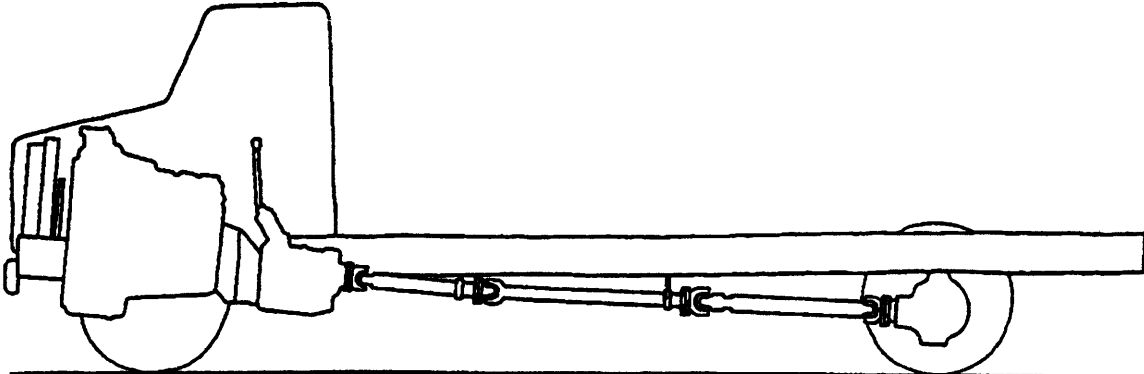


Drive Shaft Phase Angles All Models

Drive Shaft Phase Angles



T4006302

There are vehicles which have various sections of the drive shaft phased at specific angles. Factory set phase angles are vitally important to the quality of the ride, the reduction of drive line vibration and major component life.



CAUTION

Under no circumstances should the phasing of any component of the drive shaft system be changed or tampered with in any way. Doing so could cause severe vibration, decreased U-joint life and/or damage to axles or transmissions.



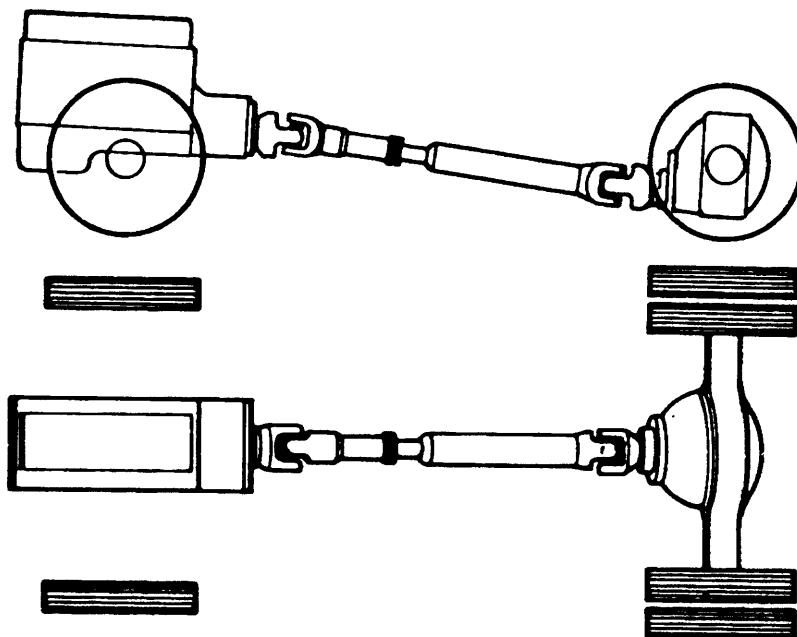
This TSI Service Bulletin replaces TSI Service Manual
451-600, "Drive Shafts and Universal Joints" (6.94),
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Date	Group	No.	Supp.	Page
3.2001	451	011		1(30)

Drive Shafts and Universal Joints

All Models

Drive Shafts and Universal Joints



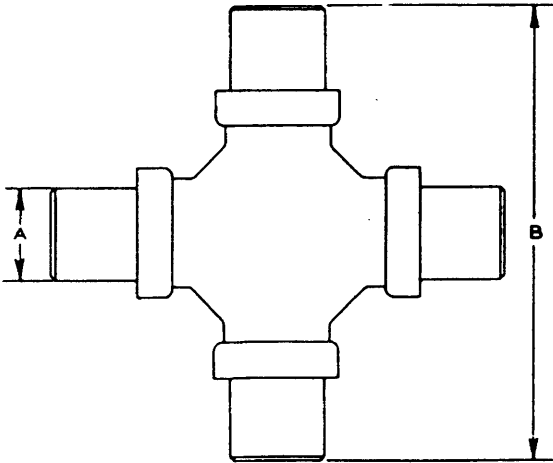
W4000036

This information covers design information, specifications, and service of drive shafts and universal joints used on Volvo vehicles.

Specifications

Drive Shaft

Universal Joint Journal Cross Dimensions



W4000033

Fig. 1: Universal Joint Journal Cross Dimensions

Series	A		B	
	mm	in	mm	in
1600	32.54	1 9/32	127.00	5
1610	32.15	1 17/64	127.00	5
1650	26.59	1 3/64	131.76	5 3/16
1700	33.34	1 5/16	136.92	5 25/64
1710	32.94	1 19/64	146.84	5 25/32
1760	32.94	1 19/64	159.54	6 9/32
1800	42.86	1 11/16	159.54	6 9/32

Series	A		B	
	mm	in	mm	in
1800HD	42.47	1 43/64	155.97	6 9/64
1810	32.94	1 19/64	184.15	7 1/4
1820	34.93	1 3/8	192.88	7 19/32
1850	34.93	1 3/8	192.88	7 19/32
1900	49.61	1 61/64	211.93	8 11/32

Note: Measure the diameter "A" and the span, or length "B" of the journal cross to determine universal joint size or series.

Half-Round End Yoke

Series	Thread Size	Bolt Torque	
		Nm	ft-lb
1610	(3/8) 0.375-24	68-81	50-60
1710	(1/2) 0.500-20	156-176	115-130
1760	(1/2) 0.500-20	156-176	115-130
1810	(1/2) 0.500-20	156-176	115-130

Full Round End Yoke

Series	Thread Size	Capscrew Torque	
		Nm	ft-lb
1610	(5/16) 0.312-24	19-35	14-26
1710	(3/8) 0.375-24	38-65	28-48
1760	(3/8) 0.375-24	38-65	28-48
1810	(3/8) 0.375-24	38-65	28-48

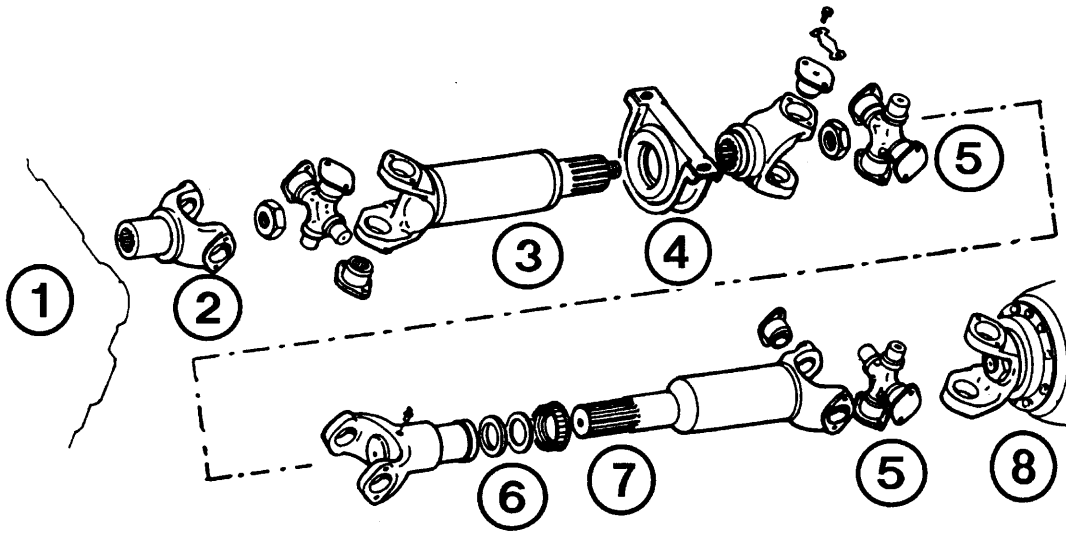
Maximum Drive Shaft Operating Angle

Normal Angles	
Drive Shaft rpm	Maximum Operating Angles
5000	3°-15'
4500	3°-40'
4000	4°-15'
3500	5°-0'
3000	5°-50'
2500	7°-0'
2000	8°-40'
1500	1°-30'

Drive Shaft, Maintenance Intervals

Service	miles (km)	Time/Month
City	5 000/8 000 (8 000/13 000)	3
On Highway	10 000/15 000 (16 000/24 000)	1
On/Off Highway	5 000/8 000 (8 000/13 000)	3
Extended Line Haul (1610-1880)	50 000 (80 000)	1
Severe Use Off Highway 4 x 4	2 000/3 000 (3 000/5 000)	1

Drive Shafts



W4000010

Fig. 2: Typical Drive Shaft and Universal Joint Assembly

- | | | | |
|----------------------|-------------------|--------------------|----------------|
| 1 Transmission | 4 Center bearing | 6 Seal | 8 Differential |
| 2 Yoke | 5 Universal Joint | 7 Slipshaft spline | |
| 3 Drive shaft tubing | | | |

The drive shaft is a steel tube that transmits power from the transmission output shaft to the differential. To accommodate various model, wheelbase and transmission combinations, drive shafts differ in length, diameter and the type of splined yoke. Each shaft is installed in the same manner. A universal joint and splined yoke are located at the transmission rear extension. The slip yoke permits fore and aft movement of the drive shaft as the differential assembly moves up and down. The spline is lubricated internally through a grease fitting. An oil seal prevents leakage and protects the slip yoke from dust, dirt and other harmful materials.

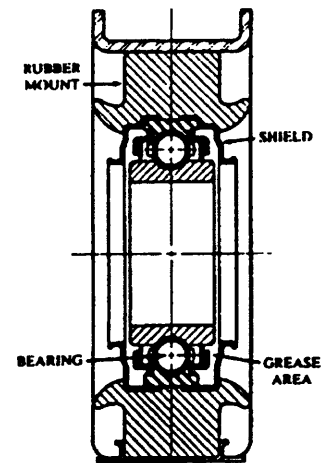
Since the drive shaft is a balanced unit, it should be kept completely free of undercoating and other foreign material which would upset shaft balance.

One-, two- and three-piece drive shafts are used, depending on the total length.

On models that use a two-piece or three-piece shaft, the shaft is supported near its splined end in a rubber-cushioned ball bearing (commonly referred to as the center bearing) which is mounted in a bracket attached to a frame crossmember. The center bearing is permanently lubricated and sealed.

Drive Shaft Center Bearing

If replacing the center bearing, it is not necessary to pack it with grease. However, chassis lubricant should be packed within the dust shields to form a dam to help prevent water and dirt from reaching the bearing. The dust shields are staked into position.



W4000012

Fig. 3: Cutaway View of Center Bearing

Drive Shaft Function

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

The drive shaft must operate through constantly changing relative angles between the transmission and axle. It must also 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. This means the drive shaft must be able to change length and operating angles when going over bumps or depressions. This is accomplished through universal joints, which permit the drive shaft to operate at different angles, and slip joints, which permit lengthening or shortening of the drive shaft to take place.

Construction of a Drive Shaft

To transmit required torque loads, the drive shaft must be durable and strong. Forged steel and high-strength, cast, end yoke for heavy-duty vehicles are used to provide the necessary rigidity required to maintain bearing alignment under torque loads.

Anti-friction bearings are used to withstand oscillating loads while the drive shaft is rotating at high speeds. The needle roller bearings on the cross trunnions carry large loads and are used because of their high capacity in a limited space.

The bearing assembly inside-diameter crowning and tapered thrust pads distribute load more evenly on needle roller bearings and cross trunnion ends to significantly reduce end galling. Bearing assemblies are individually sealed to retain lubricants and keep foreign material out. If lubricants become contaminated with water or abrasive material, needle roller bearing life is seriously affected.

Abrasive material is a major problem for vehicles operating in extremely moist and dirty environments. To combat this problem, synthetic rubber seals were developed and resulted in increased life, ability to withstand high temperatures and a less critical relubrication cycle for drive shafts.

Special high-strength tubing is used to provide maximum torque carrying capacity at minimum practical weight. Drive shafts have been developed to meet the vehicular industry needs.

The sliding splines between slip joint and permanent joint must support the drive shaft and be capable of sliding under full torque loads. To aid in this axial or slip movement, Glidecote was developed to reduce sliding friction, reducing thrust under high torque. This non-metallic coating also prevents spline galling and extends spline life.

Balancing a Drive Shaft

(All types)

Rebuilding the drive-shaft assembly usually includes replacing worn cross and bearing assemblies with a new kit. These kits replace the part of a drive shaft most subject to wear in operation. The potential off-center condition present in the cross and bearing assemblies make 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 drive shaft assembly.

Drive Shaft Angles and Phasing

(All types)

Proper drive shaft angles and correct phasing of the yokes are very important in maintaining long life and quiet running drive 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 drive 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 drive shaft to ensure proper reassembly.

Be careful not to change or remark a drive shaft assembly manufactured out-of-phase for special applications. Locate the arrows marked for the out-of-phase drive shaft and do not change them. Do not replace an out-of-phase drive shaft with a drive shaft that is in phase.

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

Drive shaft angles are a little more complicated. 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.

The simple one-plane angle found in most installations confines all driveline slopes to one plane, usually the vertical plane.

The other type of drive shaft angle is the compound angle in two planes. This is found in drive-shaft designs where offset exists in both the vertical and horizontal planes.

High angles combined with high rpm reduce U-joint life. Too large and unequal U-joint angles can cause vibration and contribute to U-joint, transmission and differential problems. Improper U-joint angles must be corrected.

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

The main factor in determining maximum allowable operating angles is rpm. As a guide to maximum normal operating angles, refer to "Maximum Drive Shaft Operating Angle" page 3.

Tube diameter and normal operating rpm determine maximum allowable tube length. If "critical length" is reached, use a three-joint drive shaft with center support. Refer to the Spicer "Drive Shaft Speed Calculator", Form M3-11.

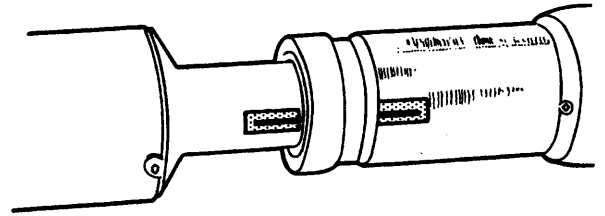


Fig. 4: Drive-Shaft Arrows Lined Up "In Phase" W4000020

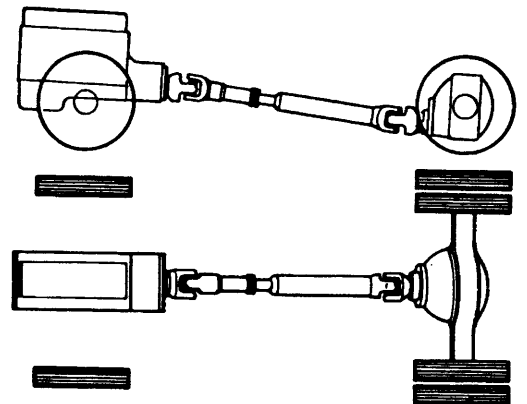


Fig. 5: One-Plane Angle Drive Shaft W4000036

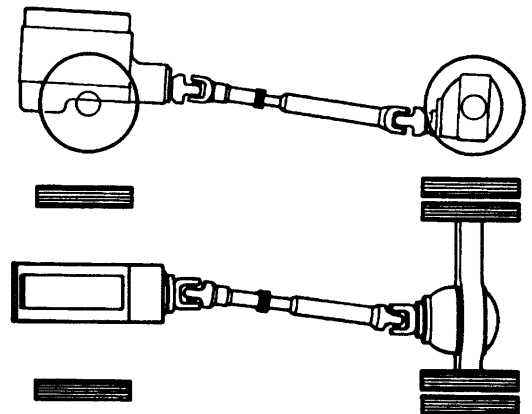


Fig. 6: Two-Plane Angle Drive Shaft W4000037

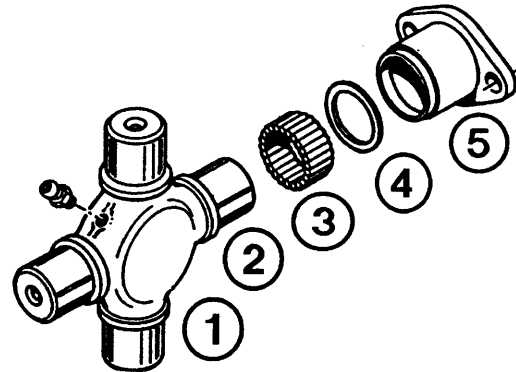
Universal Joints

The simple universal joint is basically two Y-shaped yokes connected by a crossmember called a "spider." The spider is shaped like an "X", and has arms that extend from it called trunnions. The spider allows two yoke/shafts to operate at an angle to each other.

This type of universal joint is designed to make disassembly and reassembly a comparatively simple matter. No hand fitting or special tools are required. The journals and needle bearing assemblies are the parts most subject to wear. When it becomes necessary to replace bearings, remove the drive shaft from the vehicle.

The procedure used to remove a drive shaft depends on the type and design of the universal joints. A shaft with flange-type yokes is disconnected by removing the attaching bolts and nuts from the flanges and separating the flange yokes from the companion flanges. A shaft connected to an end yoke is disconnected by partially disassembling the universal joint. Universal joints with strap or cap-and-bolt type end yokes are disconnected by removing the strap and bolts or caps and bolts.

After disassembling a universal joint, check the fit of each bearing on its respective journal. If looseness is evident, the journal cross and all four bearing assemblies and journal cross are in serviceable condition. Clean bearings and reassemble universal joint with bearings and journals in their original positions.



W4000011

Fig. 7: Exploded View of Universal Joint

- 1 Trunnion
- 2 Seal
- 3 Bearing
- 4 Washer
- 5 Bearing cap

Correcting Universal Joint Operating Angles

The recommended method for correcting severe universal joint operating angles depends on the vehicle's suspension or drive-shaft design.

Typical chart to record drive shaft/yoke angles

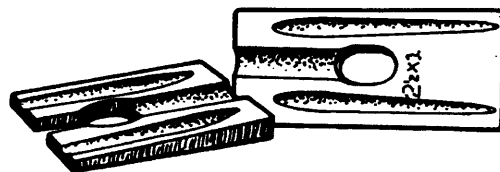
On vehicles with leaf-spring suspensions, axle shims (thin wedges) can be installed between the spring and axle housing. This will tilt the axle housing to raise the pinion up and correct the universal joint operating angles. Shims are available in a range of sizes to change the pinion angle of the rear axle.

Vehicles with tandem suspensions use torque or radius rods to control the pinion angles. Various methods are used: shims between the torque rod and axle; adjustable torque rods; and eccentric bushings in the radius rod leaf eye. The control of these angles can also depend on the suspension or vehicle manufacturer as to what method is used. If a fixed torque rod is used, the angle is controlled by the use of various size rods.

Generally, adding or removing a 6 mm (1/4 in.) shim from a torque rod changes the pinion angle $3/4^\circ$. A $3/4^\circ$ change in the pinion angle changes the universal joint operating angle about $1/4^\circ$.

Note: Both sides of the axle must be changed to balance the pinion and universal joint angles. Also, remember that changing the pinion angle may affect the rear axle(s) lube level(s).

If unusual universal-joint operating angle problems are experienced, or for troubleshooting three or more universal joints or multiple drive-shaft arrangements, consult your authorized Volvo Trucks dealer.



W4000042

Fig. 8: Typical Axle Housing Shims

Troubleshooting

Drive Shaft Troubleshooting

Fault	Reason	Remedy
Vibration		
Low-gear shudder	U-joint angle too large for continuous running	Reduce U-joint continuous running angle
	Worn U-joint	Replace U-joint
	Incompatible drive shaft	Install two-piece drive shaft with center support bearing
	Drive shaft weight not compatible with engine/transmission mounting	Use larger diameter tube
	Drive shaft too long for speed	Shim drive train components to equalize U-joint angles
	Unequal U-joint angles	Shim drivetrain components to equalize U-joint angles
	Excessively loose U-joint for speed	Inspect U-joint flex effort for looseness, torque to specification, straighten and balance shaft
	Drive shaft out of balance; not straight torsional and/or inertial excitation; secondary couple load reaction at center support bearing	Consult component manufacturer; replace shaft bearing
	Improper phasing	
	Inadequate torque on bearing plate capscrews	Check drive shaft for correct yoke phasing. Torque bearing capscrews to specifications
Premature Wear		
Low-mileage U-joint wear	End yoke cross hole misalignment	Use Spicer alignment bar to check for end-yoke cross-hole misalignment
Repeated U-joint wear	Excessive angularity	Check U-joint operating angles with a Spicer Anglemaster™ Electronic Drive Shaft Inclinator; reduce excessive operating angles
	Contamination and abrasion	Lubricate to Spicer specifications. Replace U-joint kit
End galling of cross trunnion and bearing assembly	Excessive U-bolts torque on retaining nuts	Torque bearing retention method to specifications
	Contamination and abrasion	Replace U-joint kit
	Improper lubrication	Lubricate to Spicer specifications

Fault	Reason	Remedy
Needle rollers brinelled into bearing cup and cross trunnion	Excessive continuous running load	Reduce U-joint continuous running U-joint operating angles
	Excessive torque load (shock loading) angle Continuous operation at high angle and or high speed	Replace with higher capacity U-joint assemblies
Broken cross and bearing	Worn or damaged seals	Realign to proper running angle, minimum 1/2°

Causes of Universal Joint Operating Angle Changes

- Suspension changes, worn bushings in the spring hangers, worn bushings in the torque rods, incorrect air spring height.
- Revisions in the components of the drive shaft.
- Stretching or shortening of the chassis.
- Adding an auxiliary transmission or transfer case in the main drive shaft.
- Worn engine mounts.

Vibration-Related Problems

Drive shaft assemblies can be the source of first order vibrations (one excitation per revolution) and second order vibration (two excitations per revolution).

First order vibration

First order vibration results from an imbalance in the drive shaft assembly caused by improper balancing procedures, loss of the drive shaft balancing weights, excessive runout, poor spline fit or undercoating on the drive shaft.

Drive shaft vibration problems due to an imbalance or first order excitation are vehicle-speed sensitive since drive shaft speed is directly related to vehicle speed by the rear axle ratio.

In the case of conditions as a "sloppy" spline fit, imbalance may be engine-torque sensitive in that the torque causes the spline to center itself differently than if no torque were present.

Second order vibration

Second order vibration occurs when the drive shaft transmits torque through an angle at each end. The excitation level is related to both the amount of angle the U-joints operate through and the amount of torque transmitted. A second order drive shaft excitation is sensitive to vehicle speed, torque and jounce. Drive shaft angles must be set in the optimum position to accommodate various loads and rear-axle windup during acceleration.

To determine if the drive shaft is the source of a vibration, drive the vehicle and note the speed range at which the vibration occurs and the vibration frequency (using a Reed tachometer). Determine the drive shaft speed by placing the transmission in direct drive and reading the drive shaft rpm with an engine tachometer. If it is determined that the vibration is related to first order excitation of the drive shaft, balance the drive shaft.

Lubrication Related Problems

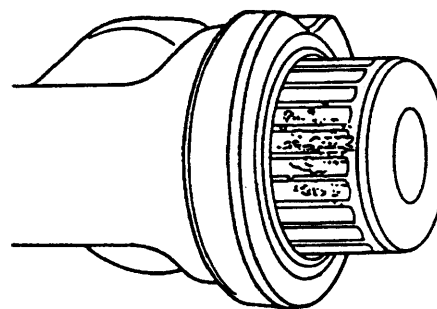
The most common reasons for U-joint wear are lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough.

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

Failures which are not a result of lubrication film breakdown are associated with the installation, angles and speeds, and manufacturing discrepancies.

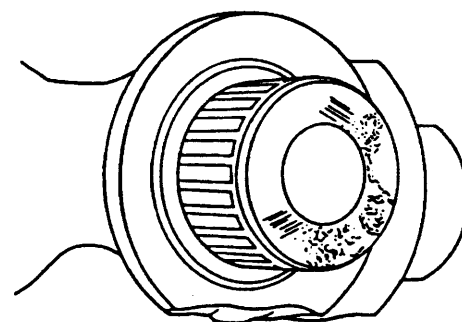
Drive shaft failures through torque, fatigue and bending are associated with overload, excessively high U-joint angles and drive shaft lengths excessive for operating speeds.

The troubleshooting chart in this manual (refer to "Drive Shaft Troubleshooting" page 10) is intended to help service people associate complaints with some of the probable causes and probable corrections. Through normal vehicle maintenance and recognition of discrepancies, this may enable them to make the corrections necessary to ward off a serious breakdown.



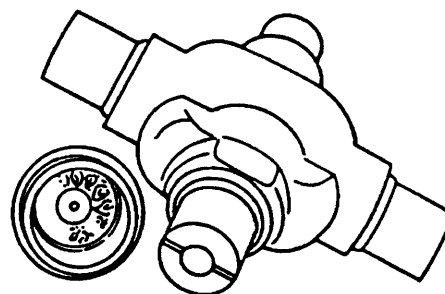
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Typical Lack of Lubrication



W4000052

Typical Trunnion Brinelling

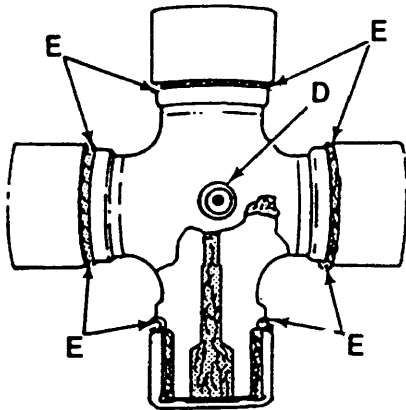


W4000053

Typical End Galling

4511-10-02-01 Drive Shaft, Lubrication

To avoid lubrication-related problems:



W4000051

Correct Purging of U-joint

- Lube all fittings, including those that are often overlooked, out of sight, dirt covered or difficult to reach.
- Note how some lube fittings appear different from regular chassis lube fittings and require a needle-nose attachment for the grease gun.
- Do not overlook slip-yoke lubrication.
- Use correct lube technique.
- Use recommended lubricant, such as NLGI Grade 2 with extreme pressure additives and high temperature resistance.
- Lubricate new U-joints when installing into the drive-shaft yokes.
- Observe recommended lubrication cycle. Refer to "Drive Shaft, Maintenance Intervals" page 3. One of the most common causes of U-joint and slip yoke problems is lack of proper lubrication. Properly sized U-joints that are adequately lubricated at recommended intervals will normally meet or exceed vehicle operation requirements. Relubrication flushes the joints, removing abrasive contaminants from the bearings.

Lubrications for Universal Joints

For normal application, use a good-quality, lithium-base, extreme-pressure (E.P.) grease that meets NLGI Grade 2 specifications. Grades 3 and 4 are not recommended because of their greater thickness. For severe applications, use a good-quality, lithium-base (or equivalent) E.P. grease with an operating temperature range of 157–163°C (315–325°F). In addition, the grease should meet the NLGI Grade 2 specifications.

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

Initial Lubrication and Relube Cycle

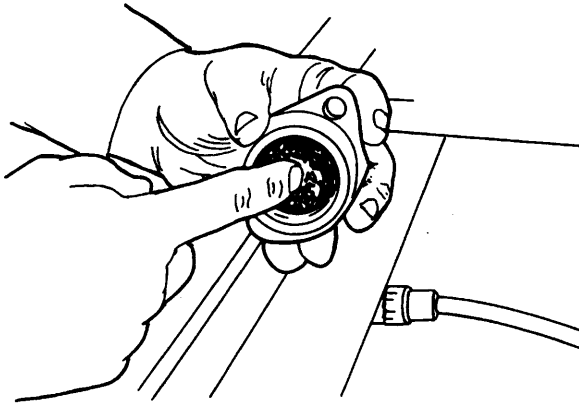
Replacement universal joint kits contain only enough grease to protect needle roller bearings during storage. It is, therefore, necessary to completely lubricate each replacement kit before assembly into the yokes. Each cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease. Fill all cavities between the needle rollers and apply a liberal grease coating on the bottom of each bearing assembly.

Too much grease can cause hydraulic "lockup", making installation difficult. Relube the kits after installing into the yokes and before placing into service. Do this through the lube fitting, using the same grease.

Relubrication cycles vary, depending on vehicle service requirements and operating conditions. Relube splines at the intervals recommended in "Drive Shaft, Maintenance Intervals" page 3.

Note: On-highway is defined as all applications that operate less than 10% of the time on gravel, dirt or unimproved roads. If higher than 10% operating time, follow off-highway recommendations.

For extended linehaul tractors, use "10" series (1610, 1710, 1760 and 1810) U-joints and Glidecote slip splines.



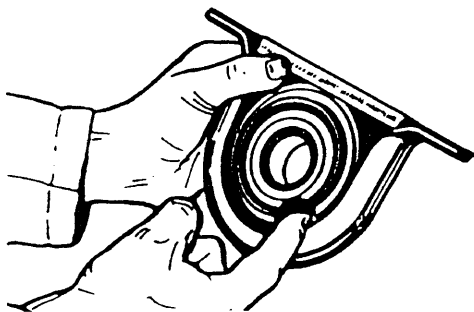
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Pre-lubing Bearing Cap

Drive Shaft Support Bearing Assemblies

Bearing manufacturers do the initial lubrication and all Spicer shaft support (center) bearings are lubed 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. Put enough grease in to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants must be waterproof. Consult your grease supplier for recommendations.

Note: Often a special lubricant is required by vehicle specification or customer request. Lubrication recommendations in this information are suggested by Spicer U-Joint engineers. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.



W4000059

Pre-lubing Center Bearing

4513-06-03-01 Universal Joint, Checking

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

DANGER

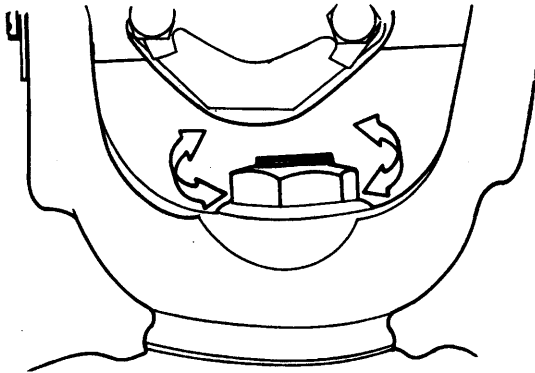
Do not go under the vehicle while the engine is running. Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running. Do not work on a shaft (with or without a guard) when the engine is running. Rotating shafts can snag clothes, skin, hair, and hands, etc. Failure to follow these instructions can result in serious personal injury or death.

The drive shaft and universal joints generally require little maintenance. Periodic inspection is recommended, however, for proper drive shaft balance and universal joint lubrication. If the area around the caps appears to be excessively dry, it may indicate a need for bearing relubrication or universal joint replacement. A failing universal joint often squeaks on start-up or "clunks" with direction change.

To keep a vehicle operating smoothly and economically, carefully inspect the drive shaft at regular intervals. Vibrations and problems with the U-joint and shaft support (center) bearing are caused by such things as 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.

1



W4000013

Inspection of Input and Output Yokes

Check the output and input end yokes on both the transmission and rear axle(s) for looseness. If loose, disconnect the drive shaft and retorque the retaining nut to specification. If a yoke replacement is required, always install a new retaining nut when replacing the yoke. Also, if the retaining nut is damaged, it must be replaced. Most self-locking retaining nuts are only used once.

2



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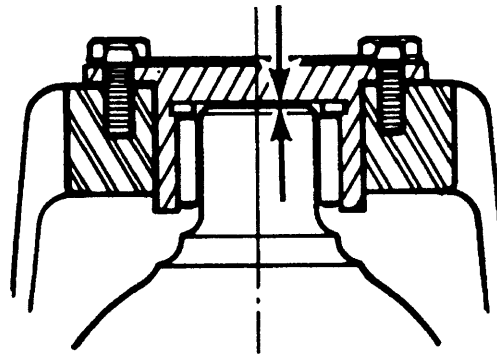
Checking End Yokes for Looseness

If the end yokes are tight, check for excessive radial looseness at the transmission output and rear axle input shafts at their respective bearings. Transmission output shaft radial play should not exceed 0.025 mm (0.001 in.)

Rear axle input shaft radial play should not exceed 0.076 – 0.178 mm (0.003 – 0.007 in.) for a new axle and 0.33 – 0.43 mm (0.013–0.017 in.) for a rebuilt axle using reused parts.

0.025 mm
(0.001 in.)
0.076–0.178 mm
(0.003–0.007 in.)
0.33–0.43 mm
(0.013–0.017 in.)

3



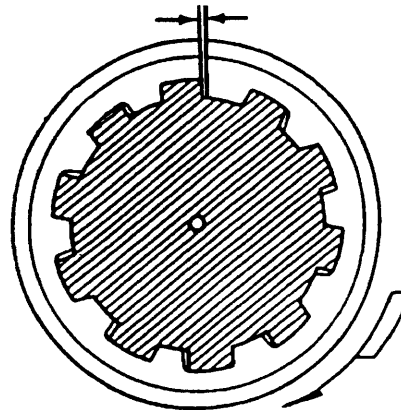
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Checking Cap for Looseness

Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed 0.152 mm (0.006 in.) maximum.

0.152 mm
(0.006 in.)

4



W4000016

Checking Slipshaft Splines for Looseness

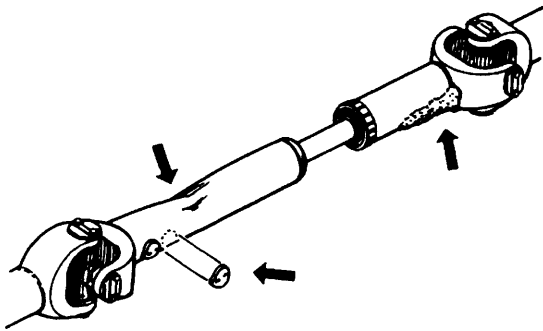
Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed 0.178 mm (0.007 in.).

0.178 mm
(0.007 in.)

5

Place an axle stand next to the drive shaft at the slip yoke. Position a dial indicator with a magnetic base onto the axle stand. Set the dial indicator to zero against the yoke and read off the movement.

6

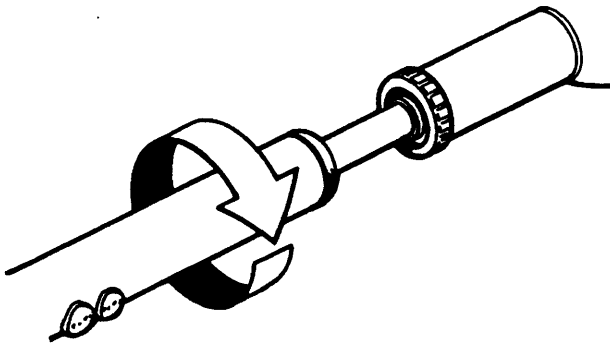


W4000017

Checking Drive Shaft for Damage

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

7



W4000018

Checking Drive Shaft for Runout

If a runout reading is required, take the reading with the drive shaft in the vehicle, the rear axle jacked up, and the transmission in neutral. This allows drive-shaft rotation by hand to check the dial indicator reading. The runout reading should be taken at various locations and should not exceed a maximum of 0.64 mm (0.025 in.).

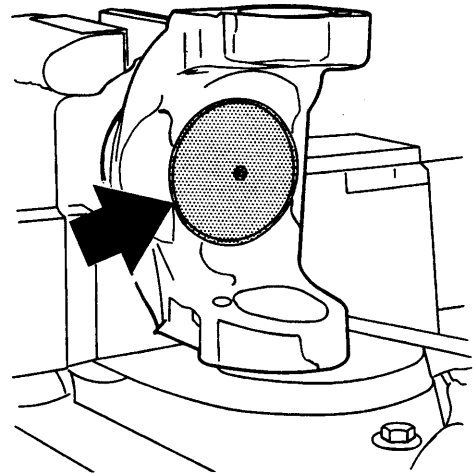
0.64 mm
(0.025 in.)

8

Place an axle stand next to the drive shaft and position a dial indicator with a magnetic base onto the axle stand. Set the dial indicator probe up against the drive shaft and set it at zero. Rotate the drive shaft and read the runout. The best way to check the drive shaft balance is to set a dial indicator and take the highest reading, place a weight on the low side, then spin the drive shaft and check for balance. Do not use more than 150 g (5 oz).

150 g (5 oz)

9



W4000019

Checking Slipshaft End Plug

Check to see that the end plug is not loose or missing. If it is, have it repaired or replaced. Loose or missing plugs indicate that there is not enough slip movement in the drive shaft.

Closed length of the drive shaft may be too great, requiring a change in the drive shaft length. Continued use of a long drive shaft can lead to failures of the transmission or rear axle bearing, as well as other journals and bearings.

4511-01-01-01 Drive Shaft, Removal

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

DANGER

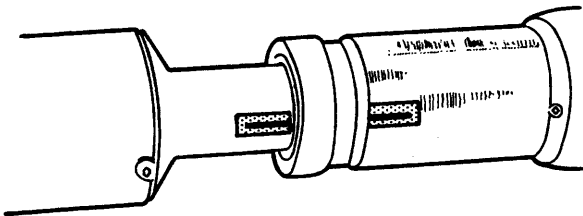
Do not go under the vehicle while the engine is running. Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running. Do not work on a shaft (with or without a guard) when the engine is running. Rotating shafts can snag clothes, skin, hair, and hands, etc. Failure to follow these instructions can result in serious personal injury or death.

WARNING

Drive shafts can be very heavy. Install a support strap when servicing a drive shaft. Failure to install a support strap can result in personal injury.

Removal (full round end yoke-style)

Note: Before removing the drive shaft, mark the slip yoke assembly and tube shaft with a marking stick or paint to ensure proper alignment when reassembled. This is known as keeping the drive shaft yokes "in phase".



W4000020

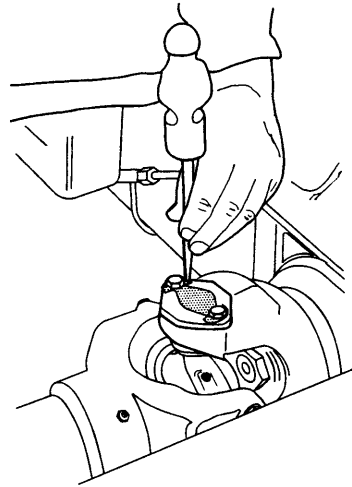
Fig. 9: Alignment Markings on Drive Shaft

CAUTION

Never heat components when disassembling.

Note: Use the drive shaft removal method that ensures safety and ease of removal without damaging the drive shaft, transmission or axle components. Volvo suggests using a hydraulic jack, nylon strap and the two-jaw puller.

1

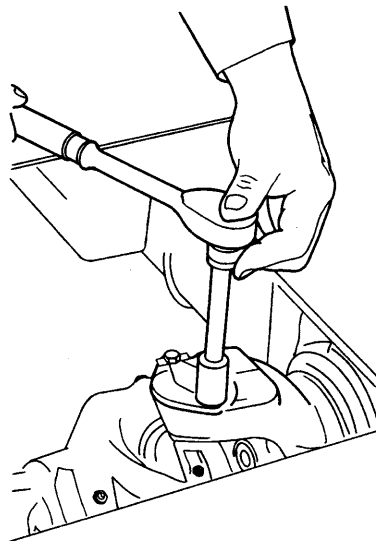


W4000021

Fig. 10: Removing Tabs from Bolts

Bend lock-strap tabs away from bolt heads with a chisel.

2



W4000022

Fig. 11: Removing Bearing Cap Bolts

Remove bolts (four) from each bearing assembly connected to the transmission and axle end yoke.

3

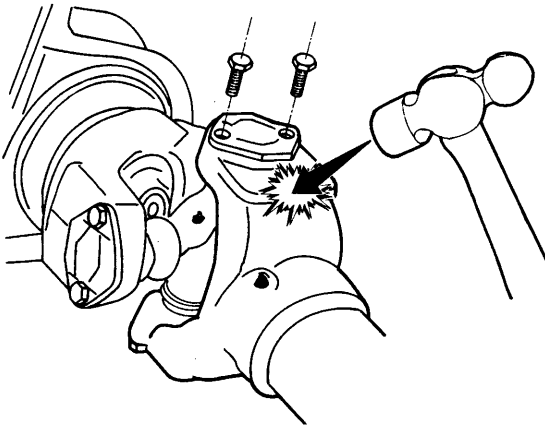


Fig. 12: Tapping Out Bearing Cap

Release bearing assemblies from the yoke cross holes by lightly tapping on the yoke, which causes the bearing cap to come out.

4

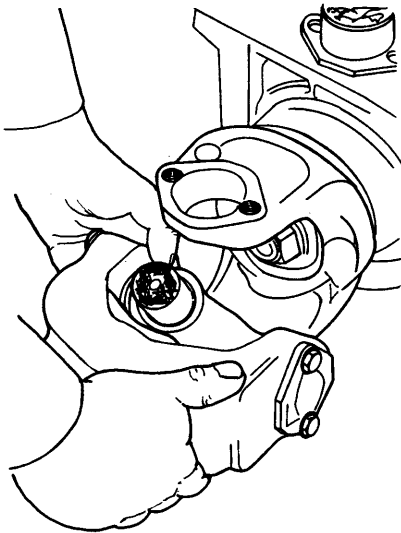


Fig. 13: Removing Trunnion from the End Yoke

Free the trunnion from the end yoke by tilting the trunnion and collapsing the drive shaft.

If only one end of the drive shaft requires service, disconnect that end, unscrew the slip seal (dustcap) from the slip yoke assembly, and then pull apart or slide off the assembly. When removing the entire drive shaft, disassemble one end at a time and carefully lay the disconnected end on the floor. When reassembling, BE SURE that the arrows or marks on the shaft and slip joint are in line to keep the drive shaft yokes in phase.

Removal (half-round end yoke style)

For half-round end yoke disassembly, install a nylon support strap. Remove the strap retaining bolts one end at a time and release the drive shaft.

Removal (flange-yoke style)

1
Install nylon support strap. Loosen and remove nuts and bolts securing flange yoke to transmission or axle companion flange.

2
Holding drive shaft firmly, tap loose and compress from one end and lower to floor

3
Repeat at other end.

4513-03-04-01

Universal Joint, Replacement

DANGER

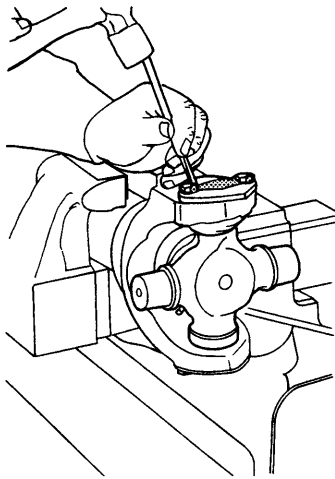
Driveline components should be assembled according to proper procedures. Do not use worn out or damaged driveline components. Do not use driveline components in a non-approved application. Failure to follow these instructions can result in serious personal injury or death.

WARNING

Drive shafts can be very heavy. Install a support strap when servicing a drive shaft. Failure to install a support strap can result in personal injury.

Disassembly

1



W4000025

Fig. 14: Removing Cap Locking Tabs

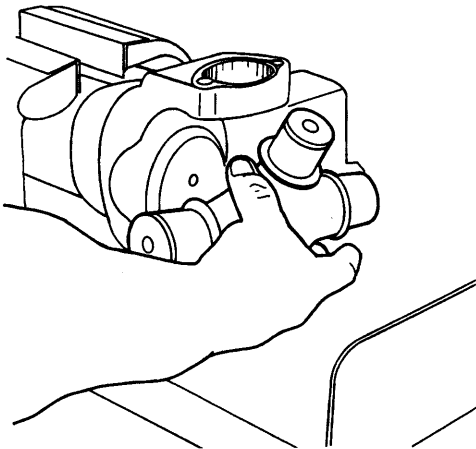
Place the drive shaft in a bench vise, clamping on the tube adjacent to the cross and bearing assemblies being removed.



CAUTION

Do not distort the tube with excessive pressure.

2

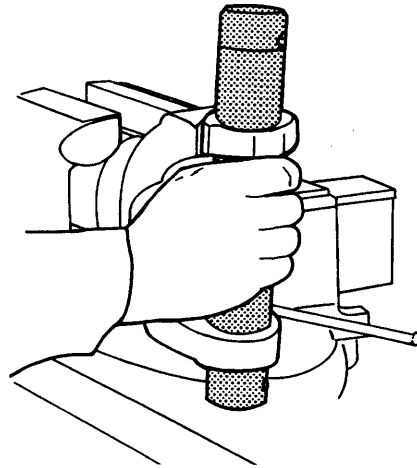


W4000029

Fig. 15: Removing Cross

Completely remove the cross and bearings from both ends of the drive shaft by disassembling the bearing assemblies from the slip yoke and tube yoke (and flange yoke where applicable).

3



W4000027

Fig. 16: Checking Yoke Alignment

After removing the cross and bearings at 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 and emery cloth.

4

Check the yoke lug cross holes with a No-Go Wear Gauge and then use a Spicer Alignment Bar to inspect for damage by sliding through both cross holes simultaneously. The alignment bar identifies yoke lugs that have taken a set because of excessive torque. Raised metal or distorted lugs can cause premature cross and bearing problems.

5

At this time, clean the cross holes of the yokes on the transmission and axle and inspect with an alignment bar gauge as described in step 4. If, after properly cleaning the cross holes, the alignment bar will not pass through simultaneously, the yoke lugs are distorted and the yoke or yokes must be replaced.

Assembly (full and half-round drive shafts)

Place each end of the drive shaft, less cross and bearing kits, into a bench vice. Check the paint markings placed on the tube and slip yoke assembly before removing from the vehicle to be sure they are lined up or in phase.

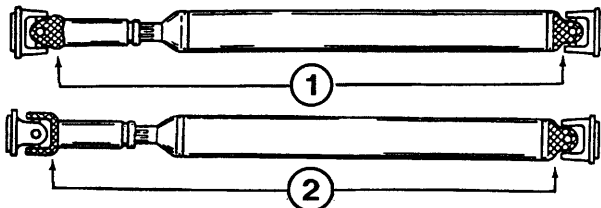


Fig. 17: Drive Shaft Phasing

- 1 Correct phasing
- 2 Incorrect phasing

1

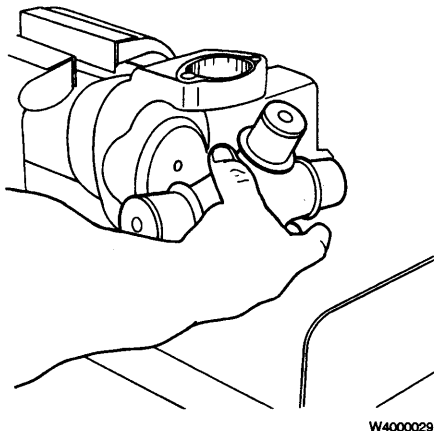


Fig. 18: Reinstalling the Cross into the End Yoke

Remove the cross and bearings from the box and remove all four bearing assemblies. Rotate the cross to inspect for presence of the one-way check valve in each lube hole of all four trunnions. Then position the cross into the end yoke with its lube fitting in line as near as possible with the slip spline lube fitting. Keep the lube fitting on the inboard side.

Note: The zerk fitting must be on the compression side when driving forward.

2

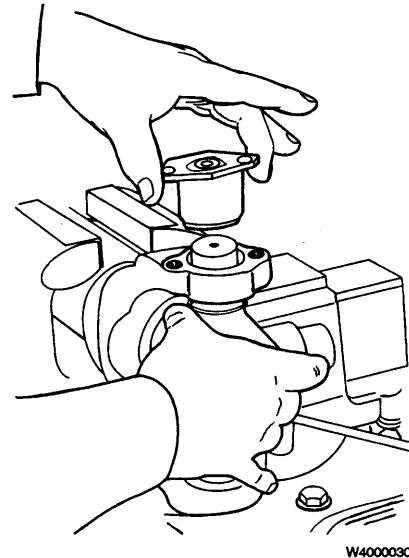


Fig. 19: Reinstalling Bearing Cap on Trunnion

Apply an anti-seize compound to the outside diameter of the 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. Holding the trunnion in alignment with the cross hole, press bearing flush to face of end yoke by hand.

Note: Make sure to pre-lube the bearing cap before installing.

3

When the bearing assembly is completely seated, put the lock plate tab in place. Insert the "Grade 8" capscrews that are furnished with the kit through the capscrew holes in both the lock strap and bearing assembly. Thread with hand or wrench into tapped holes in yoke. Do not torque down bolts.

4

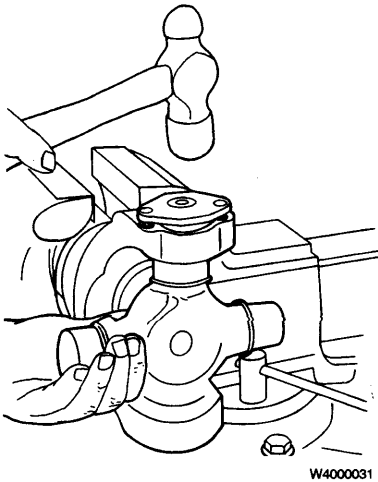


Fig. 20: Tapping in Bearing Cap

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.

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

5

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.

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. Follow this method also when assembling full round drive shafts to full round yokes of vehicle at transmission and axle or axles.

6

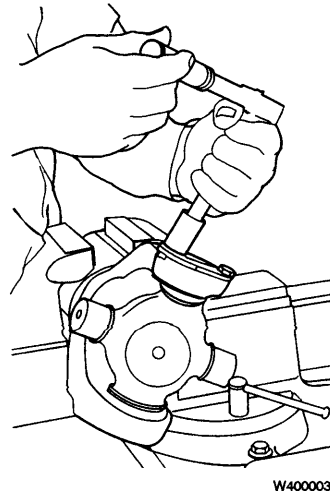


Fig. 21: Reinstalling Bearing Cap Bolts

Put the lock plate tab in place and thread the bolts with hand or wrench into tapped holes in yoke.

7

Repeat installation process for cross and bearing kit at the opposite end of the drive shaft. 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.

8

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

CAUTION

Using a new cross with a worn bearing assembly, or a worn cross with a new bearing assembly will cause rapid wear, making another replacement necessary in a short time. Always replace the cross, four bearing assemblies and bolts as a unit. Full round and half round require different kits.

4511-02-01-01 Drive Shaft, Installation

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

DANGER

Do not go under the vehicle while the engine is running. Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running. Do not work on a shaft (with or without a guard) when the engine is running. Rotating shafts can snag clothes, skin, hair, and hands, etc. Failure to follow these instructions can result in serious personal injury or death.

DANGER

Driveline components should be assembled according to proper procedures. Do not use worn out or damaged driveline components. Do not use driveline components in a non-approved application. Failure to follow these instructions can result in serious personal injury or death.

WARNING

Drive shafts can be very heavy. Install a support strap when servicing a drive shaft. Failure to install a support strap can result in personal injury.

Installation

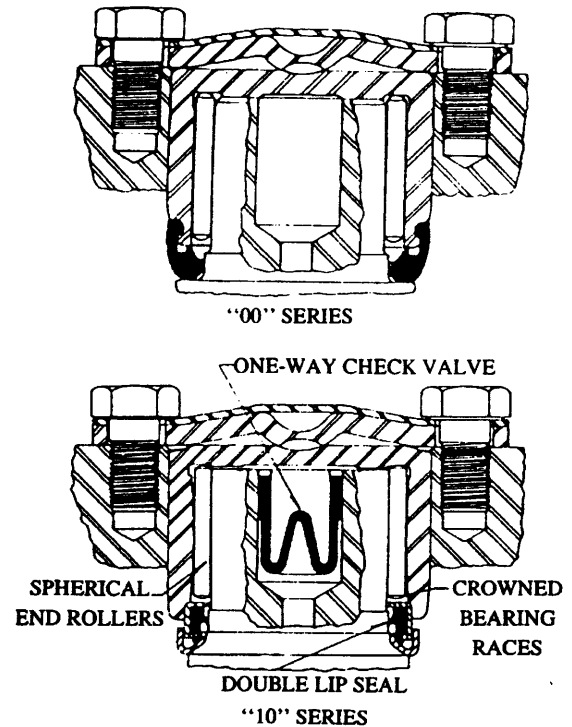


Fig. 22: Journal Cross and Bearing Assembly

W4000034

The installation of a drive shaft does not present any unusual mechanical difficulties. Before installation, check the drive shaft for the following items:

- Damage or dents on the drive shaft 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 undesirable and will result in an unbalanced drive shaft.
- Mounting flanges and pilots should be free from burrs, paint and foreign substances which would not allow proper seating at assembly.

Full round end-yoke style

1

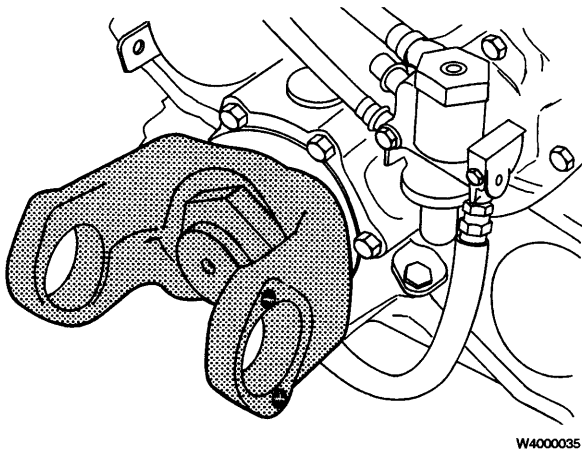


Fig. 23: Placing End Yoke in a Horizontal Position

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.

2

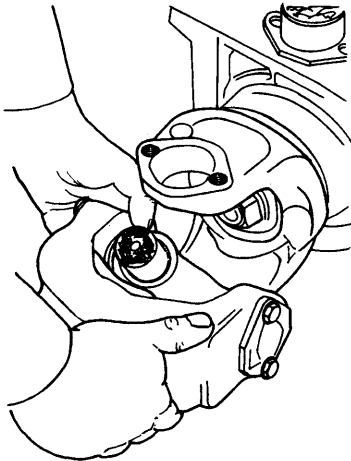


Fig. 24: Installing Trunnion into End Yokes

Tilt the cross trunnions of the drive shaft (both ends) with trunnions pointing toward each other from end to end, one side. Install with the slip joint nearest the source of power. Use a nylon support strap to aid in handling the drive shaft.

3

Holding the drive shaft 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. The drive shaft is being supported at each end by one trunnion surface in a cross hold and the nylon support strap. Tilt a cross trunnion until the opposite side can be inserted through a cross hole. Repeat at opposite end. The drive shaft is now being supported at each end by two trunnion surfaces in the cross holes and the nylon support strap.

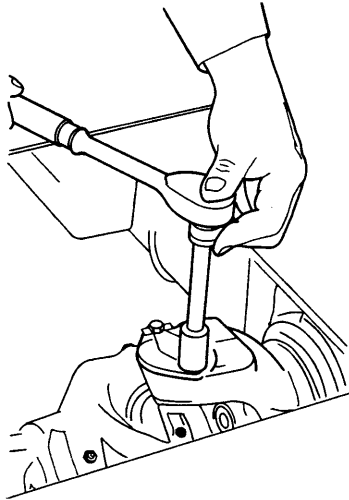
4

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 machined face of the yoke lug.

5

Place a bearing assembly over the trunnion diameter and align it to the cross hole. Holding the trunnion in alignment with the cross hole, press bearing assembly flush to face of end yoke by hand. 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.

6



W4000022

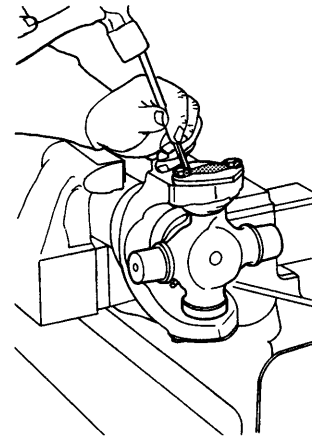
Fig. 25: Reinstalling Bearing Cap Bolts

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 in step 5. Put the lock plate tab in place and insert the "Grade 8" capscrews through the holes in the lock plates and bearing assemblies. Thread capscrews into end yokes. Tighten with wrench until plates are flush against end yoke faces.

7

Lubricate the cross and bearing assembly until lube appears at all four seals. Also check slip yoke lubrication.

8



W4000025

Fig. 26: Bending Lock Tabs Over

Torque all eight bolts to specification. Refer to "Full Round End Yoke" page 3. Bend lock plate tabs to flat of cap-screw heads to lock in place.

Half-round end yoke style



CAUTION

Do not reuse half-round, self-locking retaining bolts more than five times. Follow instructions explicitly to prevent danger of serious personal injury or death from loss of drive shaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.

For half-round yokes, place the bearing assemblies on the cross trunnion and seat the bearing cup into the end yoke shoulders. Place straps over the bearing assemblies, thread special self-locking capscrews into tapped holes and torque bolts to specification. Refer to "Half-Round End Yoke" page 3. Lubricate the cross and bearing assemblies.

Note: Bearing caps should be held in place by clips or tape so they will not fall off when installing the drive shaft.

Flange yoke style

With nylon support strap in place and holding the drive shaft firmly, align the (permanent end) flange pilots of the drive shaft flange and axle companion flange with each other. Align bolt holes and install bolts, lock washers and nuts to temporarily secure drive shaft to axle. Compress the slip assembly to position the opposite end of the drive shaft to the transmission companion flange. Align bolt holes and install bolts, lock washers, and nuts and torque to specifications.

Note: 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 prevent the bearing assembly from rotating.

4513-10-02-01

Universal Joint, Lubrication



DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

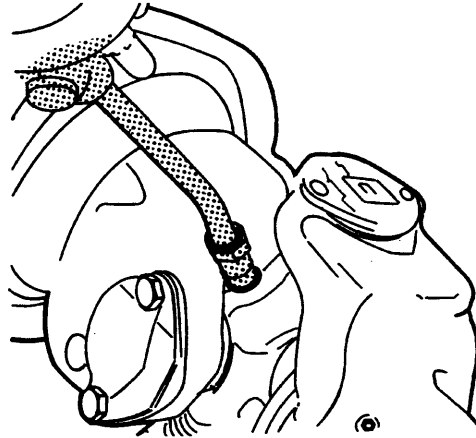


DANGER

Do not go under the vehicle while the engine is running. Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running. Do not work on a shaft (with or without a guard) when the engine is running. Rotating shafts can snag clothes, skin, hair, and hands, etc. Failure to follow these instructions can result in serious personal injury or death.

U-Joints

1



W4000055

Fig. 27: Greasing U-joint

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. Pop the seals.

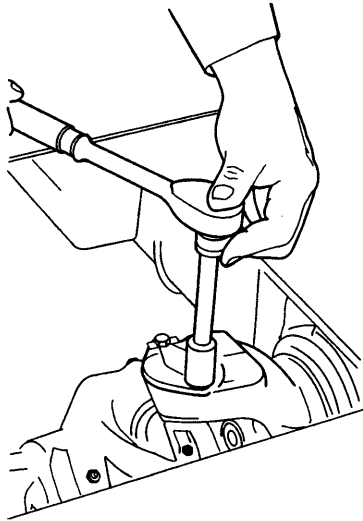
2

If any seals fail to purge, move the drive shaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging.

3

Because of the superior sealing capability of the seal design on the 1610, 1710, 1760, 1810 and 1880 Series, there will occasionally be one or more bearing assembly seals that will not purge.

4



W4000022

Fig. 28: Loosening Bearing Cap

Release seal tension by loosening the bolts holding the bearing assembly that does not purge. It may be necessary to loosen the bearing assembly approximately 0.625 mm (1/16 in.) minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

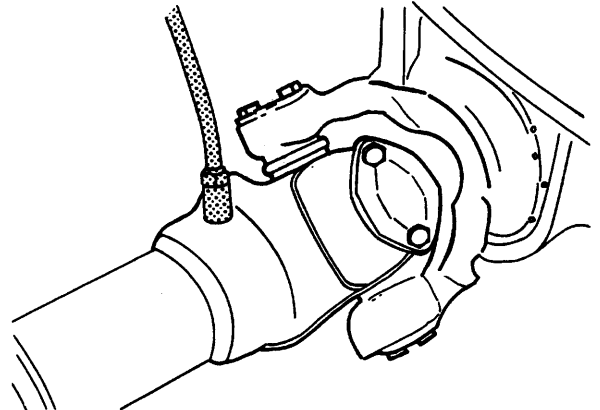
5

Retorque bolts to specification.

Slip Splines

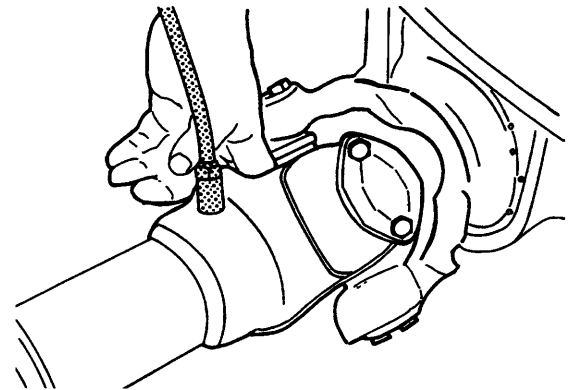
The lubricant used for U-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting NLGI Grade 2 specifications.

Relube splines at the intervals recommended in "Drive Shaft, Maintenance Intervals" page 3.



W4000056

1

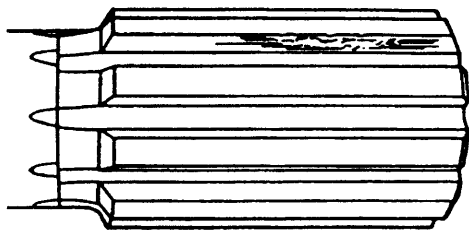


W4000057

Fig. 29: Lubrication Slip Shaft

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

2



W4000058

Fig. 30: Typical Slip Shaft Spline Galling

Now cover the pressure-relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

**CAUTION**

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 can cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize.

4511-06-02-01

Drive Shaft Angles, Checking

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral, and block the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**DANGER**

Do not go under the vehicle while the engine is running. Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running. Do not work on a shaft (with or without a guard) when the engine is running. Rotating shafts can snag clothes, skin, hair, and hands, etc. Failure to follow these instructions can result in serious personal injury or death.

Preparing the Vehicle

1

Inflate the tires to normal operating pressure.

2

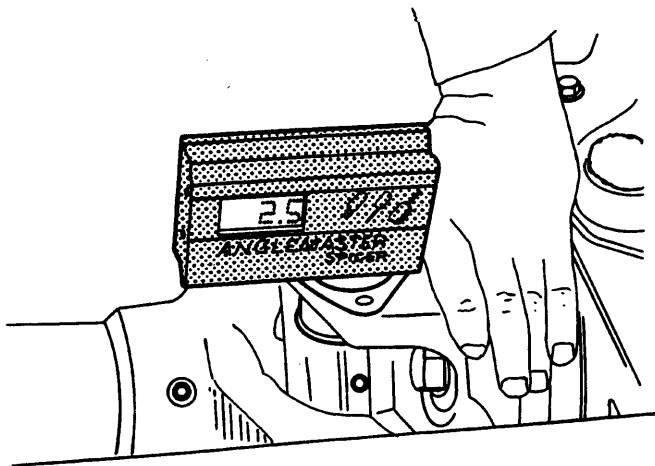
Park the vehicle on a flat and level surface, front to rear and side to side. Do not level the vehicle by jacking up the front or rear axles. Do not apply the parking brakes, and make sure the rear air-suspension ride height is correct, if applicable.

3

Jack up one rear wheel, just enough to clear the floor.

Procedure

1



W4000038

Fig. 31: Checking Transmission Yoke Angle

Rotate the rear wheel by hand until the output yoke on the transmission is vertical, then lower the rear wheel to the floor. Check the drive shaft angles in the same loaded or unloaded conditions as when the vibration or noise occurred.

2



Fig. 32: Checking Drive-Shaft Angle

To determine drive shaft angles, an electronic protractor, or equivalent, is required. To use the electronic protractor, place it onto the component to be measured. A display module will show the angle and in which direction it slopes.

3

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

Note: Two outlets for the electronic protractor are Spicer and Schaevitz Sensing Systems. Contact your local Spicer distributor for the Spicer model. For the Schaevitz model contact Schaevitz at 1-800-545-3243.

4

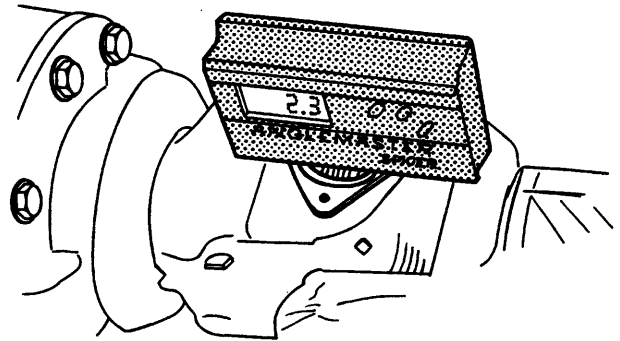


Fig. 33: Checking Front-Axle Yoke Angle

Check and record the angle on the main transmission. This reading can be taken on the end yoke lug with the bearing cap assembly removed; or on a flat, machined surface on the transmission parallel or perpendicular to the output-shaft yoke lug plane. Record the reading.

5

Check the drive shaft angle between the transmission and the forward rear axle. On short tube length drive shafts, check the angle of the drive shaft on either the tube or slip-tube yoke lug with the bearing cap assembly removed. On long tube length drive shafts, check the angle on the tube at least 76 mm (3 in.) away from the circle tube weld or at least 25 mm (1 in.) from a balance weight. Be sure to remove any rust, scale or sound-deadening compounds from the tube shaft to obtain an accurate measurement.

6

Check the forward rear axle input yoke angle. This can be done by removing a bearing cap assembly and measuring the angle on the yoke lug, or measuring at a flat, machined surface on the rear axle parallel or perpendicular to the input-shaft yoke lug plane.

7

If applicable, measure the output-yoke angle of the forward rear axle through the shaft yoke. This is the angle of the inter-axle drive shaft between the tandem axles and the input yoke angle of the rear-rear axle.

8

To determine the universal joint operating angles, simply find the difference in the slopes of the components.

9

When the slopes are in the same direction on two connected components, subtract the smaller reading from the highest reading to find the universal joint operating angle. When the slopes are in the opposite direction on two connected components, add the readings to find the universal joint operating angle.

10

Compare the universal joint operating angles to the instructions in "Maximum Drive Shaft Operating Angle" page 3.