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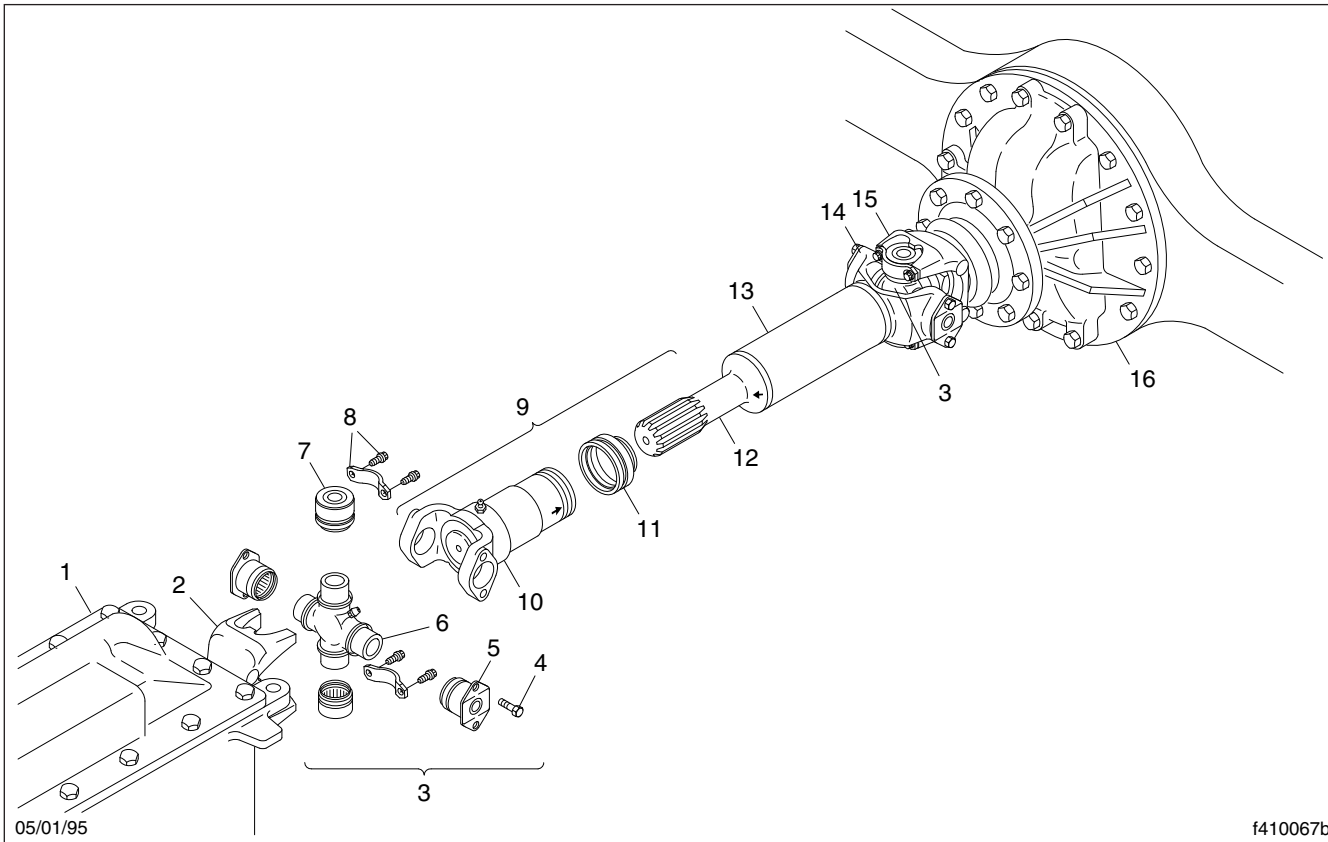
Contents

General Information

The simplest driveline consists of a transmission output-shaft end-yoke, an axle input-shaft end-yoke, and a single slip-jointed driveshaft connecting the two end-yokes. See **Fig. 1**. The driveshaft is made up of a universal joint (U-joint), a sleeve-yoke, a splined stub shaft, a driveshaft tube, a tube-yoke, and a second U-joint.

Driveline Configurations

The specific type and number of drivelines used on each vehicle depends on its number of transmissions, its number of drive axles, and its wheelbase. See **Fig. 2**. A driveline is used between each driving and driven component. A driveline connecting a main transmission (or an auxiliary transmission) to a single drive axle or forward-rear axle of a dual-drive vehicle is always referred to as a No. 2 driveline. See **Fig. 2**, examples A, B, C, D, and E. An interaxle driveline of a dual-drive vehicle is always called a No. 3 drive-



NOTE: Not all fasteners are shown.

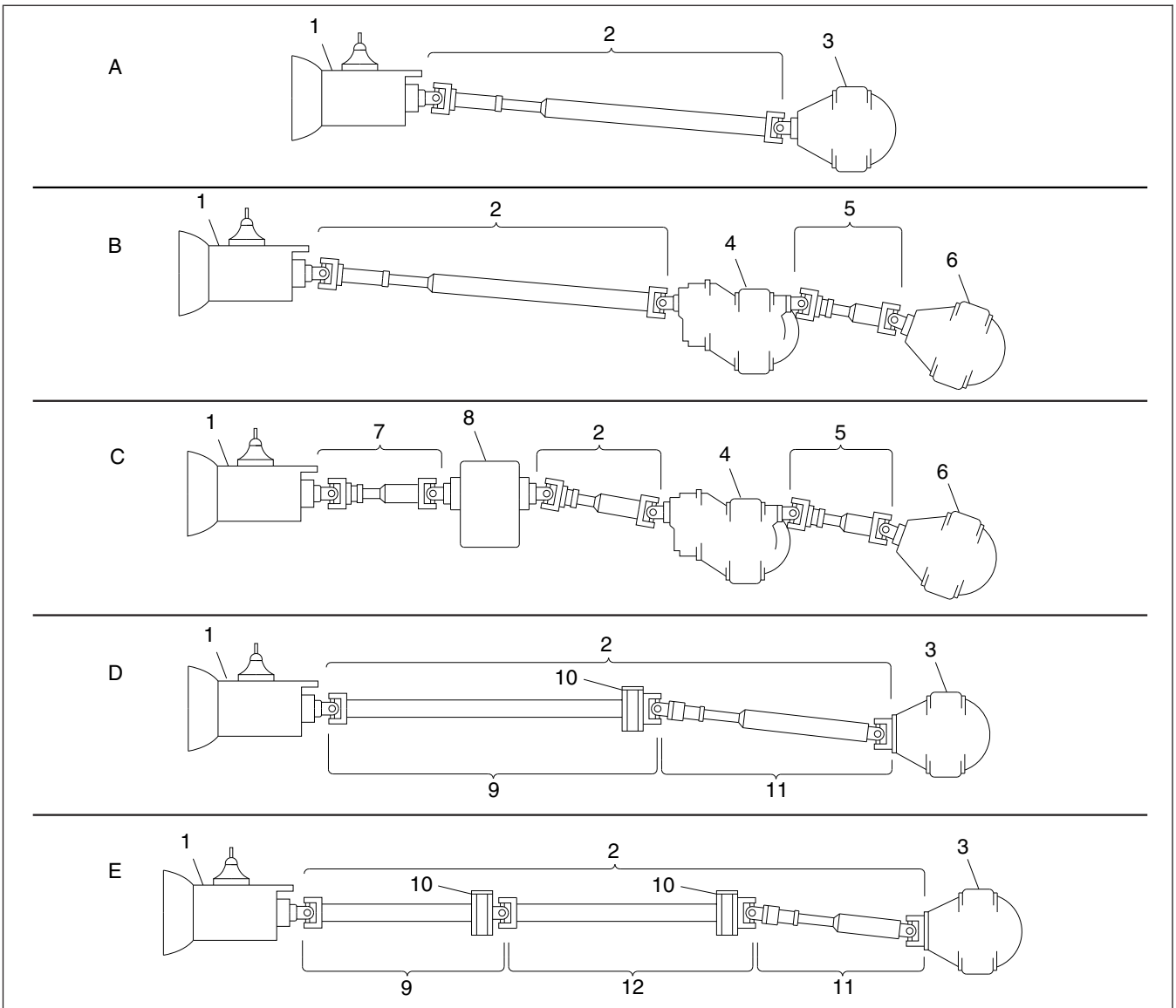
1. Transmission
2. Transmission Output-Shaft End-Yoke (half-round)
3. U-Joint Assembly
4. Bearing Plate Self-Locking Capscrew
5. Bearing Cup (for full-round yoke)
6. U-Joint Cross
7. Bearing Cup (for half-round yoke)
8. Bearing Strap and Bearing-Strap Capscrew
9. Slip-Joint Assembly
10. Sleeve-Yoke (full-round)
11. Dust Cap
12. Splined Stub Shaft
13. Driveshaft Tube
14. Tube-Yoke (full-round)
15. Axle Input-Shaft End-Yoke (half-round)
16. Rear Axle

Fig. 1, Components of a Basic Driveline

General Information

line. See **Fig. 2**, examples B and C. A driveline connecting a main transmission to an auxiliary transmission is always referred to as a No. 1 driveline. See **Fig. 2**, example C.

A long driveshaft, supported only at its ends, will sag in the middle from its own weight. When turning at high rpm, it will flex, causing an out-of-balance vibration. Therefore, vehicles having a long wheelbase



1. Main Transmission
2. No. 2 Driveline
3. Rear Axle
4. Forward-Rear Axle
5. No. 3 Driveline
6. Rearmost Axle
7. No. 1 Driveline
8. Auxiliary Transmission
9. Primary Coupling Shaft
10. Midship Bearing
11. No. 2 Driveshaft
12. Intermediate Coupling Shaft

Fig. 2, Driveline Configurations

use a midship bearing, mounted on a frame crossmember, for additional support. See **Fig. 2**, example D. This allows the No. 2 driveline to be separated into two, shorter shafts (a coupling shaft and a No. 2 driveshaft), thus improving balance and stability.

Vehicles having an even longer wheelbase use two crossmember-mounted midship bearings, allowing the No. 2 driveline to be separated into three short shafts, joined by four U-joints. See **Fig. 2**, example E. The first shaft is the primary coupling shaft, the second is the intermediate coupling shaft, and the third is the No. 2 driveshaft.

Slip-Joints, U-Joints, and Yokes

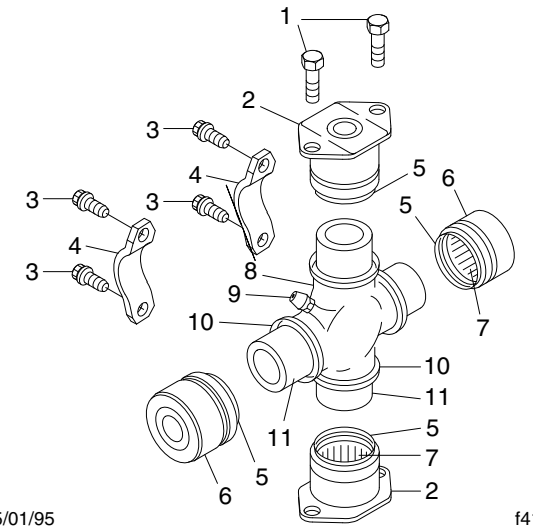
The basic function of the driveline is to send torque from the transmission to the axle in a smooth and continuous action. Because the vehicle axles are not attached directly to the frame, but are suspended by springs, they ride in an irregular, floating motion (when going over bumps or depressions), thus changing the distance between the transmission (or coupling shaft) and the rear axle, and the distance between the rear axles. The slip-joints of the No. 2 and No. 3 driveshafts, by expanding and contracting, allow for length changes between drivetrain components. Coupling shafts do not require a slip-joint.

Motion of the rear axle(s) also causes changes to the relative angles between drivetrain components. U-joints allow transfer of torque from an output shaft (or coupling shaft) to the driveshaft, and from the driveshaft to an input shaft, even though the angles between the shafts may be constantly changing.

Each U-joint consists of a cross with a close-tolerance ground cylindrical surface (trunnion) at the end of each of the four arms. Installed on each trunnion is a bearing cup lined with bearing needles. All bearing cups are sealed to retain lubricants, and to prevent entry of foreign material. See **Fig. 3**. In operation, the four bearing cups are held stationary in a pair of yokes, while the U-joint cross pivots on its trunnions.

Full-round yokes are installed at the front of coupling shafts and at both ends of the No. 2 and No. 3 driveshafts. All tube-yokes (yokes that are welded into driveshaft tubes) and all sleeve-yokes (yokes that are part of the internally splined half of slip-joints) are full-round yokes. See **Fig. 4**, items 4 and 9.

An end-yoke is an internally splined yoke, held on an externally splined shaft by a locknut. As standard



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1. Bearing-Plate Capscrews
2. Bearing Cup (for full-round yoke)
3. Bearing-Strap Capscrew
4. Bearing Strap
5. Bearing-Cup Seal
6. Bearing Cup (for half-round yoke)
7. Bearing Needles
8. U-Joint Cross
9. Grease Fitting
10. U-Joint Cross Slinger
11. Trunnion

Fig. 3, Typical U-Joint

equipment, all No. 2 driveline end-yokes are half-round, with full-round optional. And, as standard equipment, all No. 3 driveline end-yokes are full-round, with half-round optional. End-yokes are installed on the transmission output shaft, on each axle input and output shaft, and behind the midship bearing of most coupling shafts. See **Fig. 4**, items 2, 7, 12, and 14.

Meritor 17T and 18T U-joints are coupled to half-round end-yokes by capscrews inserted through semicircular bearing straps that hold the bearing cups in place under tabs in the yoke cross-holes. See **Fig. 5**.

Meritor RPL Series U-joints are coupled to half-round end-yokes by capscrews inserted through the bearing cups. See **Fig. 6**.

U-joints are installed in full-round tube-yokes, sleeve-yokes, and end-yokes, by inserting the cross through from the inside of both yoke cross-holes, then install-

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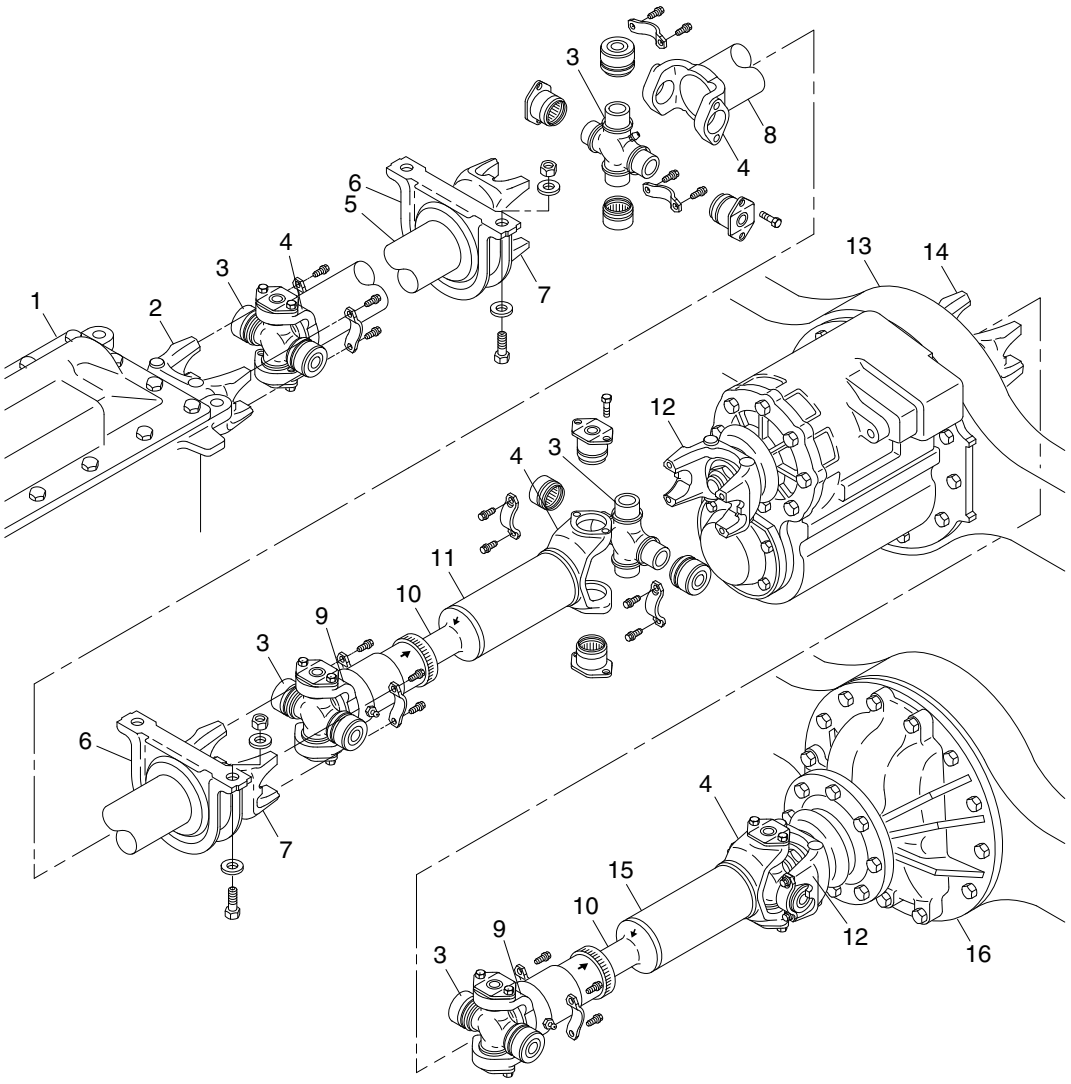

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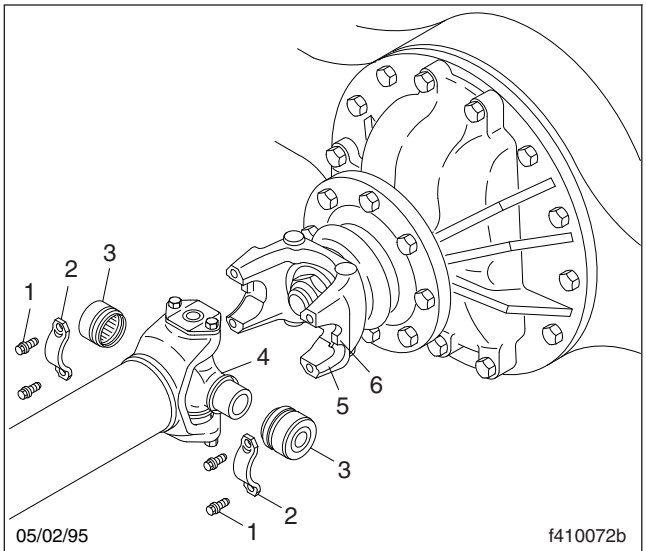
NOTE: Not all fasteners are shown.

1. Transmission
2. Transmission Output-Shaft End-Yoke (half-round)
3. U-Joint Assembly
4. Full-Round Tube-Yoke
5. Primary Coupling Shaft Tube
6. Midship Bearing Assembly
7. Coupling Shaft End-Yoke (half-round)
8. Intermediate Coupling Shaft Tube
9. Sleeve-Yoke (full-round)
10. Slip-Joint Assembly
11. No. 2 Driveshaft Tube
12. Axle Input-Shaft End-Yoke (half-round)
13. Forward-Rear Axle
14. Axle Output-Shaft End-Yoke (half-round)
15. No. 3 Driveshaft Tube
16. Rearmost Axle

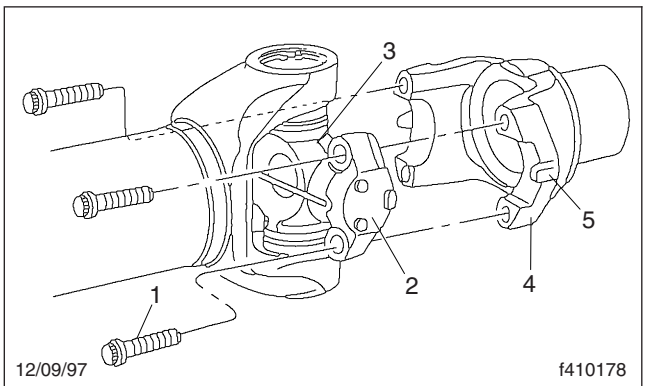
Fig. 4, Dual-Drive Installation With Primary and Intermediate Coupling Shafts

ing the bearing cups into the outsides of the yoke and over the ends of the trunnions. Snap rings or self-locking capscrews are installed into the yoke to secure the cups. See **Fig. 7**.



1. Bearing-Strap Capscrew
2. Bearing Strap
3. Bearing Cup
4. U-Joint Cross
5. Half-Round Yoke
6. Yoke Cross-Hole Tab

Fig. 5, Coupling of a U-Joint With a Half-Round End-Yoke

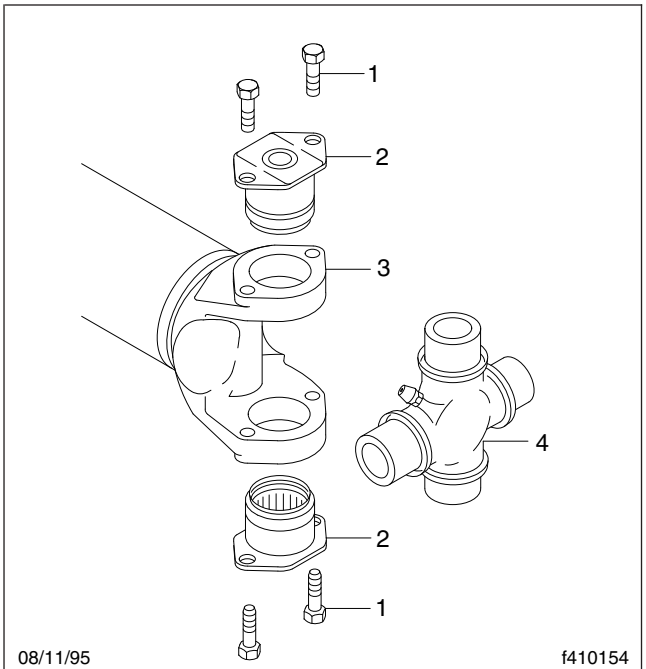


1. Capscrew
2. Bearing Cup
3. U-Joint Cross
4. Half-Round Yoke
5. Yoke Cross-Hole Tab

Fig. 6, Coupling of a RPL Series U-Joint

U-Joint Angles, Phasing, and Driveline Balance

Correct U-joint working angles, U-joint phasing, and driveline balance are vital to maintaining a quiet-running drivetrain and long life of drivetrain components (including driveline components).



1. Bearing-Plate Self-Locking Capscrew
2. Bearing Cup (bearing-plate-type)
3. Full-Round Yoke
4. U-Joint Cross

Fig. 7, Installation of a U-Joint in a Full-Round Yoke

The U-joint working angle is the angle formed by the intersection of the driveshaft centerline and the extended centerline of the shaft of any component (or other driveshaft) to which the U-joint connects. See **Fig. 8**. Because the double oscillating motion of a U-joint that connects angled shafts causes a fluctuating speed difference between the shafts, the effect created by the U-joint at one end of the shaft must cancel the effect created by the U-joint at the other end. This is done by making U-joint working angles at both ends of the driveshaft approximately equal, with the U-joints in phase. If the yoke lugs at both ends of the shaft are lying in the same plane (a plane that bisects the shaft lengthwise) the U-joints will be in phase. See **Fig. 9**.

NOTE: Some driveshafts are designed and phased with their end yokes clocked 90 degrees from each other. This is referred to as cross phasing.

After manufacture, each driveline yoke is statically balanced. After assembly, each driveshaft and cou-

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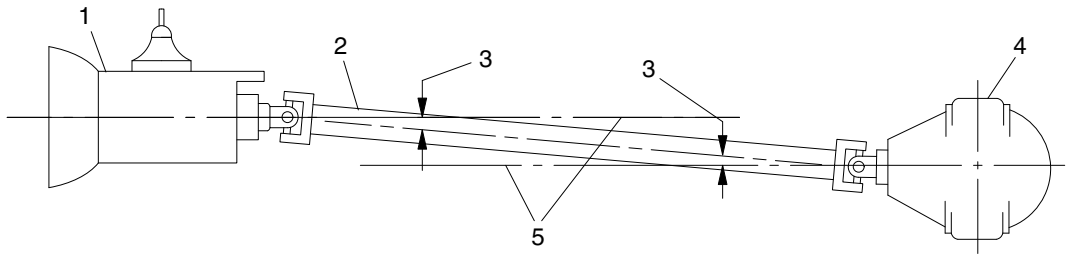
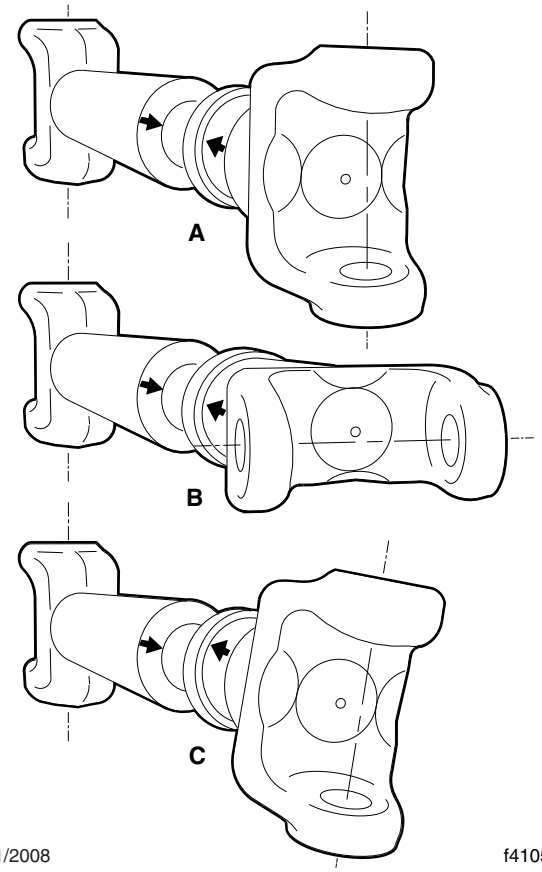


1. Transmission
2. No. 2 Driveshaft
3. U-Joint Working Angles
4. Rear Axle
5. Extended Centerlines

Fig. 8, U-Joint Working Angles



A. In Phase (parallel phased)
B. In Phase (cross phased)
C. Out of Phase

Fig. 9, U-Joint Phasing

pling shaft is checked for out-of-roundness, straightened as necessary, then dynamically balanced.

Avoiding Driveline Problems

To ensure that U-joints turn in phase, sleeve-yokes, splined shafts, coupling shaft end-yokes, and coupling shafts, should be marked for assembly reference before disassembly. A misaligned slip-joint will seriously affect driveline balance (and U-joint phasing). Even if a slip-joint is assembled 180 degrees from its original position (which will keep the U-joints in phase), the dynamic balance of the driveshaft will be negatively affected.

A driveline can become unbalanced or greatly weakened if a driveshaft has been dented, bent, twisted, or otherwise damaged. Operating a vehicle at speeds that exceed the speed of the driveshaft's design specifications will cause an out-of-balance vibration. Any condition that allows excessive movement of a driveshaft will cause driveline imbalance: loose end-yoke nuts, loose midship bearing mounts, loose U-joint bearing cup retaining capscrews, worn U-joint trunnions and bearings, and worn slip-joint splines.

Among the most common causes of U-joint and slip-joint damage is lack of lubrication.

To keep a vehicle operating smoothly and economically, the driveline must be carefully checked and lubricated at regular intervals. For inspection and lubrication intervals and procedures, see **Group 41** of the *Business Class M2 Maintenance Manual*.

U-Joint Uncoupling and Coupling With a Half-Round End-Yoke

U-Joint Uncoupling

NOTE: It is easier to check driveline parts, and to replace a U-joint or midship bearing assembly if the driveshaft is removed from the vehicle. If a driveshaft requires straightening or balancing, it must be removed, and installed on a lathe or a balance machine. Removal is required for replacement of slip-joint parts, a driveshaft tube, or a tube-yoke. To remove the driveshaft, see **Subject 120**.

NOTE: Many service operations do not require driveshaft removal from the vehicle: end-yoke nut tightening; drive component shaft seal or end-yoke replacement; changing U-joint phasing at the slip-yoke; and transmission or axle removal (for overhaul, repair, or replacement). To perform these operations, uncouple the U-joint at the applicable end of the appropriate driveshaft.

1. Roll the vehicle forward or backward as needed to turn the rearmost end-yoke (of the driveline that is being uncoupled) until the centerline through its cross-holes is horizontal. See **Fig. 1**, Ref. A and Ref. B.
2. Apply the parking brakes, and chock the tires.
3. If the half-round bearing cups do not already have a retaining wire installed, install a bearing-cup retaining wire. See **Fig. 1**, Ref. C. Or, install safety wire from the retaining-wire groove of one half-round bearing cup to the other.
4. Support the driveshaft with a nylon support strap.

   When uncoupling a coupling shaft, install two or three support straps, as needed. Remove the fasteners that attach the midship bearing(s) to its bracket(s). See **Fig. 1** and **Fig. 2**.
5. Remove the capscrews that secure the bearing cups or straps to the half-round yoke. Remove the bearing straps, if equipped.
6. Compress the slip-joint to remove the U-joint from the yoke.

⚠ CAUTION

Do not expose the U-joint trunnions or bearing-cup needles to dirt or grit. The smallest bits of dirt or grit can cause rapid wear and serious damage to the U-joint.

U-Joint Coupling

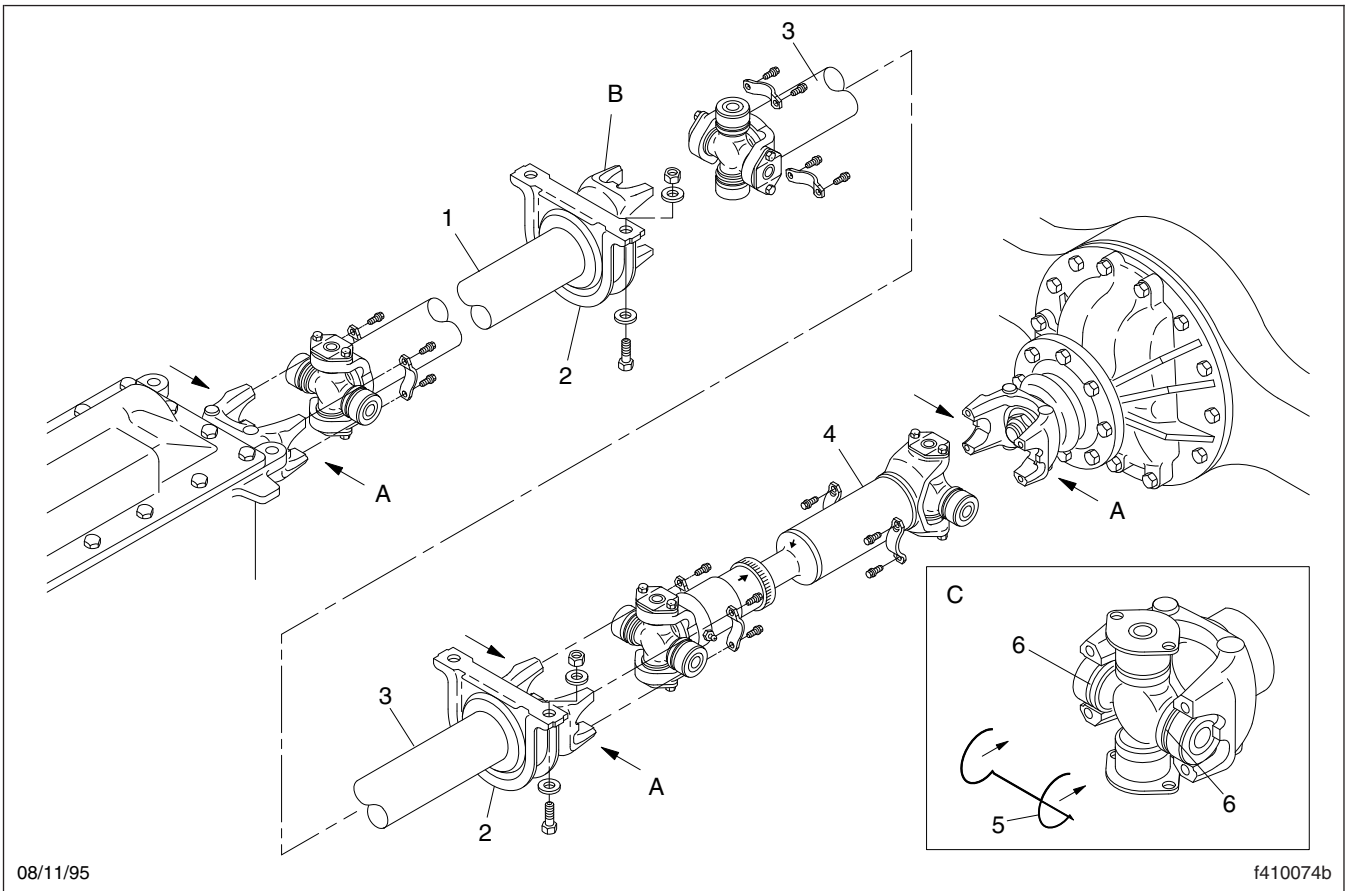
1. Check and clean the end-yoke.
   - 1.1 Check the torque on the end-yoke nut. See **Specifications 400**.
   - 1.2 Check the end-yoke cross-holes for burrs or raised metal. Using a half-round file, remove burrs or raised metal. See **Fig. 3**.
   - 1.3 Using fine emery cloth, smooth and clean the entire surface of the yoke cross-holes and bearing straps. See **Fig. 4**.
   - 1.4 Turn the end-yoke until its cross-holes are horizontal. See **Fig. 1** and **Fig. 2**.
2. Check, clean, and lubricate the U-joint.
   - 2.1 Remove the bearing-cup retaining wire or safety wire. See **Fig. 1**, Ref. C.

⚠ CAUTION

Do not expose the U-joint trunnions or bearing-cup needles to dirt or grit. The smallest bits of dirt or grit can cause rapid wear and serious damage to the U-joint.

   - 2.2 Using fine emery cloth, smooth and clean the outside surfaces of both bearing cups. See **Fig. 5**.
   - 2.3 Check the U-joint trunnions and bearing cups for minute particles of dirt or grit. Clean if necessary. See **Subject 140**.
   - 2.4 Using NLGI grade 2 grease with EP additives, wipe a small amount of grease on the needles in the bearing cups.
   - 2.5 Using a light-weight oil, lubricate the lips of the bearing-cup seals. See **Fig. 6**.
   - 2.6 Install the bearing cups on the cross.
   - 2.7 Install a bearing-cup retaining wire. See **Fig. 1**, Ref. C. Or, install safety wire from the retaining-wire groove of one half-round bearing cup to the other.
3. Extend the slip-joint, while pressing the cross and bearing cups into place in the yoke cross-

U-Joint Uncoupling and Coupling With a Half-Round End-Yoke



NOTE: Not all fasteners are shown.

A. End-yoke cross-hole centerline is horizontal.
B. Before uncoupling/coupling the U-joint, turn the end-yoke until its cross-hole centerline is horizontal.
C. Install a half-round bearing-cup retaining wire (or safety wire) before removing the bearing straps.

1. Primary Coupling Shaft
2. Midship Bearing
3. Intermediate Coupling Shaft
4. No. 2 Driveshaft
5. Half-Round Bearing-Cup Retaining Wire
6. Retaining-Wire Groove

Fig. 1, U-Joint Uncoupling/Coupling for Drivelines With Half-Round End-Yokes, Except RPL U-Joints

holes. Using a rubber or plastic mallet, gently tap the bearing cups to seat them in the yoke. See **Fig. 7**.

⚠ CAUTION

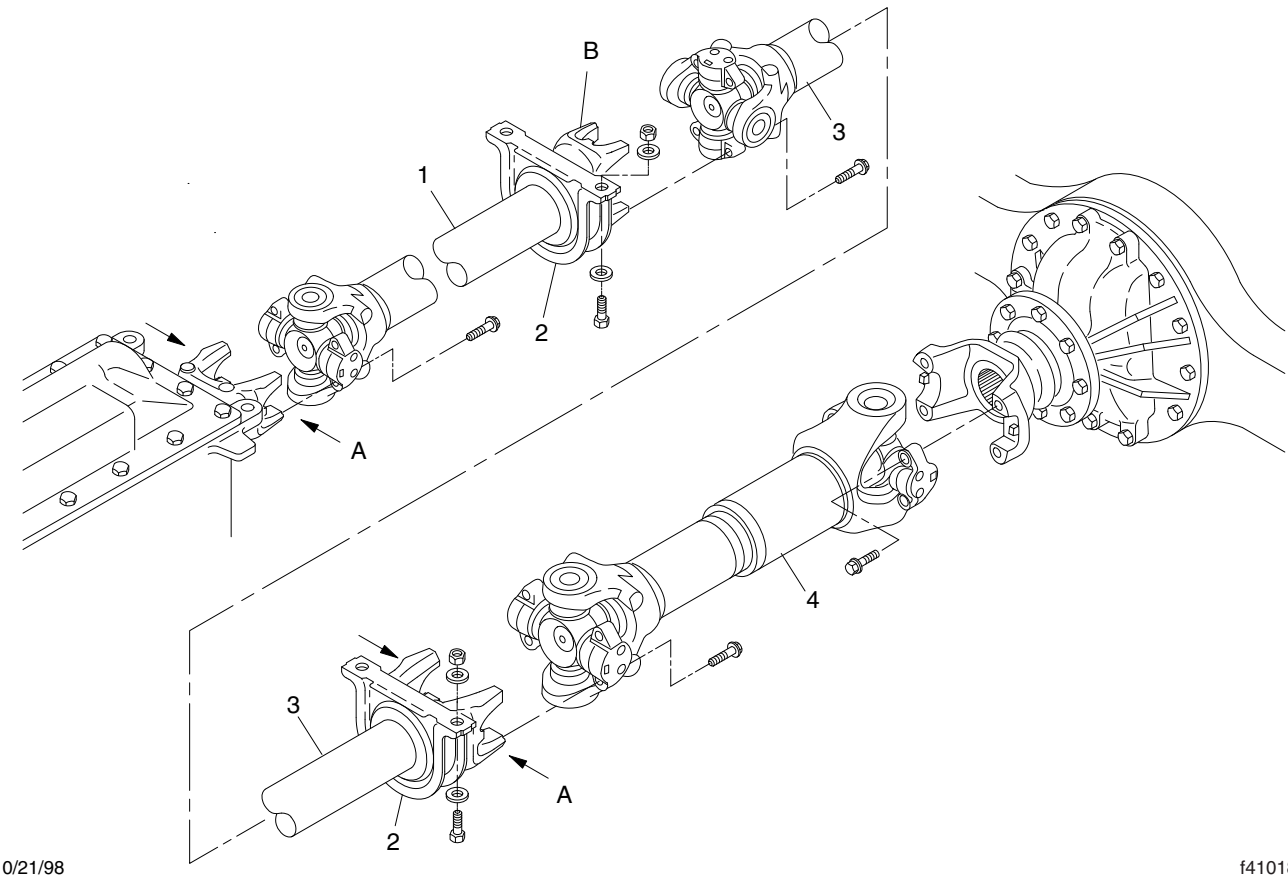
Do not use the capscrews and bearing straps (if equipped) to seat the bearing cups in the yoke. Seating the cross by tightening the bearing straps can deform the bearing straps, allowing the bearing cups to spin, which will cause rapid wear and serious damage to the U-joint.

4. Place the bearing straps (if equipped) over the cups. Install the capscrews, finger-tight.

⚠ WARNING

The self-locking capscrews must not be reused. Replace the capscrews with new ones. Also, do not undertighten or overtighten the capscrews. A loose or broken fastener at any point in the driveline weakens the driveline connection, which could cause serious vehicle damage, or could result in a driveshaft separating from the vehicle.

U-Joint Uncoupling and Coupling With a Half-Round End-Yoke



NOTE: Not all fasteners are shown.

A. End-yoke cross-hole centerline is horizontal.
B. Before uncoupling/coupling the U-joint, turn the end-yoke until its cross-hole centerline is horizontal.

1. Primary Coupling Shaft
2. Midship Bearing
3. Intermediate Coupling Shaft
4. No. 2 Driveshaft

Fig. 2, U-Joint Uncoupling/Coupling for Drivelines With Half-Round End-Yokes, RPL U-Joints

Driveline separation can cause loss of vehicle control that could result in serious personal injury or death.

Separation of the driveline can also cause damage to the driveline, driveline components, or other areas of the vehicle.

5. Alternately tighten the capscrews in increments of 20 lbf·ft (27 N·m) to the applicable torque value in **Specifications 400**.
6. If they were removed, install the fasteners that attach each midship bearing to its bracket; tighten the flanged locknuts 68 lbf·ft (92 N·m).
7. Lubricate the U-joint, following the procedure in Group 41 of the *Business Class M2 Maintenance Manual*.
8. Remove the nylon support straps, then remove the chocks.

U-Joint Uncoupling and Coupling With a Half-Round End-Yoke

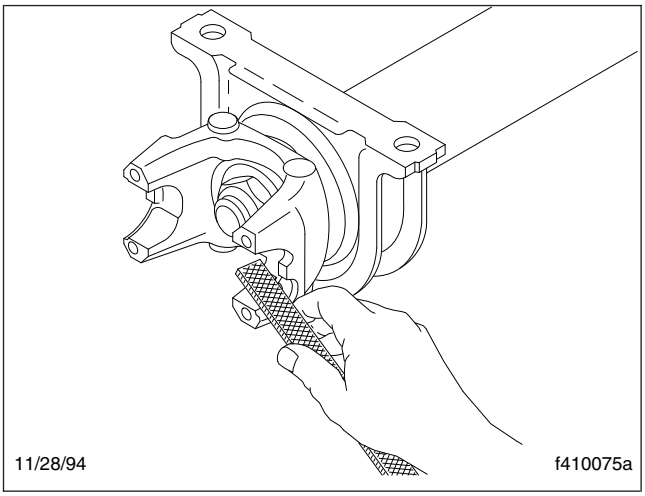
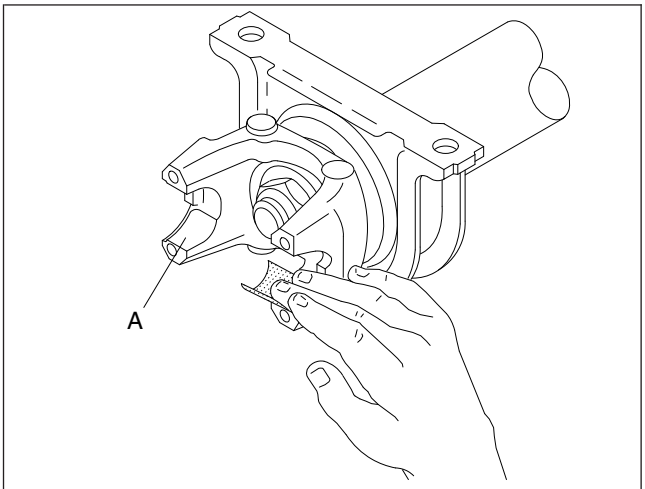
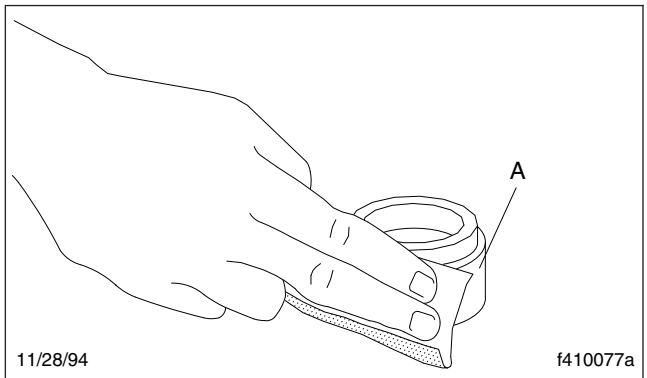


Fig. 3, Remove Burrs from a Half-Round End-Yoke Cross-Hole



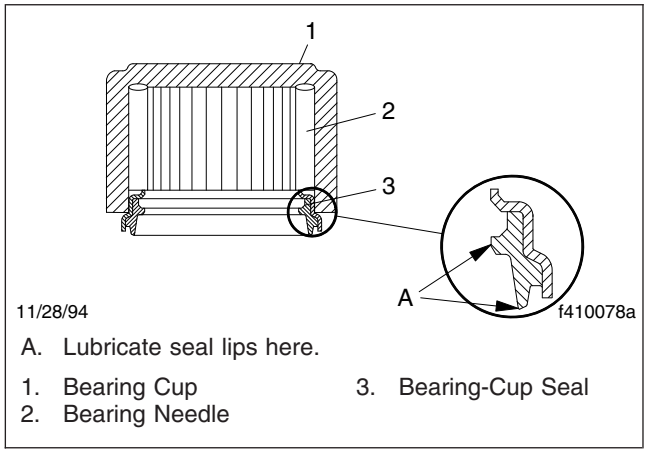
A. Use fine emery cloth on this surface.

Fig. 4, Smooth a Half-Round End-Yoke Cross-Hole



A. Use fine emery cloth on this surface.

Fig. 5, Smooth a Half-Round End-Yoke U-Joint Bearing Cup

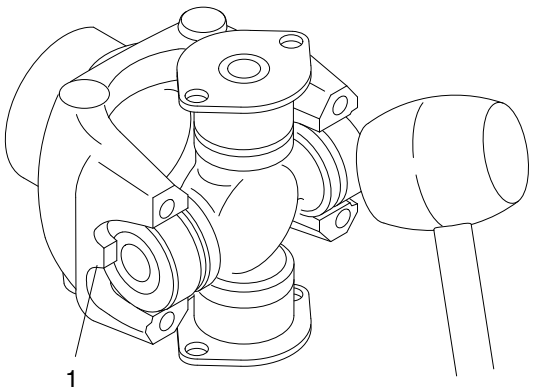


A. Lubricate seal lips here.

1. Bearing Cup
2. Bearing Needle
3. Bearing-Cup Seal

Fig. 6, Sectional View of a Half-Round End-Yoke U-Joint Bearing Cup

U-Joint Uncoupling and Coupling With a Half-Round End-Yoke



1. Retaining Tab

Fig. 7, Seat a U-Joint in a Half-Round End-Yoke

U-Joint Uncoupling and Coupling With a Full-Round End-Yoke

U-Joint Uncoupling

NOTE: It is easier to check driveline parts, and to replace a U-joint or midship bearing assembly if the driveshaft is removed from the vehicle. If a driveshaft requires straightening or balancing, it must be removed, and installed on a lathe or a balance machine. Removal is required for replacement of slip-joint parts, a driveshaft tube, or a tube-yoke. To remove the driveshaft, see **Subject 120**.

NOTE: Many service operations do not require driveshaft removal from the vehicle: end-yoke nut tightening; drive component shaft seal or end-yoke replacement; changing U-joint phasing at the slip-yoke; and transmission or axle removal (for overhaul, repair, or replacement). To perform these operations, uncouple the U-joint at the applicable end of the appropriate driveshaft.

1. Roll the vehicle forward or backward as needed to turn the end-yoke (of the driveline that is being uncoupled) until the centerline through its cross-holes is vertical. See **Fig. 1**.
2. Apply the parking brakes, and chock the tires.
3. Support the driveshaft with a nylon support strap.

   When uncoupling a coupling shaft, install two or three support straps, as needed. Remove the fasteners that attach the midship bearing(s) to its bracket(s).
4. Remove and discard all four bearing-cup-plate self-locking capscrews.
5. Using one of the U-joint pullers listed in **Specifications 400**, remove both bearing assemblies from the end-yoke cross-holes. See **Fig. 2**.
6. Compress the slip-joint and pivot the end of the U-joint cross to remove it from the yoke. Install the bearing cups on the U-joint cross, and secure them with tape.

CAUTION

Do not expose the U-joint trunnions or bearing-cup needles to dirt or grit. The smallest bits of dirt or grit can cause rapid wear and serious damage to the U-joint.

U-Joint Coupling

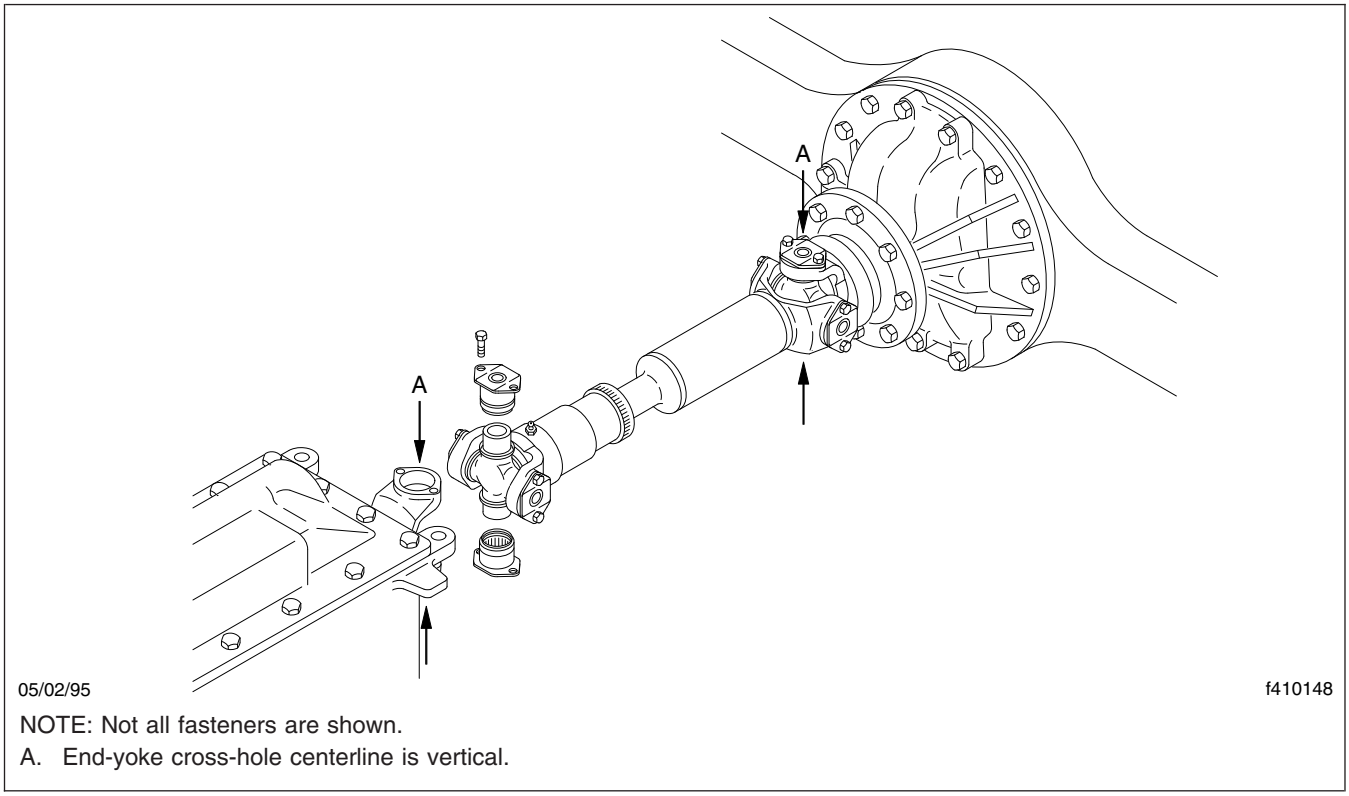
1. Check and clean the end-yoke.
   - 1.1 Check the torque on the end-yoke nut. See **Specifications 400**.
   - 1.2 Check the end-yoke cross-holes for burrs or raised metal. Using a rat-tail or half-round file, remove burrs or raised metal. See **Fig. 3**.
   - 1.3 Using a mill file, and holding it flat against the machined surface of the yoke lug, remove any burrs or raised metal. See **Fig. 4**.
   - 1.4 Using fine emery cloth, smooth and clean the entire surface of the yoke cross-holes. See **Fig. 5**.
   - 1.5 Turn the end-yoke until the centerline through its cross-holes is vertical. See **Fig. 1**.
2. Check, clean, and lubricate the U-joint.
   - 2.1 Using fine emery cloth, smooth and clean the outside surfaces of both bearing cups. See **Fig. 6**.
   - 2.2 Check the U-joint trunnions and bearing cups for minute particles of dirt or grit. Clean if necessary; see **Subject 140**.

CAUTION

Do not expose the U-joint trunnions or bearing-cup needles to dirt or grit. The smallest bits of dirt or grit can cause rapid wear and serious damage to the U-joint.

   - 2.3 Using NLGI grade 2 grease with EP additives, wipe a small amount of grease on the needles in the bearing cups.
   - 2.4 Using a light-weight oil, lubricate the lips of the bearing-cup seals. See **Fig. 7**.
3. Couple the U-joint cross to the end-yoke.
   - 3.1 Extend the slip-joint, while pivoting the U-joint cross into place in the yoke cross-holes.
   - 3.2 Move one end of the cross until a trunnion projects through the cross-hole, beyond the outer machined face of the yoke lug.

U-Joint Uncoupling and Coupling With a Full-Round End-Yoke



NOTE: Not all fasteners are shown.
A. End-yoke cross-hole centerline is vertical.

Fig. 1, U-Joint Uncoupling/Coupling of a Driveline With Full-Round End-Yokes

Using a Spicer trunnion (journal) locator (**Specifications 400**), hold the trunnions in alignment with the cross-holes, while placing a bearing assembly over the projected trunnion, and aligning it with the cross-hole. See **Fig. 8**.

IMPORTANT: A Spicer trunnion (journal) locator should be used, to prevent damage to the U-joint trunnions and slingers.

3.3 By hand, press the bearing assembly flush with the face of the yoke. If the bearing assembly binds in the cross-hole, tap the *center* of the bearing plate with a rubber or rawhide mallet; do not tap the outer edges of the bearing plate. See **Fig. 9**.

3.4 Install *new* bearing-cup-plate self-locking capscrews. See **Fig. 10**. Tighten the capscrews until all the parts are drawn down tight, with no gaps; do not tighten the capscrews to their final torque value.

⚠ WARNING

Self-locking bearing-cup-plate capscrews must not be reused; replace the capscrews with new ones. Also, do not undertighten or overtighten any bearing-cup-plate capscrews. A loose or broken fastener at any point in the driveline weakens the driveline connection, which could cause serious vehicle damage, or could result in a driveshaft separating from the vehicle, possibly causing loss of vehicle control that could result in serious personal injury or death.

3.5 Move the cross until it projects beyond the machined surface of the opposite yoke lug. Repeat applicable substeps to install the opposite bearing.

3.6 Alternately tighten the bearing-cup-plate capscrews in increments of 5 lbf·ft (7 N·m), to the torque value in **Specifications 400**.

U-Joint Uncoupling and Coupling With a Full-Round End-Yoke

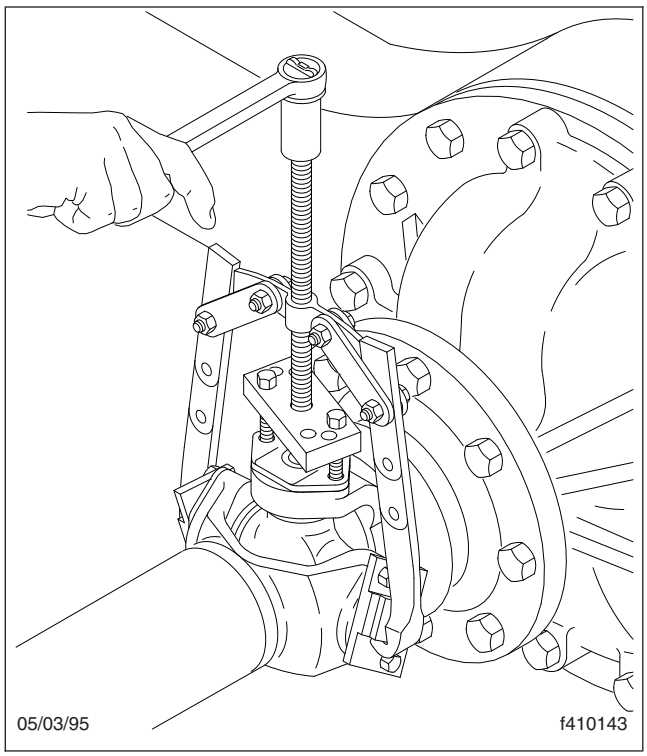


Fig. 2, Remove a Bearing Cup from a Full-Round End-Yoke

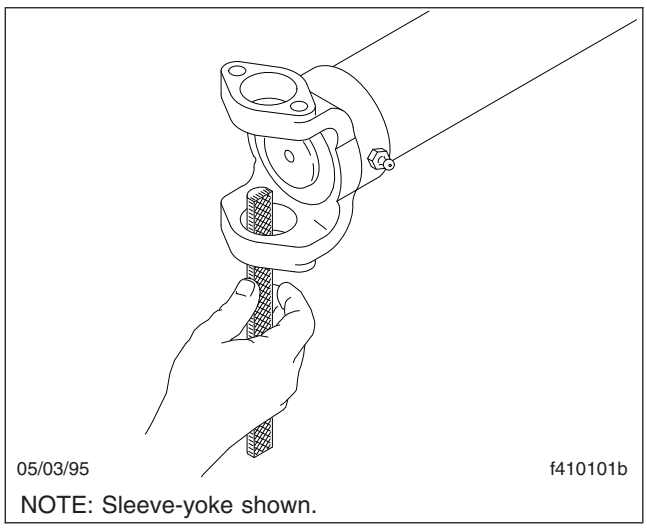


Fig. 3, Remove Burrs from a Full-Round Yoke Cross-Hole

4. If they were removed, install the fasteners that attach each midship bearing to its bracket; tighten the flanged locknuts 68 lbf·ft (92 N·m).

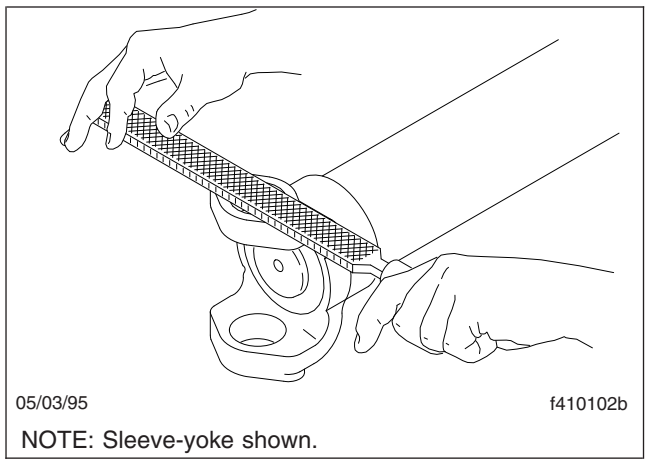


Fig. 4, Remove Burrs from the Machined Surface of a Full-Round Yoke Lug

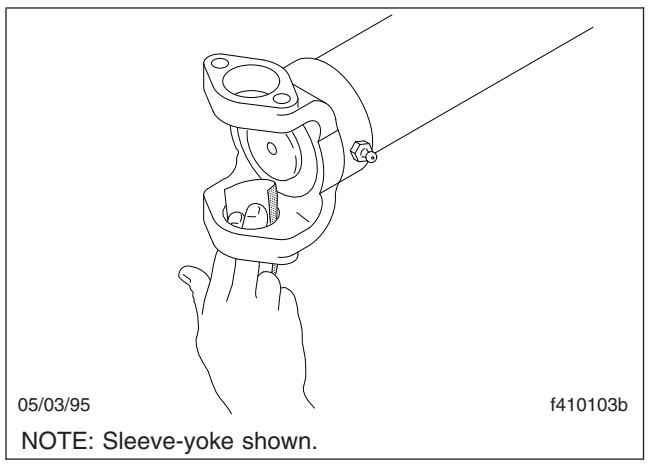
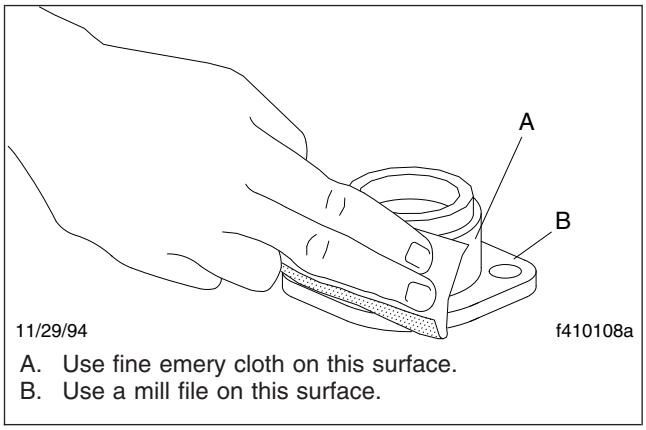


Fig. 5, Smooth a Full-Round Yoke Cross-Hole

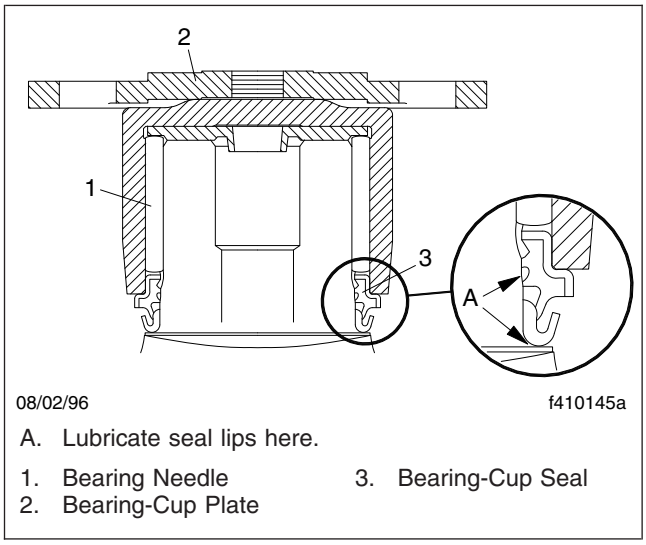
5. Lubricate the U-joint, following the procedure in Group 41 of the *Business Class M2 Maintenance Manual*.
6. Remove the nylon support straps, then remove the chocks.

U-Joint Uncoupling and Coupling With a Full-Round End-Yoke



A. Use fine emery cloth on this surface.
B. Use a mill file on this surface.

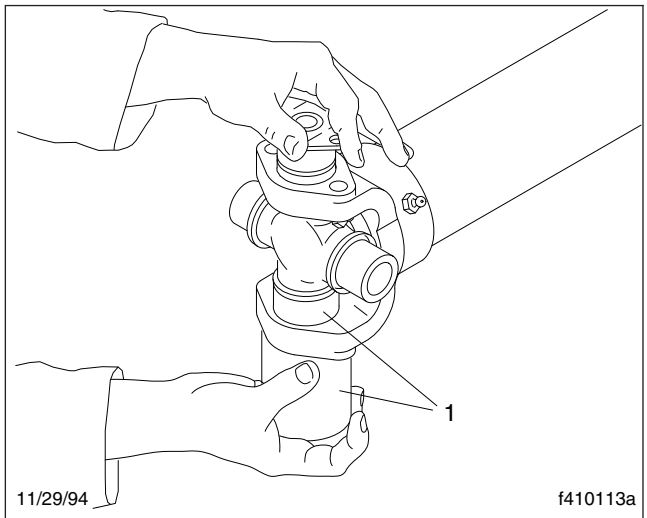
Fig. 6, Smoothing a Full-Round Yoke U-Joint Bearing Cup



A. Lubricate seal lips here.

1. Bearing Needle
2. Bearing-Cup Plate
3. Bearing-Cup Seal

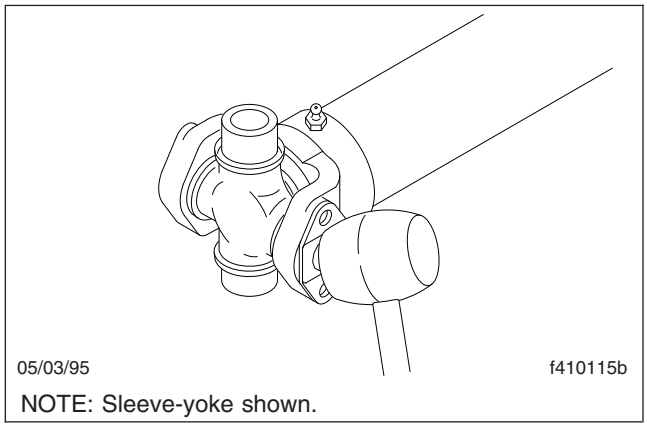
Fig. 7, Sectional View of a Full-Round Yoke U-Joint Bearing Cup



NOTE: Sleeve-yoke shown.

1. Trunnion Locator

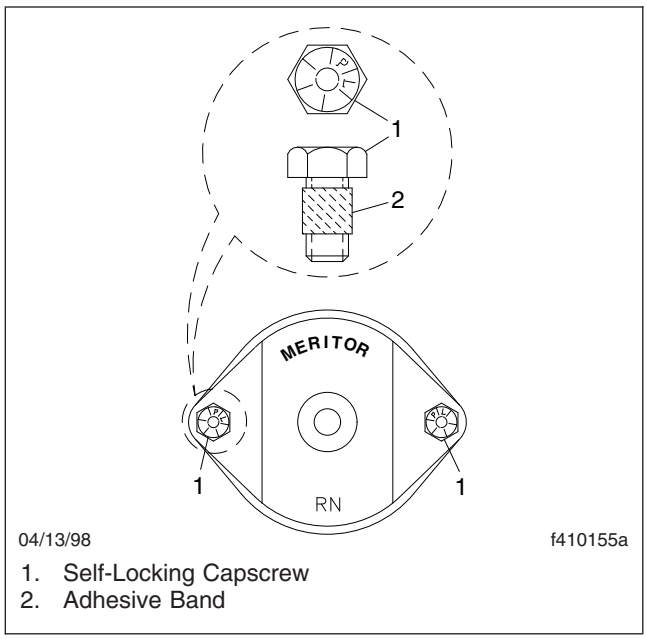
Fig. 8, Use a U-Joint Trunnion Locator



NOTE: Sleeve-yoke shown.

Fig. 9, Seat a U-Joint Bearing Cup in a Full-Round Yoke

U-Joint Uncoupling and Coupling With a Full-Round End-Yoke



1. Self-Locking Capscrew
2. Adhesive Band

Fig. 10, Meritor U-Joint Fasteners for Full-Round Yokes

NOTE: Many service operations do not require driveshaft removal from the vehicle: end-yoke nut tightening; drive component shaft seal or end-yoke replacement; changing U-joint phasing at the slip-yoke; and transmission or axle removal (for overhaul, repair, or replacement). To perform these operations, uncouple the U-joint at the applicable end of the appropriate driveshaft. See **Subject 100** for uncoupling from a *half-round* end-yoke, or see **Subject 110** for uncoupling from a *full-round* end-yoke.

NOTE: It is easier to check driveline parts, and to replace a U-joint or midship bearing assembly if the driveshaft is removed from the vehicle. If a driveshaft requires straightening or balancing, it must be removed, and installed on a lathe or balance machine. Removal is required for replacement of slip-joint parts, a driveshaft tube, or a tube-yoke.

No. 3 Driveshaft Removal

1. Uncouple the No. 3 driveshaft from the rearmost axle. See **Fig. 1** and **Fig. 2**. If the No. 3 driveshaft is coupled to *half-round* end-yokes, follow the uncoupling procedure in **Subject 100**. If the No. 3 driveshaft is coupled to *full-round* end-yokes, follow the uncoupling procedure in **Subject 110**.
2. Uncouple the No. 3 driveshaft from the forward-rear axle. See **Fig. 1** and **Fig. 2**. If the No. 3 driveshaft is coupled to half-round end-yokes, follow the uncoupling procedure in **Subject 100**. If the No. 3 driveshaft is coupled to full-round end-yokes, follow the uncoupling procedure in **Subject 110**.
3. Lift the No. 3 driveshaft out of the chassis.

No. 2 Driveshaft Removal

1. Uncouple the No. 2 driveshaft from the single or forward-rear axle. See **Fig. 3** and **Fig. 4**. If the No. 2 driveshaft is coupled to *half-round* end-yokes, follow the uncoupling procedure in **Subject 100**. If the No. 2 driveshaft is coupled to *full-round* end-yokes, follow the uncoupling procedure in **Subject 110**.
2. Uncouple the No. 2 driveshaft from the transmission or coupling shaft. See **Fig. 3** and **Fig. 4**. If the No. 2 driveshaft is coupled to half-round end-yokes, follow the uncoupling procedure in **Subject 100**. If the No. 2 driveshaft is coupled to full-round end-yokes, follow the uncoupling procedure in **Subject 110**.
3. Lift the No. 2 driveshaft out of the chassis.

Intermediate Coupling Shaft Removal

1. If the No. 2 driveshaft is also being removed, remove it first.

   If the No. 2 driveshaft is not being removed, use a nylon support strap to support its forward end.
2. Uncouple the intermediate coupling shaft from the No. 2 driveshaft. If the intermediate coupling shaft has a *half-round* end-yoke, follow the uncoupling procedure in **Subject 100**. If the intermediate coupling shaft has a *full-round* end-yoke, follow the uncoupling procedure in **Subject 110**.
3. Uncouple the intermediate coupling shaft from the primary coupling shaft. See **Fig. 5** and **Fig. 6**. If the primary coupling shaft has a half-round end-yoke, follow the uncoupling procedure in **Subject 100**. If the primary coupling shaft has a full-round end-yoke, follow the uncoupling procedure in **Subject 110**.
4. Lift the intermediate coupling shaft out of the chassis.

Primary Coupling Shaft Removal

1. *For a vehicle with one coupling shaft:*

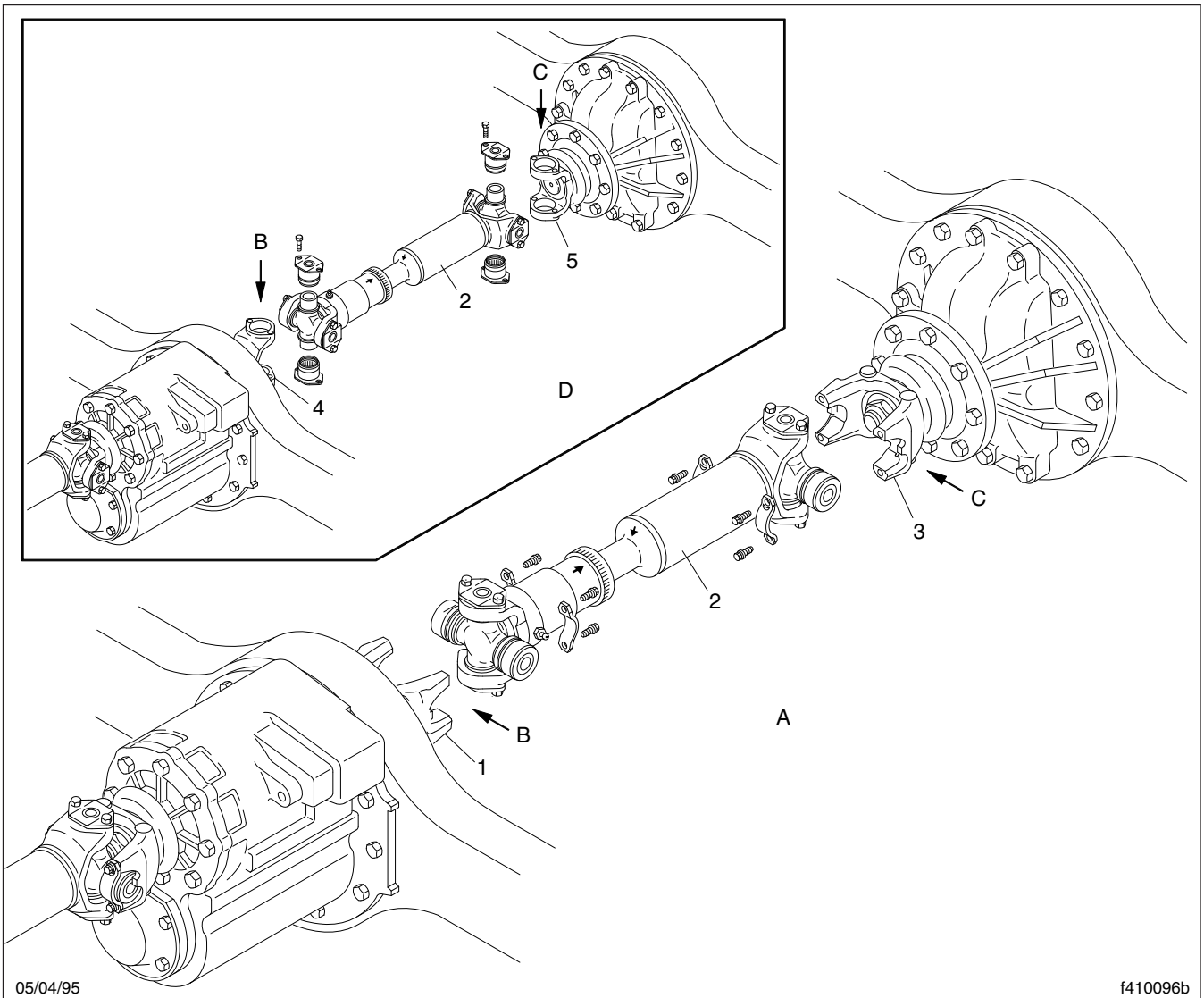
   If the No. 2 driveshaft is also being removed, remove it first.

   If the No. 2 driveshaft is not being removed, use a nylon support strap to support its forward end.

   For a vehicle with two coupling shafts:

   If the No. 2 driveshaft is also being removed, remove it first; then, remove the intermediate coupling shaft.

Driveshaft Removal and Installation



NOTE: Not all fasteners are shown.

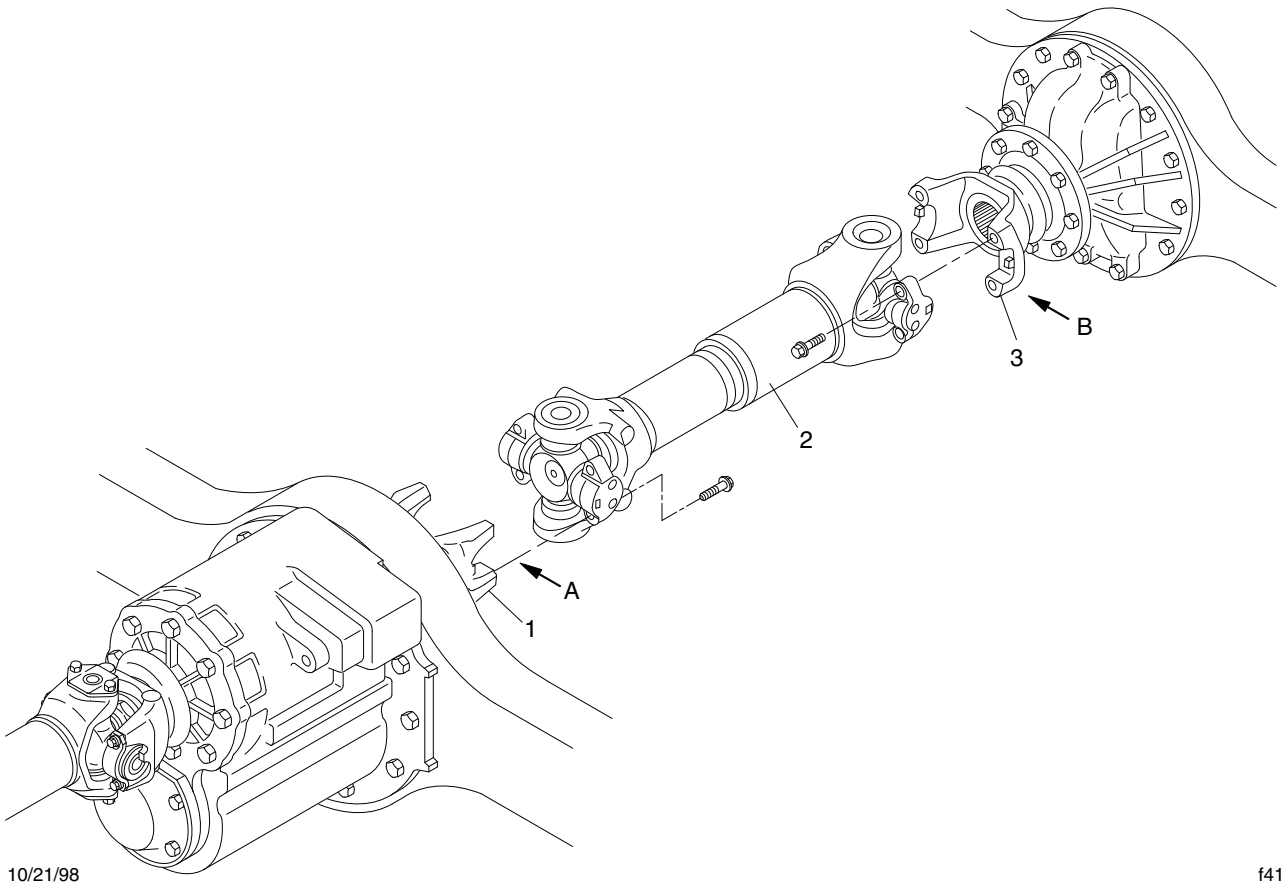
A. No. 3 Driveshaft Coupled to Half-Round End-Yokes
B. Uncouple this end last; couple this end first.
C. Uncouple this end first; couple this end last.
D. No. 3 Driveshaft Coupled to Full-Round End-Yokes

1. Forward-Rear Axle Output-Shaft Half-Round End-Yoke
2. No. 3 Driveshaft
3. Rearmost Axle Input-Shaft Half-Round End-yoke
4. Forward-Rear Axle Output-Shaft Full-Round End-Yoke
5. Rearmost Axle Input-Shaft Full-Round End-yoke

Fig. 1, Removal/Installation of a No. 3 Driveshaft Without RPL U-Joints

If the intermediate coupling shaft is also being removed (but not the No. 2 driveshaft), remove the intermediate coupling shaft first.

If only the primary coupling shaft is being removed, use nylon support straps to support the forward end of the No. 2 driveshaft and both ends of the intermediate coupling shaft. Then,



NOTE: Not all fasteners are shown.

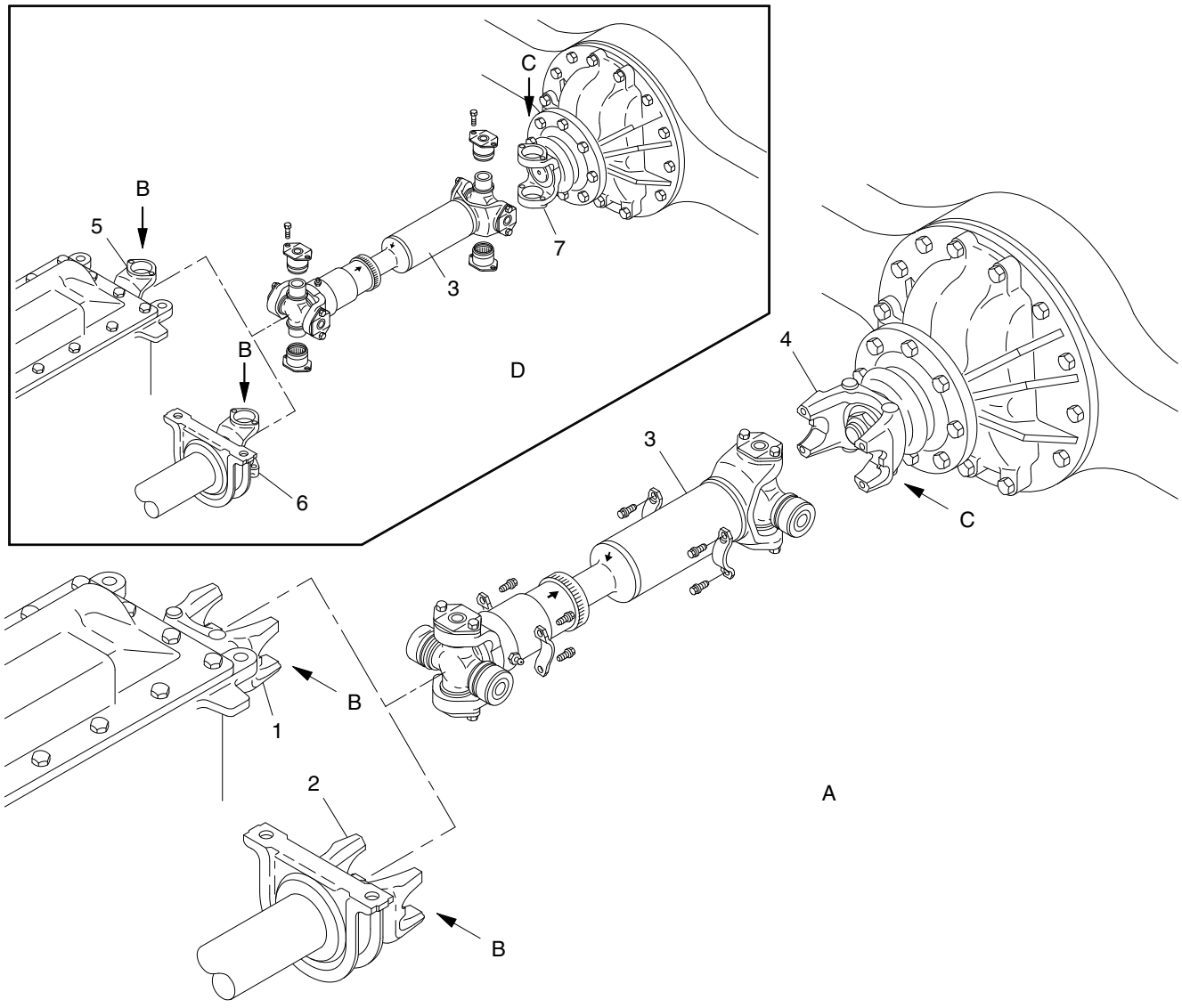
A. Uncouple this end last; couple this end first.
B. Uncouple this end first; couple this end last.
1. Forward-Rear Axle Output-Shaft Half-Round End-Yoke
2. No. 3 Driveshaft
3. Rearmost Axle Input-Shaft Half-Round End-Yoke

Fig. 2, Removal/Installation of a No. 3 Driveshaft With RPL U-Joints

remove the fasteners that attach the intermediate coupling shaft midship bearing to its bracket. See **Fig. 7** and **Fig. 8**.

2. If not already done, uncouple the primary coupling shaft from the No. 2 driveshaft or intermediate coupling shaft. If the primary coupling shaft has a *half-round* end-yoke, follow the uncoupling procedure in **Subject 100**. If the primary coupling shaft has a *full-round* end-yoke, follow the uncoupling procedure in **Subject 110**.
3. Using two nylon support straps, support the primary coupling shaft. Then remove the fasteners that attach the primary coupling shaft midship bearing to its bracket. See **Fig. 7** and **Fig. 8**.
4. Uncouple the primary coupling shaft from the transmission. If the primary coupling shaft is coupled to a half-round end-yoke, follow the uncoupling procedure in **Subject 100**. If the primary coupling shaft is coupled to a full-round end-yoke, follow the uncoupling procedure in **Subject 110**.
5. Lift the primary coupling shaft out of the chassis.

Driveshaft Removal and Installation



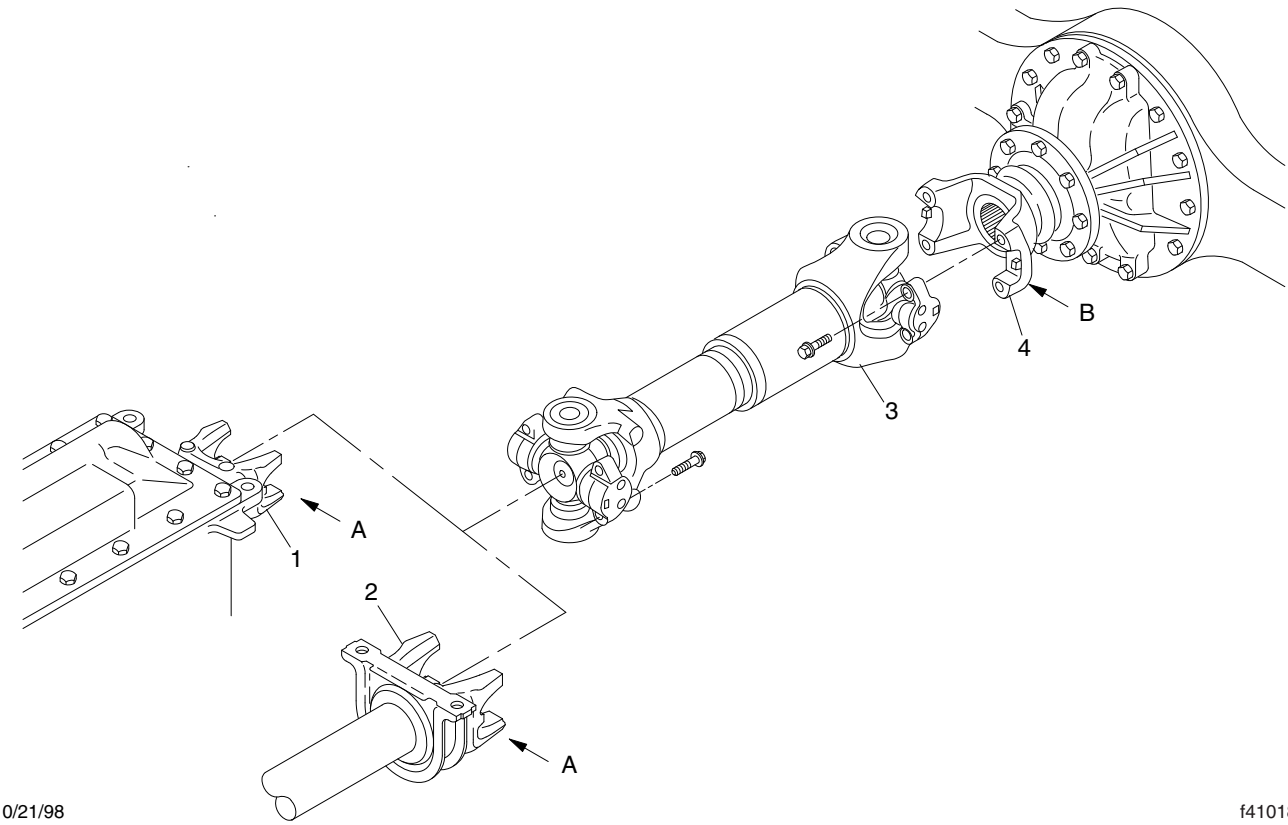
05/05/95 f410080b

NOTE: Not all fasteners are shown.

A. No. 2 Driveshaft Coupled to Half-Round End-Yokes
B. Uncouple this end last; couple this end first.
C. Uncouple this end first; couple this end last.
D. No. 2 Driveshaft Coupled to Full-Round End-Yokes

1. Transmission Output-Shaft Half-Round End-Yoke
2. Coupling Shaft Half-Round End-Yoke
3. No. 2 Driveshaft
4. Single Axle or Forward-Rear Axle Input-Shaft Half-Round End-Yoke
5. Transmission Output-Shaft Full-Round End-Yoke
6. Coupling Shaft Full-Round End-Yoke
7. Single Axle or Forward-Rear Axle Input-Shaft Full-Round End-Yoke

Fig. 3, Removal/Installation of a No. 2 Driveshaft Without RPL U-Joints



NOTE: Not all fasteners are shown.

A. Uncouple this end last; couple this end first.

B. Uncouple this end first; couple this end last.

1. Transmission Output-Shaft Half-Round End-Yoke
2. Coupling Shaft Half-Round End-Yoke
3. No. 2 Driveshaft
4. Single Axle or Forward-Rear Axle Input-Shaft Half-Round End-Yoke

Fig. 4, Removal/Installation of a No. 2 Driveshaft With RPL U-Joints

Primary Coupling Shaft Installation

IMPORTANT: Before installing a coupling shaft, make sure the yokes are aligned to keep the U-joints in phase. See **Fig. 9**.

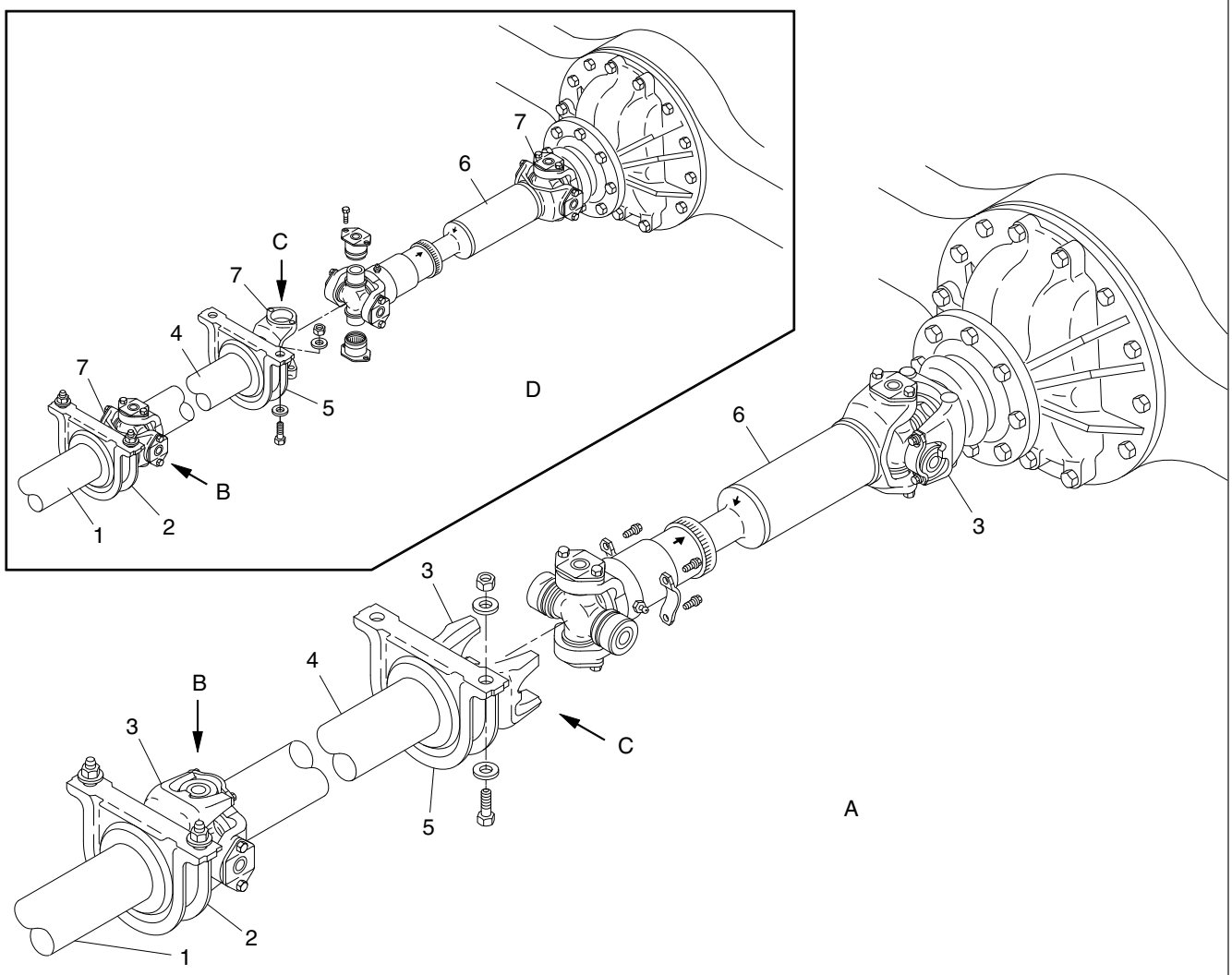
1. Place the primary coupling shaft under the vehicle and support it with nylon support straps so it can be coupled to the transmission end-yoke.
2. Couple the shaft to the transmission end-yoke. If the primary coupling shaft was coupled to a *half-round* end-yoke, follow the coupling procedure in **Subject 100**. If the primary coupling shaft was coupled to a *full-round* end-yoke, follow the coupling procedure in **Subject 110**.
3. *For a vehicle with one coupling shaft:*

   If the No. 2 driveshaft was also removed, install it, as instructed in this subject.

   If the No. 2 driveshaft was not removed, couple it to the primary coupling shaft end-yoke. If the primary coupling shaft has a half-round end-yoke, follow the coupling procedure in **Subject 100**. If the primary coupling shaft has a full-round end-yoke, follow the coupling procedure in **Subject 110**.

   For a vehicle with two coupling shafts:

Driveshaft Removal and Installation



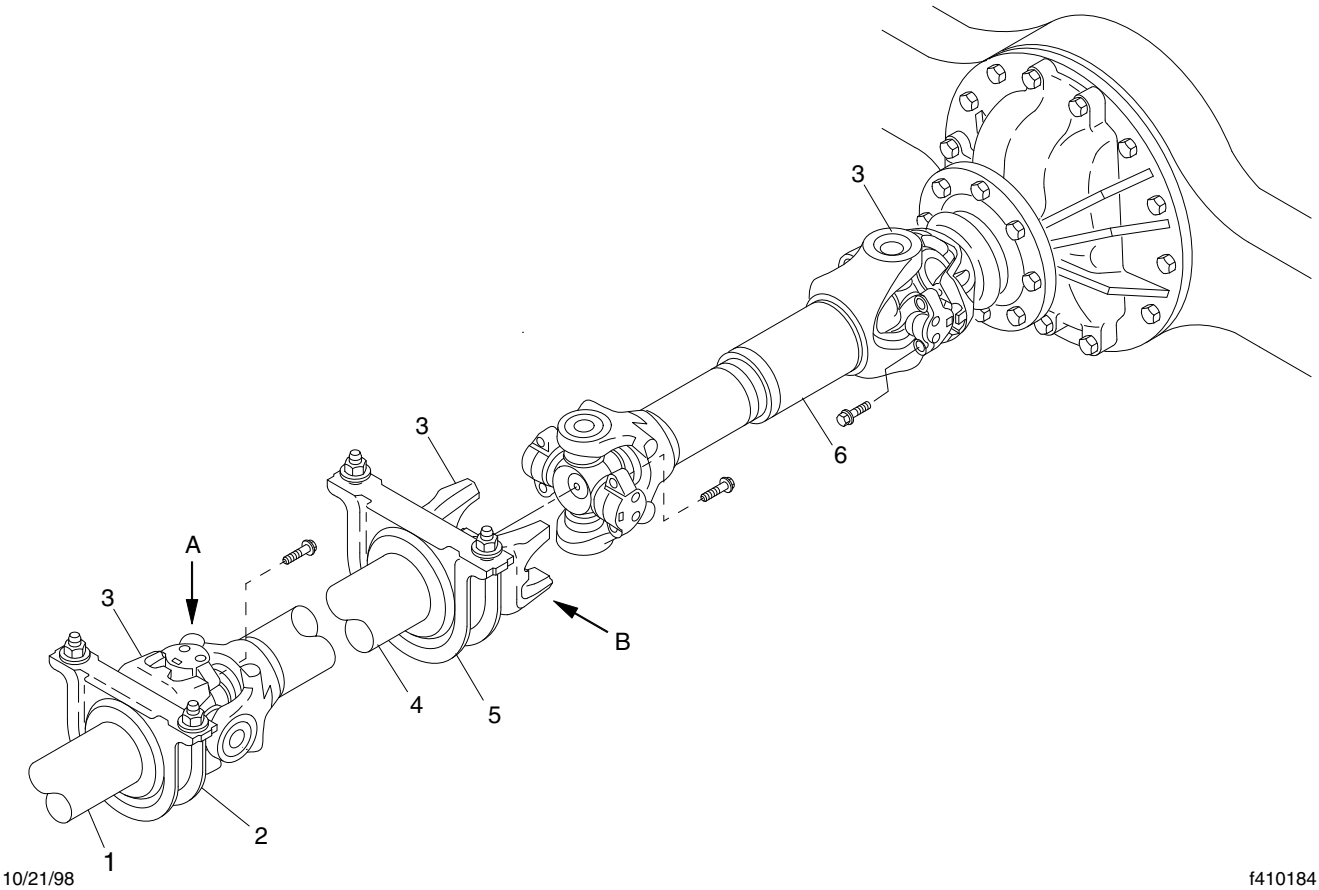
05/04/95 f410084b

NOTE: Not all fasteners are shown.

A. No. 2 Driveline With Half-Round End-Yokes
B. Uncouple this end last; couple this end first.
C. Uncouple this end first; couple this end last.
D. No. 2 Driveline With Full-Round End-Yokes

1. Primary Coupling Shaft
2. Primary Coupling Shaft Midship Bearing
3. Half-Round End-Yoke
4. Intermediate Coupling Shaft
5. Intermediate Coupling Shaft Midship Bearing
6. No. 2 Driveshaft
7. Full-Round End-Yoke

Fig. 5, Removal/Installation of an Intermediate Coupling Shaft Without RPL U-Joints



NOTE: Not all fasteners are shown.

A. Uncouple this end last; couple this end first.
B. Uncouple this end first; couple this end last.

1. Primary Coupling Shaft
2. Primary Coupling Shaft Midship Bearing
3. Half-Round End-Yoke
4. Intermediate Coupling Shaft
5. Intermediate Coupling Shaft Midship Bearing
6. No. 2 Driveshaft

Fig. 6, Removal/Installation of an Intermediate Coupling Shaft With RPL U-Joints

If the intermediate coupling shaft was also removed, install it, as instructed in this subject.

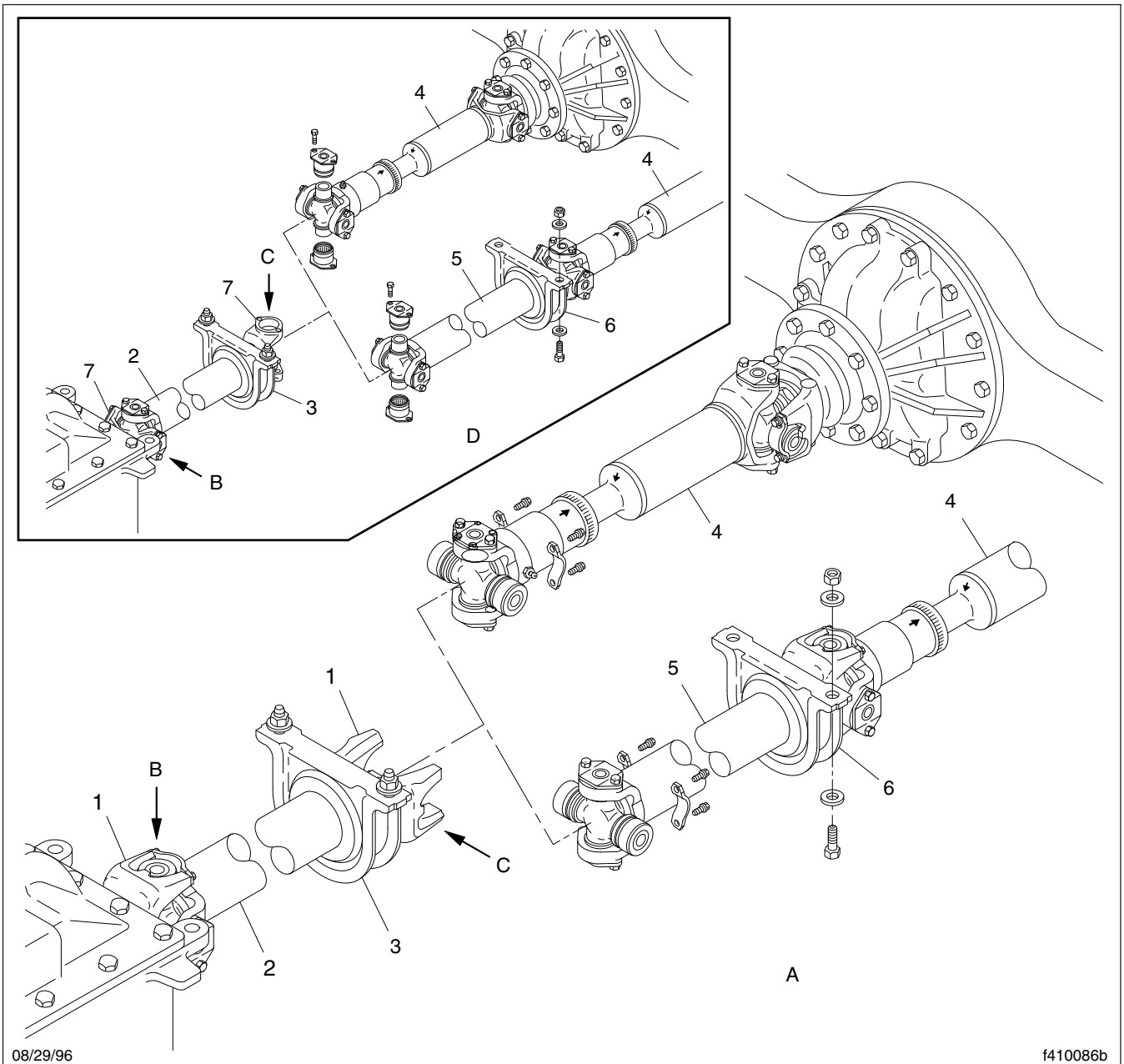
If only the primary coupling shaft was removed, couple the intermediate coupling shaft to the primary coupling shaft end-yoke. If the primary coupling shaft has a half-round end-yoke, follow the coupling procedure in **Subject 100**. If the primary coupling shaft has a full-round end-yoke, follow the coupling procedure in **Subject 110**.

Intermediate Coupling Shaft Installation

IMPORTANT: Before installing a coupling shaft, make sure the yokes are aligned to keep the U-joints in phase. See **Fig. 9**.

1. If the primary coupling shaft was also removed, install it first, as instructed in this subject.
2. Place the intermediate coupling shaft under the vehicle and support it with nylon support straps

Driveshaft Removal and Installation

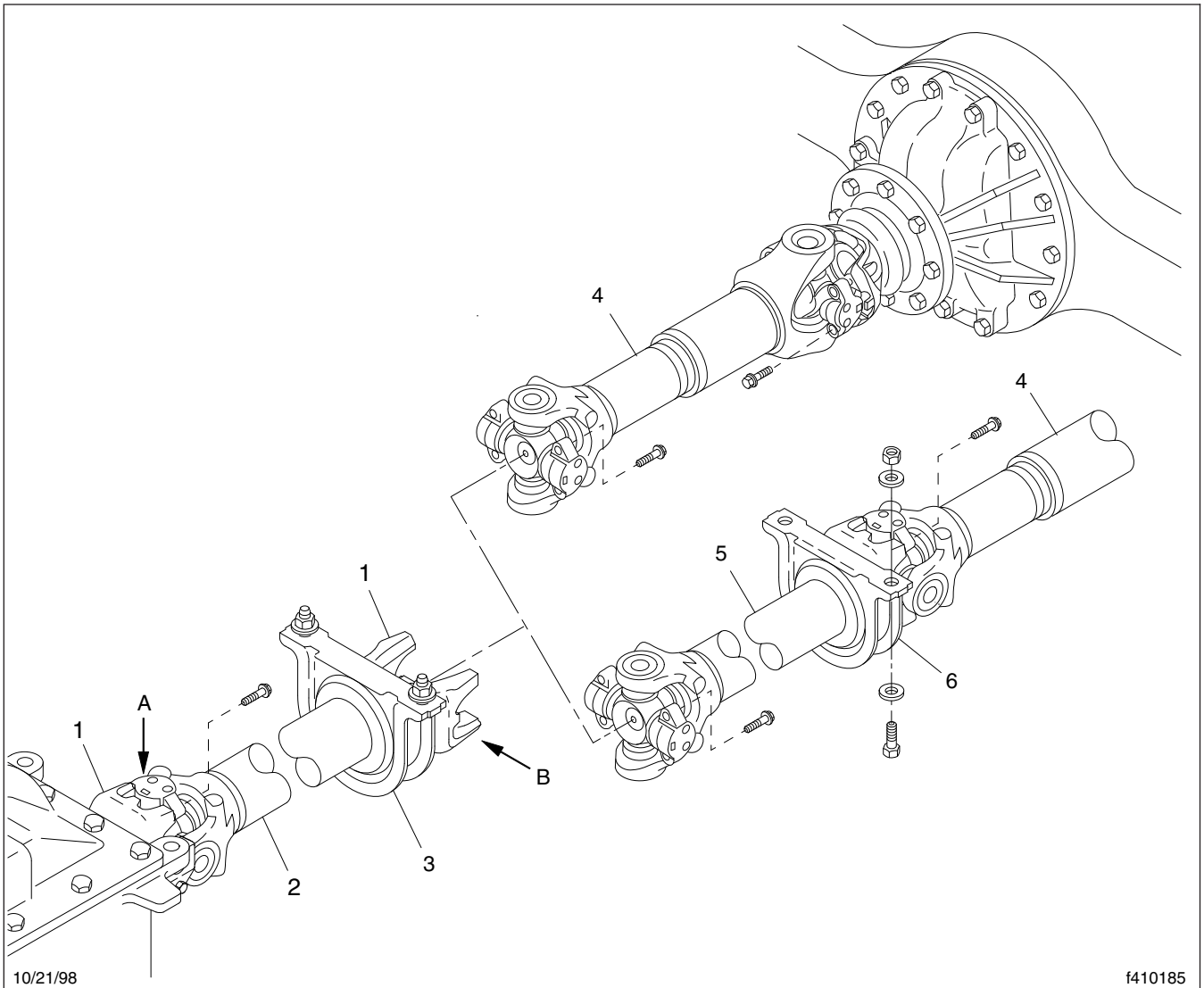


NOTE: Not all fasteners are shown.

A. No. 2 Driveline With Half-Round End-Yokes
B. Uncouple this end last; couple this end first.
C. Uncouple this end first; couple this end last.
D. No. 2 Driveline With Full-Round End-Yokes

1. Half-Round End-Yoke
2. Primary Coupling Shaft
3. Primary Coupling Shaft Midship Bearing
4. No. 2 Driveshaft
5. Intermediate Coupling Shaft
6. Intermediate Coupling Shaft Midship Bearing
7. Full-Round End-Yoke

Fig. 7, Removal/Installation of a Primary Coupling Shaft Without RPL U-Joints



NOTE: Not all fasteners are shown.

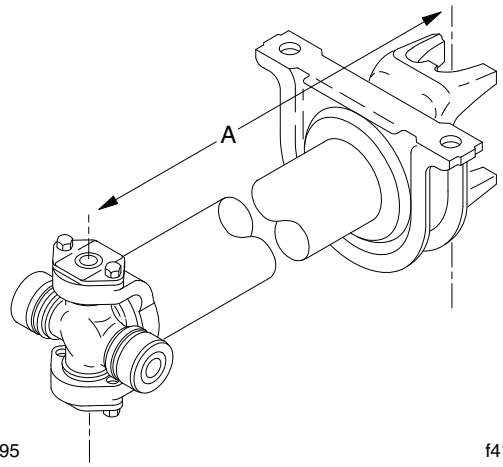
A. Uncouple this end last; couple this end first.
B. Uncouple this end first; couple this end last.
1. Half-Round End-Yoke
2. Primary Coupling Shaft
3. Primary Coupling Shaft Midship Bearing
4. No. 2 Driveshaft
5. Intermediate Coupling Shaft
6. Intermediate Coupling Shaft Midship Bearing

Fig. 8, Removal/Installation of a Primary Coupling Shaft With RPL U-Joints

so it can be coupled to the primary coupling shaft end-yoke.

3. Couple the intermediate coupling shaft to the primary coupling shaft end-yoke. If the intermediate coupling shaft was coupled to a *half-round* end-yoke, follow the coupling procedure in **Subject 100**. If the intermediate coupling shaft was coupled to a *full-round* end-yoke, follow the coupling procedure in **Subject 110**.
4. If the No. 2 driveshaft was also removed, install it, as instructed in this subject.

Driveshaft Removal and Installation



A. Cross-hole centerlines of both yokes must be in alignment.

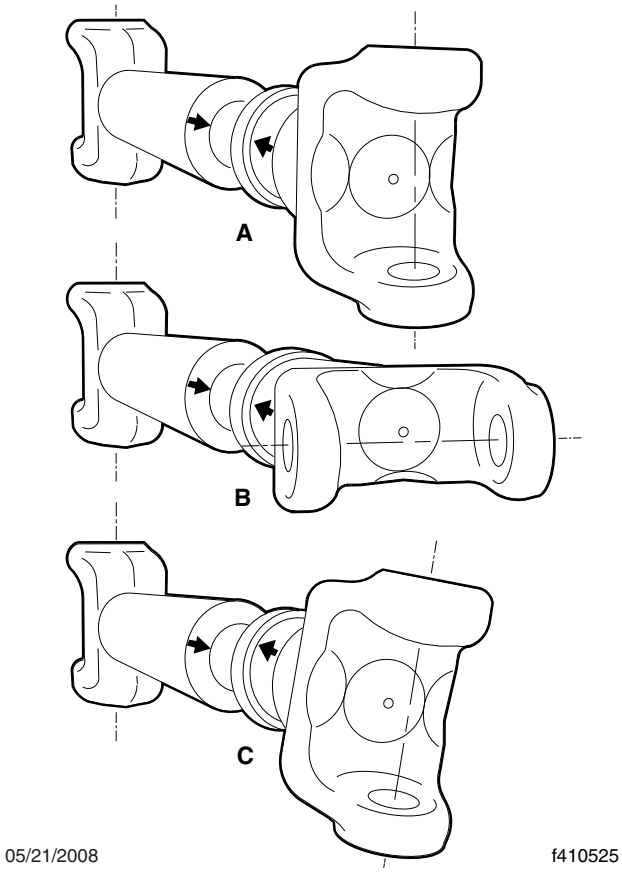
Fig. 9, U-Joint Phasing of a Coupling Shaft

If the No. 2 driveshaft was not removed, couple it to the intermediate coupling shaft end-yoke. If the intermediate coupling shaft has a half-round end-yoke, follow the coupling procedure in **Subject 100**. If the intermediate coupling shaft has a full-round end-yoke, follow the coupling procedure in **Subject 110**.

No. 2 Driveshaft Installation

IMPORTANT: Before installing a No. 2 driveshaft, make sure the alignment marks on the slip-joint assembly are aligned, to keep the U-joints in phase; see **Fig. 10**.

1. If a primary coupling shaft was also removed, install it first, as instructed in this subject.
2. If an intermediate coupling shaft was also removed, install it before installing the No. 2 driveshaft.
3. Place the No. 2 driveshaft under the vehicle with its sleeve-yoke at the forward end, and support its rear end with a nylon support strap.
4. Couple the sleeve-yoke to the coupling shaft end-yoke or transmission output-shaft end-yoke, as applicable. If the No. 2 driveshaft was coupled to *half-round* end-yokes, follow the coupling procedure in **Subject 100**. If the No. 2 driveshaft was coupled to *full-round* end-yokes, follow the coupling procedure in **Subject 110**.
5. Couple the No. 2 driveshaft to the axle input-shaft end-yoke. If the No. 2 driveshaft was coupled to half-round end-yokes, follow the coupling procedure in **Subject 100**. If the No. 2 driveshaft was coupled to full-round end-yokes, follow the coupling procedure in **Subject 110**.



A. In Phase (parallel phased)
B. In Phase (cross phased)
C. Out of Phase

Fig. 10, U-Joint Phasing

No. 3 Driveshaft Installation

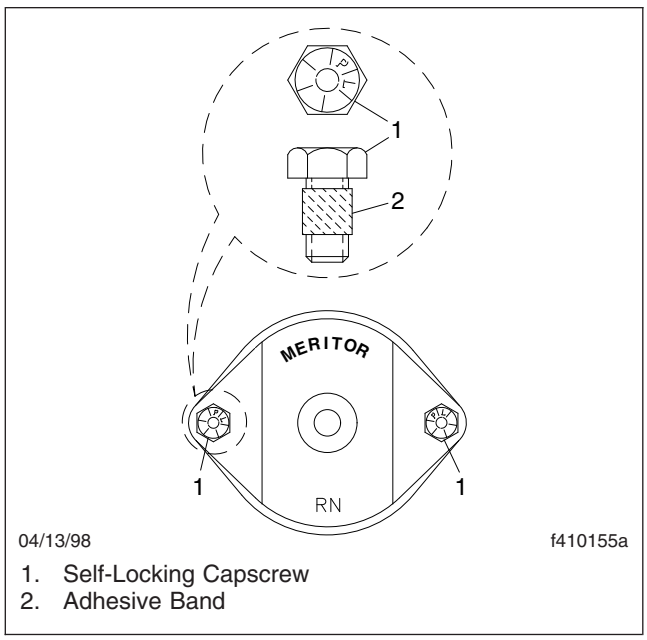
IMPORTANT: Before installing a No. 3 driveshaft, make sure the alignment marks on the slip-joint assembly are aligned, to keep the U-joints in phase; see **Fig. 10**.

1. Place the No. 3 driveshaft under the vehicle with its sleeve-yoke at the forward end, and support its rear end with a nylon support strap.
2. Couple the sleeve-yoke to the forward-rear axle output-shaft end-yoke. If the No. 3 driveshaft was coupled to *half-round* end-yokes, follow the coupling procedure in **Subject 100**. If the No. 3 driveshaft was coupled to *full-round* end-yokes, follow the coupling procedure in **Subject 110**.
3. Couple the No. 3 driveshaft to the axle input-shaft end-yoke. If the No. 3 driveshaft was coupled to half-round end-yokes, follow the coupling procedure in **Subject 100**. If the No. 3 driveshaft was coupled to full-round end-yokes, follow the coupling procedure in **Subject 110**.

U-Joint Removal

Full-Round Yokes

1. Remove the driveshaft from the vehicle. See **Subject 120**.
2. Place the driveshaft in V-blocks or a soft-jawed vise; do not distort the tube with excessive grip.
3. Remove and discard all four bearing-plate self-locking capscrews. See **Fig. 1**.



1. Self-Locking Capscrew
2. Adhesive Band

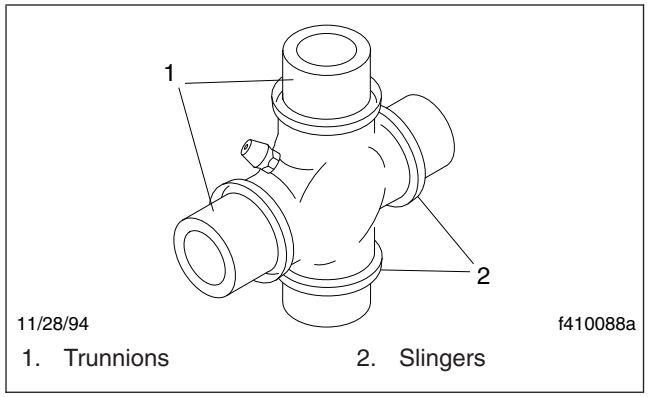
Fig. 1, Meritor U-Joint Fasteners for Full-Round Yokes

IMPORTANT: If the U-joint will be reinstalled, use care not to nick the cross trunnions or damage the slingers. See **Fig. 2**.

4. Using one of the U-joint pullers listed in **Specifications, 400**, remove both bearing cups from the yoke cross-holes. See **Fig. 3**. Remove the cross from the yoke.

RPL Series U-Joint

NOTE: Do not reuse RPL U-joints. Always replace an RPL U-joint with a new one after they have been disassembled and removed from a driveshaft.



1. Trunnions
2. Slingers

Fig. 2, U-Joint Cross

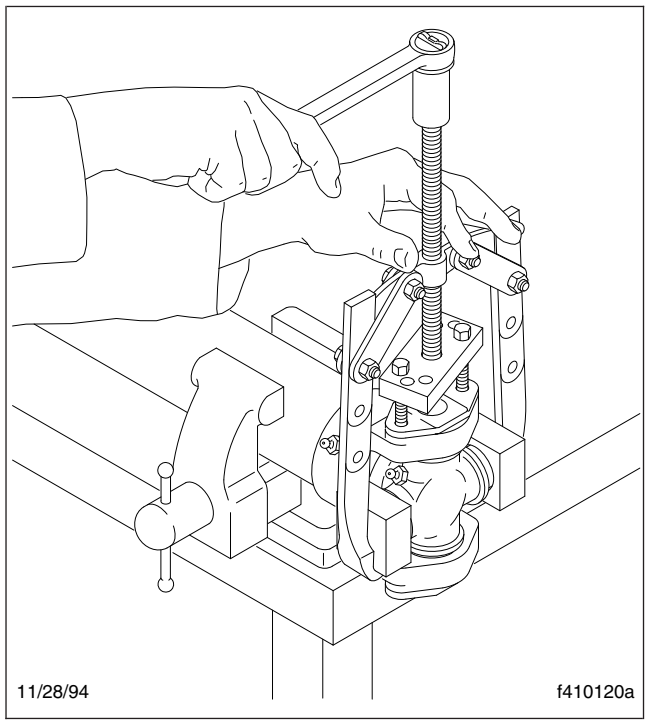
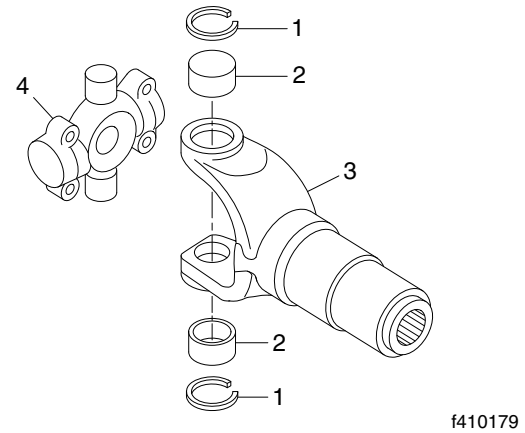


Fig. 3, Removing a Bearing Cup from a Full-Round Yoke

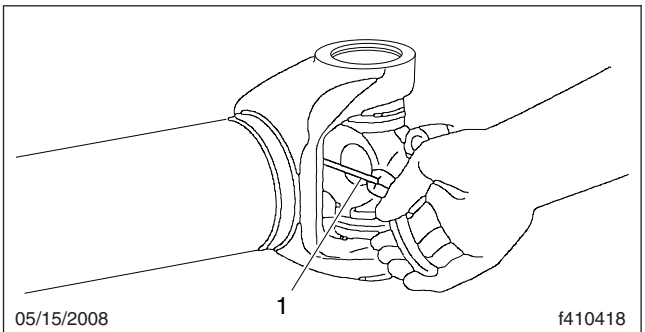
1. Remove the driveshaft from the vehicle. See **Subject 120**.
2. Place the driveshaft in V-blocks or a soft-jawed vise; do not distort the tube with excessive grip.
3. Remove and discard the snap rings. See **Fig. 4**.
4. Cut the weld strap that retains the bearing cups. See **Fig. 5**. Remove both bearing cups. See **Fig. 6**.

Driveline Component Removal/Disassembly



1. Snap Ring
2. Bearing Cups
3. Full Round Yoke
4. Bearing Cups (RPL Joint)

Fig. 4, RPL U-Joint Components



1. Weld-Strap

Fig. 5, Cutting the Weld-Strap

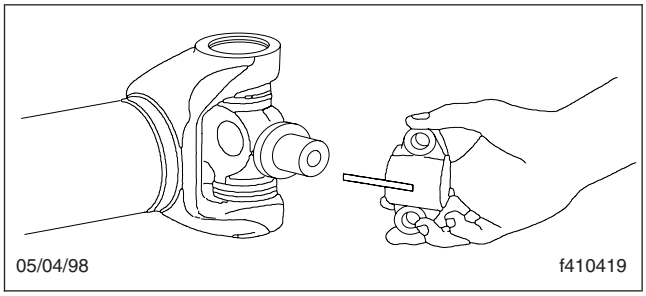
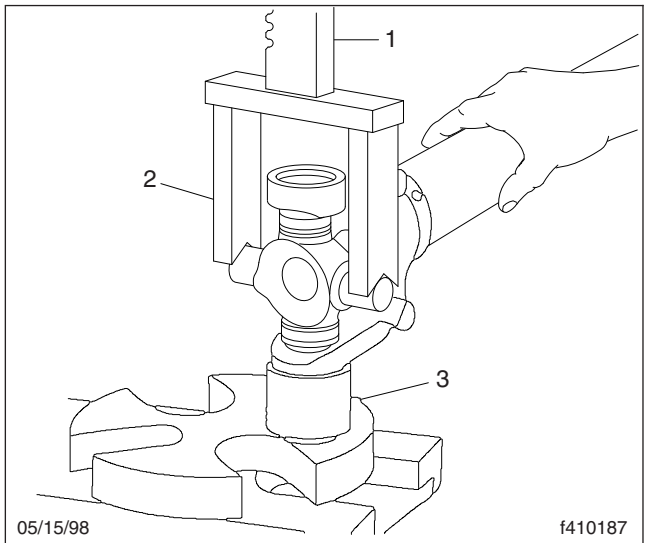


Fig. 6, Removing the Bearing Cups

5. Remove both bearing cups from the yoke cross-holes. See **Fig. 7**. Remove the cross from the yoke.



1. Press
2. Bridge
3. Bearing Cup Receiver

Fig. 7, Removing Bearing Cups from an RPL U-Joint

Slip-Joint Disassembly

Except RPL Drivelines

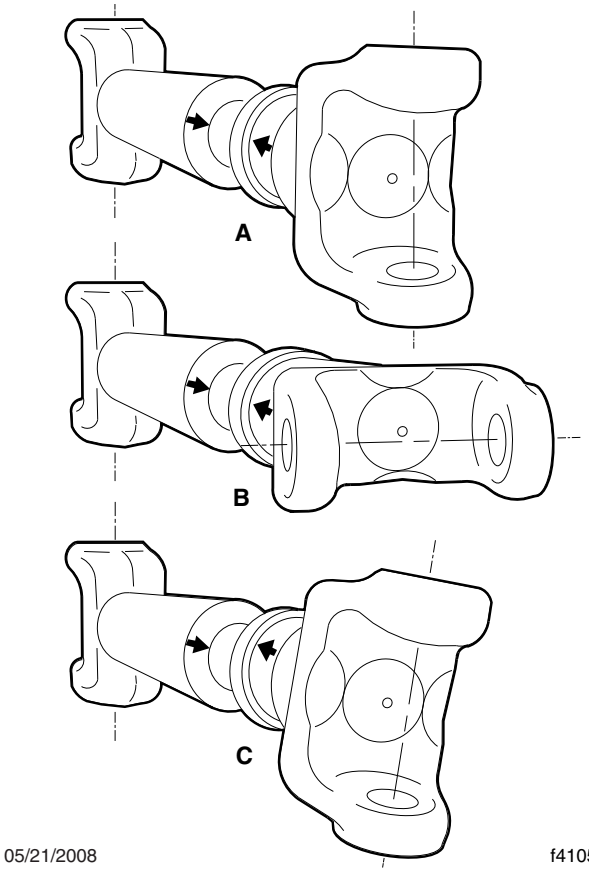
1. Check that the driveshaft yokes are aligned to hold the U-joints at either end in phase, as shown in **Fig. 8**. Using a marking stick or paint, mark the sleeve-yoke and splined shaft with alignment marks, as shown in **Fig. 9**. This will ensure proper alignment of the slip-joint components when the driveshaft is assembled.

IMPORTANT: Misaligned driveshaft yokes will cause the U-joints to be out of phase, which will cause vibration in the driveline.

2. With the driveshaft uncoupled at one end, *or* removed from the vehicle, use a strap wrench to unscrew the slip-joint dust cap from the sleeve-yoke, then pull the sleeve-yoke off of the splined shaft. Remove the dust cap, and (if so equipped) the steel washer and cork seal. See **Fig. 10**.

RPL Drivelines

1. Check that the driveshaft yokes are aligned to hold the U-joints at either end in phase, as shown in **Fig. 8**. Using a marking stick or paint, mark the sleeve-yoke and splined shaft with alignment marks, as shown in **Fig. 9**. This will



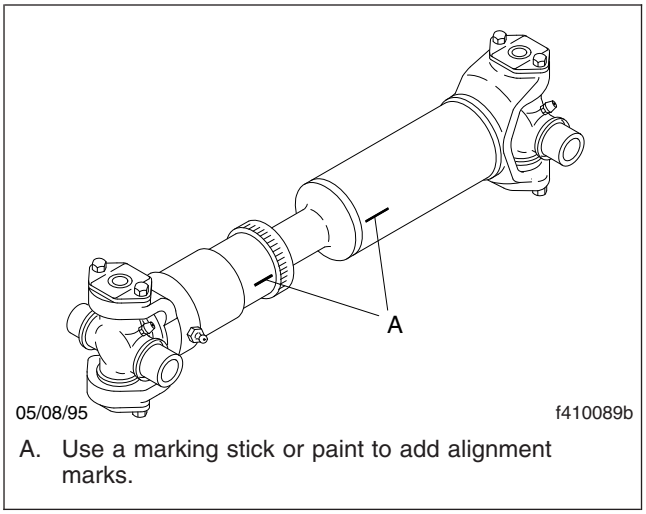
A. In Phase (parallel phased)
B. In Phase (cross phased)
C. Out of Phase

Fig. 8, U-Joint Phasing

ensure proper alignment of the slip-joint components when the driveshaft is assembled.

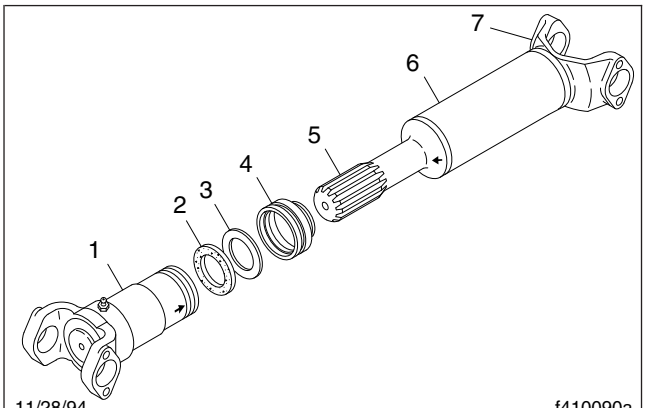
IMPORTANT: Misaligned driveshaft yokes will cause the U-joints to be out of phase, which will cause vibration in the driveline.

2. With the driveshaft uncoupled at one end, *or* removed from the vehicle, use a brass hammer and punch to tap the shroud off the slip seal. See **Fig. 11**.
3. Use a screwdriver to pry the seal out of the groove in the slip yoke, then pull the sleeve-yoke off of the splined shaft. Remove the shroud and seal.



A. Use a marking stick or paint to add alignment marks.

Fig. 9, Slip-Joint Alignment Marks



1. Sleeve-Yoke
2. Cork Washer
3. Steel Washer
4. Dust Cap
5. Splined Stub Shaft
6. Tube
7. Tube-Yoke

Fig. 10, Slip-Joint Components

Transmission/Axle End-Yoke Removal

IMPORTANT: Before removing a transmission output-shaft end-yoke or an axle shaft end-yoke, do the steps under "End-Yoke Cleaning and Inspection," in **Subject 140**.

1. Uncouple the driveshaft from the end-yoke (**Subject 100** for a half-round yoke or **Subject 110** for

Driveline Component Removal/Disassembly

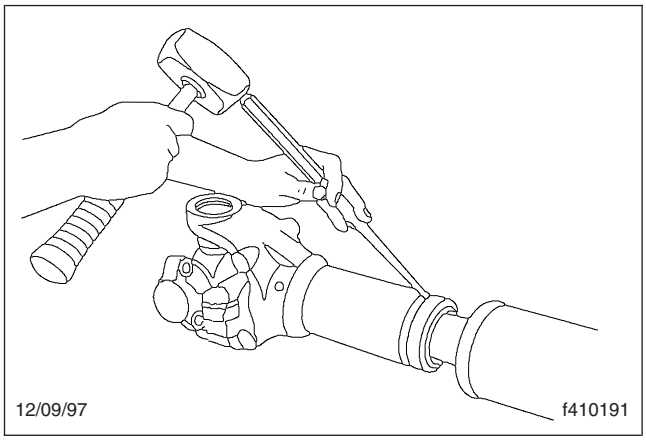


Fig. 11, Shroud Removal

a full-round yoke), or remove the driveshaft from the vehicle (**Subject 120**).

2. Remove the end-yoke locknut. See **Fig. 12**.
3. Using a yoke puller, remove the end-yoke. See **Fig. 13** for a half-round end-yoke, or see **Fig. 14** for a full-round end-yoke.

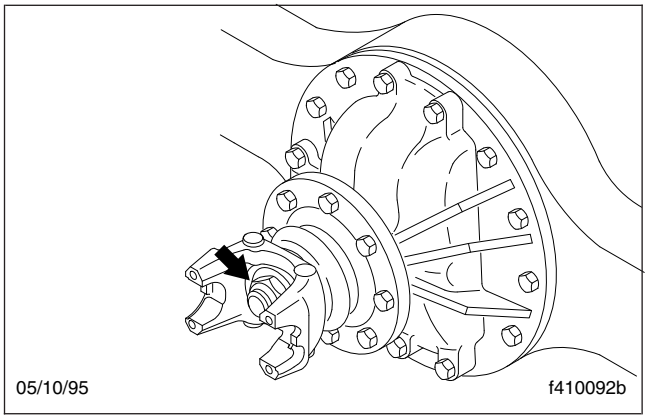
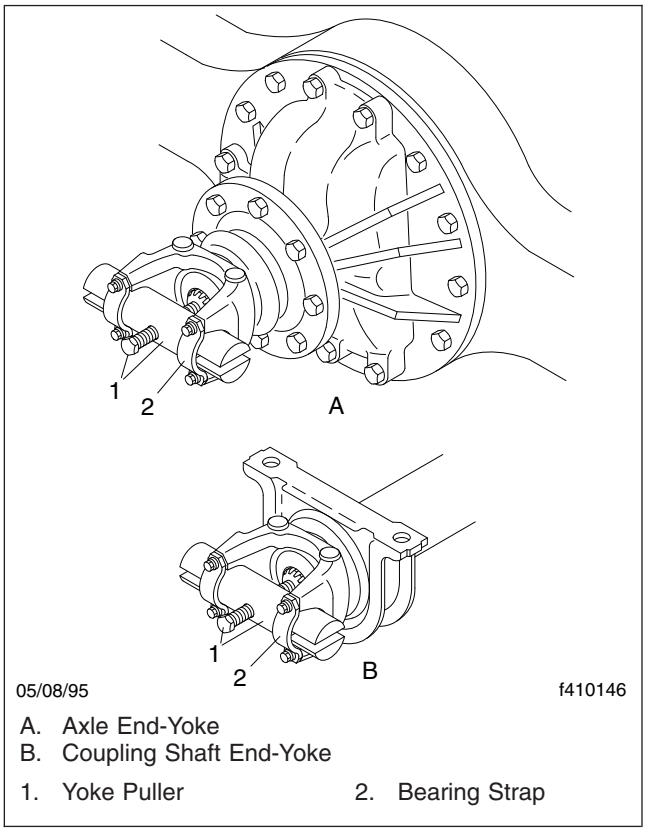


Fig. 12, Axle End-Yoke Locknut

Coupling Shaft End-Yoke and Midship Bearing Removal

1. Remove the coupling shaft from the vehicle. See **Subject 120**.
2. Clamp the coupling shaft in a soft-jawed vise; do not distort the tube with excessive grip.
3. Remove the end-yoke; see **Fig. 13** for a half-round end-yoke, or see **Fig. 14** for a full-round



A. Axle End-Yoke
B. Coupling Shaft End-Yoke
1. Yoke Puller
2. Bearing Strap

Fig. 13, Removing a Half-Round End-Yoke

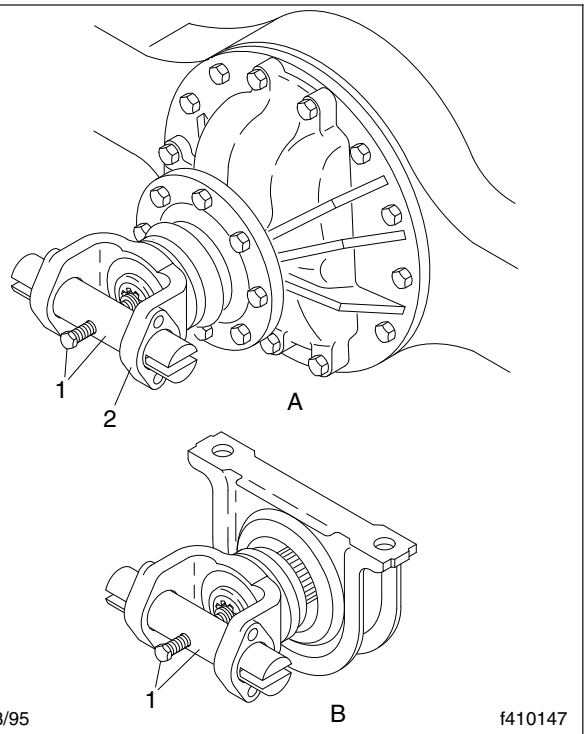
end-yoke. Then, remove the midship bearing as follows. See **Fig. 15**.

3.1 Use a marking stick or paint to mark the end-yoke and coupling shaft with alignment marks. See **Fig. 16**.

3.2 Remove the coupling shaft end-yoke locknut.

3.3 Using a yoke puller, remove the end-yoke. See **Fig. 13** for a half-round end-yoke, or see **Fig. 14** for a full-round end-yoke.

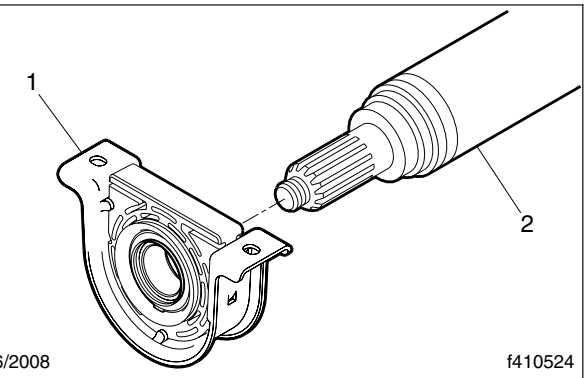
3.4 Use a hammer and a brass drift to remove the midship bearing. See **Fig. 15**.



A. Axle End-Yoke
B. Coupling Shaft End-Yoke

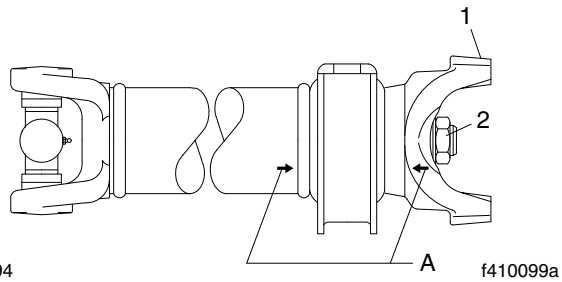
1. Yoke Puller
2. Full-Round End-Yoke

Fig. 14, Removing a Full-Round End-Yoke



1. Midship Bearing
2. Midship Bearing Shaft

Fig. 15, Midship Bearing



A. Use a marking stick or paint to mark the end-yoke and coupling shaft with alignment marks.

1. Half-Round End-Yoke
2. End-Yoke Locknut

Fig. 16, Alignment Marks on a Coupling Shaft With an End-Yoke

Driveshaft Tube, Slip-Joint, Sleeve-Yoke, and Tube-Yoke Cleaning and Inspection

1. With the driveshaft removed, scrape or soak away any foreign material.
2. Examine the driveshaft tube for dents, bends, twists, splitting weld-seams, and signs of missing balance weights.

   Replace the driveshaft tube if damaged; see "Driveshaft Tube, Stub Shaft (Slip-Joint), or Tube-Yoke Replacement," in **Subject 150**. If balance weights appear to be missing, have the driveshaft balanced to a maximum tolerance of one inch-ounce per ten pounds weight per end, at 3000 rpm.
3. Clean the slip-joint (male and female) splines, then check them for twisting and galling. See **Fig. 1**. Replace both the sleeve-yoke and the splined shaft if the slip-joint is damaged; see "Driveshaft Tube, Stub Shaft (Slip-Joint), or Tube-Yoke Replacement," in **Subject 150**. Remove any burrs or rough spots using fine emery cloth.

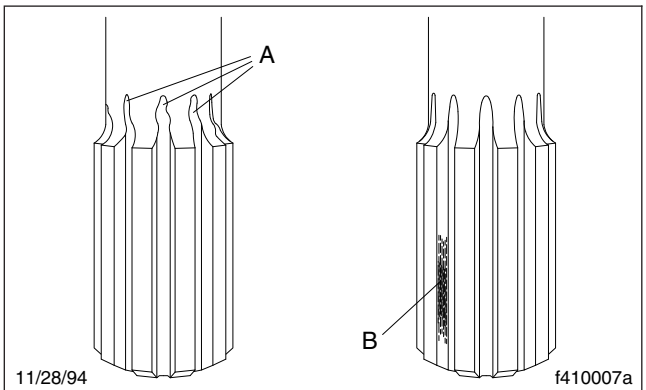


Fig. 1, Damaged Slip-Joint Splines

4. Check for a loose or missing sleeve-yoke plug. See **Fig. 2**. Repair or replace the plug as needed.
5. With the U-joint assemblies removed, check all driveshaft yoke cross-holes for raised metal. Using a rat-tail or half-round file, remove burrs or raised metal. See **Fig. 3**.

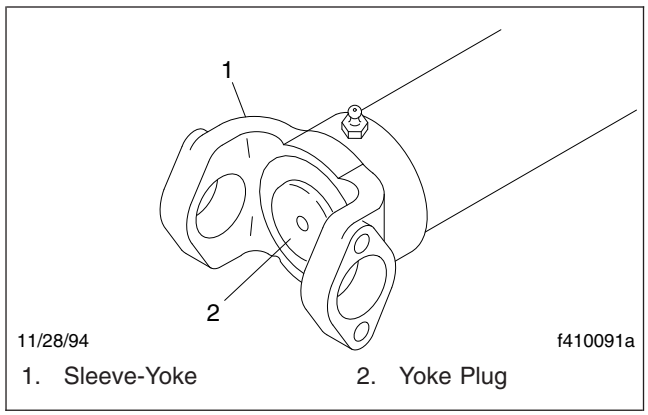


Fig. 2, Sleeve-Yoke Plug

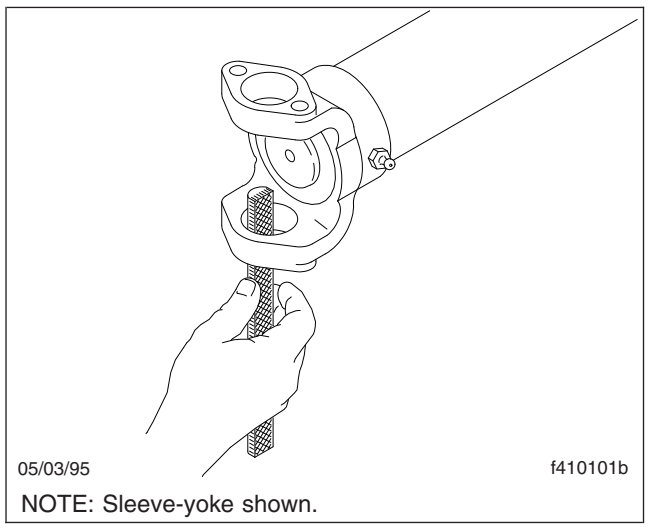


Fig. 3, Removing Burrs From a Full-Round Yoke Cross-Hole

6. Using a mill file, and holding it flat against the machined surface of the driveshaft yoke lug, file each yoke lug, to remove any burrs or raised metal. See **Fig. 4**.
7. Using fine emery cloth, smooth and clean the entire surface of all driveshaft yoke cross-holes. See **Fig. 5**.

Midship Bearing Cleaning and Inspection

1. With the midship bearing removed from the coupling shaft, use clean rags or paper towels to

Driveline Component Cleaning and Inspection

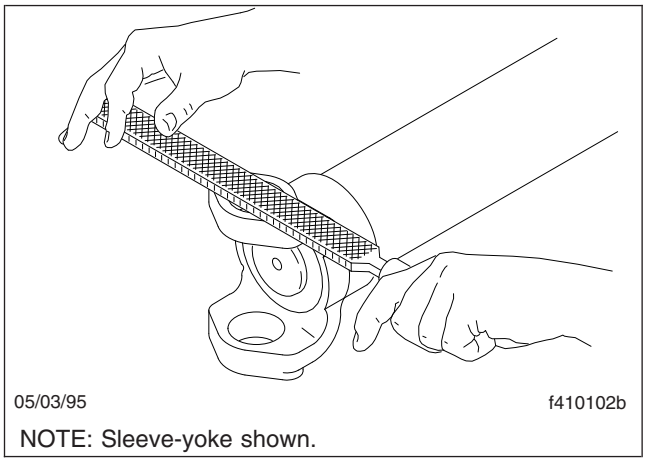


Fig. 4, Removing Burrs From the Machined Surface of a Full-Round Yoke Lug

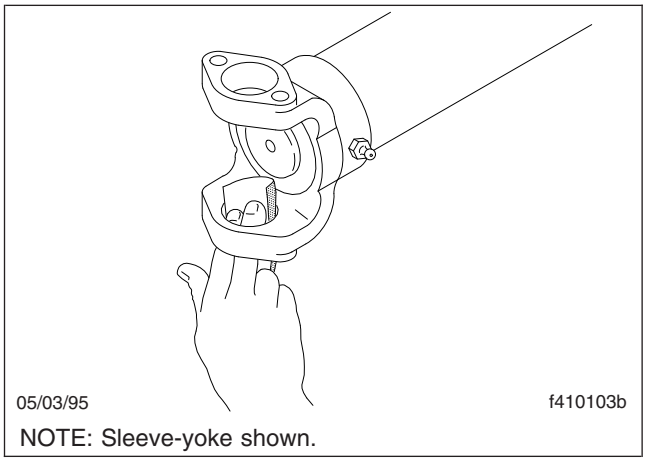


Fig. 5, Smoothing a Full-Round Yoke Cross-Hole

wipe off the outside of the midship bearing and rubber cushion.

IMPORTANT: Do not immerse the midship bearing in cleaning solvent. The solvent will wash out the lubricant, requiring bearing-assembly replacement.

2. Check the midship bearing for roughness or rattles by holding the outside of the bearing while manually turning the inner bearing race. Replace the bearing assembly if there are any rough spots or rattles.
3. Check the rubber cushion for deterioration or oil-soaking, and replace the midship bearing assembly if needed.

End-Yoke Cleaning and Inspection

1. With the transmission output-shaft and axle shaft end-yokes installed, check them for cracks and looseness.

   Replace cracked yokes. If the end-yoke can be moved in or out on its shaft, or can be rocked on its shaft, uncouple the driveshaft from the end-yoke. Check the drive component's shaft seal for leakage or other visible damage that may have been caused by the loose yoke. Replace the shaft seal if needed. Tighten the end-yoke nut to the torque value given in **Specifications 400**. If the end-yoke is still loose after tightening the yoke nut, install a new yoke and yoke nut.

NOTE: If the end-yoke locknut is removed for any reason, install a new one.

2. With the U-joints uncoupled from the end-yokes, check all driveshaft and input/output shaft end-yoke cross-holes for raised metal. Using a rat-tail or half-round file, remove burrs or raised metal. See **Fig. 3** for full-round yokes, or see **Fig. 6** for half-round yokes.

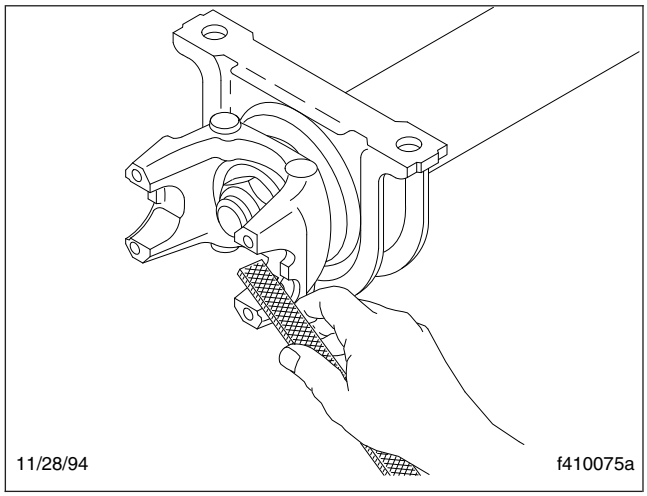
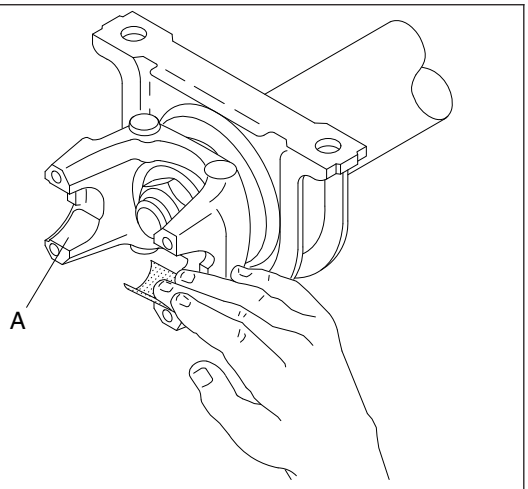


Fig. 6, Removing Burrs From a Half-Round End-Yoke Cross-Hole

3. Using a mill file, and holding it flat against the machined surface of the *full-round* end-yoke lug, file each yoke lug, to remove any burrs or raised metal. See **Fig. 4**.

4. Smooth and clean the entire surface of all end-yoke cross-holes, using fine emery cloth. See **Fig. 5** for full-round yokes, or see **Fig. 7** for half-round yokes.



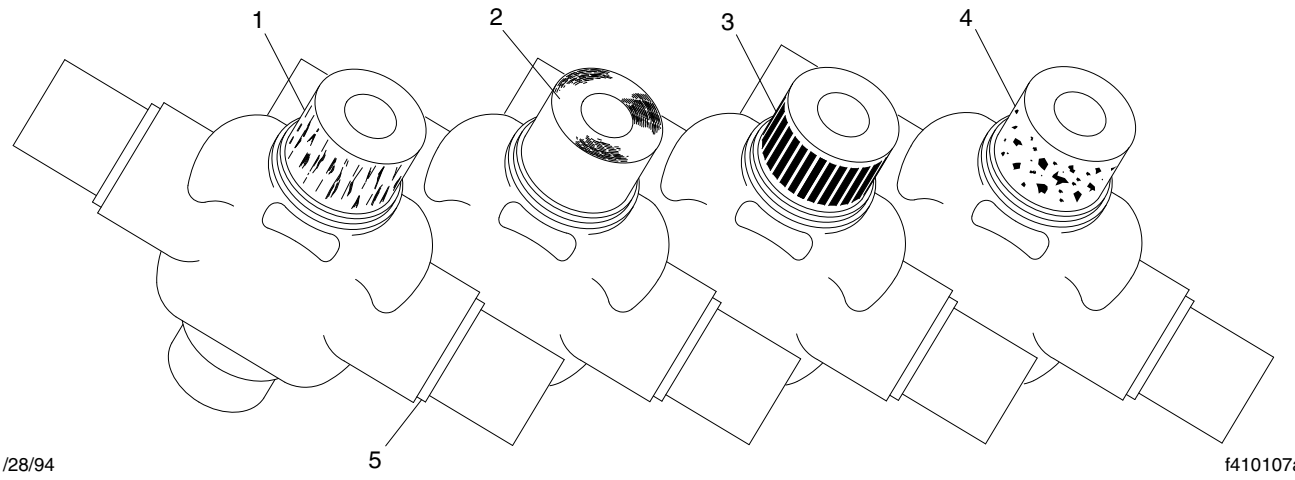
A. Use fine emery cloth on this surface.

Fig. 7, Smoothing a Half-Round End-Yoke Cross-Hole

U-Joint Cleaning and Inspection

1. With the U-joints removed from the yokes, and the bearing cups removed from the crosses, inspect the U-joint cross slingers for damage, then inspect the U-joint trunnions for spalling (flaking metal), end galling (displacement of metal), brinelling (grooves caused by bearing needles), and pitting (small craters caused by corrosion). See **Fig. 8**. If damaged, replace the U-joint assembly.
2. Using a hand-type grease gun, apply multipurpose chassis grease to the fitting on each U-joint cross until all old lubricant is forced out. See **Fig. 9**. Examine the old lubricant. If it appears rusty, gritty, or burnt, replace the U-joint assembly.
3. Soak the bearing cups in a non-flammable cleaner until particles of grease and foreign matter are loosened or dissolved. Do not disassemble the bearing cups; clean the bearing needles with a short, stiff brush, then blow them dry with compressed air. Check for minute particles of dirt or grit, and clean again if necessary.
4. Check each bearing cup for missing bearing needles. Check the bearing-cup seals for nicks. See **Fig. 10** for a half-round-yoke U-joint bearing cup, or see **Fig. 11** for a full-round-yoke U-joint bearing cup. Replace the U-joint assembly if any bearing needles are missing or any seals are damaged.
5. Apply a small quantity of multipurpose chassis grease to the bearing needles in each cup, then apply a small amount of light-weight oil to the lips of the bearing-cup seals. Rotate each bearing cup on the cross to check for wear. Replace the U-joint assembly if any bearing surfaces are worn.
6. Check the underside of each bearing-cup plate for burrs or raised metal. Use a mill file to remove any burrs or raised metal. See **Fig. 12**.
7. Using fine emery cloth, smooth and clean the outside surfaces of all bearing cups. See **Fig. 12** and **Fig. 13**.

Driveline Component Cleaning and Inspection



1. Spalling
2. End Galling
3. Brinelling
4. Pitting
5. Slinger

Fig. 8, Damaged U-Joint Crosses

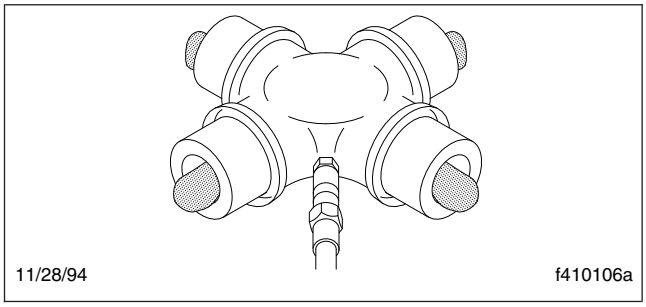
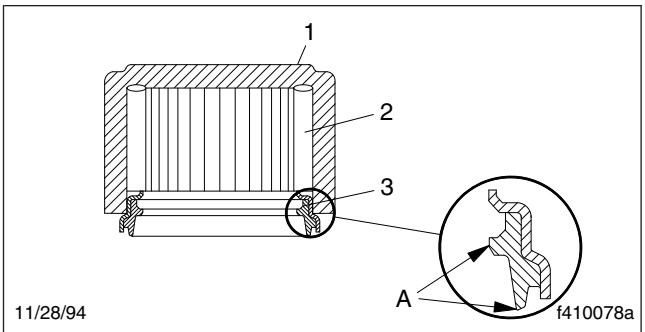


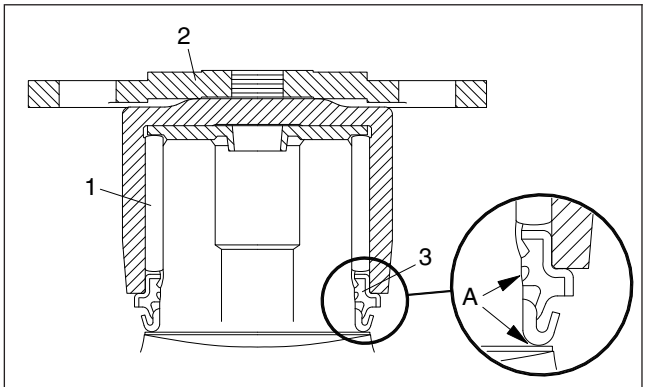
Fig. 9, Forcing Out Old Lubricant From a U-Joint Cross



A. Lubricate seal lips here.

1. Bearing Cup
2. Bearing Needle
3. Bearing-Cup Seal

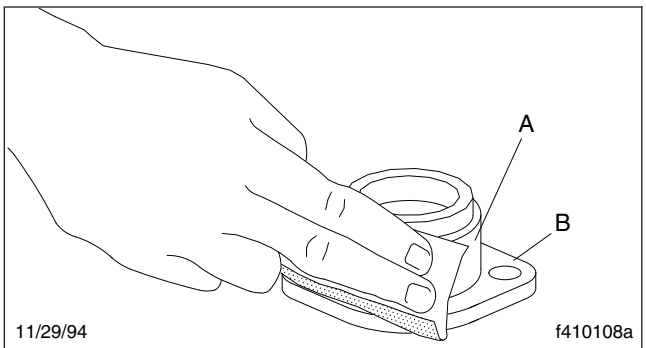
Fig. 10, Sectional View of a Half-Round End-Yoke U-Joint Bearing Cup



A. Lubricate seal lips here.

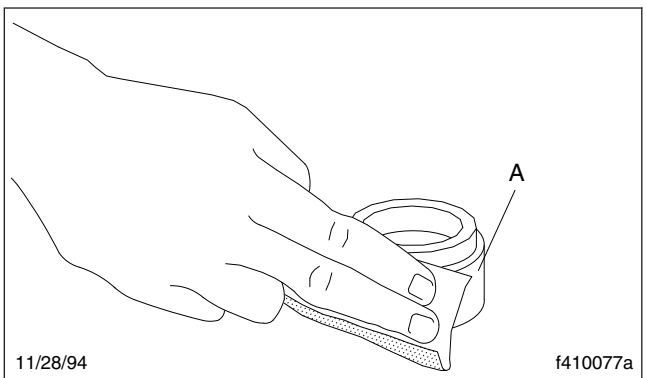
1. Bearing Needle
2. Bearing-Cup Plate
3. Bearing-Cup Seal

Fig. 11, Sectional View of a Full-Round Yoke U-Joint Bearing Cup



A. Use fine emery cloth on this surface.
B. Use a mill file on this surface.

Fig. 12, Smoothing a Full-Round Yoke U-Joint Bearing Cup



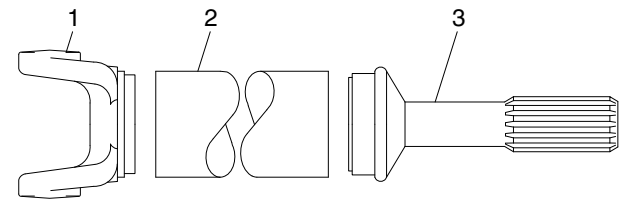
A. Use fine emery cloth on this surface.

Fig. 13, Smoothing a Half-Round Yoke U-Joint Bearing Cup

Driveshaft Tube, Stub Shaft (Slip-Joint), and Tube-Yoke Replacement

IMPORTANT: Parts for different series drivelines must not be intermixed. Incorrectly assembled or worn components can affect the entire driveline, resulting in too much vibration or driveline damage.

To replace a driveshaft tube, a tube-yoke, or a stub shaft (**Fig. 1**), the driveshaft must be chucked in a lathe, so the welds can be removed. Driveshaft rebuilding should be done by a machine shop that specializes in driveline repair.



1. Tube-Yoke
2. Driveshaft Tube
3. Stub Shaft

Fig. 1, Driveshaft Tube, Stub Shaft, and Tube-Yoke

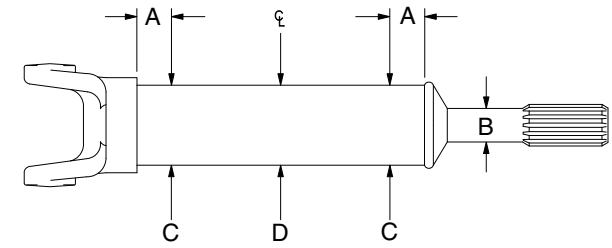
Runout limits for a new (rebuilt) driveshaft (**Fig. 2**) are:

- 0.005 inch (0.127 mm) T.I.R. (Total Indicator Reading) on the smooth portion of the stub shaft neck;
- 0.010 inch (0.254 mm) T.I.R. on the tube 3 inch (76 mm) from the front and rear welds;
- 0.015 inch (0.381 mm) T.I.R. at the center of the tube.

Balance the rebuilt driveshaft to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

Slip-Joint Replacement or Assembly

IMPORTANT: Parts for different series drivelines must not be intermixed. Incorrectly assembled or worn components can affect the entire driveline, resulting in too much vibration or driveline damage.

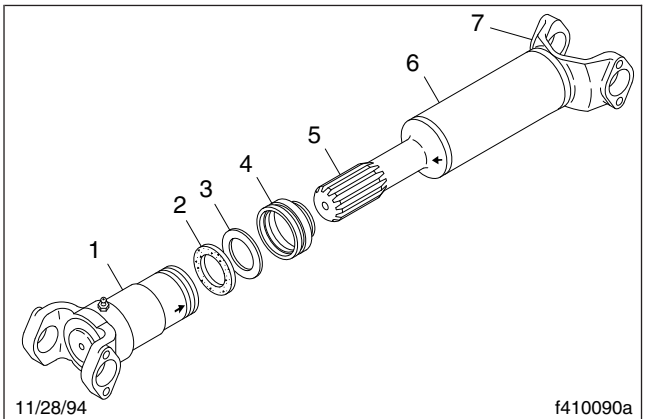


A. Measurement: 3 inches (76 mm)
B. Measurement: 0.005 inch (0.127 mm)
C. Measurement: 0.010 inch (0.2540 mm)
D. Measurement: 0.015 inch (0.381 mm)

Fig. 2, Runout Specifications for a Rebuilt (or New) Driveshaft

Except RPL Drivelines

1. Place the slip-joint dust cap, and (if so equipped) steel washer and cork seal, over the splined shaft. See **Fig. 3**.



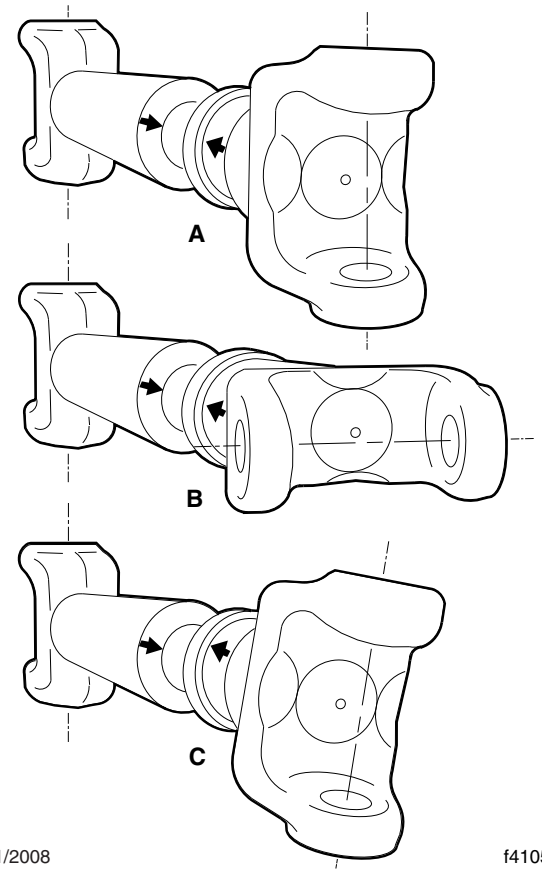
1. Sleeve-Yoke
2. Cork Washer
3. Steel Washer
4. Dust Cap
5. Splined Stub Shaft
6. Tube
7. Tube-Yoke

Fig. 3, Slip-Joint Components

2. Coat the splines of the shaft with multipurpose chassis grease.

Driveline Component Replacement or Installation/ Assembly

3. Insert the splined shaft in the sleeve-yoke, so that the alignment marks are aligned, and the U-joints at each end of the driveshaft will be in phase. See **Fig. 4** and **Fig. 5**.

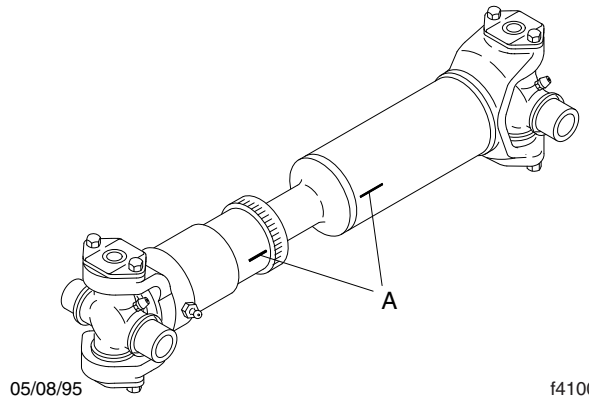


A. In Phase (parallel phased)
B. In Phase (cross phased)
C. Out of Phase

Fig. 4, U-Joint Phasing

IMPORTANT: If no alignment marks are visible, or new slip-joint components have been installed, align the yokes, assemble the slip-joint, then have the driveline balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

4. Install the slip-joint dust cap. Use only enough torque to seat the steel washer and cork seal (if so equipped) snug against the end of the sleeve-yoke; do not overtighten.



A. Use a marking stick or paint to add alignment marks.

Fig. 5, Slip-Joint Alignment Marks

NOTE: The splines should slide freely, with only a slight drag from the slip-joint dust cap.

RPL Drivelines

1. Remove the grease plug from the sleeve-yoke.
2. Coat the splines of the sleeve-yoke with multipurpose chassis grease.
3. Install the shroud on the splined shaft.
4. Install the seal onto the shroud.
5. Insert the splined shaft in the sleeve-yoke so that the alignment marks are aligned, and the U-joints at each end of the driveshaft will be in phase. See **Fig. 4** and **Fig. 5**.

IMPORTANT: If no alignment marks are visible, or new slip-joint components have been installed, align the yokes, assemble the slip-joint, then have the driveline balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

6. Install the seal into the shaft groove.
7. Install the shroud. Use a brass hammer to tap the shroud over the seal.
8. Install the grease plug in the sleeve-yoke.

NOTE: The splines should slide freely, with only a slight drag from the slip-joint dust cap.

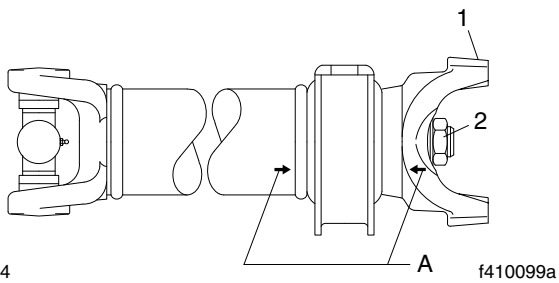
Midship Bearing and Coupling Shaft End-Yoke Replacement or Assembly

IMPORTANT: Parts for different series drivelines must not be intermixed. Incorrectly assembled or worn components can affect the entire driveline, resulting in too much vibration or driveline damage.

1. Place the coupling shaft in a soft-jawed vise; do not distort the tube with excessive grip.

NOTE: Midship bearings are permanently lubricated when manufactured; it is not necessary to pack the bearing with grease.

2. Install the midship bearing on the coupling shaft. Press the bearing on by hand, as far as it will go.
3. Install the end-yoke. See **Fig. 6**.
   - 3.1 Apply Loctite® 242 to the shaft threads where the end-yoke locknut will be installed.
   - 3.2 Align the marks added to the coupling shaft and end-yoke during removal, then place the end-yoke on the shaft so the yoke bores are aligned at both ends of the shaft. See **Fig. 6**.



A. Use a marking stick or paint to mark the end-yoke and coupling shaft with alignment marks.

1. Half-Round End-Yoke
2. End-Yoke Locknut

Fig. 6, Alignment Marks on a Coupling Shaft With an End-Yoke

   - 3.3 Install the end-yoke nut, and tighten it 475 to 525 lbf·ft (645 to 710 N·m). Then back the nut off slightly, and tighten it to the same torque.

U-Joint Replacement or Installation

IMPORTANT: Parts for different series drivelines must not be intermixed. Also, components of the various makes of U-joints may not be interchangeable, and must be assembled only with compatible products. Incorrectly assembled or worn components can affect the entire driveline, resulting in too much vibration or driveline damage.

Worn bearing assemblies used with a new cross, or new bearing assemblies used with a worn cross will wear rapidly, making another replacement necessary in a short time. Always replace the cross and all four bearing assemblies at the same time.

If the slip-joint of a No. 2 or No. 3 driveshaft has been disassembled, assemble the slip-joint before installing the U-joints.

Full-Round Yokes

1. Place the assembled driveshaft in V-blocks or a soft-jawed vise; do not distort the tube with excessive grip.
2. For a No. 2 or No. 3 driveshaft, check that the slip-joint alignment marks are aligned, so that the U-joints at each end of the driveshaft will be in phase. See **Fig. 4** and **Fig. 5**.

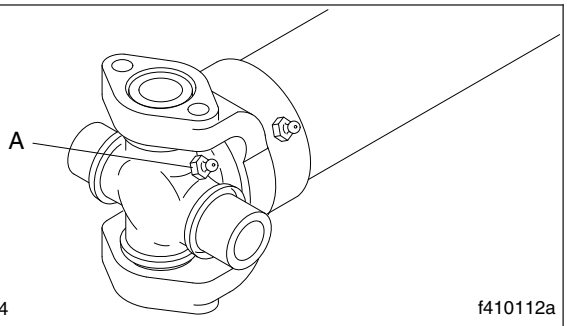
   For a coupling shaft, check that the end-yoke and tube-yoke are aligned, so that the U-joints at each end of the coupling shaft will be in phase. See **Fig. 6**.

IMPORTANT: Misaligned driveshaft yokes will cause the U-joints to be out of phase, which will cause vibration in the driveline.

3. Inspect and lubricate the U-joint; see **Subject 140**.
4. Install the U-joint cross and bearing assemblies in the yoke.
   - 4.1 Position the U-joint cross in the driveshaft yoke so one grease fitting points toward

Driveline Component Replacement or Installation/ Assembly

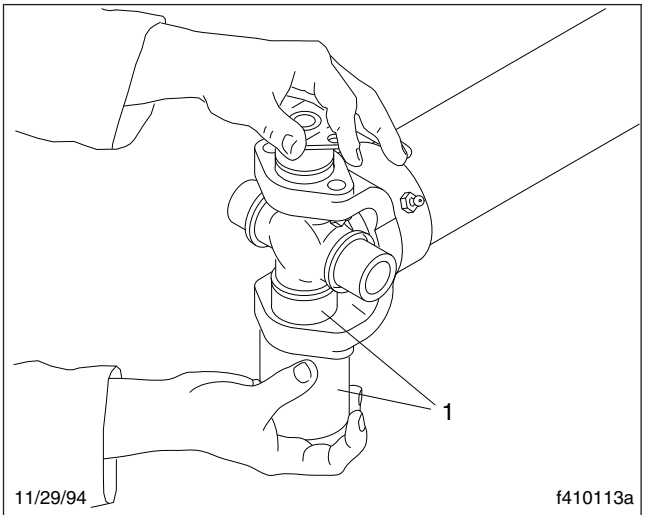
the driveshaft, and aligns with the grease fitting on the sleeve-yoke (if so equipped). See **Fig. 7**.



A. Install the cross with grease fitting pointing toward the driveshaft, and aligned with the sleeve-yoke grease fitting.

Fig. 7, U-Joint Grease Fitting Positioning

4.2 Move one end of the cross until a trunnion projects through the cross-hole, beyond the outer machined face of the yoke lug. Using a Spicer trunnion (journal) locator (see **Specifications 400**), hold the trunnions in alignment with the cross-holes, while placing a bearing cup (plate-type) over the projected trunnion, and aligning it with the cross-hole. See **Fig. 8**.



NOTE: Sleeve-yoke shown.

1. Trunnion Locator

Fig. 8, Using a U-Joint Trunnion Locator

IMPORTANT: A Spicer trunnion (journal) locator should be used to prevent damage to the U-joint trunnions and slingers.

4.3 By hand, press the bearing-cup-plate flush with the face of the yoke. If the bearing cup binds in the cross-hole, tap the *center* of the bearing-cup plate with a leather or rubber mallet; do not tap the outer edges of the plate. See **Fig. 9**.

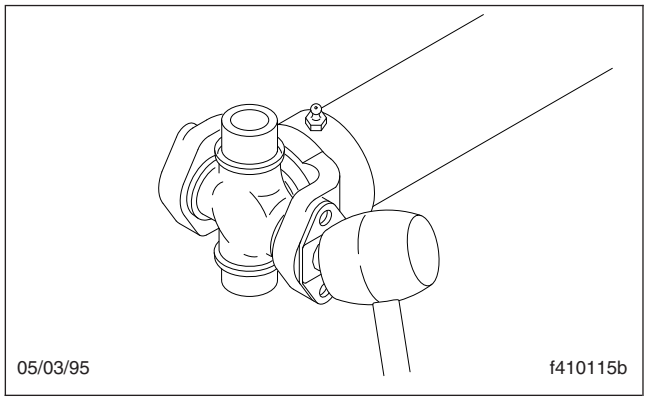


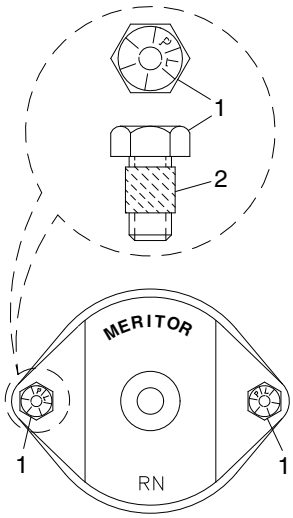
Fig. 9, Seating a U-Joint Bearing Cup In a Full-Round Yoke

4.4 Install *new* bearing-cup-plate self-locking capscrews. See **Fig. 10**. Tighten the capscrews until all the parts are drawn down tight, with no gaps; do not tighten the capscrews to their final torque value.

⚠ WARNING

Self-locking bearing-cup-plate capscrews must not be reused; replace the capscrews with new ones. Also, do not undertighten or overtighten any bearing-cup-plate capscrews. A loose or broken fastener at any point in the driveline weakens the driveline connection, which could cause serious vehicle damage, or could result in a driveshaft separating from the vehicle, possibly causing loss of vehicle control that could result in serious personal injury or death.

4.5 Move the cross until it projects beyond the machined surface of the opposite yoke lug. Using the above procedure, install the opposite bearing assembly and its fasteners.



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1. Self-Locking Capscrew
2. Adhesive Band

Fig. 10, Meritor U-Joint Fasteners for Full-Round Yokes

4.6 Slightly back off all four capscrews, then alternately tighten them in increments of 5 lbf·ft (7 N·m), to the applicable torque value in **Specifications 400**.

NOTE: The U-joint should flex, and be free of excessive bind. A slight drag is the most desirable condition for new U-joints. Excessive looseness is not desirable, and may result in an unbalanced driveshaft.

RPL Series U-Joint

NOTE: Do not reuse RPL U-joints. Always replace an RPL U-joint with a new one if they have been disassembled and removed from a driveshaft.

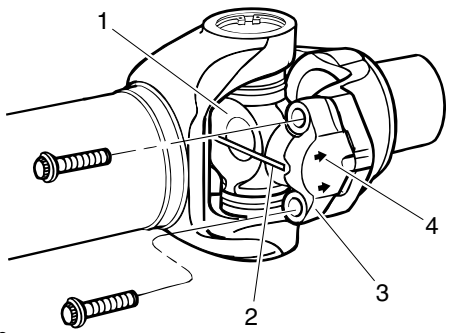
1. Place the assembled driveshaft in V-blocks or a soft-jawed vise; do not distort the tube with excessive grip.
2. For a No. 2 or No. 3 driveshaft, check that the slip-joint alignment marks are aligned, so that the U-joints at each end of the driveshaft will be in phase. See **Fig. 4** and **Fig. 5**.

   For a coupling shaft, check that the end-yoke and tube-yoke are aligned, so that the U-joints at each end of the coupling shaft will be in phase. See **Fig. 6**.

IMPORTANT: Misaligned driveshaft yokes will cause the U-joints to be out of phase, which will cause vibration in the driveline.

3. Inspect the U-joint. See **Subject 140**.
4. Install the U-joint cross and bearing assemblies in the yoke.

   4.1 Position the U-joint cross in the driveshaft yoke so that the wing bearing weld strap faces inboard, and the arrows point toward the end of the coupling yoke. See **Fig. 11**.



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1. U-Joint Cross
2. Weld Strap
3. Wing Bushing
4. Arrows

Fig. 11, Fitting the U-Joint

4.2 Move one end of the cross until a trunnion projects through the cross-hole, beyond the outer machined face of the yoke lug. Place a bearing cup over the projected trunnion, and align it with the cross-hole.

4.3 Press the bearing cup into the yoke slightly past the snap ring groove. See **Fig. 12**. Check that the bearing cup is aligned with the universal joint trunnion.

4.4 Install the snap ring into the snap ring groove. See **Fig. 13**.

4.5 Use a snap ring installation gauge to check that the snap ring is fully seated in the snap ring groove. See **Fig. 14**.

4.6 Move the cross until it projects beyond the machined surface of the opposite yoke

Driveline Component Replacement or Installation/ Assembly

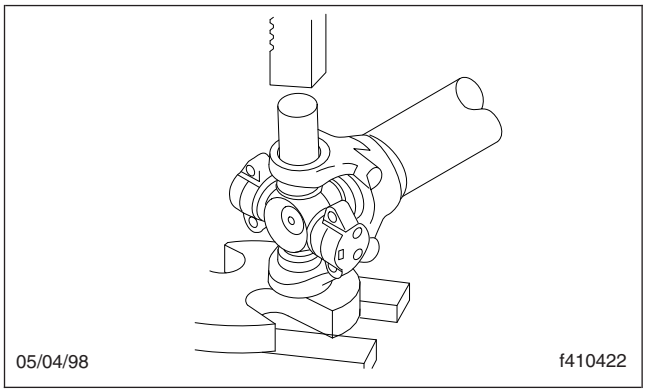
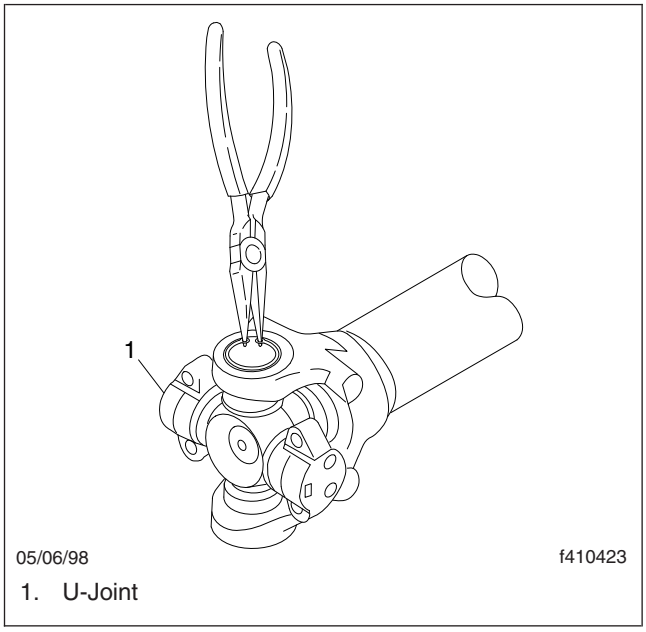


Fig. 12, Installing Bearing Cups, RPL Series U-Joint



1. U-Joint

Fig. 13, Installing the Snap Rings

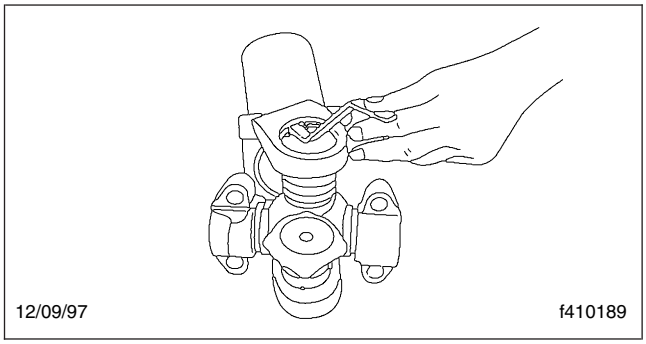
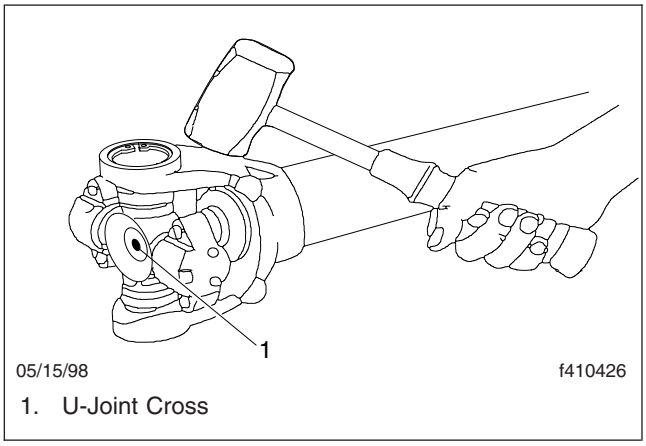


Fig. 14, Checking Snap Ring Installation

lug. Using the above procedure, install the opposite bearing cup assembly.

NOTE: The U-joint should flex, and be free of excessive bind. A slight drag is the most desirable condition for new U-joints. Excessive looseness is not desirable, and may result in an unbalanced driveshaft.

4.7 If the universal joint does not move freely, strike the yoke ear with a brass or copper hammer. See **Fig. 15**.



1. U-Joint Cross

Fig. 15, Striking the Yoke Ear

Transmission/Axle End-Yoke Replacement or Installation

IMPORTANT: Parts for different series drivelines must not be intermixed. Incorrectly assembled or worn components can affect the entire driveline, resulting in too much vibration or driveline damage.

1. Apply Loctite® 242 to the input- or output-shaft threads where the end-yoke locknut will be installed. See **Fig. 16**.
2. By hand, install the end-yoke on the input or output shaft as far as it will go.
3. Install a new end-yoke locknut, and tighten it to the applicable torque value in **Specifications 400**.

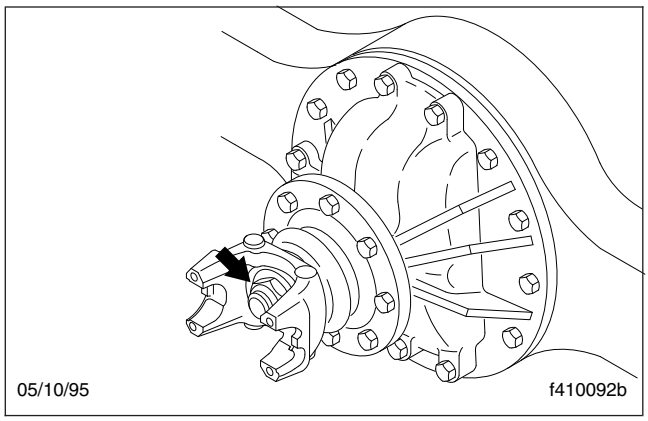


Fig. 16, Axle End-Yoke Locknut

Troubleshooting

Noise or vibration associated with the driveline can be caused by non-driveline parts. To find the cause of noise or vibration, first road test the loaded vehicle. Drive in all gears and at all speed ranges for which the vehicle was designed, including those at which problems are reported.

NOTE: Operating a vehicle at speeds that exceed its drivetrain design specifications may cause an out-of-balance vibration.

The following is a troubleshooting elimination process; checks should be made in the order listed. At each step where a problem is found, correct the problem before proceeding to the next step, then test drive the vehicle to see if other problems still exist. If no other problems exist, the elimination process may be ended at that step.

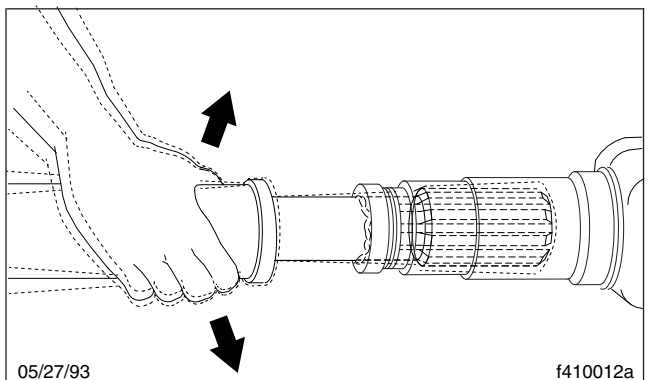
1. Check all tires for uneven wear and for out-of-roundness. Check for mismatched tires. Look for wheels and rims that are out of alignment. For instructions, see **Group 40**.
2. Check the rear suspension for loose or broken U-bolts; broken, shifted, or mismatched rear springs; or broken spring seats. If so equipped, check the air suspension for incorrect air spring height. Look for anything that could cause angular misalignment of the rear axle pinion(s). For instructions, see **Group 32**.
3. Check the frame rails and crossmembers for bends, twists, or breaks; for frame-alignment-checking and crossmember-replacement instructions, see **Group 31**.
4. Check the engine and transmission mounts; see **Group 01** (Engine) and **Group 26** (transmission). Check the coupling shaft's midship bearing mounts. Replace mountings that are deteriorated or oil-soaked; tighten loose mounting bolts. Oil-soaked or deteriorated mountings,or loose mounting bolts, can cause driveline angular misalignment.
5. Check for loose U-joint bearing-cup-plate and bearing-strap capscrews. Tighten any loose fastener to the applicable torque value in **Specifications 400**.

⚠ CAUTION

Do not overtighten the bearing-cup-plate or bearing-strap capscrews. A loose or broken fastener at any point in the driveline weakens the driveline connection, which could result in serious vehicle damage.

6. Check all U-joint assemblies, slip-joint splines, and midship bearings for wear.
   - 6.1 Try to move each driveshaft up and down, and from side to side. If movement is greater than 0.006 in (0.15 mm) of a U-joint cross in its bearings,replace the U-joint assembly.
   - 6.2 If the midship bearing rattles or is loose on its shaft, replace it.
   - 6.3 Try to bend the sleeve-yoke and splined shaft up and down, and from side to side. See **Fig. 1**. If looseness is greater than 0.007 in (0.18 mm), replace the sleeve-yoke and splined shaft.

     If driveline components must be replaced, see **Subject 150**.



Try to bend the sleeve-yoke and splined shaft up and down, and from side to side.

Fig. 1, Check for Slip-Joint Spline Wear

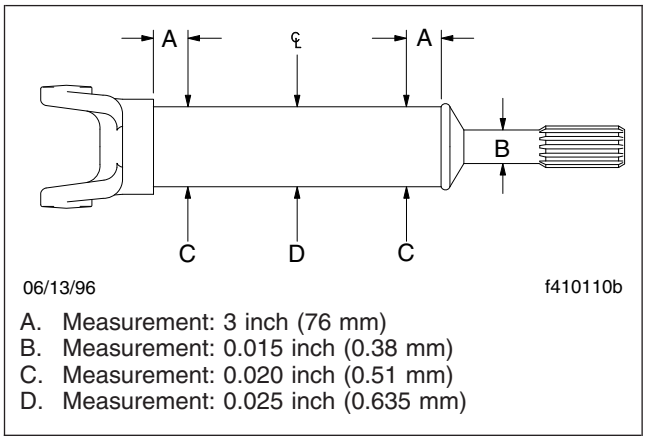
7. Check each driveshaft for an indication of missing balance weights. If any weights appear to be missing, have the driveshaft balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.
8. Check each driveshaft for dents, bends, twists, or other damage.

Troubleshooting

If damaged, jack up the rear axle, support it on jackstands, place the transmission in neutral, and turn the driveshaft by hand to check runout.

The driveshaft must be straight within 0.015 inch (0.38 mm) on the slip-joint seal surface of the splined shaft, 0.020 inch (0.51 mm) on the tube 3 inch (76 mm) from the front and the rear welds, and 0.025 inch (0.635 mm) at the center of the tube. See **Fig. 2**.

If the driveshaft is not straight within specifications, replace the tube. See **Subject 150** for runout specifications for a *new* (or rebuilt) driveshaft.



A. Measurement: 3 inch (76 mm)
B. Measurement: 0.015 inch (0.38 mm)
C. Measurement: 0.020 inch (0.51 mm)
D. Measurement: 0.025 inch (0.635 mm)

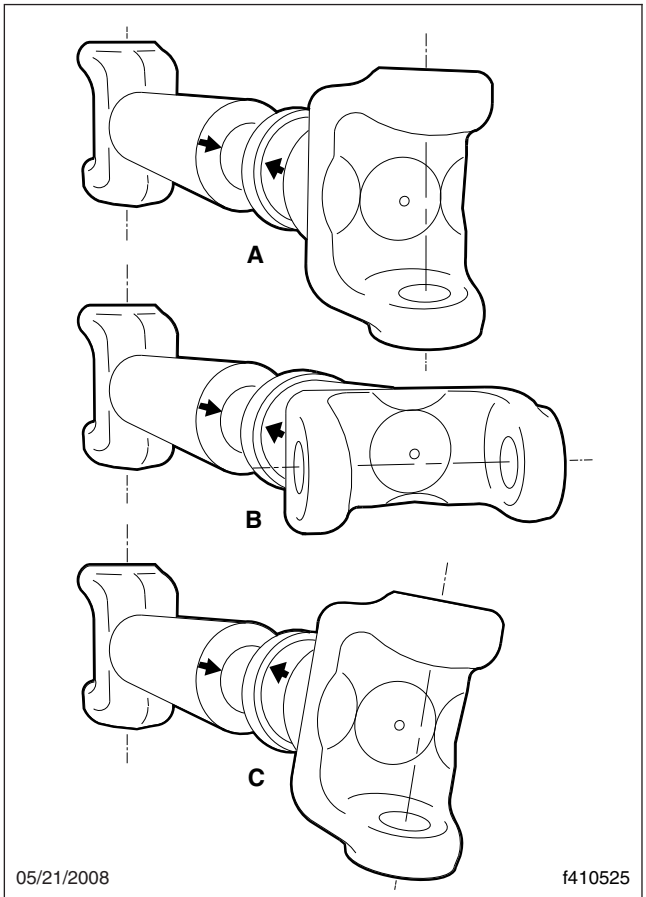
Fig. 2, Runout Specifications for a Used Driveshaft

9. Check each driveline for proper U-joint phasing. See **Fig. 3**.

   9.1 On No. 2 and No. 3 driveshafts, if the U-joints are out of phase, check the slip-joint for alignment marks. If necessary, disassemble the slip-joint, and align the marks.

   NOTE: To disassemble the slip-joint, uncouple the U-joint at one end of the driveshaft, unscrew the slip-joint seal from the sleeve-yoke, then pull the sleeve-yoke and splined shaft apart. Reverse the procedure to assemble the slip-joint.

   9.2 If no alignment marks are present, disassemble the slip-joint, and reassemble it with the U-joints in one of the two in-phase positions (180 degrees apart).



A. In Phase (parallel phased)
B. In Phase (cross phased)
C. Out of Phase

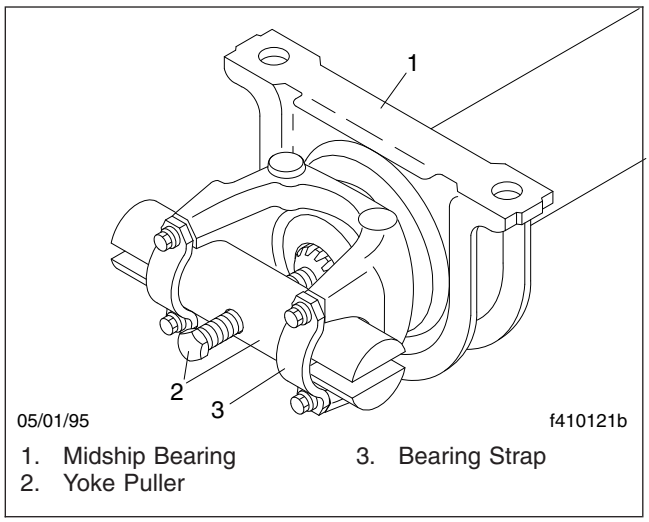
Fig. 3, U-Joint Phasing

Test drive the vehicle, then assemble the slip-joint in the other in-phase position. Test drive the vehicle again.

Determine which in-phase position provides vibration-free operation. Assemble the slip-joint in the correct in-phase position, and mark the slip-joint with alignment marks.

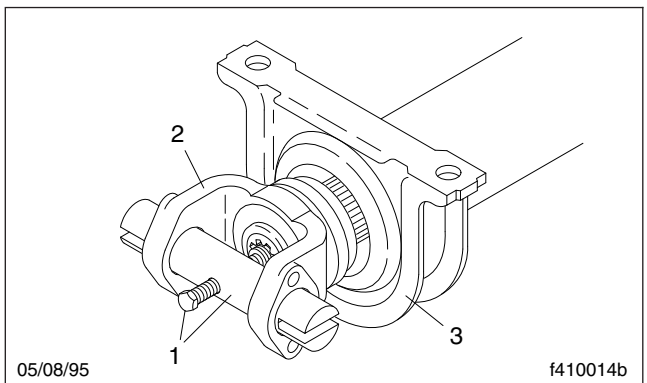
9.3 If the U-joints are out of phase on a coupling shaft, uncouple the U-joint from the coupling shaft end-yoke, then remove the end-yoke nut. Remove the end-yoke, using a yoke puller. See **Fig. 4** for a half-round end-yoke, or see **Fig. 5** for a full-round end-yoke. Align the end-yoke, then

install it by hand. Install the end-yoke nut, and tighten it 475 to 525 lbf·ft (645 to 710 N·m). Slightly back off the nut, and again tighten it to the same torque. Couple the coupling shaft to the driveshaft U-joint.



1. Midship Bearing
2. Yoke Puller
3. Bearing Strap

Fig. 4, Remove a Half-Round End-Yoke from a Coupling Shaft



1. Yoke Puller
2. Full-Round Yoke
3. Midship Bearing

Fig. 5, Remove a Full-Round End-Yoke from a Coupling Shaft

10. Check the torque on all of the end-yoke nuts in the drivetrain; see the applicable torque values in **Specifications 400**.

    If any yoke nut was not at its specified torque, check the yoke for wear by trying to move it up and down, and back and forth. If the yoke can be rocked on its shaft, or moved in or out on its shaft, replace the yoke and yoke nut. See **Subject 150**.

    If the yoke is not worn, tighten the yoke nut to its torque value.

11. *On single-drive vehicles:*

    Have the No. 2 driveshaft balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

    On dual-drive vehicles:

    11.1 Remove the No. 3 driveline; then, with the interaxle differential locked, test drive the vehicle.

    11.2 If vibration still exists, install the No. 3 driveline, then have the No. 2 driveshaft balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

    If *no* vibration exists, check that both rear axle gear ratios are matched. If the gear ratios do not match, replace one of the gear sets with a gear set having the correct ratio, then install the No. 3 driveline.

    11.3 Have the No. 3 driveshaft balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

    11.4 Have the No. 2 driveshaft balanced to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

12. If so equipped, balance the coupling shaft(s) to a maximum tolerance of 1 inch-ounce per 10 pounds weight per end, at 3000 rpm.

Transmission Output-Shaft End-Yoke Nut Fastener Torques			
Description		Size	Torque: lbf·ft (N·m)
Fuller	RT 8609	1-1/2–18	400–450 (542–610)
	T/X 14607 RT 8608 /7608LL RTO 11909MLL /14909MLL /11908LL RTX 16709 /15710 /16710 RT/X 11609 /11709 /12609 /12709 /13609 /13709 /14609 /14709 /11710 /12710 /13710 /14710 RTO/X 11708LL /14708LL RT/O/X 14715 /15715 RTLO 12610 /13610 /14610 /15610 /16610 /12713 /14713 /16713 /14718 /16718 /18718	2–16	450–500 (610–678)
Meritor	RM/O/X 9–115, –125, –135, –145, –155 RM/X 10–115, –125, –135, –145, –155, –165 RMO 13–145	2–16	450–500 (610–678)
Allison	HD Series	2–16	600–800 (813–1085)

Table 1, Transmission Output-Shaft End-Yoke Nut Fastener Torques

Midship Bearing Fastener Torques		
Location	Size	Torque: lbf·ft (N·m)
Coupling Shaft	1-1/4–18	475–525 (645–710)
Bracket to Crossmember Locknut	1/2–13	68 (92)
Bearing Mount to Bracket Locknut	1/2–13	68 (92)

Table 2, Midship Bearing Fastener Torques

Spicer U-Joint Capscrew Torque			
Series	Thread Size	Style	Torque lbf·ft (N·m)
1710 HD 1760 HD 1810 HD	1/2–20	Half Round	130–135 (176–183)
	3/8–24	Full Round	38–48 (52–65)
SPL100	3/8–24	Half Round	45–60 (61–81)
SPL140/HD/XL SPL170/XL SPL250/HD/XL	M12–1.25	Half Round	115–135 (156–183)

Table 3, Spicer U-Joint Capscrew Torque

Specifications

Meritor U-Joint Capscrew Torque			
Series	**Thread Size**	**Style**	**Torque lbf·ft (N·m)**
16T	3/8–24	Half Round	45–60 (61–81)
16N	5/16–24	Full Round	26–35 (35–47)
17T	1/2–20	Half Round	115–135 (156–183)
17N	3/8–24	Full Round	38–48 (52–65)
176T	1/2–20	Half Round	115–135 (156–183)
176N	3/8–24	Full Round	38–48 (52–65)
18T	1/2–20	Half Round	115–135 (156–183)
18N	3/8–24	Full Round	38–48 (52–65)
RPL20 G2 RPL250HD G2	1/2–20	Wing Yoke	115–135 (156–183)

Table 4, Meritor U-Joint Capscrew Torque

Axle End-Yoke Fastener Torques				
Position	**Brand**	**Model Number**	**Input Size**	**Torque: lbf·ft (N·m)**
Single Axle Input Shaft	Meritor	MS-21-14X	M39- 1.5	920-1130 (1250-1530)
		RS-23-160, RS-23-161, RS-23-186, RS-25-160, RS-26-185, RS-30-185,	M45-1.5	1000-1230 (1355-1670)
		RS-30-380, RS-38-380	1-1/2 -12 UNF	800-1100 (1085-1490)
	Detroit	DA-RS-17.5-4, DA-RS-19.0-4, DA-RS-21.0-4, DA-RS-23.0-4	M45-1.5	627-850 (850-1150)
First Carrier Input Shaft	Meritor	MT-40-143/4M, MT-40-14X, MT-40-14XGP, MT-40-14XP, MT-44-14X, MT-44-14XP	M 45-1.5	750-850 (1015-1150)
		RT-40-145, RT-40-145A, RT-40-145GP, RT-40-145P, RT-44-145, RT-44-145P, RT-40-160, RT-40-160P, RT-46-160, RT-46-160GP, RT-46-160P, RT-46-164, RT-46-164P		
		RT-50-160, RT-50-160GP, RT-50-160P, RZ-166, RZ-166 R-SERIES		
		RT-52-185, RT-52-185G, RT-58-185, RT-52-380G, RT-70-380, RT-70-380P, RZ-186, RZ-188, RZ-188G	1-3/4x12 UN	
	Detroit	DA-RT-40.0-4, DA-RT-40.0-4 HT, DA-RT-44.0-4, DA-RT-44.0-4 HT, DA-RT-46.0-4 HH	M45-1.5	627-850 (850-1150)
	Dana Spicer	DT463P, DD404, DD405, DD405P, DDH40, DDH40P, DS404, DS404P, DS405, DS405P, DSH40, DSH40P, DST40, DST41, DDH44P, DSH44P	M42 X 1.5	840-1020 (1140-1385)
		S23-190, D46-170, D50-170P, D52-190P, D40-170, D40-170P, D46-170P	M48 X 1.5	800-1000 (1085-1355)

Axle End-Yoke Fastener Torques				
Position	**Brand**	**Model Number**	**Input Size**	**Torque: lbf·ft (N·m)**
First Carrier Output Shaft	Meritor	MT-40-143/4M, MT-40-14X, MT-40-14XGP, MT-40-14XP, MT-44-14X, MT-44-14XP	M 39 x 1.5	600-800 (815-1085)
		RT-40-145, RT-40-145A, RT-40-145GP, RT-40-145P, RT-44-145, RT-44-145P, RT-40-160, RT-40-160P, RT-46-160, RT-46-160GP, RT-46-160P, RT-46-164, RT-46-164P		
		RT-50-160, RT-50-160GP, RT-50-160P, RZ-166, RZ-166 R-SERIES		
		RT-52-185, RT-52-185G, RT-58-185, RT-52-380G, RT-70-380, RT-70-380P, RZ-186, RZ-188, RZ-188G	1-1/2x12 UNF	450-650 (610-880)
	Detroit	DA-RT-40.0-4, DA-RT-40.0-4 HT, DA-RT-44.0-4, DA-RT-44.0-4 HT, DA-RT-46.0-4 HH	M39 x 1.5	520 - 700 (705-950)
	Dana Spicer	DT463P, DD404, DD405, DD405P, DDH40, DDH40P, DS404, DS404P, DS405, DS405P, DSH40, DSH40P, DST40, DST41, DDH44P, DSH44P	M39 X 1.5	680 - 832 (920-1130)
		S23-190, D46-170, D50-170P, D52-190P, D40-170, D40-170P, D46-170P	M42 x 1.5	800-1000 (1085-1355)
Second Carrier Input Shaft	Meritor	MT-40-143/4M, MT-40-14X, MT-40-14XGP, MT-40-14XP, MT-44-14X, MT-44-14XP	M 39 x 1.5	920-1130 (1250-1530)
		RT-40-145, RT-40-145A, RT-40-145GP, RT-40-145P, RT-44-145, RT-44-145P		
		RT-40-160, RT-40-160P, RT-46-160, RT-46-160GP, RT-46-160P, RT-46-164, RT-46-164P, RT-50-160, RT-50-160GP, RT-50-160P, RT-52-185, RT-52-185G, RT-58-185	M45 x 1.5	1000-1230 (1355-1670)
		RT-52-380G, RT-70-380, RT-70-380P	1-1/2 - 12 UNF	800-1100 (1085-1490)
		RZ-166, RZ-166 R-SERIES, RZ-186	M45 x 1.5	600-800 (815-1085)
		RZ-188, RZ-188G	1-3/4 - 12 UN	600-800 (815-1085)
Second Carrier Output Shaft	Meritor	RZ-166, RZ-166 R-SERIES, RZ-186	M39 x 1.5	450-650 (610-880)
		RZ-188, RZ-188G	1-1/2 -12 UNF	450-650 (610-880)
Third Carrier Input Shaft	Meritor	RZ-166, RZ-166 R-SERIES, RZ-186, RZ-188, RZ-188G	M45 x 1.5	1000-1230 (1355-1670)

Table 5, Axle End-Yoke Fastener Torques

Contents

Driveline Angularity

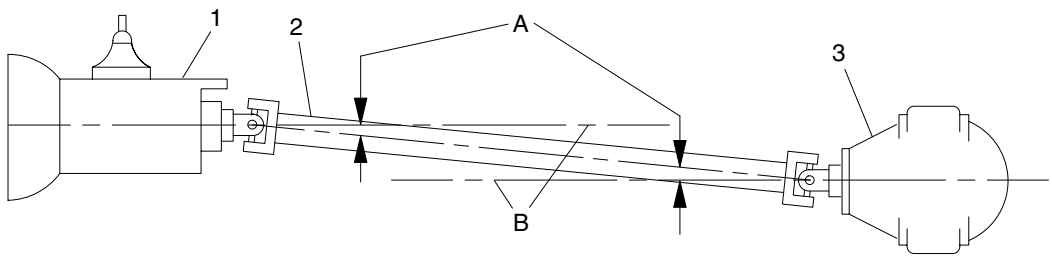
The most important consideration of driveline angularity is the U-joint working angle. A U-joint working angle is the angle formed by the intersection of the driveshaft centerline and the extended centerline of the shaft of any component to which the U-joint connects. See **Fig. 1**. Because the action of a U-joint causes a fluctuating speed difference between the shafts it connects, the effect created by the U-joint at the input-shaft end-yoke must cancel the effect created by the U-joint at the output-shaft end-yoke. This is done by making the U-joint working angles at both ends of the driveshaft approximately equal, with the U-joints in phase.

The U-joint working angles may be made approximately equal by either of two basic arrangements: a parallel arrangement (**Fig. 1**), or an intersecting arrangement (**Fig. 2**).

Driveline angularity may be adversely affected if rear suspension U-bolts are loose or broken; rear springs are broken, shifted, or mismatched; spring seats are broken; frame rails are bent, twisted, or broken; or transmission or engine mounts are loose or deteriorated.

U-Joint Phasing

The fluctuating speed difference, caused by the action of a U-joint connecting angled shafts, can be cancelled only if the U-joint at the other end of the driveshaft is in phase with that U-joint (and the U-joint working angles are approximately equal). If the yoke lugs at both ends of the driveshaft are lying in the same plane (a plane that bisects the shaft lengthwise) the U-joints will be in phase. See **Fig. 3**.



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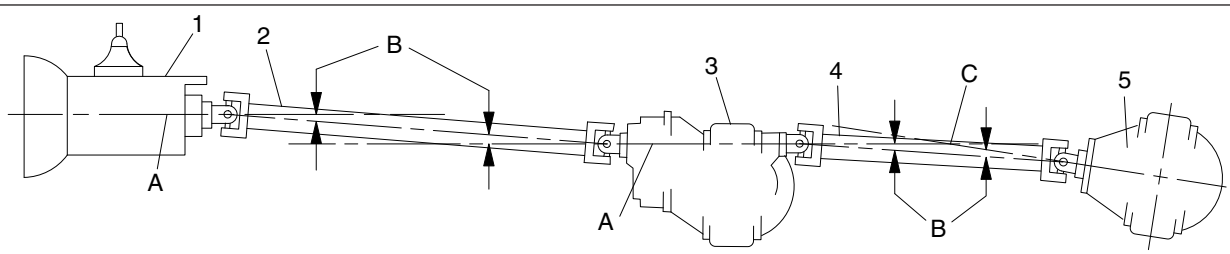
A. Equal U-Joint Working Angles
B. Parallel Centerlines
1. Transmission
2. No. 2 Driveshaft
3. Rear Axle

Fig. 1, Parallel Arrangement for Single-Drive Vehicles



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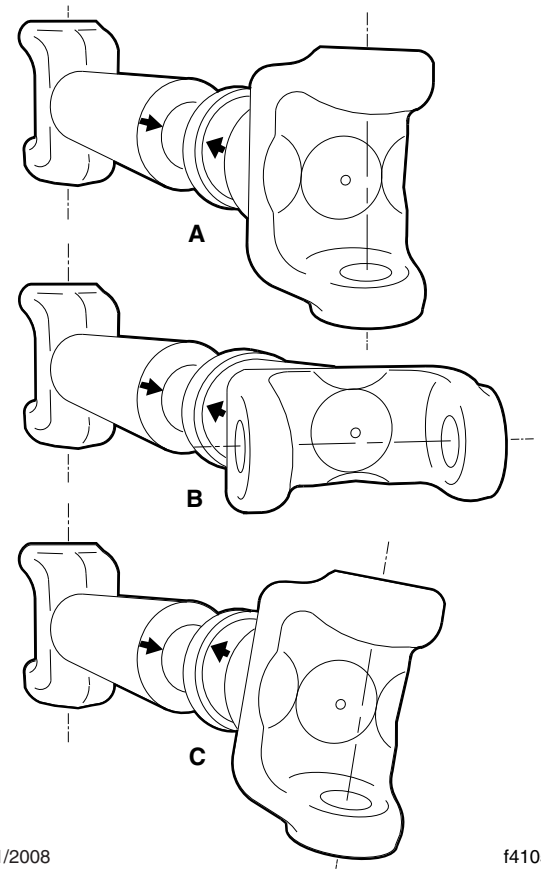
A. Parallel Centerlines
B. Equal U-Joint Working Angles
C. Intersecting Centerlines
1. Transmission
2. No. 2 Driveshaft
3. Forward-Rear Axle
4. No. 3 Driveshaft
5. Rearmost Axle

Fig. 2, Intersecting Planing Arrangements for Dual-Drive Vehicles

General Information

NOTE: Some driveshafts are designed and phased with their end yokes clocked 90 degrees from each other. This is referred to as cross phasing.



A. In Phase (parallel phased)
B. In Phase (cross phased)
C. Out of Phase

Fig. 3, Driveline U-Joint Phasing

To ensure that the U-joints turn in phase, the sleeve-yoke and splined shaft of driveshaft slip-joints, and the coupling shaft and midship bearing end-yoke, should be marked for assembly reference before disassembly.

Driveline Balance

After manufacture, each driveline yoke is statically balanced. After assembly of the slip-joint, each driveshaft is checked for out-of-roundness, and straightened as necessary; then each shaft is dynamically balanced.

If the driveshaft slip-joint is disassembled for any reason, the sleeve-yoke and splined shaft should be marked for assembly alignment. Misaligned slip-joints will seriously affect the U-joint phasing and balance of the driveline. Even if the slip-joint is assembled 180 degrees from its original position (which will keep the U-joints in phase), the dynamic balance of the driveshaft will be negatively affected.

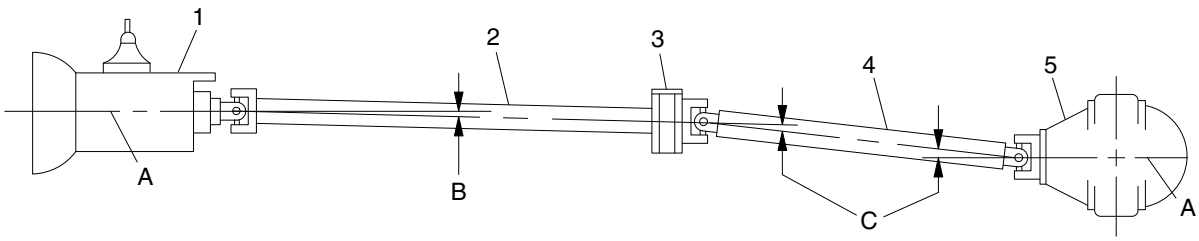
A driveline can become unbalanced or greatly weakened if a driveshaft has been dented, bent, twisted, or otherwise damaged. Operating a vehicle at speeds that exceed the speed of the driveshaft's design specifications will cause an out-of-balance vibration. Loose end-yoke nuts, loose midship bearing or auxiliary transmission mounts, loose bearing retainer capscrews, worn U-joint trunnions or bearings, and worn slip-joint splines can lead to excessive movement of the driveshaft and cause driveline imbalance.

Midship Bearings

A long driveshaft, supported only at its ends, will sag in the middle from its own weight. When turning at high rpm, it will flex, causing an out-of-balance vibration. Therefore, most vehicles having a long wheelbase use a midship bearing, mounted on a crossmember in the frame, for additional driveline support. See **Fig. 4**. This allows the driveshaft to be separated into two shorter shafts, thus improving balance and stability.

Angularity Standards and Drivetrain Configuration

The U-joints require a minimum working angle of 1/2 degree to ensure needle-roller movement in the U-joint bearings. Without this movement, brinelling of the trunnion bearing-contact surfaces would occur. Suspension movement causes driveshaft angles to change (and therefore, needle-roller movement) in both of the U-joints attached to driveshafts that connect to the axles. However, no angle change occurs in the U-joints attached to a driveshaft that connects the main transmission to a midship bearing or auxiliary transmission. Their working angles must be established during installation.



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A. Parallel Centerlines
B. 1/2 to 1 Degree
C. Working Angles Unequal by 1/2 to 1 Degree

1. Main Transmission
2. Coupling Shaft
3. Midship Bearing
4. No. 2 Driveshaft
5. Rear Axle

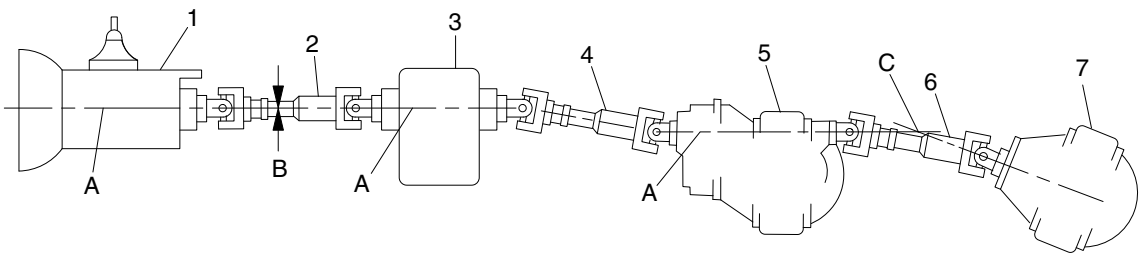
Fig. 4, Midship Bearing in a Single-Drive Vehicle

When a midship bearing is included in the drivetrain, it is installed so that the centerline of the coupling shaft is in horizontal (side-to-side) alignment within 1/2 degree, and within 1/2 to 1 degree of vertical alignment, with the centerline of the main transmission output shaft. See **Fig. 4**.

When an auxiliary transmission is included in the drivetrain, it is installed so that the centerline of the inter-transmission (no. 1) driveline is in exact horizontal (side-to-side) alignment (within 1/2 degree), and down 1/2 to 1 degree from vertical alignment, with the centerline of the main transmission output shaft. Further, the auxiliary transmission thru-shaft centerline must be parallel (horizontally and vertically) to the centerline of the main transmission output shaft, in order to achieve equal working angles. See **Fig. 5**.

Every U-joint has a maximum working angle, determined by the design and size of its cross assembly and yokes. Exceeding the maximum working angle can cause rapid U-joint wear, or in severe cases, destruction of the U-joint. For smooth operation and long drivetrain component life, the U-joint working angles must be kept small and approximately equal for each shaft.

The U-joint working angles may be made approximately equal by either of two basic arrangements: a parallel arrangement (**Fig. 1**) or an intersecting arrangement (**Fig. 2**). The parallel arrangement consists of installing the drivetrain components so that all of the input, output, and thru-shaft centerlines are approximately parallel. The intersecting arrangement (used only for some interaxle drivelines) consists of installing the drive components so that the rearmost



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A. Parallel Centerlines
B. 1/2 to 1 Degree
C. Intersecting Centerlines

1. Main Transmission
2. No. 1 Driveline
3. Auxiliary Transmission
4. No. 2 Driveshaft
5. Forward-Rear Axle
6. No. 3 Driveshaft
7. Rearmost Axle

Fig. 5, Auxiliary Transmission in a Dual-Drive Vehicle

General Information

axle pinion shaft's extended centerline intersects the forward-rear axle thru-shaft's extended centerline approximately midway between the U-joints, when all of the other shafts (including the forward-rear axle thru-shaft) are approximately parallel.

All single-drive vehicles, and the forward-rear axles of dual-drive vehicles, use the parallel arrangement. Rearmost axles of dual-drive vehicles may use the parallel arrangement or the intersecting arrangement, depending on the drivetrain configuration.

The specific drivetrain configuration of each Freightliner vehicle consists of its wheelbase, number and type of axles, axle spacing, type of suspension, and number of transmissions. The specific drivetrain configuration determines the driveline arrangement and required installation angles of all the vehicle's drivetrain components.

The simplest drivetrain configuration consists of a single short driveline connecting a main transmission to a single-drive axle, in a parallel arrangement. This driveshaft is always referred to as the no. 2 driveshaft. The parallel arrangement always used on single-drive vehicles is shown in **Fig. 1**.

On dual-drive vehicles that have both axle input shafts of approximately the same height, a parallel arrangement is used. The driveshaft connecting the main (or auxiliary) transmission to the forward-rear axle is always referred to as the no. 2 driveshaft; and the interaxle driveshaft is always referred to as the no. 3 driveshaft. See **Fig. 6**, which shows a parallel arrangement when used on dual-drive vehicles.

Most dual-drive vehicles have a high thru-shaft on the forward-rear axle, and a low pinion on the rearmost axle. When the vehicle is on level ground, the interaxle (no. 3) driveshaft may create very sharp U-joint working angles with the input and output shafts when they are parallel. In normal driving, the U-joints could momentarily exceed their maximum working angle, and driveline or drivetrain damage could result. By using an intersecting arrangement at the no. 3 driveshaft, smaller U-joint working angles are created, promoting longer U-joint life and reduced driveline vibration. An intersecting arrangement used on dual-drive vehicles is shown in **Fig. 2**.

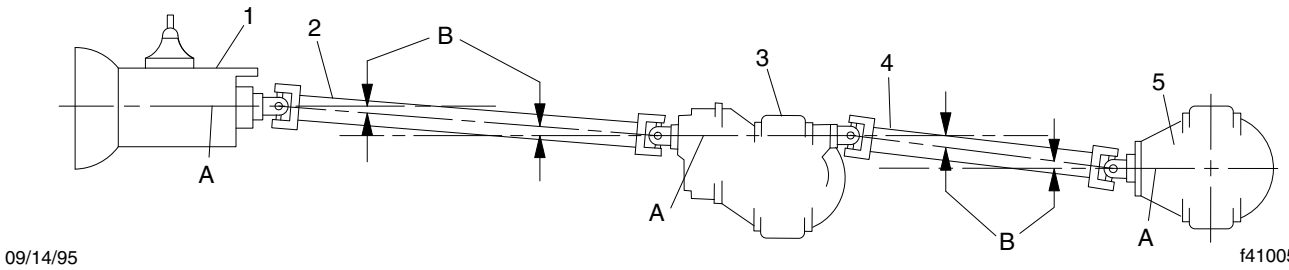
However, some axle spacings, axle models, and suspension designs allow additional axle movement or axle windup that requires additional clearances between the driveshaft and the frame or suspension components, or that creates other conditions that make the intersecting arrangement of the no. 3 driveshaft unsatisfactory. For those drivetrain configurations, it is necessary to use a modified parallel or modified-intersecting arrangement for the no. 3 driveshaft.

On drivetrain configurations that require a modified parallel arrangement, the rearmost-axle pinion shaft centerline is placed at an angle that is 2 degrees higher above horizontal than are the other input and output shafts. See **Fig. 7**.

On drivetrain configurations that require a modified-intersecting arrangement, the "proper" intersecting angle is determined, then the rearmost-axle pinion shaft centerline is placed at an angle that is 2 degrees closer to horizontal than the "proper" intersecting angle. See **Fig. 8**.

The axle pinion angles for all suspensions are factory-set for correct driveline angularity. On Freightliner spring suspensions, tapered axle planing shims at the springs maintain the correct axle pinion angle. On Hendrickson suspensions, spacers at the torque rods are used to maintain the correct axle pinion angles.

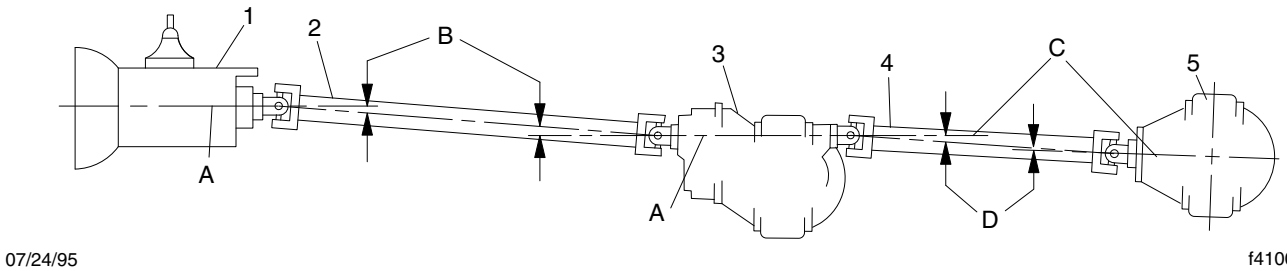
In the field, whenever axle or suspension components are changed, the axle pinion angles may also change. If this occurs, contact your district service manager for the correct axle pinion angle adjustment procedure.



A. Parallel Centerlines
B. Equal U-Joint Working Angles

1. Transmission
2. No. 2 Driveshaft
3. Forward-Rear Axle
4. No. 3 Driveshaft
5. Rearmost Axle

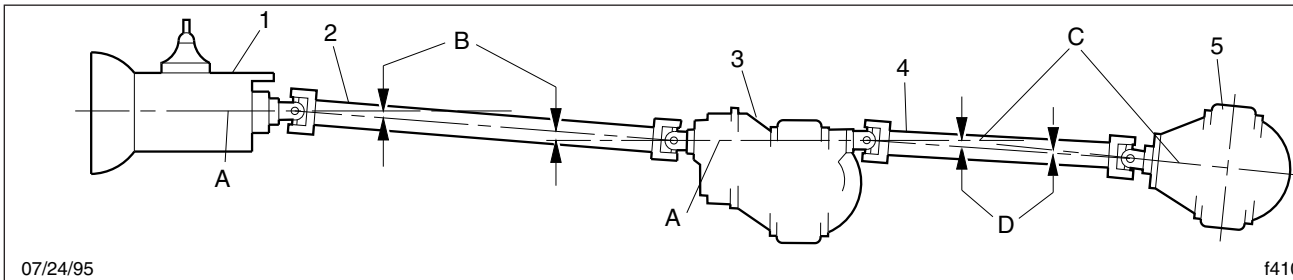
Fig. 6, Parallel Arrangement for Dual-Drive Vehicles



A. Parallel Centerlines
B. Equal U-Joint Working Angles
C. Modified-Parallel Centerlines
D. U-Joint Working Angles Not Equal by 2 Degrees

1. Transmission
2. No. 2 Driveshaft
3. Forward-Rear Axle
4. No. 3 Driveshaft
5. Rearmost Axle

Fig. 7, Modified-Parallel Arrangement for Dual-Drive Vehicles



A. Parallel Centerlines
B. Equal U-Joint Working Angles
C. Modified-Intersecting Centerlines
D. U-Joint Working Angles Not Equal by 2 Degrees

1. Transmission
2. No. 2 Driveshaft
3. Forward-Rear Axle
4. No. 3 Driveshaft
5. Rearmost Axle

Fig. 8, Modified-Intersecting Arrangement for Dual-Drive Vehicles

Use the procedure below for the type of tool being used. The Digital Angle Analyzer is the recommended tool.

Digital Angle Analyzer

Before checking the pinion angles or engine angle, check that the engine and transmission mounts are tight and in good condition. Loose or deteriorated mounts will cause inaccurate readings.

IMPORTANT: When using a digital angle analyzer (DAA) or digital level, be sure to always take readings from the same side of the vehicle. Also, keep the same end of the DAA pointed toward the front of the truck.

Using a DAA (**Fig. 1**), measure the engine angle, driveshaft angles, and pinion angles. Read all angles to the nearest one-tenth of a degree.

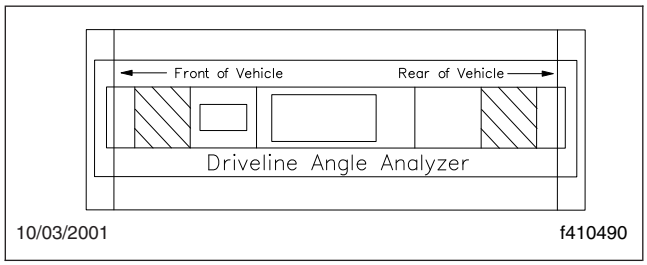
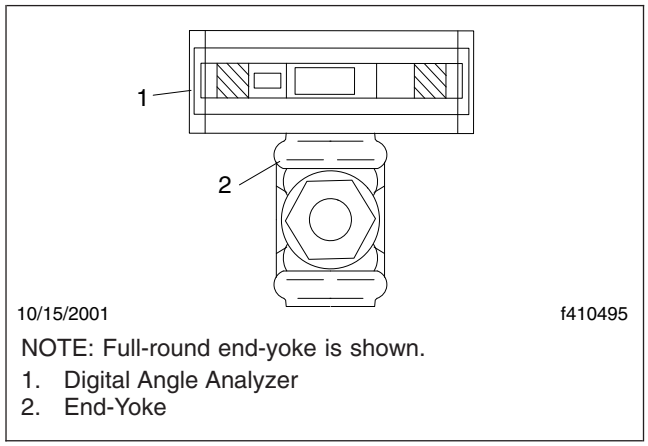


Fig. 1, Digital Angle Analyzer

After adjustment of any driveline angle, check the angle again. Also, verify ride height if the vehicle has an air suspension.

To measure the engine angle (transmission output-shaft angle) or axle pinion angles, do the following:

1. Inflate the vehicle tires to their normal operating pressure.
2. Park the unloaded vehicle on a level surface. Do not try to level the vehicle frame by jacking the front or rear axles. If the frame cannot be leveled from front to rear, determine and record the off-level inclination of the frame, and add or subtract that value from the measured values.
3. Chock the tires and place the transmission in neutral. Release the parking brakes.
4. The transmission output-shaft, coupling-shaft, and axle input- and output-yoke angles can be measured at either the top or bottom lug of the end-yoke being checked. For a full-round end-yoke, remove the bearing cup from the yoke lug. See **Section 41.00** for full-round end-yoke bearing cup removal.
5. Turn the end-yoke until the machined surface of the yoke lug is horizontal. See **Fig. 2**.



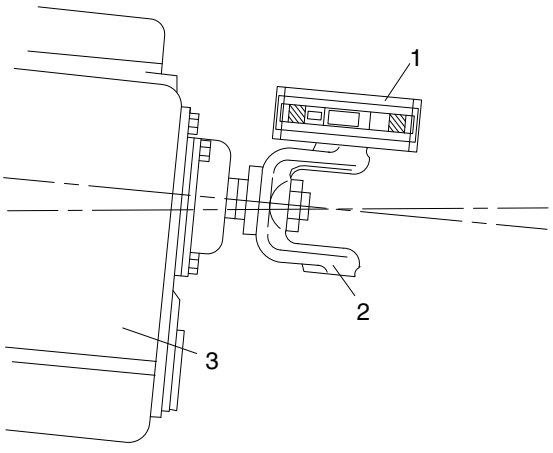
NOTE: Full-round end-yoke is shown.

1. Digital Angle Analyzer
2. End-Yoke

Fig. 2, Horizontal Positioning of Yoke Lug Machined Surface

6. To turn the driveshaft, raise one side of the rear (single-drive) or rearmost (dual-drive) axle until the tires are off the ground. Place a safety stand under the axle. With the transmission in neutral, and the interaxle differential (if equipped) unlocked, turn the tire to move the driveshaft.
7. Calibrate the digital level by placing it on the surface where the vehicle is parked at a 90-degree angle to the frame centerline. Zero the digital level.
8. Position the DAA alongside the U-joint trunnion, on the machined surface of the end-yoke, and at a 90-degree angle to the frame centerline. See **Fig. 2**. Then turn the end-yoke until the DAA reads 0 degrees. Remove the jack stand and lower the rear axle to the ground.
9. Calibrate the digital level by placing it on the surface where the vehicle is parked parallel to the frame centerline. Zero the digital level.
10. Without changing the position of the end-yoke, turn the DAA until it is parallel to the frame centerline. See **Fig. 3**. Record the measured angle of the pinion.

Engine and Pinion Angle Measurement



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NOTE: Full-round end-yoke is shown.

1. Digital Angle Analyzer
2. End-Yoke
3. Transmission

Fig. 3, Measuring Pinion Angles

11. For a full-round end-yoke, install the bearing cup. See **Section 41.00** for full-round end-yoke bearing cup installation.

Spirit Level Protractor

Before checking the pinion angles or engine angle, check that the engine and transmission mounts are tight and in good condition. Loose or deteriorated mounts will cause inaccurate readings.

Using a digital angle meter, spirit level protractor (see **Fig. 4**), or the head of a machinists's protractor, measure the engine angle, driveshaft angles, and pinion angles. Read all angles to the nearest one-tenth of a degree (6 minutes).

After adjustment of any driveline angle, check the angle again.

To measure the engine angle (transmission output-shaft angle) or axle pinion angles, do the following:

1. Inflate the vehicle tires to their normal operating pressure.
2. Park the unloaded vehicle on a level surface. Do not try to level the vehicle frame by jacking the front or rear axles. If the frame cannot be leveled from front to rear, determine and record the off-level inclination of the frame, and add or subtract that value from the measured values.

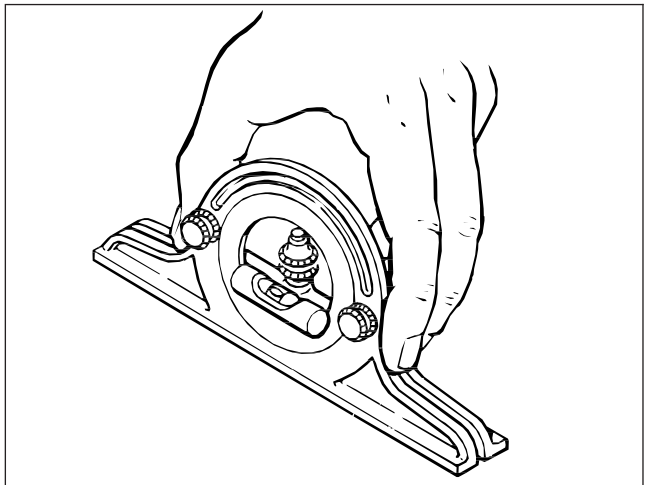

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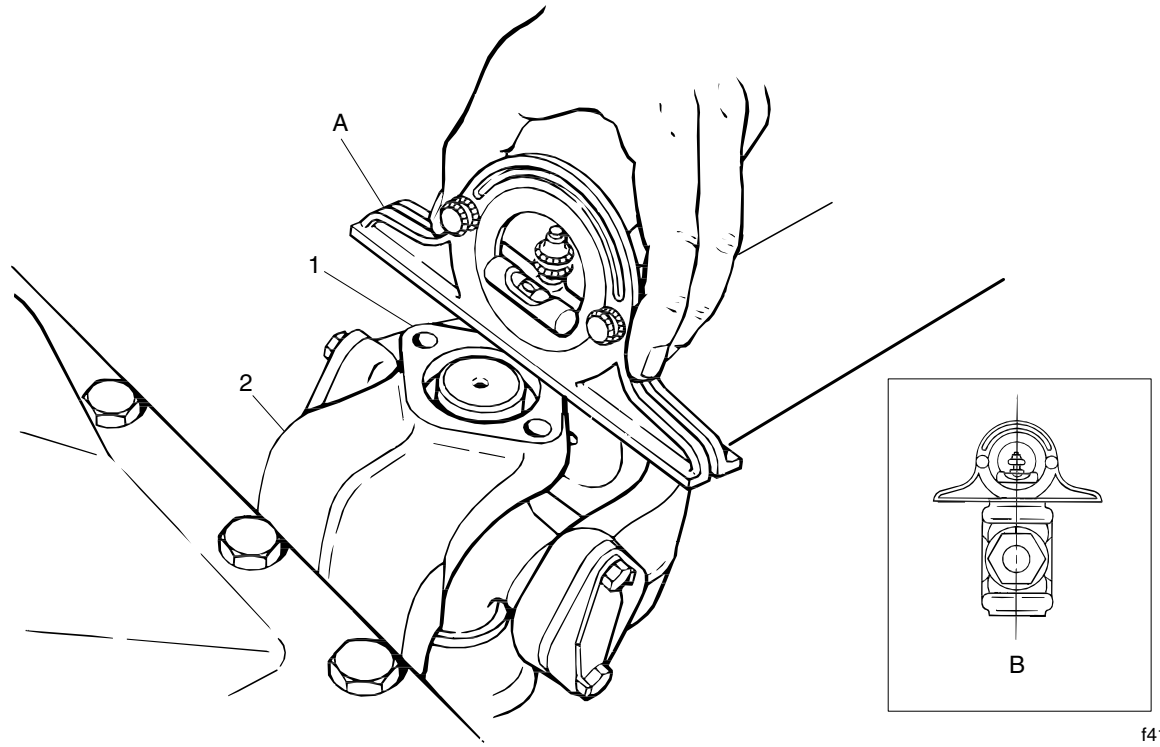
Fig. 4, Spirit Level Protractor

3. Chock the tires and place the transmission in neutral. Release the parking brakes.
4. The transmission output-shaft, coupling-shaft, and axle input- and output-yoke angles can be measured at either the top or bottom lug of the end-yoke being checked. For a full-round end-yoke, remove the bearing cup from the yoke lug. See **Section 41.00** for full-round end-yoke bearing cup removal.
5. Turn the end-yoke until the machined surface of the yoke lug is horizontal. See **Fig. 5**.

NOTE: To turn the driveshaft, raise one side of the rear (single-drive) or rearmost (dual-drive) axle until the tires are off the ground. Place a safety stand under the axle. With the transmission in neutral, and the interaxle differential (if equipped) unlocked, turn the tire to move the driveshaft.

6. Adjust the protractor scale to read 0 degrees. Position the protractor alongside the U-joint trunnion, on the machined surface of the end-yoke, and at a 90-degree angle to the frame centerline. See **Fig. 2**. Then turn the end-yoke until the bubble in the level vial is exactly between the two marks on the vial. Remove the jack stand and lower the rear axle to the ground.



NOTE: Full-round end-yoke is shown.

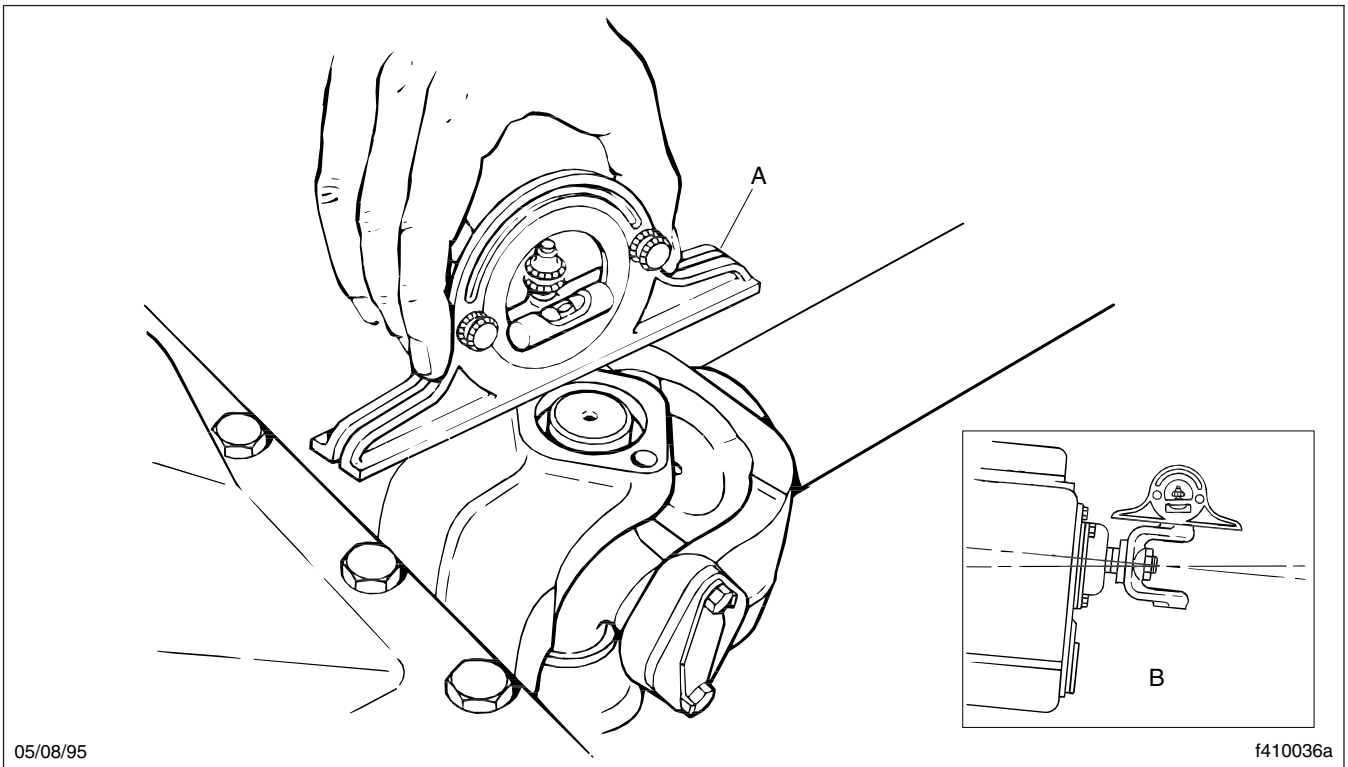
A. Protractor held at right angle to vehicle frame centerline.
B. End view of end-yoke.

1. Machined Surface of Yoke Lug
2. End-Yoke

Fig. 5, Horizontal Positioning of Yoke Lug Machined Surface

7. Without changing the position of the end-yoke, turn the protractor until it is parallel to the frame centerline. See **Fig. 6**. Adjust the calibrated scale so the bubble is exactly between the two marks on the level vial. Record the calibrated scale reading opposite the "0" mark. Correct this value for any previously recorded off-level inclination.
8. For a full-round end-yoke, install the bearing cup. See **Section 41.00** for full-round end-yoke bearing cup installation.

Engine and Pinion Angle Measurement



NOTE: Full-round end-yoke is shown.

A. Protractor held parallel to vehicle frame centerline.
B. Side view of end-yoke.

Fig. 6, Measuring Pinion Angles

Driveline Angle Checking

NOTE: Driveline suppliers have made angle checking software availble. Contact your local driveline representative or check the manufacturers website for the software. Angles need to be mearsure at the locations shown in **Fig. 1**.

If a vehicle is equipped with a Freightliner spring suspension, the axle pinion angles are factory-set using alignment shims at the rear springs. These shims have notches on the thick end of the shim. Count the number of notches in the thick end of each shim to make sure that the correct shim is used. Also, make sure the thick end of the shim is positioned correctly. See the applicable table in **Specifications, 400** for shim identification and use. If the axle pinion angles on these suspensions are incorrect, contact your district service manager for the adjustment procedure.

If the vehicle is equipped with an air suspension, verify ride height is correct. See **Group 32**.

If a vehicle is equipped with a Hendrickson suspension, spacers at the torque rods are used to maintain the correct axle pinion angles. If the measured axle pinion angles on these suspensions are not the same as the angles listed in the applicable table in **Specifications, 400**, contact your district service manager for the adjustment procedure.

NOTE: In any of the following steps, if an off-level inclination was added to or subtracted from the engine angle, the same figure must be added to or subtracted from the coupling shaft or axle pinion reading before comparing the angles. Also, avoid inperfections in paint.

IMPORTANT: DO NOT make any driveline angle adjustments before contacting your district service manager.

1. Check the engine angle at the transmission output-shaft end-yoke. The engine angle must be 3 degrees ±1/2 degree. For instructions, see **Subject 100**.

IMPORTANT: When using a digital angle analyzer (DAA), be sure to always take readings from the same side of the vehicle. Also, keep the same end of the DAA pointed toward the front of the truck.

2. If the driveline includes a midship bearing, place a digital angle analyzer (DAA) on top of the coupling shaft. Align the DAA with the shaft centerline. See **Fig. 2**. Read the scale to the nearest one-tenth of a degree (6 minutes). The centerline of the coupling shaft must be 1/2 degree out of vertical alignment with the transmission output shaft. See **Fig. 3**. Compare this reading with the measured engine angle.

   If the driveline angles are out of specification, contact your district service manager for midship bearing mount adjusting procedures.

3. On single-drive installations, measure the rear axle pinion angle at the back of the no. 2 driveline; for instructions, see **Subject 100**.

   The measured rear axle pinion angle must be equal ±1 degree to the measured engine angle. If the rear axle pinion angle does not meet the above specification, contact your district service manager.

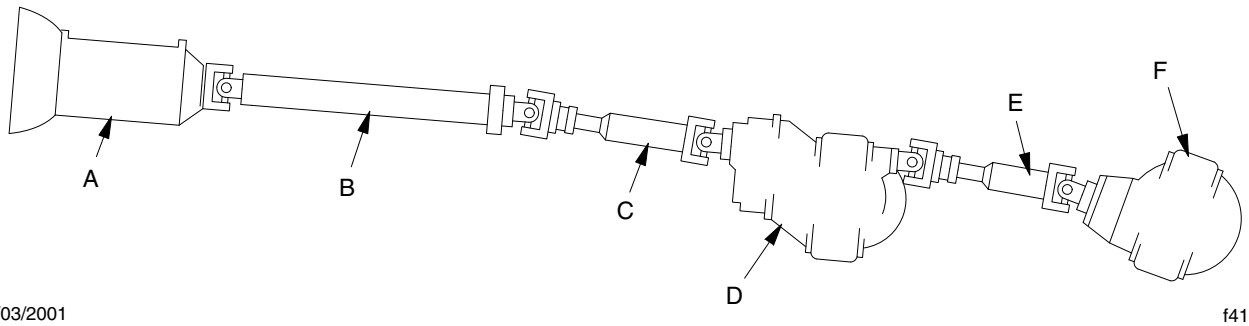
4. On dual-drive installations, measure the forward-rear-axle pinion angle (at the rear of the no. 2 driveline); for instructions, see **Subject 100**.

   The measured forward-rear-axle pinion angle must be equal ±1 degree to the measured engine angle. If the forward-rear-axle pinion angle does not meet the above specification, contact your district service manager.

   Measure the rearmost-axle pinion angle (at the rear of the no. 3 driveline); for instructions, see **Subject 100**.

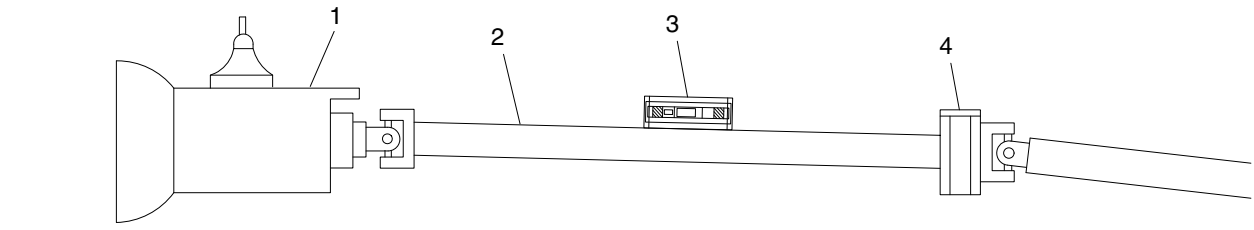
   Compare the measured angle with that shown in the applicable table in **Specifications 400**. The measured rearmost-axle pinion angle must be equal ±1 degree to the angle shown in the table. If the measured angle is incorrect, contact your district service manager.

Driveline Angle Checking



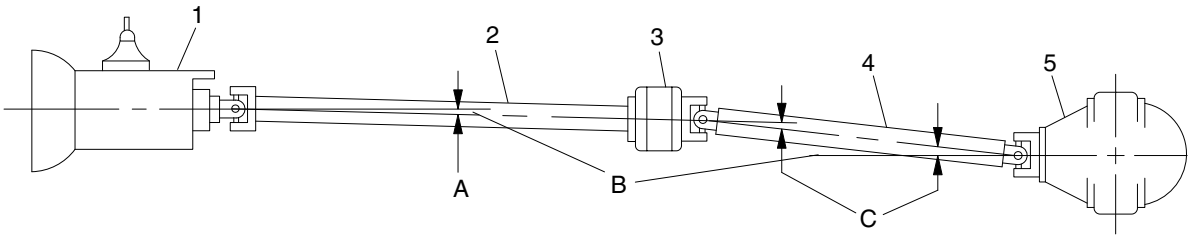
A. Tranmission
B. First Driveshaft
C. Second Driveshaft
D. Rear Drive Axle
E. Inter-Axle Driveshaft
F. Rear Drive Axle (rear-most)

Fig. 1, Driveline Angle Analysis (measuring locations)



1. Transmission
2. Coupling Shaft
3. Digital Angle Analyzer (DAA)
4. Midship Bearing

Fig. 2, Coupling Shaft Angularity



A. 1/2-Degree Minimum
B. Parallel Centerlines
C. Working Angles Unequal by 1/2 to 1 Degree

1. Transmission
2. Coupling Shaft
3. Midship Bearing
4. No. 2 Driveshaft
5. Rear Axle

Fig. 3, Midship Bearing in a Single-Drive Vehicle

Planing Angle Specifications

Engine Angle (for All Single-Drive-Axle Suspensions): Adjust to 3 or 5 degrees ±1/2 degree depending on vehicle specification in modules 101 and 109.

Engine Angle (for All Dual-Drive-Axle Suspensions): Adjust to 3-1/2 or 5 degrees ±1/2 degree depending on vehicle specification in modules 101 and 109.

Single-Drive-Axle Suspensions (All): Adjust rear axle pinion angle to 3 or 5 degrees ±1 degree depending on vehicle specification in modules 420 and 431.

Dual-Drive-Axle—Freightliner AirLiner Suspensions With Meritor RT–40/–44/–46 Axles: Adjust axle pinion angles to the values in **Table 1**, ±1 degree.

Dual-Drive-Axle—Freightliner Spring Suspensions (with Meritor RT–40/–44/–46 Axles): Adjust axle pinion angles to the values in **Table 2**, ±1 degree. See **Table 3** for shim notch decoding.

Dual-Drive-Axle—Hendrickson Suspensions With 52-Inch Axle Spacing: Adjust axle pinion angles to the values in **Table 4**, ±1 degree.

Dual-Drive-Axle—Hendrickson Suspensions With 54-Inch Axle Spacing: Adjust axle pinion angles to the values in **Table 5**, ±1 degree.

Dual-Drive-Axle—Hendrickson Suspensions With 56-Inch Axle Spacing: Adjust axle pinion angles to the values in **Table 6**, ±1 degree.

Dual-Drive-Axle—Hendrickson Suspensions With 60-Inch Axle Spacing: Adjust axle pinion angles to the values in **Table 7**, ±1 degree.

Dual-Drive-Axle—Hendrickson Suspensions With 72.5-Inch Axle Spacing: Adjust axle pinion angles to the values in **Table 8**, ±1 degree.

Business Class M2 Single Spring Suspension Ride Heights and Planning Angles in **Table 9**.

Freightliner AirLiner Suspensions With Meritor RT–40/–44/–46 Axles												
Axle Seat Angle (degrees)		Measured Suspension Height * (Inches)	Rear Suspension Load (pounds)									
			Unladen		30,000		34,000		36,000		40,000	
			Axle Pinion Angle (degrees)									
Fwd	Rear		Fwd	Rear	Fwd	Rear	Fwd	Rear	Fwd	Rear	Fwd	Rear
3.0	5.5	2.375 (min)	2.1	10.6	3.0	11.5	3.2	11.7	3.3	11.8	3.5	12.0
		2.5	2.4	10.9	3.3	11.8	3.5	12.0	3.6	12.1	3.7	12.2
		2.625	2.7	11.2	3.6	12.1	3.8	12.3	3.8	12.3	4.0	12.5
		2.75	2.9	11.4	3.9	12.4	4.0	12.5	4.1	12.6	4.3	12.8
		2.87 (max)	3.2	11.7	4.2	12.7	4.3	12.8	4.4	12.9	4.6	13.1

* Measure suspension height at the forward drive-axle stop on the driver's side; see **Section 32.04** for complete instructions.

Table 1, Freightliner AirLiner Suspensions With Meritor RT-40/-44/-46 Axles

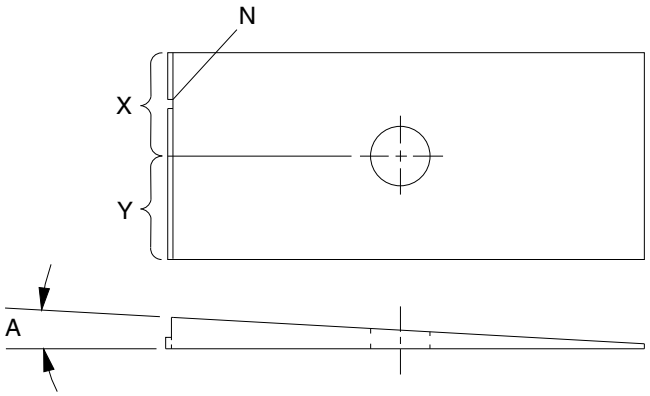
Freightliner Spring Suspensions (with Meritor RT–40/–44/–46 Axles)										
Axle Model	Forward-Rear Axle					Rearmost Axle				
	Pinion Angle (degrees)	Spring Seat Spacer	Shim Angle (degrees)	Orientation of Shim's Thick End	Number of Shim Notches *	Pinion Angle (degrees)	Spring Seat Spacer	Shim Angle (degrees)	Orientation of Shim's Thick End	Number of Shim Notches †
RT–40/–44/–46	3.0	Yes	None	—	—	11.0	None	1.0	Aft	2

* See **Table 3** for shim notch decoding.

† See **Table 3** for shim notch decoding.

Table 2, Freightliner Spring Suspensions (with Meritor RT-40/-44/-46 Axles)

Specifications



Shim Angle *A* (degrees)	Notches (N) at *X*	Notches (N) at *Y*
0.5	One (total at x plus y)	
1.0	Two	none
1.5	Three	none
2.0	Four (total at x plus y)	
2.5	Five (total at x plus y)	
3.0	Six (total at x plus y)	
3.5	Zero	Zero
4.0	One	One
4.5	Two	One

Table 3, Shim Notch Decoding

Hendrickson Suspensions With 52-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT40/44–145(P)	RS–400, –460	12.88	3.2	11.6	3.0	11.8	22.5	—	25.75	0.125
RT40/44–145(P)	RS–400, –460	14	3.3	11.5	3.0	11.8	22.5	—	25.75	—
RT40/44–145(P)	RT2–400	7.19	4.2	12.6	3.0	11.8	22.25	—	25.75	—
RT40/44–145(P)	RT2–460	6	4.4	12.6	3.0	11.8	22.5	0.125	25.75	—
RT40/44–145(P)	RT2–460	7.19	2.8	10.8	3.0	11.8	22.5	—	26	0.125

Specifications

Hendrickson Suspensions With 52-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT40/44–145(P)	RTE2–400	7.19	4.6	12.9	3.0	11.8	22	0.125	26.25	0.125
RT40/44–145(P)	RTE2–460	7.19	4.8	12.9	3.0	11.8	22.25	—	26	—
RT46–160(P)	RS–400, –460	12.88	3.1	11.3	3.0	11.4	22.5	0.125	25.75	0.125
RT46–160(P)	RS–400, –460	14	3.2	11.1	3.0	11.4	22.5	—	25.75	0.125
RT46–160(P)	RT2–400	7.19	4.1	12.2	3.0	11.4	22.25	—	25.75	—
RT46–160(P)	RT2–460	6	4.3	12.3	3.0	11.4	22.5	0.125	25.75	—
RT46–160(P)	RT2–460	7.19	2.8	10.5	3.0	11.4	22.5	0.125	25.75	—
RT46–160(P)	RTE2–400	7.19	4.5	12.6	3.0	11.4	22	0.125	26.25	0.125
RT46–160(P)	RTE2–460	7.19	4.7	12.5	3.0	11.4	22.25	0.125	26	—

Table 4, Hendrickson Suspensions With 52-Inch Axle Spacing

Hendrickson Suspensions With 54-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT40/44–145(P)	RS–400, –460	14	3.3	10.8	3.0	11.1	23.5	—	26.5	—
RT40/44–145(P)	RS–400, –460	12.88	3.1	10.9	3.0	11.1	23.5	—	26.5	0.125
RT40/44–145(P)	RT2–400	7.19	4.2	11.9	3.0	11.1	23.25	—	26.5	—
RT40/44–145(P)	RT2–460	6	4.4	12.0	3.0	11.1	23.5	0.125	26.5	—
RT40/44–145(P)	RTE2–400	7.19	4.6	12.2	3.0	11.1	23	—	27	—
RT40/44–145(P)	RTE2–460	7.19	4.8	12.2	3.0	11.1	23.25	0.125	26.75	—
RT46–160(P)	RS–400	14	3.2	10.6	3.0	10.8	23.5	—	26.5	0.125
RT46–160(P)	RS–460	14	3.2	10.6	3.0	10.8	23.5	—	26.5	—
RT46–160(P)	RS–400, –460	12.88	3.1	10.7	3.0	10.8	23.5	0.125	26.5	0.125
RT46–160(P)	RT2–400	7.19	4.1	11.7	3.0	10.8	23.25	—	26.5	—
RT46–160(P)	RT2–460	6	4.3	11.7	3.0	10.8	23.25	—	26.5	—
RT46–160(P)	RTE2–400	7.19	4.5	12.0	3.0	10.8	23	0.125	27	0.125
RT46–160(P)	RTE2–460	7.19	4.7	11.9	3.0	10.8	23.25	0.125	26.75	—

Table 5, Hendrickson Suspensions With 54-Inch Axle Spacing

Specifications

Hendrickson Suspensions With 56-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT40/44–145(P)	RTE2–460	7.19	4.4	11.7	3.0	10.6	24.25	0.125	27.75	0.125
RT46–160(P)	RTE2–460	7.19	4.7	11.4	3.0	10.3	24.25	0.125	27.5	—

Table 6, Hendrickson Suspensions With 56-Inch Axle Spacing

Hendrickson Suspensions With 60-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT40/44–145(P)	RS–400, –460	12.88	3.1	9.5	3.0	9.7	26.5	—	29	0.125
RT40/44–145(P)	RS–400, –460	14	3.2	9.4	3.0	9.7	26.5	—	29	—
RT40/44–145(P)	RT2–400	7.19	4.2	10.5	3.0	9.7	26.25	—	29	—
RT40/44–145(P)	RT2–460	6	4.3	10.6	3.0	9.7	26.5	0.125	29	—
RT40/44–145(P)	RTE2–400	7.19	4.6	10.9	3.0	9.7	26	—	29.5	—
RT40/44–145(P)	RTE2–460	7.19	4.7	10.8	3.0	9.7	26.25	0.125	29.25	—
RT46–160(P)	RS–400, –460	12.88	3.1	9.4	3.0	9.5	26.5	0.125	29	0.125
RT46–160(P)	RS–400, –460	14	3.2	9.3	3.0	9.5	26.5	—	29	—
RT46–160(P)	RT2–400	7.19	4.1	10.4	3.0	9.5	26.25	—	29	—
RT46–160(P)	RT2–460	6	4.3	10.4	3.0	9.5	26.25	—	29	—
RT46–160(P)	RTE2–400	7.19	4.5	10.7	3.0	9.5	26	0.125	29.5	—
RT46–160(P)	RTE2–460	7.19	4.6	10.8	3.0	9.5	26.25	0.125	29.25	—

Table 7, Hendrickson Suspensions With 60-Inch Axle Spacing

Hendrickson Suspensions With 72.5-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT40/44–145(P)	RS–460	12.88	3.1	7.5	3.0	7.6	32.75	0.125	34.5	0.125
RT40/44–145(P)	RS–460	14	3.2	7.4	3.0	7.6	32.75	—	34.5	—
RT40/44–145(P)	RT2–460	6	4.3	8.5	3.0	7.6	32.75	0.125	34.5	—
RT40/44–145(P)	RTE2–460	7.19	4.6	8.6	3.0	7.6	32.5	0.125	34.75	—

Specifications

Hendrickson Suspensions With 72.5-Inch Axle Spacing										
Axle Model	Suspension Model	Saddle Height (inches)	Planing Angle (degrees)				Suspension Control Rod			
			Unladen		Laden		Forward Axle		Rear Axle	
			Front	Rear	Front	Rear	Rod Length (inches)	Spacer Thickness (inches)	Rod Length (inches)	Spacer Thickness (inches)
RT46–160(P)	RS–460	12.88	3.1	7.3	3.0	7.4	32.75	0.125	34.5	0.125
RT46–160(P)	RS–460	14	3.1	7.2	3.0	7.4	32.75	0.125	34.5	—
RT46–160(P)	RT2–460	6	4.2	8.4	3.0	7.4	32.5	—	34.5	—
RT46–160(P)	RTE2–460	7.19	4.6	8.6	3.0	7.4	32.5	0.125	34.75	—

Table 8, Hendrickson Suspensions With 72.5-Inch Axle Spacing

Business Class M2 Single Spring Suspension Ride Heights / Planing Angles		
Description	Ride Height *	Available Planing Angles †
10k M2 52" Vari-Rate Spring	260 mm (unladen)	3, 5 Degrees
12.5k M2 52" Vari-Rate Spring	260 mm (unladen)	
16k M2 52" Vari-Rate Spring w/ RS 13/15-120 axles	270 mm (unladen)	
16k M2 52" Vari-Rate Spring w/ RS 17-145 axles	285 mm (unladen)	
18k w/ & w/o Helper	300 mm (unladen)	
21k w/ & w/o Helper	310 mm (unladen)	
23k w/ & w/o Helper	310 mm (unladen)	
18k 60" Taper leaf 2 stage spring	235 mm (laden)	
21k 60" Taper leaf 2 stage spring	235 mm (laden)	
23k 60" Taper leaf 2 stage spring	235 mm (laden)	

* Ride height taken from the bottom bolt of the forward suspension hanger.

† Check the vehicle specification in module 421 to determine if the suspension is 3 or 5 degrees.

Table 9, Business Class M2 Single Spring Suspension Ride Heights / Planing Angles