

Roadranger®

Dana® Spicer® Single Drive Axles

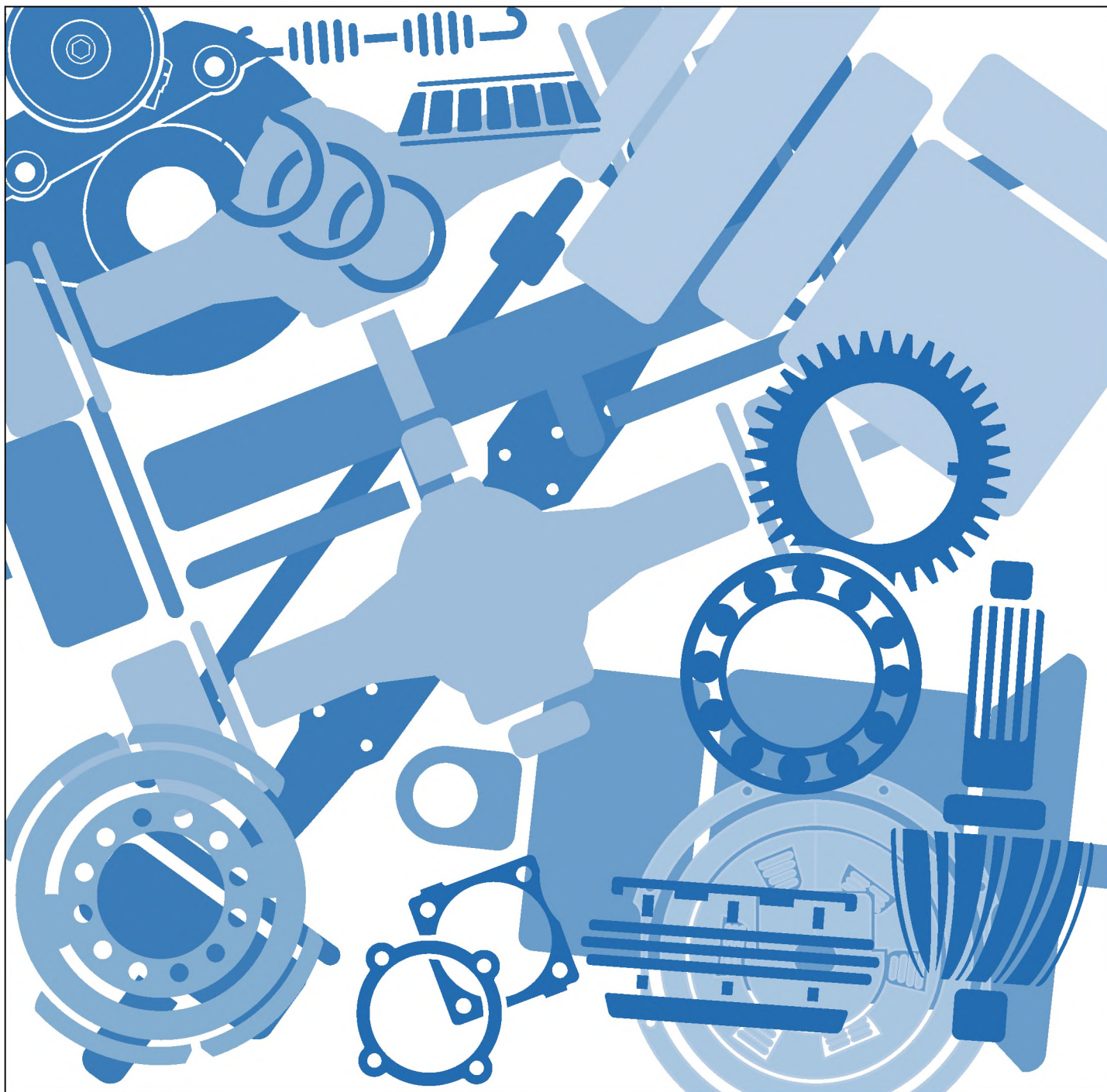
Single Reduction Axles
with Controlled Traction Differentials



EATON

One Great Drivetrain from Two Great Companies

Service Manual AXSM-0047 December 1991



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Eaton Axle Service and Maintenance Instructions

Eaton^R Controlled Traction Differentials

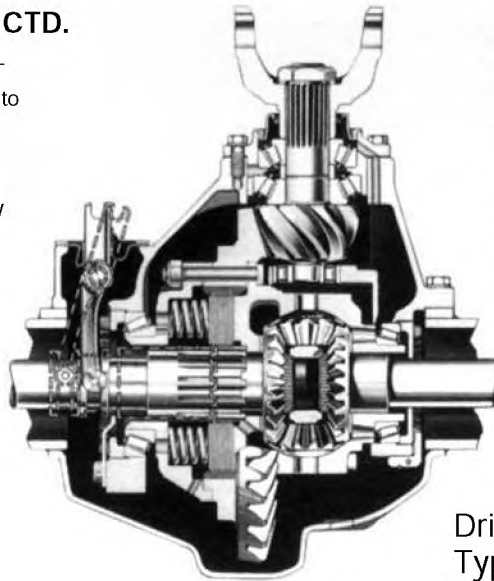
Introduction

Eaton Corporation, Axle & Brake Division presents this publication to aid in maintenance and overhaul of Eaton single reduction axles equipped with a biasing-type, controlled traction differential. In this manual, this unit is termed Controlled Traction Differential (or CTD).

Two design types are available: medium-duty and heavy-duty.

Medium-duty CTD.

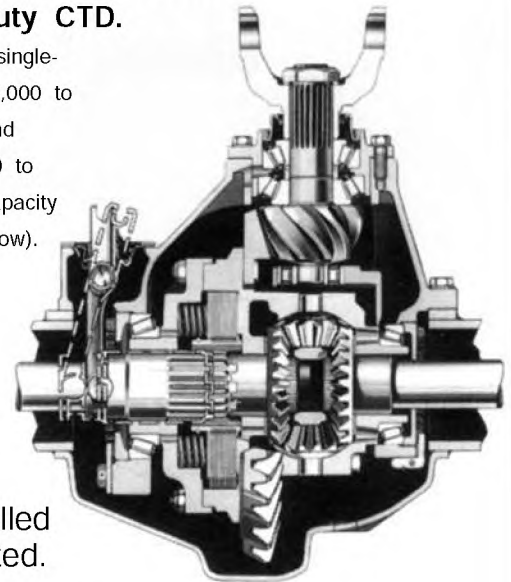
Designed for single-drive axels 19,000 to 22,000 lbs. and tadems 34,000 to 45,000 lbs. capacity (see chart below).



In this manual, instructions for both CTD design types are the same except where specified otherwise. This manual includes specific instructions for single reduction, differential carriers (both single drive and tandem axles) equipped with Controlled Traction Differentials. For service instructions covering other axle parts and adjustments, refer to the appropriate Eaton axle service manuals (see back cover).

Medium-duty CTD.

Designed for single-drive axels 23,000 to 30,000 lbs. and tadems 44,000 to 52,000 lbs. capacity (see chart below).



Driver-Controlled Type Illustrated.

Controlled Traction Differential (CTD) Applications

Axle Models

Friction Plates (qty.)

Clutch Pack Kit

Medium Duty CTD

17401, 17421, 21421, 22421
DC381 (P), DC401-P
DC402(P), DC451-P

(8) Splined O.D. (7) Splined I.D.
Part No. 111027 Part No. 111028

Total Plates 15
Part No. 118291

Heavy Duty CTD

23105C, 26105C, 30105C

(9) Tanged O.D. (8) Splined I.D.
Part No. 113972 Part No. 113971

Total Plates 17
Part No. 121704

*23421, 26421, 23085
DC460-P, DC480-P
DC461-P, DC521-P

(13) Tanged O.D. (12) Splined I.D.
Part No. 82446 Part No. 82445

*Total Plates 25
Part No. 211361

(11) Tanged O.D. (10) Splined I.D.
Part No. 82446 Part No. 82445

*Total Plates 21
Part No. 084827

*NOTE: Original equipped clutch pack may include 21 or 25 friction plates. The packs are interchangeable. Individual plates are identical in both clutch packs. The 25-plate clutch pack will produce a higher biasing torque. Eaton recommends using the 25-plate clutch pack for replacement.

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Remove Differential and Clutch Pack Assembly from Carrier

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Assemble and install Clutch Pack

Heavy-Duty CTD

Remove and Disassemble Clutch Pack .
Assemble and install Clutch Pack

All Types

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Troubleshooting (Tandem Axles)
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***For Service Instructions covering other Axle Parts and Adjustments,
refer to the appropriate Eaton Axle Service Manual ... See back cover.***

Eaton[®] Controlled Traction Differentials (All Types)

Description and Operation

Eaton Controlled Traction Differentials (or CTD) incorporate a friction plate assembly designed to transfer torque from the slipping wheel to the one with traction. Engaged, the Eaton CTD converts to a biasing differential and assists in overcoming adverse operating conditions. Disengaged, it restores conventional differential action for normal road conditions.

The CTD unit is basically multiple-disc clutch designed to slip above predetermined torque values. This controlled slipping characteristic at higher torque values enables the vehicle to negotiate turns in a normal manner. Resistance to slippage at lower torque values enables the vehicle to maintain an appreciable amount of tractive effort when one wheel encounters relatively poor traction.

The Controlled Traction Differential friction plate assembly (clutch pack) is under constant spring pressure.

The Heavy-duty CTD clutch pack includes tanged and splined friction plates. The tanged plates, attached to the differential case, drive both axle shafts through the splined plates, thereby limiting differential action.

The Medium-duty CTD clutch pack includes internal-splined and external-splined plates. The external-splined plates (engaged with internal teeth of the ring gear) drive the axle shafts through the internal-splined plates, thereby limiting differential action.

In operation, the clutch pack resists spin-out and directs torque to the wheel with better traction.

Operating Types

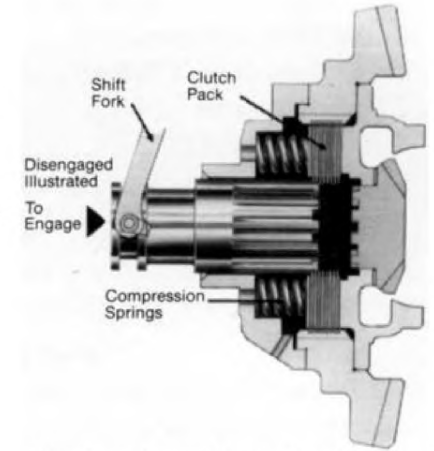
The CTD is available in three operating types:

1. Driver-Controlled CTD.

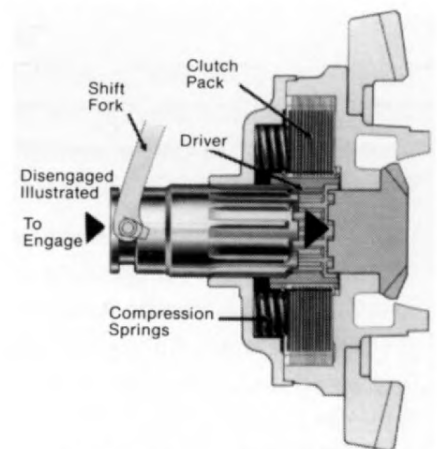
Engagement is controlled by a cab-mounted air valve using an Eaton straight-air shift system. See Shift System Section of this Manual for description, service and maintenance.

2. **Seasonal Engagement.** Manual adjustment in the shop.

3. **Permanent Engagement.** Constantly engaged.



Medium-Duty CTD with Optional Fork for Seasonal or Driver-Controlled Engagement.



Heavy-Duty CTD with Optional Fork for Seasonal or Driver-Controlled Engagement.

Checking Effectiveness of Controlled Traction Differentials

(to determine friction plate condition)

The bias torque of a new unit will check out at approximately 4,000 ft-lbs. (or higher) for Heavy-duty CTD, 3,000 ft-lbs. (or higher) for Medium-duty CTD. If bias torque value drops to 1,500 ft-lbs. (or less), replace the clutch pack.

Check bias torque values as follows:

- Disconnect drive shaft at drive pinion.
- Block one wheel or otherwise restrain vehicle.
- Jack up other wheel free of the ground.

d. Using a torque wrench, rotate pinion and note torque reading.

e. **Formula:** Torque times axle ratio equals bias differential torque.

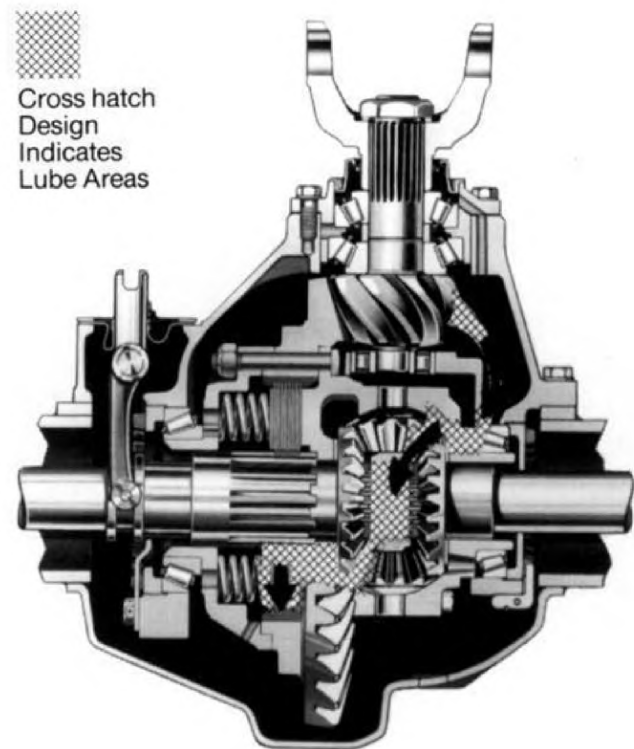
⚠ WARNING: USE JACK STAND AS ADDITIONAL SUPPORT OF VEHICLE TO PREVENT PERSONAL INJURY OR VEHICLE DAMAGE.

Lubrication

Clutch Pack Lubrication

Axle lube provides lubrication for the clutch pack through a unique system of distribution channels. The diagram (to the right) illustrates how the lube is forced through the wheel differential and clutch pack.

*Controlled Traction
Differential Lube System*



Driver-Controlled CTD Shift Unit

The driver-controlled type traction differential is usually engaged and disengaged by an air-type shift unit, operated from the vehicle cab. Shift units are activated by air. For details, see Shift System Section of this manual.

*Typical Air Shift Unit
for Driver-Controlled
Traction Differential*



Shift Unit Lubrication

Use SAE 10 motor oil for temperatures above 0° F (-18° C). For temperatures below 0° F (-18° C), mix three parts of SAE 10 motor oil with one part of kerosene. This cold weather mixture can be safely used up to 32°F (0°C).

NOTE: Commercially available automatic transmission fluid may be used in place of SAE 10 motor oil. Automatic transmission fluid can be used for all temperatures. Do not mix kerosene with automatic transmission fluid.

Lubricant Check and Level

Each 20,000 miles or 6 months, remove pipe plug in shift unit housing cover to check lubricant level. Oil should be level with bottom of filler hole.

Lubricant Change

At least once a year, remove shift unit housing cover and drain old lubricant. Wash parts thoroughly and air dry. Reinstall cover. Remove pipe plug in cover. Fill through pipe plug opening until lubricant is level with bottom of filler hole.



*Air-Shift
Unit Oil
Filler Hole*

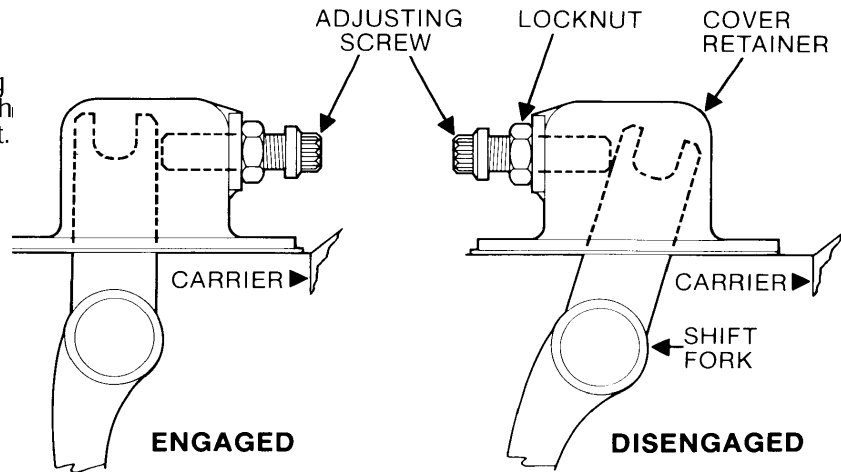
Adjustments

CTD Adjustments

No specific adjustments are required for the controlled traction differential unit itself. If clutch plates are worn excessively, replace clutch pack.

Shifting Seasonal CTD

Provisions are made for engaging or disengaging this type CTD with a simple manual shop adjustment.



Procedure for Engaging and Disengaging Seasonal CTD

Engaging — To engage, remove the shift fork cover retainer. Push the protruding end of the shift fork away from the carrier. If the shift fork will not move, lift both wheels off the ground (leave vehicle transmission in gear and release parking brake). While pushing on the shift fork, rotate the wheel on the shift fork side of the carrier very slowly. The shift fork should now be in the engaged position.

To reassemble cover retainer, the adjusting screw must be backed out several turns. This is done so that the shift fork cover retainer bolt holes align with the studs on the carrier. Once the shift fork cover retainer is in place (adjusting screw facing carrier), tighten the shift fork cover retainer nuts to the specified torque (see chart). Now turn the adjusting screw in until it contacts the shift fork. While holding the adjusting screw with a wrench, tighten the locknut to the torque specified (see chart).

Disengaging — To disengage, remove the shift fork cover retainer. Push the protruding end of the shift fork toward the carrier. If the shift fork will not move, lift both wheels off the ground (leave vehicle transmission in gear and release parking brake), then push on the shift fork. The shift fork should now move to the disengaged position.

To reassemble, place the shift fork cover retainer on the carrier so that the adjusting screw is facing away from the carrier. The adjusting screw may need to be backed out of the shift fork cover retainer several turns so that the shift fork cover bolt holes align with the studs on the carrier. Once the shift fork cover is in place, tighten the shift fork cover nuts to the specified torque (see chart). Now turn the adjusting screw in until it contacts the shift fork. While holding the adjusting screw with a wrench, tighten the locknut to the torque specified (see chart).

Fastener Tightening Specifications

	Size	Ft-lbs.	N.m
Ring Gear to Support Case			
Bolt/Nut	3/4-16 (Grade 8)	275-300	373-407
	5/8-18 (Grade 8)	195-245	264-332
Shift Unit Stud/Nut	7/16-20 (Grade 8)	55-61	74-82
Shift Fork Cover Cap Screw	7/16-14 (Grade 5)	35-45	47-61
(Permanent CTD only)			
Shift Fork Cover Retainer Stud/Nut . . .	7/16-20 (Grade 8)	55-61	74-82
(Seasonal CTD only)			
Adjusting Screw Locknut	1/2-20	30-40	41-54
(Seasonal CTD only)			
Other Axle Parts	Refer to appropriate Eaton Service Manual (See back cover).		

CTD Overhaul (All Type.)

Remove Differential Carrier Assembly from Axle Housing

IMPORTANT: Detailed procedures for each type, capacity or model axle may vary. For specific service instructions on your axle, refer to the appropriate Eaton Service Manual. The following instructions are applicable to axles equipped with Controlled Traction Differentials.

1. Driver-Controlled CTD: Remove shift unit nuts and flat washers. Disconnect air line to permit removal of shift unit. Place sliding clutch in the engaged position. (Sliding clutch must be engaged to allow removal of carrier from housing.)

2. Seasonal CTD Remove nuts and washers from shift fork cover retainer, then remove cover retainer. Place sliding clutch in the engaged position. (Sliding clutch must be engaged to allow removal of carrier from housing.)

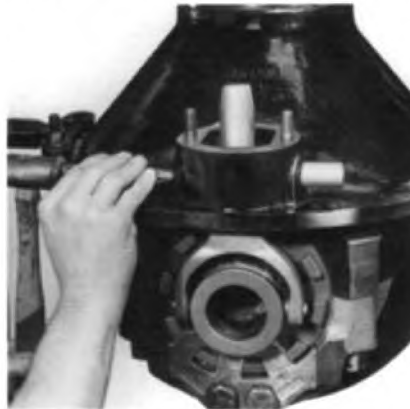
3. Permanent CTD: This type CTD is always engaged. No procedure is necessary.

4. All Types CTD: Drain lubricant. Disconnect drive shaft and remove axle shafts. Remove differential carrier to axle housing cap screws and lockwashers or stud nuts. Remove differential carrier.

Remove Differential and Clutch Pack Assembly from Carrier

NOTE: If the gear set is to be reused, check tooth contact pattern and ring gear backlash before beginning disassembly. Best overhaul results are obtained when used gearing is adjusted to run in established wear patterns. Omit this step if the gear set is to be replaced.

When reusing the gear set, remove the left-hand bearing cap, adjuster and lock as a unit. This will help return the gear set to its original adjustment during reassembly.



Removing Shift Fork Shaft



Removing Sliding Clutch

1. Mount the differential carrier in a repair stand.

2. Driver-Controlled and Seasonal CTD Only: Remove shift fork seal and spring. Remove expansion plugs, then working at the lower (or small) plug hole, drive out the shift fork shaft.



WARNING: WHEN USING A DRIFT, PUNCH OR SIMILAR TOOL, WEAR SAFETY GLASSES.

3. Driver-Controlled and Seasonal CTD Only: Disengage shift fork yoke from sliding collar. Then remove clutch and shift fork.

CTD Overhaul (All Types)

Remove Differential and Clutch Pack Assembly from Carrier (Cont'd)



4. If reusing gear set, punch mark bearing adjusters for reference during assembly.



5. On teeth-side of ring gear, cut lockwire and remove bearing cap screws. Remove cap, adjuster and lock.



6. On back-side of ring gear, cut lockwire and remove bearing cap screws. If the gear set is to be reused, remove bearing cap, adjuster and lock as an assembly. This will facilitate correct positioning of ring gear during reassembly.



7. Remove bearing cups, then lift ring gear and differential assembly out of carrier.

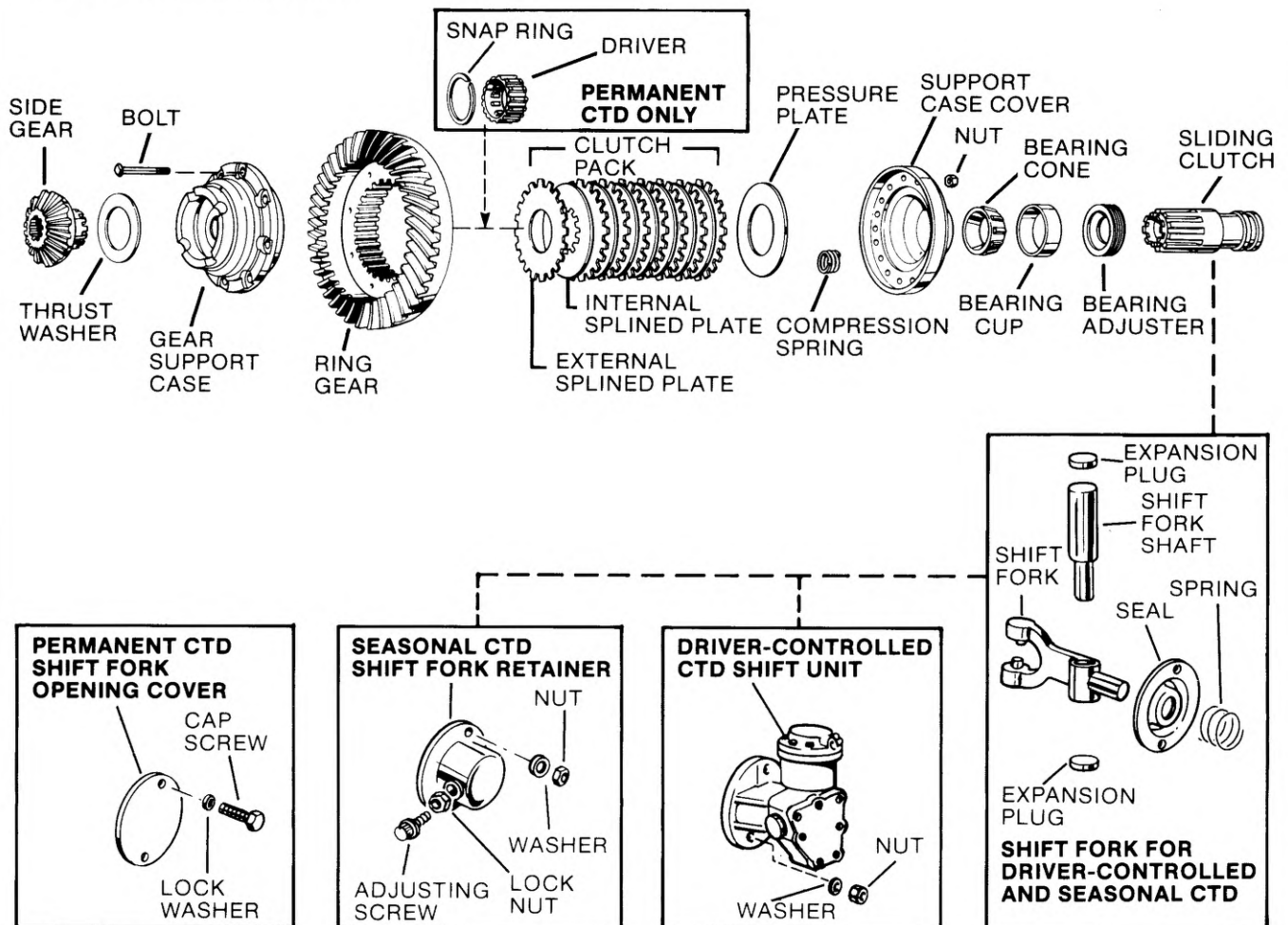
Remove Drive Pinion

1. For pinion instructions, refer to appropriate Eaton Axle Service Manual covering your specific axle model. (see back cover).

CTD Overhaul (Medium-duty Type)

Remove and Disassemble Clutch Pack

Medium-duty CTD Illustrated.



1. Place differential assembly (clutch pack up) on workbench.

WARNING: TAKE PRECAUTIONARY MEASURES TO PREVENT PERSONAL INJURY OR PARTS DAMAGE DURING REMOVAL OF GEAR SUPPORT COVER (Step 2) THE COVER IS UNDER SPRING PRESSURE AND MAY POP OFF WHEN THE LAST LOCKNUT IS REMOVED.

2. Remove two self-locking nuts and bolts (180° apart) fastening support case cover, then temporarily install two clamping bolts and nuts (see photo).

NOTE: These clamping bolts will hold cover in position while removing the other cover self-locking bolts and nuts.

Remove cover self-locking bolts and nuts.



Removing Case Cover (with clamping nuts and bolts installed)

CTD Overhaul *(Medium-duty Type)*

Remove and Disassemble Clutch Pack *(Cont'd)*



Removing Clamping Nuts and Bolts

3. With cover self-locking bolts and nuts removed, alternately loosen and remove the two clamping nuts and bolts.



Removing Support Case Cover

4. Lift off cover and remove springs.



Removing Clutch Pack

5. **Driver-Controlled and Seasonal CTDs Only:** With cover and springs removed, the pressure plate and clutch pack (friction plates) can be withdrawn or lifted out of ring gear bore. If difficulty is experienced, first remove pressure plate then lift out friction plates individually.

6. **Permanent CTDs Only:** This type unit includes a driver to engage internal-splined friction plates to the differential side gear. With cover and springs removed, the pressure plate, clutch plate and driver can be withdrawn or lifted out of the ring gear bore. The individual parts can then be separated. The snap ring on the friction plate driver acts as a stop for the plates. Remove snap ring if replacement is necessary.

7. If necessary, the ring gear can be removed from its mounting on the differential and gear support case (flanged case half). If difficulty is encountered, loosen gear by tapping on opposite sides with a soft-nosed hammer.

8. If necessary, remove bearing cone from support case cover using suitable puller.

NOTE: Holes are provided in the cover to enable removal of bearing cone with a punch. Tap alternately through each hole until cone is removed.

9. **Inspect Friction Plates.** With plates removed, inspect surfaces for deeply scored or burned condition. If a faulty condition is found or if torque check indicates a worn condition (see "Checking Effectiveness of the Controlled Traction Differential," page 4), replace the clutch pack:

Disassemble and Reassemble Wheel Differential

1. For procedure, refer to the appropriate Eaton Axle Service Manual covering your specific axle model (see back cover).

Assemble and Install Clutch Pack

NOTE: The clutch pack can be installed in differential and gear support case with wheel differential assembled or disassembled. With differential assembled, proceed as follows:

1. All Medium-duty CTD. Place differential assembly on a work bench (clutch pack mounting area up). Install ring gear on support case flange, aligning bolt holes with two temporarily-installed alignment bolts.

Remove alignment bolts.



*Installing Clutch Plates Individually
(Permanent CTD Only)*



*installing Clutch Pack and Driver
Assembly (Permanent CTD Only)*

2. Install Friction Plates and Driver (Permanent CTD Only).

NOTE: Brush surface of each plate, as it is assembled, with heavy application of axle lube (SAE 90).

NOTE: To assemble friction plates, one of two procedures can be used: Install driver and plates individually (Step 3) or install driver and clutch pack as an assembly (Step 4).

3. Install Friction Plates Individually (Permanent CTD Only).

- If removed, install snap ring on friction plate driver. Then, install driver assembly (snap ring down) in bore of support case, engaging teeth of differential side gear.
- Place one external-splined plate in ring gear bore (engaging gear internal teeth). Brush plate with lube.
- Place one internal-splined plate on driver splines and on top of the external-splined plate. Brush plate with lube.
- Repeat this procedure until fourteen (14) friction plates (seven internal-splined and seven external-splined) are installed.
- Install the last external-splined plate and pressure plate. Then install springs and cover (see Step 6).

4. Install Driver and Clutch Pack as an Assembly (Permanent CTD Only).

- If removed, install snap ring on friction plate driver. Then, place driver (snap ring down) on work bench.
- Place one external-splined plate on driver. Brush plate with lube.
- Place one internal-splined plate on top of the external-splined plate. Brush plate with lube.
- Repeat this procedure until fourteen (14) friction plates (seven external-splined and seven internal-splined) are installed. Then install the last external-splined plate and pressure plate.
- Rotate external-splined plates as necessary to align the teeth. Then grasp the entire assembly by hand (see photo) and install it in the ring gear.

NOTE: As the assembly is installed, maneuver plates with external splines to align them with the ring gear teeth. Also make sure the driver engages teeth of the differential side gear.

- Install compression springs and case cover (Step 6).

CTD Overhaul *(Medium-duty Type)*

Assemble and Install Clutch Pack *(Cont'd)*

5. Install Friction Plates (Driver-Controlled and Seasonal CTD Only).

NOTE: During friction plate (internal-splines) installation, align each plate as it is installed in ring gear, using the sliding clutch. If plates are not in alignment, it will be difficult to install sliding clutch, after clutch pack is assembled. Also, as each plate is installed, brush top of plate with a heavy application of axle lube (SAE 90). Proceed as follows:

- a. Place one external-splined plate in ring gear bore (engaging gear internal teeth). Brush plate with lube.
- b. Place one internal-splined plate on top of the external-splined plate and brush plate with lube. For alignment purposes, temporarily insert sliding clutch to engage side gear and plate splines. Remove clutch.
- c. Repeat this procedure until fourteen (14) friction plates (seven internal-splined and seven external-splined) are installed.
- d. Install the last external-splined plate and the pressure plate. And, again, insert sliding clutch to make sure internal-splined plates are in alignment. Install springs and case cover (see Step 6).



Installing External-Splined Friction Plate



Aligning internal-Splined Friction Plate with Sliding Clutch

6. Install Compression Springs and Cover (All Types CTD).



- a. Install springs on pressure plate, positioning them in the smallest circle possible (see photo).



- b. Place support case cover over springs and temporarily install two alignment bolts (heads up).



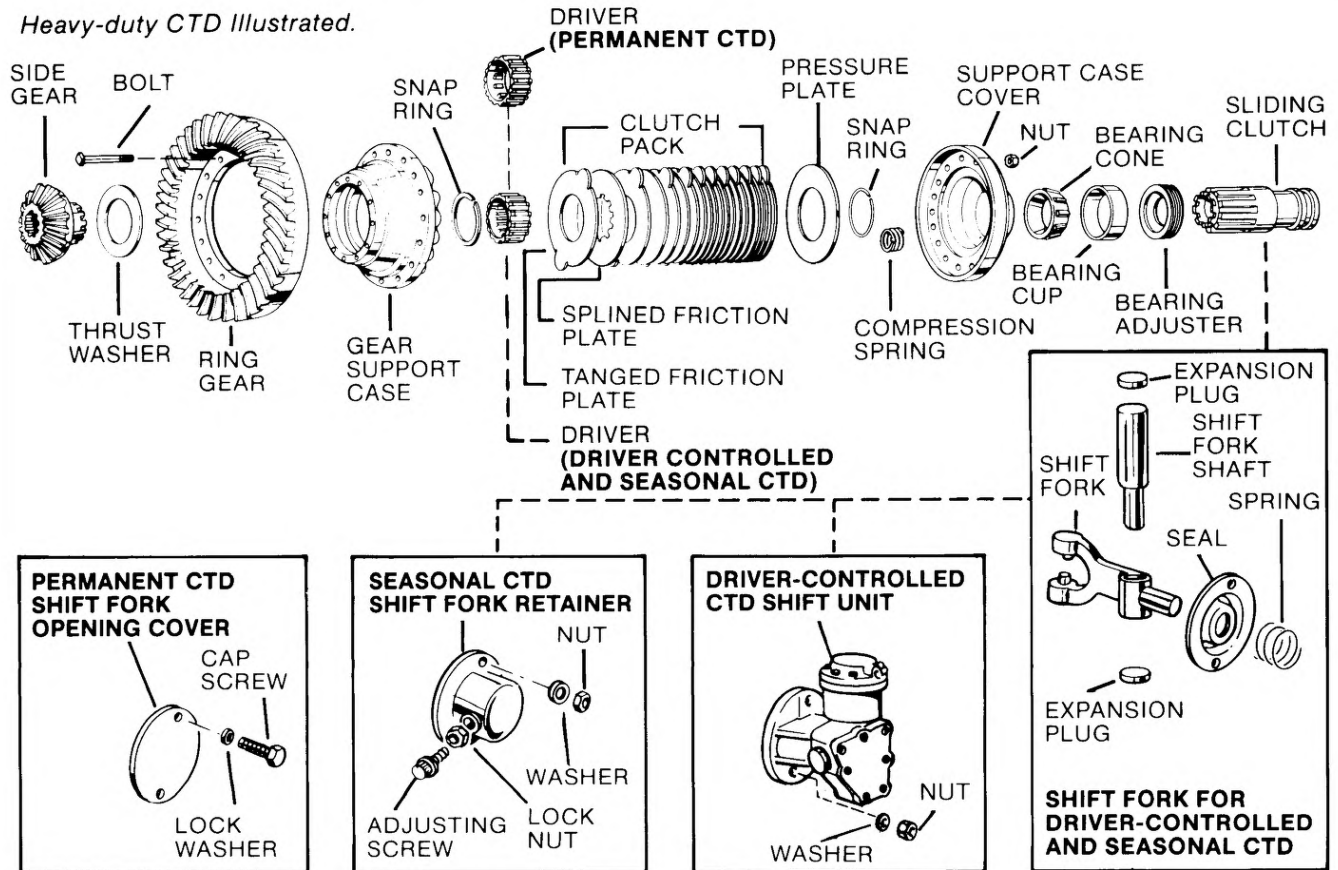
- c. Temporarily, install two clamping nuts and bolts (nuts up). Remove alignment bolts. Alternately, tighten clamping nuts until cover is in mounting position on ring gear.

- d. Install bolts and self-locking nuts that fasten cover to ring gear. Remove the temporarily-installed clamping nuts and bolts and install the remaining cover bolts and self-locking nuts. Torque nuts to 275-300 ft-lbs. (373-407 N.m).

CTD Overhaul (Heavy-duty Type)

Remove and Disassemble Clutch Pack

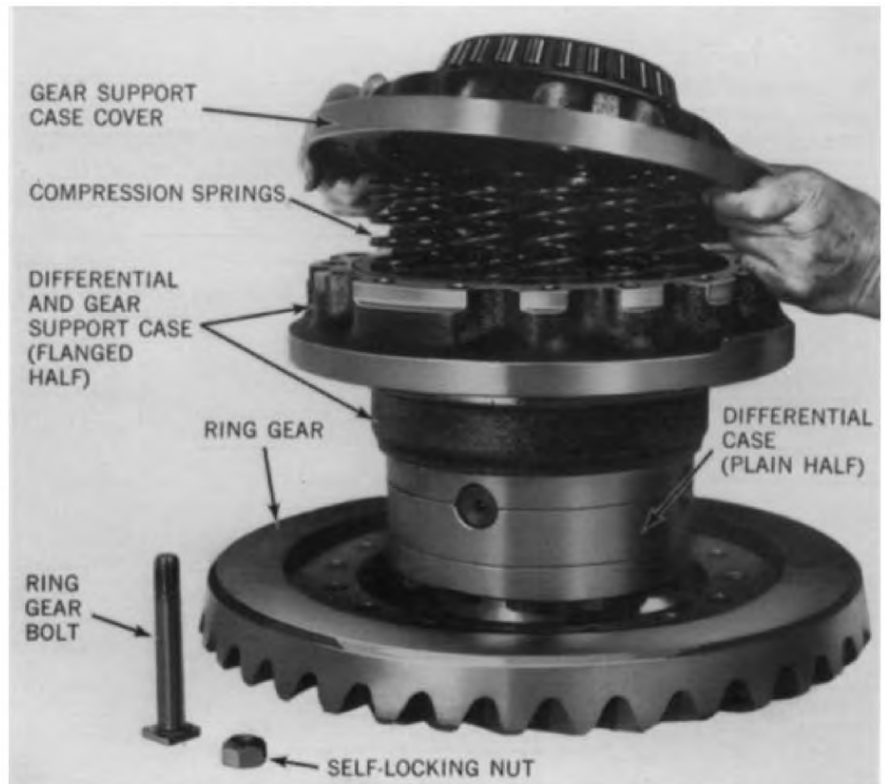
Heavy-duty CTD Illustrated.



1. Place differential and gear support case (clutch pack up) on workbench.

WARNING: EXERCISE CARE DURING DISASSEMBLY PROCEDURE (Step 2 below). THE GEAR SUPPORT CASE COVER IS UNDER SPRING PRESSURE AND THE RING GEAR MAY FALL OFF THE SUPPORT CASE AFTER THE LAST LOCKNUT IS REMOVED. TAKE PRECAUTIONARY MEASURES TO PREVENT PERSONAL INJURY OR PARTS DAMAGE DURING PROCEDURE IN STEP 2, BELOW.

2. Remove self-locking nuts and bolts, then lift off gear support case cover and compression springs.



Removing Gear Support Case Cover

CTD Overhaul (Heavy-duty Type)

Remove and Disassemble Clutch Pack (Cont'd)

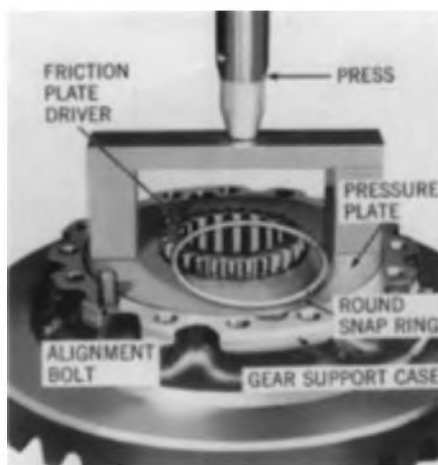
(Heavy-duty Type)



Removing Clutch Pack

3. Lift up and remove clutch pack assembly from the differential and gear support case (see photo),

4. If ring gear had an interference fit and did not fall off as previously mentioned in the warning note for Step 2, tap ring gear alternately on opposite sides with soft-nosed hammer until ring gear is free of gear support case flange.



Compressing Clutch Pack in a Press (with clutch pack installed in support case)

5. **Disassemble Clutch Pack.** To disassemble clutch pack, use a press and suitable adapters.

NOTE: This procedure can be accomplished with clutch pack removed from or installed in support case (see photo).

Compress clutch pack, then remove "round" snap ring. Remove pressure plate, then alternately remove tanged and splined friction plates from friction plate driver.



Removing Tanged and Splined Friction Plates

6. If necessary, remove "rectangular" snap ring from friction plate driver.

7. If necessary to remove bearing cone from differential case cover, place pilot punch in holes provided and tap on bearing cone inner race alternately through each hole until cone is removed.

8. **Inspect Friction Plates.** With plates removed, inspect surfaces for deeply scored or burned condition. If a faulty condition is found or if torque check indicates a worn condition (see "Checking Effectiveness of the Controlled Traction Differential," page 4), replace the clutch pack.

Disassemble and Reassemble Wheel Differential

1. For procedure, refer to the appropriate Eaton Axle Service Manual covering your specific axle model (see back cover).

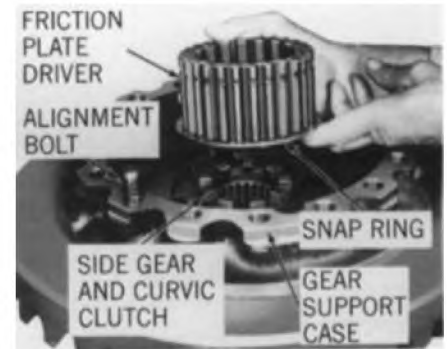
Assemble and Install Clutch Pack

NOTE: The clutch pack can be installed in gear support case with wheel differential assembled or disassembled. With differential assembled, proceed as follows:

NOTE: Ring gear may fit loosely or have an interference fit on the gear support case. Proceed as necessary to assemble ring gear to support case (Step 1 or 2).

1. Install Ring Gear with interference Fit. Place gear support case assembly on bench with clutch pack side down. Position ring gear (gear teeth up) on gear support case and align bolt holes. Temporarily, install two ring gear bolts to assure alignment, then tap ring gear alternately on opposite sides with a soft-nosed hammer until gear is fully seated against gear support case flange. Turn assembly over, then place in press (gear teeth down) on hard wood blocks. Position blocks to the outside of the ring gear to allow clearance for installation of two alignment bolts. Install alignment bolts, then proceed with reassembly procedures in Step 3.

2. Install Ring Gear with Loose Fit. Place ring gear in press (gear teeth down) on hard wood blocks. Position blocks to the outside of the ring gear to allow clearance for installation of the gear support case assembly and two alignment bolts. Place gear support case assembly in ring gear and align bolt holes. Install two alignment bolts in mounting holes, then proceed with reassembly procedures in Step 3.



Installing Friction Plate Driver

3. Install snap ring in square ring groove of friction plate driver. Place friction plate driver (with snap ring down) in center of gear support case.

4. Place one tanged friction plate over friction plate driver, positioning tangs into slots in gear support case (see photo). Brush top of friction plate with a heavy application of axle lube (SAE 90). Place one splined friction plate over friction plate driver and brush top of this plate with lube.



Installing Friction Plates

5. Repeat procedures in Step 4 until there are an equal amount of friction plates of each (tanged and splined) mounted on the friction plate driver (see note below).

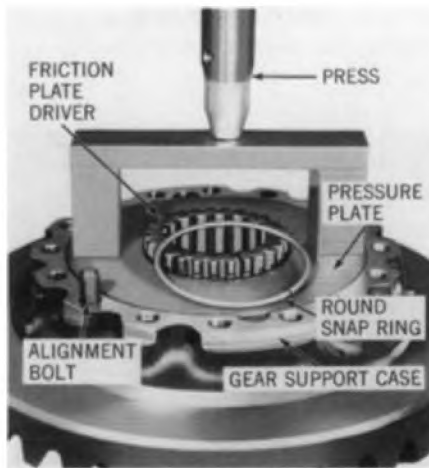
NOTE: Clutch pack friction plates vary with axle models (see chart on page 2 for detailed information).

CTD Overhaul (Heavy-duty Type)

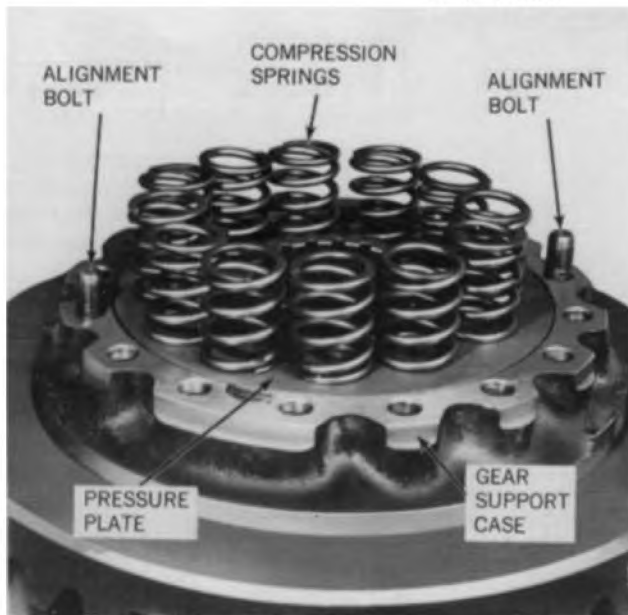
Assemble and Install Clutch Pack (Cont'd) (Heavy-duty CTD)

6. Place last tanged friction plate and pressure plate over friction plate driver. Then using a press and suitable adapters, compress clutch pack and install round snap ring in groove of friction plate driver.

7. If removed, press bearing cone on gear support case cover.

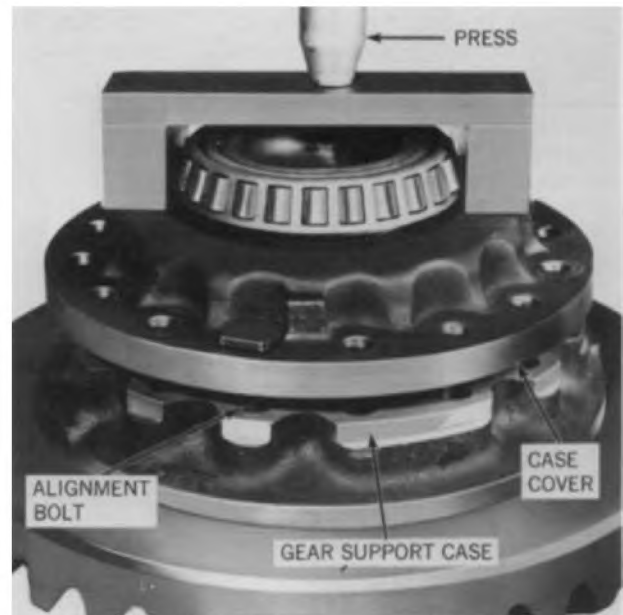


Compressing Clutch Pack in a Press



Positioning Compression Springs on Pressure Plate

8. Place compression springs in smallest possible circle on pressure plate. Place gear support case cover over springs and temporarily install two alignment bolts. Reach through hole in gear support case cover and move compression springs radially outward as far as they will go.



Compressing Springs to Assemble Ring Gear, Case and Cover

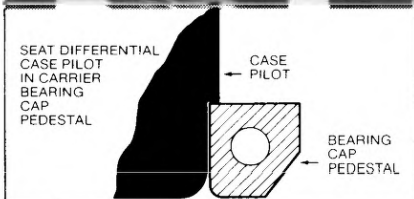
9. Compress springs until gear case cover bottoms against gear support case. With press pressure still applied, install ring gear bolts (all bolt heads on ring gear side) and locknuts. Remove assembly from press, then tighten locknuts to correct torque (195-245 ft-lbs., 264-332 N.m).

CTD Overhaul (All Types)

Install Drive Pinion

NOTE: If the drive pinion was removed, refer to the appropriate Eaton Service Manual covering your specific axle for instructions.

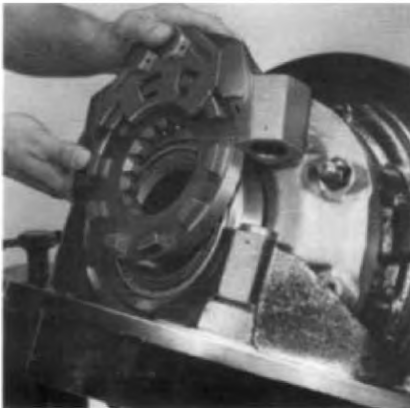
Install Differential and Clutch Pack Assembly in Carrier (All Types CTD) Ñ



NOTE: Lubricate bearings during the following assembly procedure:

1. Place ring gear and differential assembly in carrier. Insure that ring gear and drive pinion mesh properly.

During installation, tilt carrier to allow support case pilot to rest in carrier bore, then install bearing cup as shown in photo. Also install bearing cup on opposite side of differential.



2. If the same gear set is used, install the assembled bearing cap, adjuster and lock on the backface side of the ring gear. Otherwise install adjuster and cap separately.

NOTE: When installing cap, it may be necessary to tap it lightly with a hammer. Be sure cap is fully seated and threads are aligned properly. If trouble is encountered, check for cross-threading of bearing adjuster and carrier threads.

On teeth side of ring gear, install the other adjuster and bearing cap, observing same precautions to avoid cross-threading.



3. Install and tighten bearing cap screws *finger-tight*. If this is difficult, use hand wrench.

NOTE: The assembly is now ready for adjustment of differential bearing preload, ring gear backlash and gear tooth contact.

CTD Overhaul (All Types)

Adjust Differential Bearing Preload:

1. At the teeth-side of ring gear, position bearing adjuster until its first thread is visible.
2. At the back-face side of ring gear, tighten adjuster until there is no backlash.
3. At the teeth-side of ring gear, tighten adjuster until it contacts the bearing cup. Continue tightening adjuster two or three notches. This will preload bearings and provide backlash.
4. **Check Ring Gear Backlash.** Measure backlash with a dial indicator. Specifications are listed below.

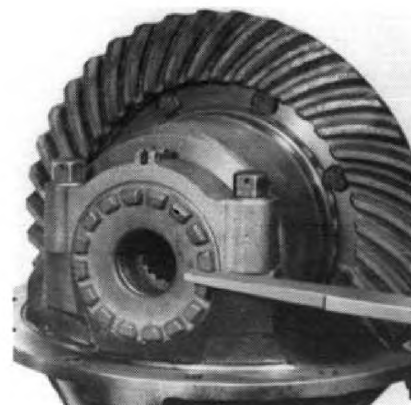
Ring Gear Backlash Specifications

USED GEARING - Reset to backlash recorded before disassembly.
NEW GEARING - Backlash should be as follows:

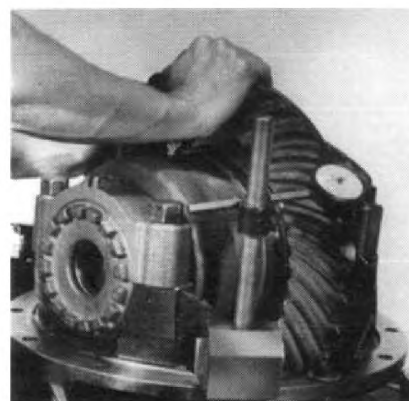
Axles with 16 1/2" (419.10 mm) or smaller ring gear diameter	0.006" to 0.016" (0.152 to 0.406 mm)
Axles with 18" (457.20 mm) ring gears	0.008" to 0.018" (0.203 to 0.457 mm)

5. **Check Ring Gear Tooth Contact.** Paint ring gear teeth and check tooth contact pattern. Correct tooth patterns are illustrated below.

NOTE: For detailed instructions on checking and adjusting procedures, refer to the appropriate Eaton service manual covering your specific axle.



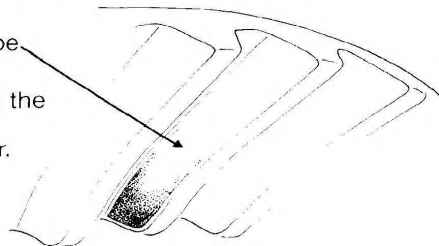
Adjusting Bearing Adjuster



Checking Ring Gear Backlash

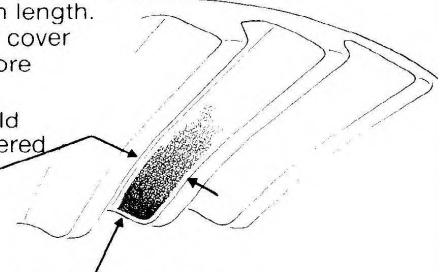
CORRECT PATTERN (USED GEARING)

- Pocket may be extended.
- Pattern along the face width could be longer.



CORRECT PATTERN (NEW GEARING)

- Could vary in length. Pattern should cover 1/2 tooth or more (face width).
- Pattern should be evenly centered between tooth top land and root.
- Pattern should be clear of tooth toe.



6. With ring gear and pinion adjusted correctly, align adjusters and locks, then tighten differential bearing cap screws to correct torque. Install cotter pin in one adjuster lock. Install cap screws in opposite adjuster lock and tighten to correct torque. Lockwire bearing and adjuster lock cap screws.

7. **Seasonal and Driver-Controlled CTD Only:** Position shift fork in carrier opening, then install-sliding clutch. With clutch installed, engage shift fork yoke with clutch collar. Then install shift fork shaft. Install expansion plugs to seal openings. Install shift fork seal and spring over end of shift fork. Move shift fork to place sliding clutch in engaged position. (Sliding clutch must be engaged to allow installation of carrier on housing.)

Install Differential Carrier Assembly in Axle Housing (All Types)

IMPORTANT: The following instructions cover single drive axles and tandem rear axles. For tandem forward axles (cliff. with power divider), refer to the appropriate Eaton Axle Service Manual.

IMPORTANT: Before installing carrier assembly, inspect and thoroughly clean interior of axle housing.

NOTE: Use silicone rubber gasket compound on axle housing mating surface as shown in the illustration. Compound will set in 20 minutes. Install carrier before compound sets or reapply.

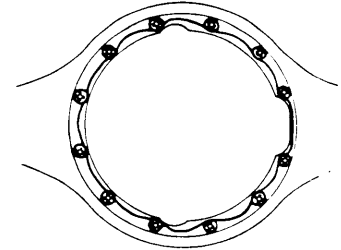
1. Install differential carrier assembly in axle housing. Install stud nuts and lockwashers, tighten to correct torque.
2. Install axle shafts and stud nuts. (If used, also install lockwashers and taper dowels.)
3. Connect driveline.
4. Fill axle with correct lube to correct level.

5. Driver-Controlled CTD: Install shift unit on carrier, engaging swivel with slot in shift fork shaft. Install mounting nuts and flat washers. Torque nuts (see chart). Connect air line to unit.

6. Seasonal CTD: Position sliding clutch in the engaged or disengaged position, then install shift fork cover retainer and secure with self-locking nuts and washers. Torque nuts (see chart).

NOTE: Shift fork cover retainer can be installed in two different positions; one to keep the sliding clutch engaged and the other to keep it disengaged. In the engaged position the shift fork cover retainer will have the adjusting screw facing the carrier, and away from the carrier in the disengaged position. Refer to page 6 for adjusting procedure.

*Silicone Gasket Compound
Pattern Differential Carrier
Mating Surface.*



Torque Chart

	Ft.-lbs.	N.m
Shift Unit STUD/NUT		
7/16-20 (Grade 8)	55-61	74-82
Shift Fork Cover (Permanent CTD only) CAP SCREW		
7/16-14 (Grade 5)	35-45	47-61
Shift Fork Cover Retainer (Seasonal CTD only) STUD/NUT		
7/16-20 (Grade 8)	55-61	74-82
Adjusting Screw (Seasonal CTD only) LOCKNUT		
1/2-20	30-40	41-54

Functional CTD Check (After Repair or Overhaul) (Single Or Tandem Axles)

NOTE: This is an operational check during or after servicing all single and tandem CTD equipped axles.

The following procedure can be used to determine whether the CTD is shifting in and out of the engaged mode. This functional check should be performed at any time the shift system components or axle CTD components are repaired or replaced.

1. Block the vehicle wheels to prevent rolling.
2. Place transmission in neutral and release parking brake.
3. Jack up both rear wheels of the drive axle.
4. With CTD selector valve in the disengaged position, the wheels will roll independent of one another.

5. With the CTD selector valve moved to the engaged position, the wheels will not turn independent of one another.

6. If the wheels turn independently in Step 5, the CTD is not functioning. Proceed to check for full system air pressure at shift unit.

NOTE: The unit operates at full reservoir pressure.

7. Remove shift unit and check to see if the shift unit pin and block were properly positioned into the shift fork opening.

NOTE: It is possible to install the shift unit and miss the fork opening. If this occurs, the CTD will be locked in either the engaged or disengaged position and will not shift. If this situation is found, reinstall the unit while carefully aligning pin into fork. Then repeat Steps 5 and 6 to verify proper function.

8. If shift unit installation and alignment was correct in Step 7, check the unit itself for proper functioning. With the shift unit removed, check it for proper travel by cycling the CTD selector valve. Travel should be 15/16" (23.8 mm). With pin in each position, pry with a screwdriver against the pin. This pin should not move when applying moderate force.

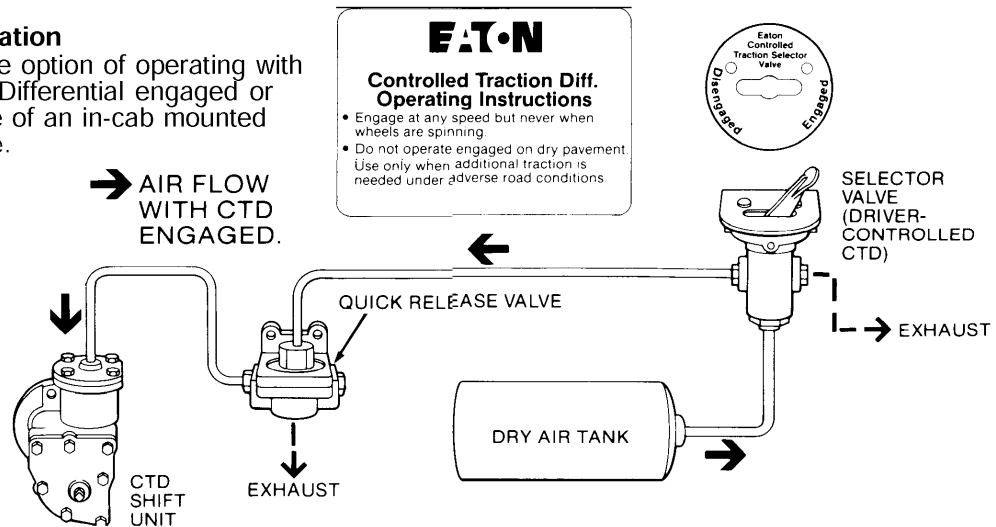
9. If all of the above checks are made and found satisfactory, the failure of the CTD to properly engage involves internal axle parts. With the shift unit removed, the CTD can be shifted in and out of engagement manually. With the shift fork away from the carrier (engaged) the wheels should not rotate together.

CTD Shift System (Single Axle)

CTD Shift System (Single Axles)

Description and Operation

This system provides the option of operating with the Controlled Traction Differential engaged or disengaged with the use of an in-cab mounted pneumatic selector valve.



Engagement. When the selector valve lever is moved to the engaged position, the selector valve is opened and air pressure is applied to the shift unit. The shift unit is connected to a shift fork and sliding clutch. The sliding clutch moves to engaged the Controlled Traction Differential. In the engaged position, the wheel differential acts a biasing differential.

Disengagement. When the selector valve lever is moved to the disengaged position, the selector valve is closed. Air pressure in the shift unit is exhausted. The sliding clutch retracts and disengages the Controlled Traction Differential. In the disengaged position, the wheel differential functions with conventional differential action.

Troubleshooting (Single Axle Shift System)

IMPORTANT: Before starting a system check, operate engine until full system air pressure (reservoir pressure) is built up in the system.

CAUTION: HIGH AIR PRESSURE MAY BE PRESENT WHEN DISCONNECTING AIR LINES DURING SYSTEM CHECK. EXERT CAUTION TO PREVENT POSSIBLE PERSONAL INJURY.

Check for Air Pressure and Air Leaks

A simple method for quickly locating trouble in a shift system can be accomplished by listening for possible air leaks and for sound (or feel by hand) which would indicate mechanical shifting.

Check Controlled Traction Differential System

1. Start the system check by placing the controlled traction selector valve in the disengaged position. Release the parking brake and place transmission in neutral.

2. Lift the wheel on the shift unit side of the axle off the ground. Turn the wheel. Both the wheel and the drive shaft should rotate. If the

wheel rotates, go to Step 6. If wheel will not rotate, proceed to the next step.

3. Verify that there is no air pressure at the shift unit by disconnecting the air line. If air pressure at the shift unit is present, check for possible exhaust port blockage at the CTD selector valve. If no blockage is found, the CTD selector valve is defective and needs replacement.

4. If there is no air pressure at the shift unit, remove the shift unit and have an assistant move the CTD selector valve back and forth. The shift unit linkage should move accordingly. If linkage does not move, disassemble shift unit and repair (see page 26). If the shift unit functions properly, proceed to Step 5.

5. With the shift unit removed, move the protruding end of the shift fork from side to side. If shift fork will not move, the problem is in the carrier assembly. Remove carrier and inspect components.

6. Have an assistant move the selector valve to the engaged posi-

tion. Turn the wheel that is off the ground. Neither the wheel or the drive shaft should rotate. If the wheel rotates, proceed to next step.

7. Verify that there is full system air pressure at the shift unit. If no air pressure is present, selector valve is defective and needs replacement.

8. If there is air pressure at shift unit, remove the shift unit by first placing the selector valve in the disengaged position. Then have an assistant move the selector valve back and forth. The shift unit linkage should move accordingly. If linkage does not move, disassemble shift unit and repair (see page 26). If the shift unit functions properly, move the protruding end of the shift fork from side to side. If the shift fork will not move, remove differential carrier and check components.

NOTE: For CTD Functional Check, see page 19.

CTD Shift System *(Tandem Axles)*

Description and Operation

The CTD Shift System provides the option of operation with the Controlled Traction Differential engaged or disengaged with the use of an in-cab pneumatic valve.

Two shift units (one on each axle) engage or disengage the Controlled Traction Differentials. A quick release valve in the system provides fast release of air pressure from the shift units.

There are two types of CTD Shift Systems for tandem axles: (1) a One-Selector Valve System controlling operation of the Inter-Axle Differential and both Controlled Traction Differentials, or (2) a Two-Selector Valve System which offers independent control of the Inter-Axle Differential and the Controlled Traction Differentials. These systems are illustrated on the next page.

Instructions in this manual are the same for both systems unless specified otherwise.

The Controlled Traction Differential engaged or disengaged with the use of an in-cab pneumatic valve.

Two shift units (one on each axle) engage or disengage the Controlled Traction Differentials. A quick release valve in the system provides fast release of air pressure from the shift units.

There are two types of CTD Shift Systems for tandem axles: (1) a One-Selector Valve System controlling operation of the Inter-Axle Differential and both Controlled Traction Differentials, or (2) a Two-Selector Valve System which offers independent control of the Inter-Axle Differential and the Controlled Traction Differentials. These systems are illustrated on the next page.

Instructions in this manual are the same for both systems unless specified otherwise.

Engagement. When the selector valve lever is moved to the engaged position, the selector valve is opened and air pressure is applied to the shift unit (or units). Each shift unit is connected to a shift fork and sliding clutch. The sliding clutch moves to engage the Controlled Traction Differential. In the engaged position, the wheel differential acts as a biasing differential.

Disengagement. When the selector valve lever is moved to the disengaged position, the selector valve is closed. Air pressure in the shift unit (or units) is exhausted. The sliding clutch retracts and disengages the Controlled Traction Differential. In the disengaged position, the wheel differential functions with conventional differential action.

In the One-Selector Valve System, the CTD and Inter-Axle Differential are controlled by one valve and both are engaged when the selector valve is in the engaged position.

In the One-Selector Valve System, both CTD wheel differentials and Inter-Axle Differential are disengaged when the selector valve is in the disengaged position.

In the Two-Selector Valve System, both CTD differentials and the Inter-Axle Differential are engaged independently.

In the Two-Selector Valve System, both CTD differentials and the Inter-Axle Differential are disengaged independently.

CTD Shift Unit. For detailed description and operation, refer to page 25.

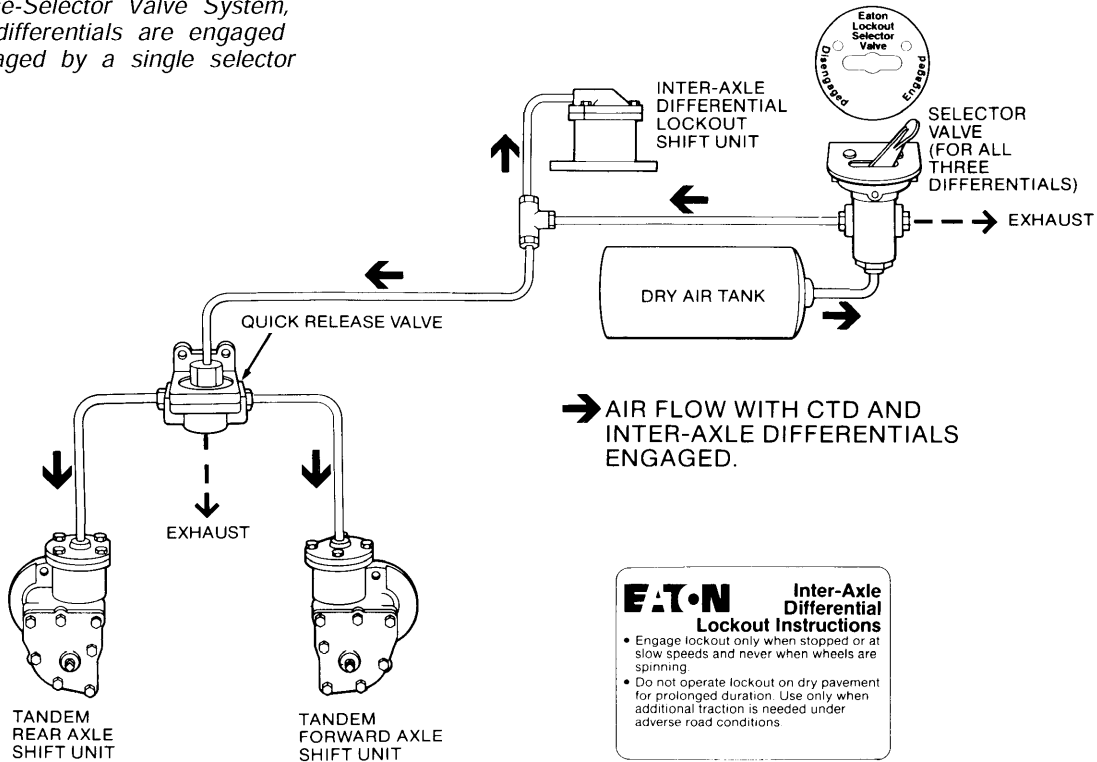
Inter-Axle Differential Lockout Shift Unit. For detailed description and operation, refer to the appropriate Eaton Axle Service Manual covering your axle model (see back cover).

iate

CTD Shift System (Tandem Axles)

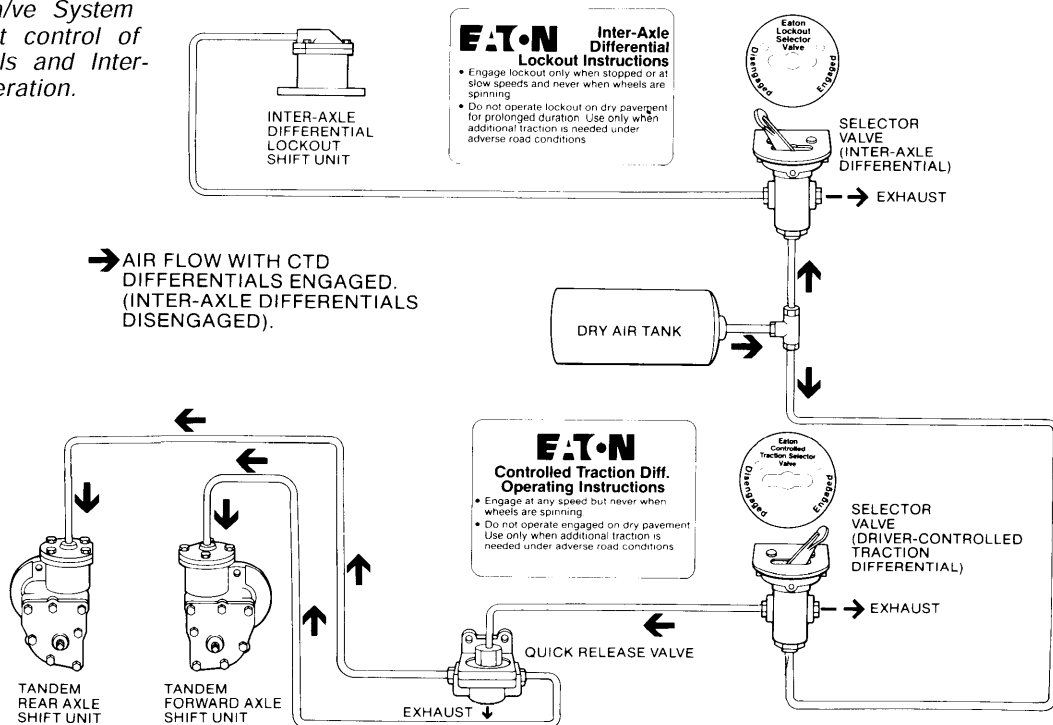
One-Selector Valve CTD Shift System

In the One-Selector Valve System, all three differentials are engaged or disengaged by a single selector valve.



Two-Selector Valve CTD Shift System

The Two-Selector Valve System provides independent control of both CTD Differentials and Inter-Axle Differential Operation.



Troubleshooting (Tandem axle Shift Systems)

Except where specified otherwise, the following instructions cover Controlled Traction Shift Systems with one or two selector valves.

IMPORTANT: Before starting a system check, make sure the inter-axle differential is disengaged. Also, operate engine until full system air pressure (reservoir pressure) is built up in the system.

Check for Air Pressure and Air Leaks

A simple method for quickly locating trouble in a shift system can be accomplished by listening for possible air leaks and for sound (or feel by hand) which would indicate mechanical shifting.

Disengage Inter-Axle Differential (One-Selector Valve System)

For vehicles equipped with a system that engages both CTD differentials when the inter-axle differential is engaged, the following steps must be taken to make sure the inter-axle differential is disengaged before checking the CTD shift system.

1. Start the system check by releasing the parking brake and place transmission in neutral.
2. Place the inter-axle differential selector valve in the disengaged position.
3. Lift both wheels of the rear axle off the ground.
4. Rotate the inter-axle drive shaft. If drive shaft turns, the inter-axle differential is disengaged. If it does not turn, the inter-axle differential shift mechanism is not functioning properly. Refer to appropriate Eaton Axle Service Manual for disassembly and repair.
5. After confirming that the inter-axle differential is disengaged, disconnect the air line connected to the inter-axle differential lockout shift unit and plug the end of the line.

 **CAUTION:** HIGH PRESSURE MAY BE PRESENT WHEN DISCONNECTING AIR LINE. EXERT CAUTION TO PREVENT POSSIBLE PERSONAL INJURY.

Disengage Inter-Axle Differential (Two-Selector Valve System)

For vehicles equipped with two selector valves, one for operating the inter-axle differential shift unit and the other for the CTD shift units, the following steps must be taken to make sure the inter-axle differential is disengaged.

1. Release the parking brake and place the vehicle transmission in neutral.
2. Place the inter-axle differential selector valve in the disengaged position.
3. Lift both wheels of the rear axle off the ground.
4. Rotate the inter-axle drive shaft. If the shaft turns, the inter-axle differential is disengaged. If it does not turn, the inter-axle differential shift mechanism is not functioning properly. Refer to the appropriate Eaton Axle Service Manual for disassembly and repair.

Check Controlled Traction Differential Shift System)

1. Two-Valve System. Start the system check by placing the CTD selector valve in the disengaged position (the inter-axle differential selector valve should still be in the disengaged position).

One-Valve System. Make sure the inter-axle differential selector valve is still in the disengaged position.

Both Systems. Make sure the parking brake is released and the transmission is in neutral.

2. Lift the wheel on the shift unit **side of rear** axle off the ground. Turn the wheel. Both the wheel and the inter-axle drive shaft should rotate. If the wheel rotates, go to Step 6. If wheel will not rotate, proceed to the next step.

 **CAUTION:** HIGH PRESSURE MAY BE PRESENT WHEN DISCONNECTING AIR LINE. EXERT CAUTION TO PREVENT POSSIBLE PERSONAL INJURY.

3. Verify that there is no air pressure at the rear axle shift unit by removing the air line. If air pressure is present, check for blockage of exhaust port at selector valve. If none is found, the CTD selector valve (or inter-axle differential

selector valve) is defective and needs replacement.

4. If no air pressure is present at the shift unit, remove the shift unit and have an assistant move the CTD selector valve back and forth. The shift unit linkage should move accordingly. If the linkage does not move, disassemble shift unit and repair (see page 26). If the shift unit functions properly, proceed to Step 5.

5. With the shift unit removed, move the protruding end of the shift fork from side to side. If the shift fork will not move, the problem is in the differential carrier assembly. Remove carrier and inspect components.

6. Two-Valve System. Move the CTD selector valve to the engaged position.

One-Valve System. Move inter-axle differential selector valve to the engaged position.

Both Systems. Turn the wheel that is off the ground. Neither wheel or the inter-axle drive shaft should rotate.

7. If the wheel rotates, check to make sure that there is full system air pressure at the rear axle shift unit by removing the air line. If no air pressure is present, the CTD selector valve (or inter-axle differential selector valve) is defective and needs replacement.

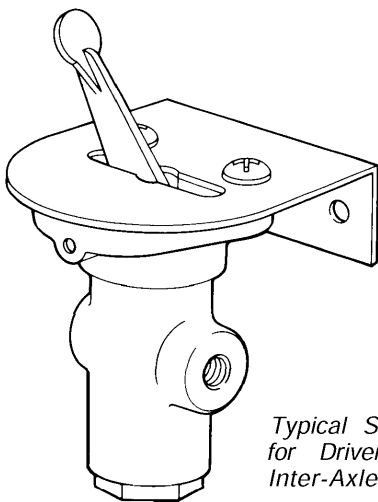
8. If air pressure is present at the shift unit, remove the unit by first placing the CTD selector valve in the disengaged position. Once the shift unit is removed, have an assistant move the CTD selector valve back and forth. The shift unit linkage should move accordingly. If the linkage does not move, disassemble the shift unit and repair (see page 26). If the shift unit functions properly, move the protruding end of the shift fork from side to side. If the shift fork will not move, remove differential carrier and check components.

9. Use same procedure to troubleshoot forward axle controlled traction differential.

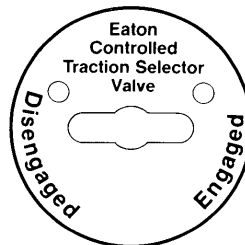
NOTE: For CTD Functional Check, see page 19.

CTD Shift System Components

Selector Valves



*Typical Selector Valve
for Driver-Controlled CTD or
Inter-Axle Differential Lockout.*



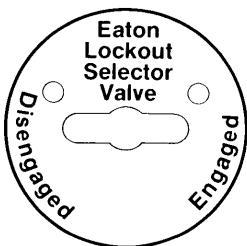
*Controlled
Traction
Differential
Selector
Valve
Plate*

EAT•N

Controlled Traction Diff. Operating Instructions

- Engage at any speed but never when wheels are spinning
- Do not operate engaged on dry pavement
- Use only when additional traction is needed under adverse road conditions

*CTD
Instruction
Plate*



*Inter-Axle
Differential
Selector
Valve Plate*

EAT•N

Inter-Axle Differential Lockout Instructions

- Engage lockout only when stopped or at slow speeds and never when wheels are spinning
- Do not operate lockout on dry pavement for prolonged duration Use only when additional traction is needed under adverse road conditions

*Inter-Axle
Differential
Lockout
Instruction
Plate*

Inter-Axle Differential Lockout Shift Unit

For information and service instructions, refer to the appropriate Eaton Axle Service Manual (see back cover).

Air Shift Unit (Single or Tandem Drive Axles)

Identification and Mounting

CTD-Equipped Single Axles and Tandem Rear Axles - Part No. 73503.

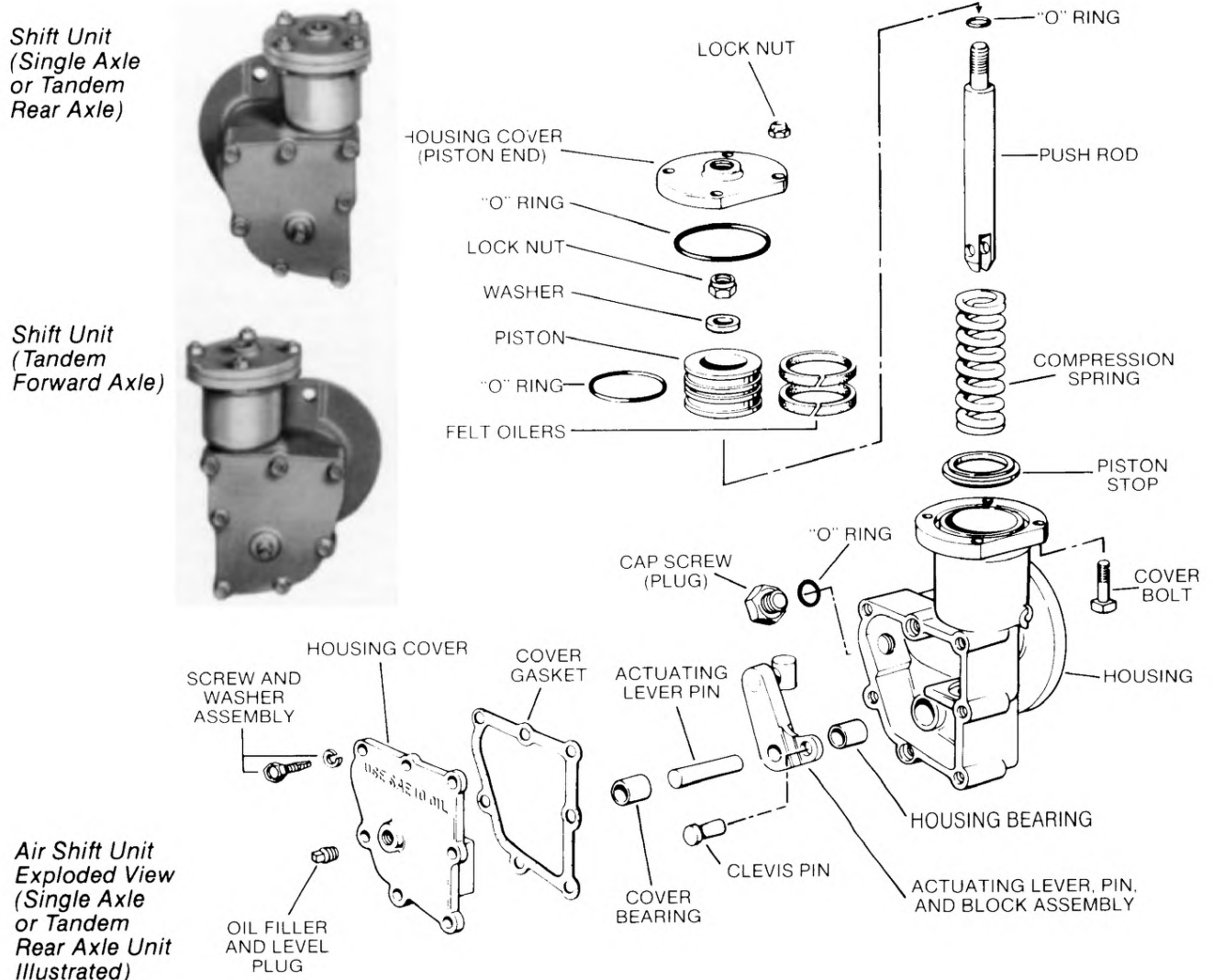
NOTE: This unit is the same as the standard Eaton 2-Speed Single Axles.

When installed, the shift unit cylinder will be positioned away from the carrier. In this application, the shift mechanism is sprung to disengagement and will be shifted to engage the CTD with air application.

CTD-Equipped Tandem Forward Axles - Part No. 73507.

NOTE: This unit is the same as the standard Eaton Dual Range Tandem Forward Axles.

When installed, the shift unit cylinder will also be positioned away from the carrier. In this application, the shift mechanism is sprung to disengagement and will be shifted to engage the CTD with air application.



Description and Operation

The Piston Air Shift Units are engineered for efficient performance and built for reliable, service-free operation.

Operation of each unit is as follows: The shift units are mechanically connected to the shift forks

and sliding clutches to engage or disengage CTD.

The unit consists of an air chamber, piston, compression spring and mechanical linkage. When air is admitted to the chamber or cylinder, the piston travels down-

ward against a compression spring, transferring motion through a push rod and actuating lever to the shift fork, engaging CTD. Exhaust of air pressure permits the heavy-duty spring to return the CTD to the disengaged position.

CTD Shift System Components

Air Shift Unit Replacement

Remove Unit

Disconnect air line at shift unit cover. Remove nuts, flat washers and piston air-shift unit from differential carrier.

NOTE: When shift unit is removed, provide container to catch oil that escapes from reservoir. Remove shift fork seal and spring.

Install Unit

1. Lubricate shift fork. Slide seal and spring assembly over fork and seal on differential carrier studs. Shift axle into Low Range.

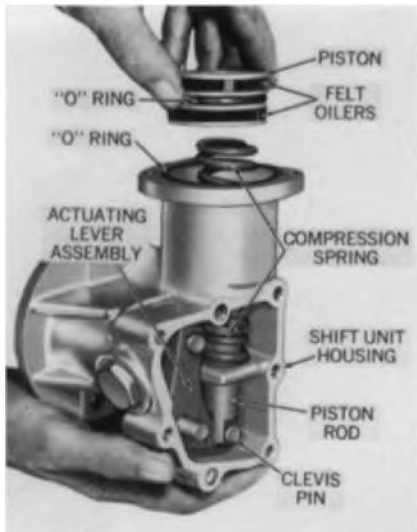
2. Place shift unit on mounting studs and make certain shift fork actuating lever engages slot in shift fork. Install flat washers and stud nuts. Tighten nuts to 55-61 ft-lbs. (74-82 N.m).

3. When axle is installed in vehicle, fill shift unit housing to level of filler plug with SAE 10 oil or automatic transmission fluid (see Lubrication on following page). Coat threads of filler plug with sealer and install plug.

4. Connect air lines to shift unit cover.

Air Shift Unit Overhaul

Disassemble Unit

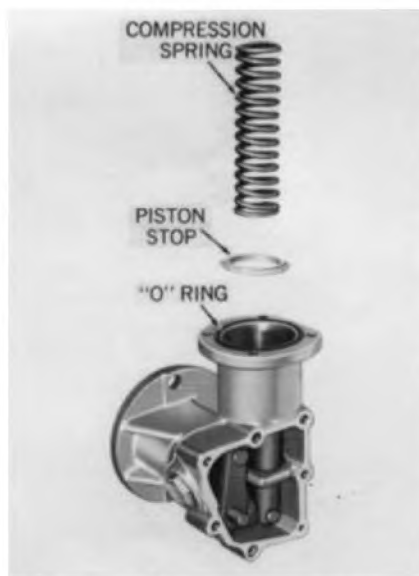


1. Remove cap screws, lock washers, cover and gasket from housing. Drain lubricant.

2. Remove bolts, locknuts, cover at piston end of housing. Remove "O" ring.

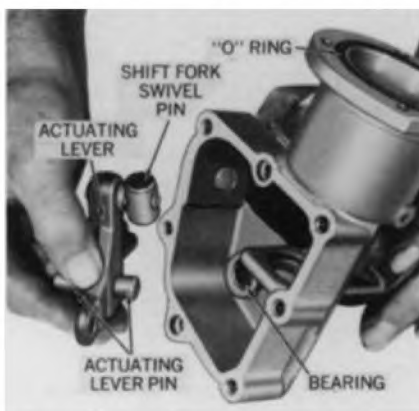
CAUTION: DURING THE FOLLOWING PROCEDURE, THE PISTON WILL POP OUT OF HOUSING UNDER SPRING PRESSURE. EXERCISE CAUTION TO PREVENT POSSIBLE INJURY.

3. Remove locknut, flat washer, and piston from push rod. Remove "O" ring and felt oilers from piston.



4. Remove compression spring and piston stop from bore of shift unit housing.

5. Remove clevis pin, then remove push rod from shift unit housing. Remove "O" Ring from push rod.



6. Remove actuating lever and pin assembly from shift unit housing. Do not disassemble actuating lever.

Parts Inspection

Shift Fork Seal - Inspect shift fork seal for defects and tight fit on shift fork. A spring is used to assure a closer fit of seal around shift fork. If this spring is not present on axle being serviced, install one when reassembling unit.

"O" Rings, Felt Oilers and Gasket - Replace "O" rings, felt oilers and cover gasket when piston air-shift unit is disassembled for repair.

Compression Spring - Inspect spring for distortion, cracks, or other visual defects. Replace a faulty spring.

Actuating Lever and Pins - Inspect lever pins and bearings for worn or grooved condition. Inspect actuating lever and push rod for worn or elongated holes at point where they are connected. Replace faulty parts.

Piston - Inspect piston friction surface for worn, grooved or damaged condition which will affect the piston movement in cylinder. Replace a faulty piston.



Air Shift Unit Overhaul (Cont'd)

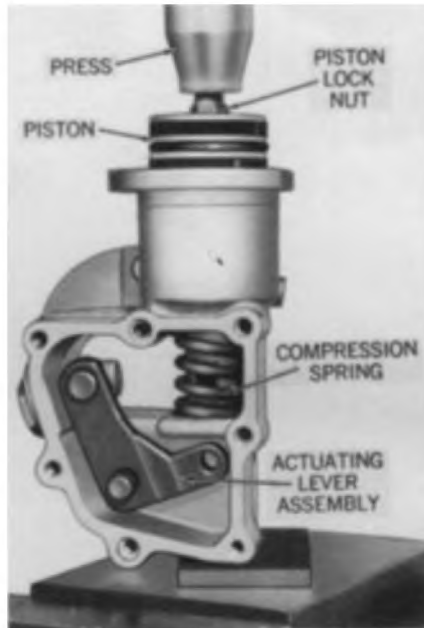
Assemble Unit

NOTE: Prior to assembly, the piston felt oilers should be soaked in SAE 10 oil for one hour. Lubricate "O" rings with a high-viscosity silicone oil or barium grease "O" ring lubricant.

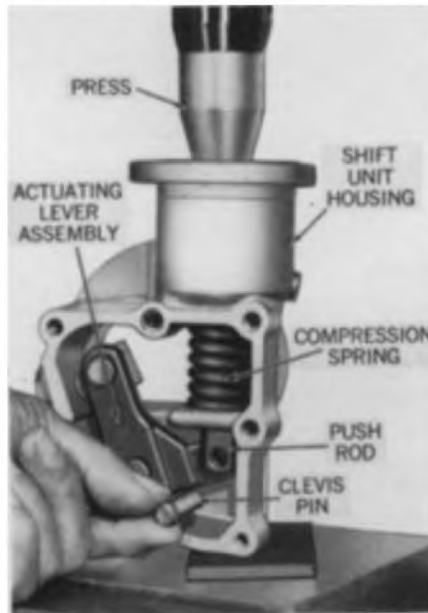
1. Assemble pin to actuating lever and install this assembly in shift unit housing.
2. Assemble "O" ring and piston to push rod and fasten with flat washer and locknut. Tighten nut to a torque of 120-150 IN-LBS. (14-17 N.m). Install felt oilers and "O" ring in piston.

CAUTION: DURING THE FOLLOWING PROCEDURE USING A PRESS, MAKE CERTAIN COMPONENTS ARE PROPERLY ALIGNED IN PRESS TO PREVENT POSSIBLE PERSONAL INJURY OR DAMAGE TO PARTS.

3. Insert piston stop and compression spring in shift unit housing. Place piston and push rod assembly in housing. Position housing assembly in arbor press.
4. Apply pressure to piston until actuating lever is in alignment with push rod end. Install clevis pin. Release press.
5. Place cover gasket in position on shift unit housing then install cover and bearing assembly and fasten with cap screw and lockwashers. If necessary, use a sealer on threads of cap screws to prevent any leaking. Tighten screws to a torque of 90-110 IN-LBS. (10-12 N.m).
6. Place "O" ring in groove of shift unit housing, then install housing cover and secure with bolts and locknuts. Tighten locknuts evenly to a torque of 108-132 IN-LBS. (12-15 N.m).
7. Fill shift unit with SAE 10 oil or automatic transmission fluid (see Lubrication) when axle is installed in vehicle.



Shift Unit Housing in Press.



Installing Push Rod Clevis Pin.

Lubrication

Lubricant - Use SAE 10 motor oil* for temperature above 0°F (-18°C). For temperatures below 0°F (-18°C), mix three parts of SAE 10 motor oil with one part of kerosene. This cold weather mixture can be safely used up to 32°F (0°C).

***NOTE:** Commercially available automatic transmission fluid may be used in place of SAE 10 motor oil. Automatic transmission fluid can be used for all temperatures. Do not mix kerosene with automatic transmission fluid.

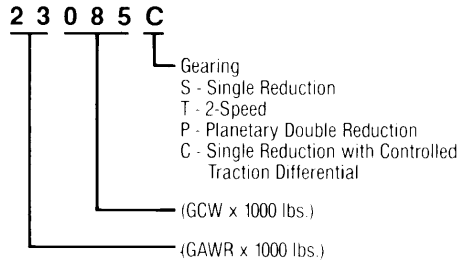
Lubricant Check and Level -

Each 20,000 miles or six months, remove pipe plug in shift unit housing cover to check lubricant level. Lube should be level with bottom of filler hole.

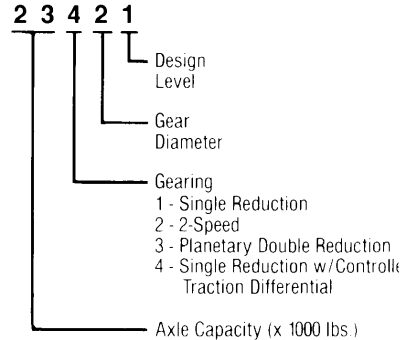
Lubricant Change - At least once a year remove shift unit housing cover and drain old lubricant. Wash parts thoroughly and air dry. Reinstall cover. Remove pipe plug in cover. Fill through pipe plug opening until lube is level with bottom of filler hole.

Single Axle Model No. Variation

Current Production Example:



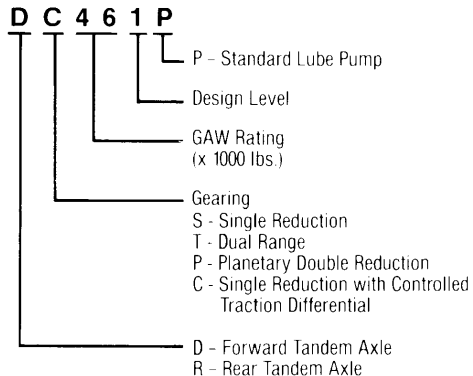
Older Model Example:



NOTE: Controlled Traction Differentials can be Identified by CT before the production assembly number on the carrier,

Tandem Axle Model No. Variation

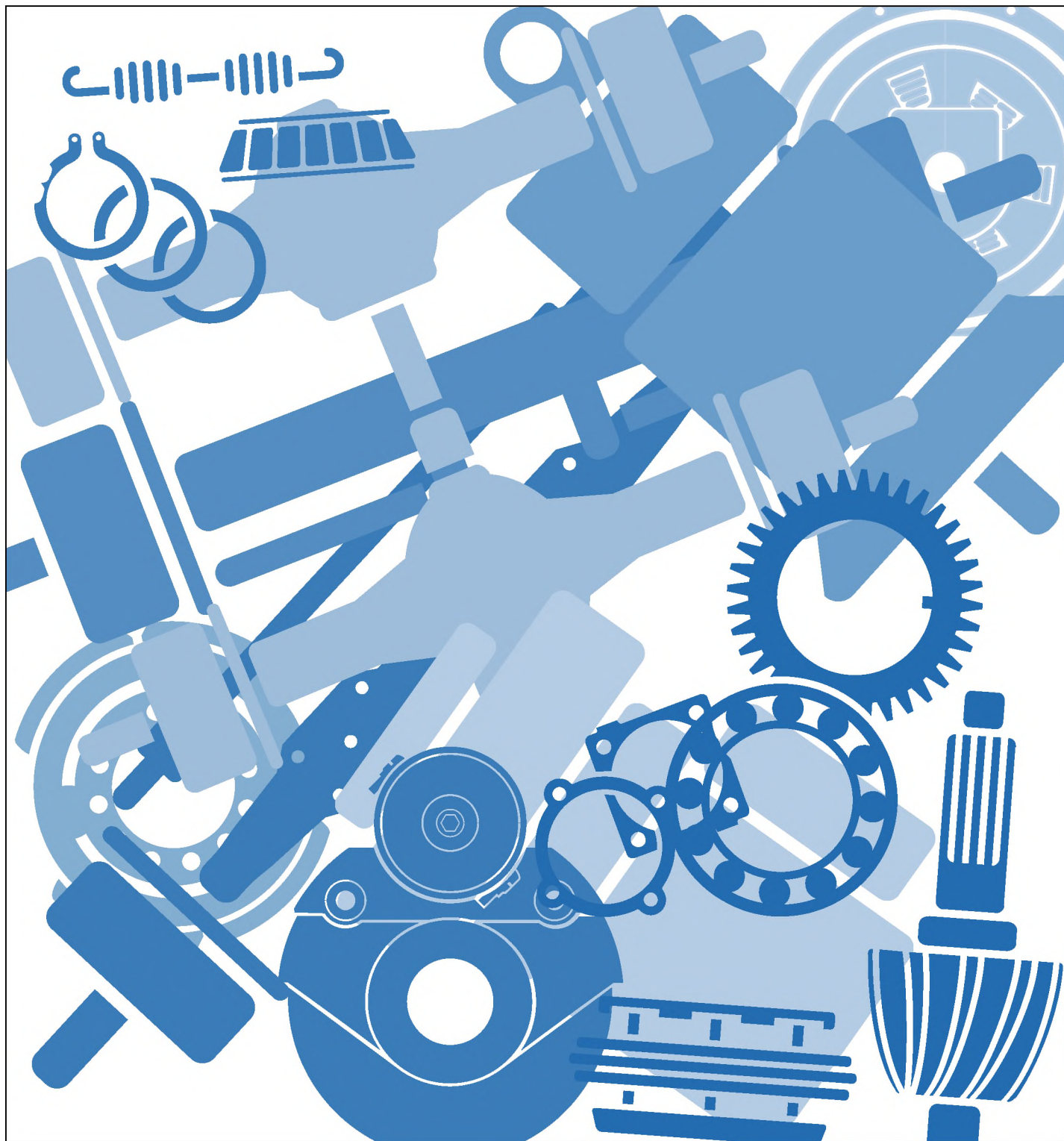
Current Production Example:



Older Model No:

DS381-P*

"S" indicated single reduction and an asterisk(*) was used to identify Controlled Traction Differential.



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