

INTRODUCTION

GENERAL

This section has the description and the repair procedures for the drive axle, speed reducer and differential for the following series of electric lift trucks:

E20-30BS
E20-30BH (Europe only)

The hubs are different between the “BS” series and the “BH” series, but the repair procedures are similar.

DESCRIPTION

The traction motor turns a speed reducer that is attached to the pinion shaft of the differential. The hypoid ring gear and pinion part of the differential assembly is also a one-stage speed reducer. The ring gear transfers power through the differential assembly to the axles. The differential assembly permits the axles to rotate at different speeds when the lift truck is turned. The brake drums and drive wheels are connected to the hubs. Different tire clearances are necessary for cushion tires (BS) and pneumatic tires (BH). The outer axles and hubs are different for the two series of lift trucks, but the operation is the same. See Figures 1 and 2.

REPAIRS

REMOVAL OF THE DRIVE AXLE (E20-30BS) (See Figure 1)

A. Remove the nuts for the drive axle. Hit the axle flange with a large hammer to loosen the tapered dowels. Remove the axle.



CAUTION
Do not hit the studs with the hammer.

B. Tilt the uprights backward. Put blocks under the uprights. Tilt the uprights forward to raise the wheels from the ground.

C. Loosen the lock plate and remove the bearing adjustment nut and lock plate.

D. To remove the outer bearing cone, push on one side of the wheel and then on the other. Remove the bearing cone and protect it from dirt. Loosen the adjustment of the brake shoes as necessary to remove the brake drum and wheel.

E. Raise or lower the lift truck as needed to slide the wheel and brake drum assembly from the lift truck.

F. If the bearing cups must be removed from the hub, use a puller or a brass driver. The inner bearing cup must be removed to replace the oil seal inside of the hub.

G. If the brake drum must be removed from the wheel for repairs, remove the wheel nuts, lock washers, and tapered dowels.

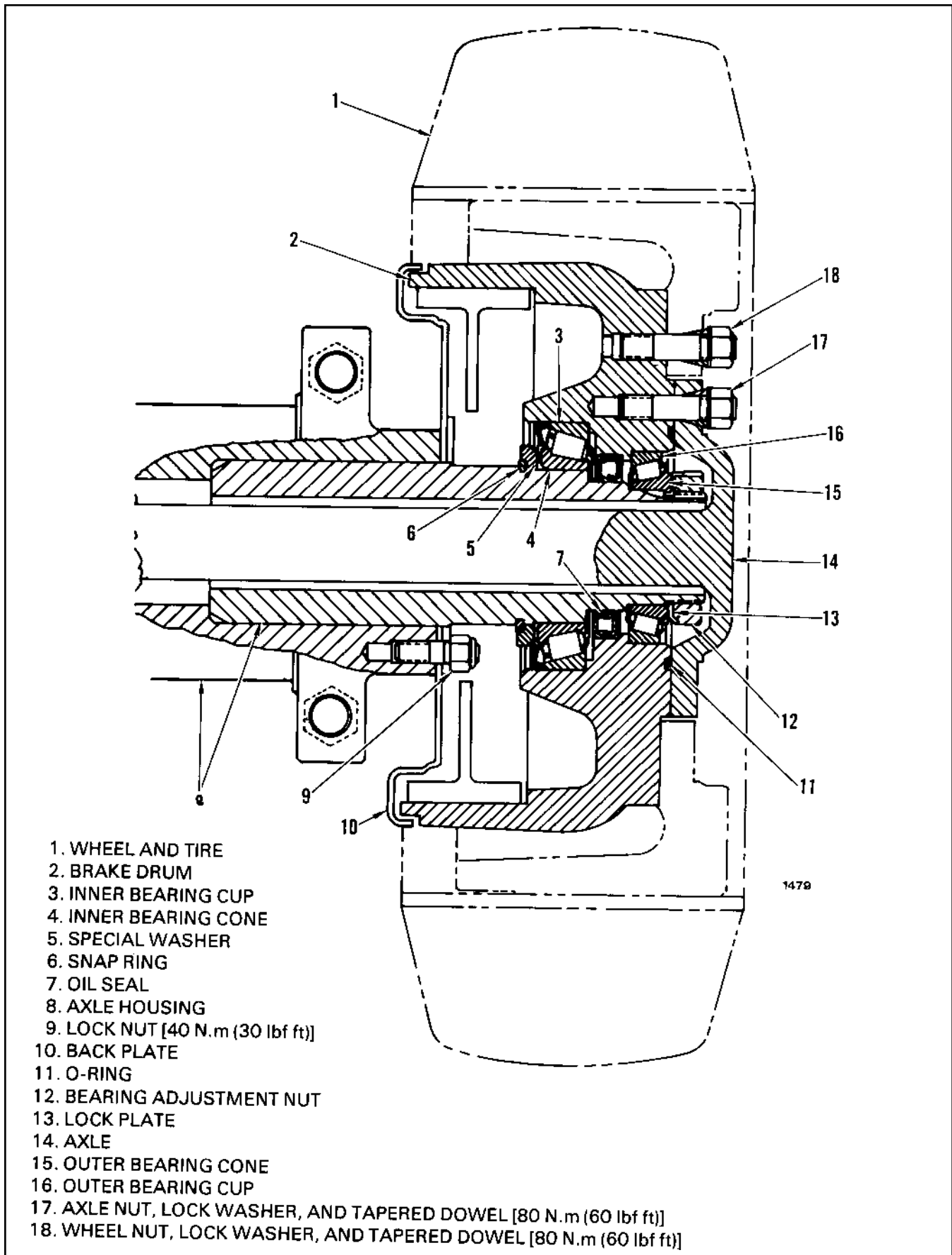


FIGURE 1. E20-30BS DRIVE WHEEL AND AXLE ARRANGEMENT

(More Content includes: Brake system, Capacities, and specifications, Frame, Hydraulic, System, Industrial battery, Main control, Valve, Mast repair, Fasteners, Schematics diagrams, Steering axle, Steering system, Wire harness repair And more)

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INSTALLATION

A. Install a new oil seal (Item 7, Figure 1) and lubricate the inner bearing with grease. Install seal with spring toward outside of truck.

B. Slide the brake drum and wheel assembly on the axle housing.



CAUTION
Do not damage the seals when installing the hub assembly.

C. Install the outer bearing, lock plate, and bearing adjustment nut.

D. Tighten the bearing adjustment nut to 200 N.m (150 lbf ft) while rotating the wheel. Loosen the bearing adjustment nut. Tighten the bearing adjustment nut to 34 N.m (25lbf ft). Bend the tabs of the lock plate to hold the bearing adjustment nut in position.

E. Use grease to hold the O-ring in position on the hub. For models that do not use an O-ring, use a liquid sealant. Apply the sealant to the axle flange.

F. Install the axle. Install the tapered dowels, lock washers, and nuts. Tighten the nuts to 80 N.m (60 lbf ft).

G. Fill the axle housing to the fill and check plug with gear oil. Wait five minutes for the oil to flow to the hubs before checking the oil level again.

REMOVAL OF THE DRIVE AXLE (E20-30BH) (See Figure 2)

A. Tilt the uprights backward. Put blocks under the uprights. Tilt the uprights forward to raise the wheels from the ground.

B. The wheel nuts hold the wheel assembly and the axle to the hub. Remove the wheel nuts and remove the wheel assembly. Remove the four socket head capscrews that hold the axle flange to the hub. Hit the axle flange with a large hammer to loosen the axle. Remove the axle.



CAUTION
Do not hit the studs with the hammer.

C. Loosen the lock plate and remove the bearing adjustment nut and lock plate.

D. To remove the bearing cone, push on one side of the brake drum and then on the other. Remove the bearing cone and protect it from dirt. Loosen the adjustment of the brake shoes as necessary to remove the brake drum.

E. If the bearing cups must be removed from the hub, use a puller or a brass driver.

The inner bearing cup must be removed to replace the oil seal inside of the hub.

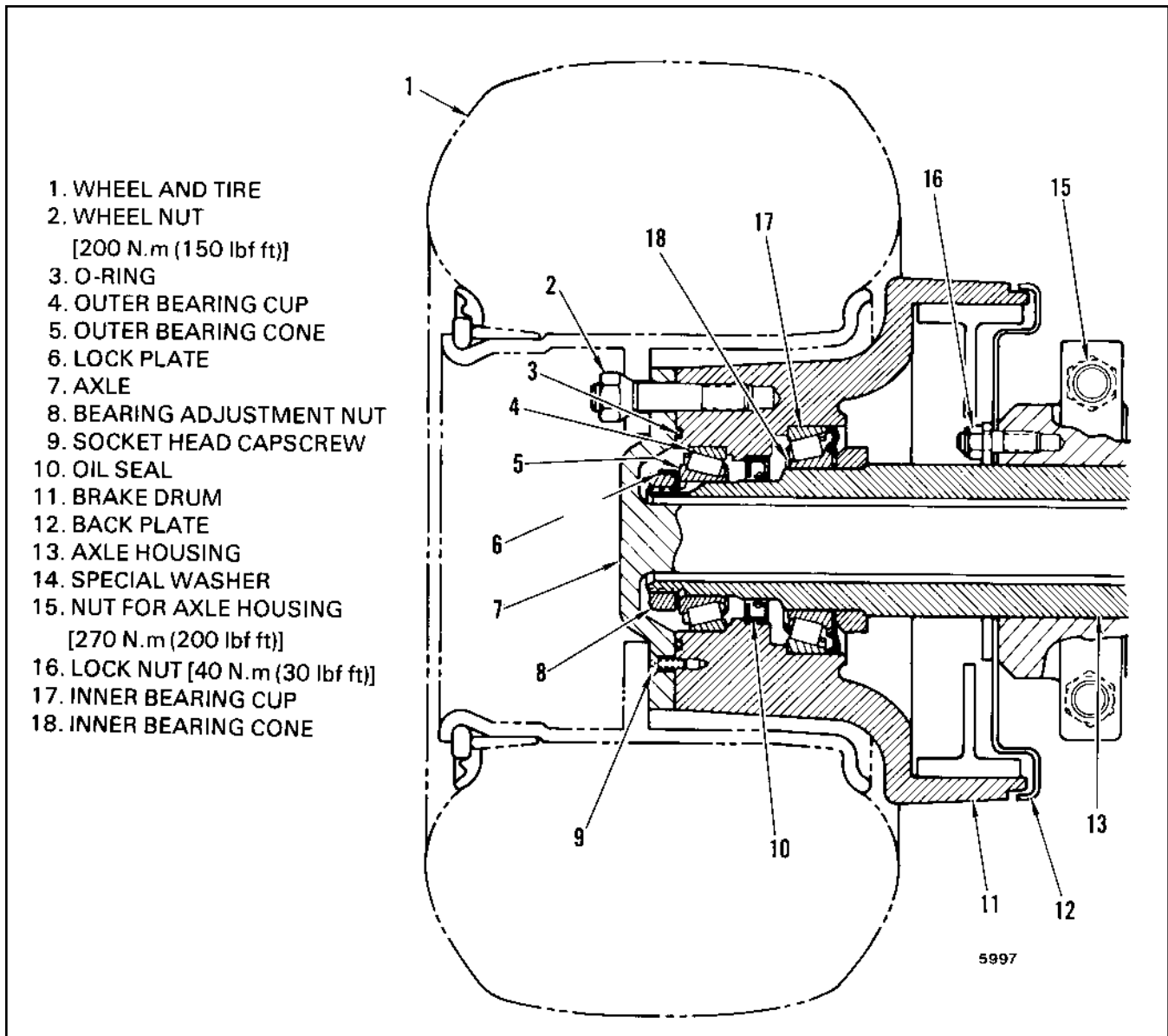


FIGURE 2. E20-30BH DRIVE WHEEL AND AXLE ARRANGEMENT

INSTALLATION

A. Install a new oil seal and lubricate the inner bearing with grease.

B. Install the brake drum and hub housing on the axle.



CAUTION
Do not damage the seals when installing the hub assembly.

C. Install the outer bearings, lock plate, and bearing adjustment nut.

D. Tighten the bearing adjustment nut to 200 N.m (150 lbf ft) while rotating brake drum. Loosen the bearing adjustment nut. Tighten the bearing adjustment nut to 34 N.m (25 lbf ft). Bend the tabs of the lock plate to hold the bearing adjustment in position.

E. Use grease to hold the O-ring in position on the hub. For models that do not use an O-ring, use a liquid sealant. Apply the sealant to the axle flange.

F. Install the axle. Install the four 1/4 UNC x 1 inch socket head capscrews that hold the axle to the hub.

G. Install the wheel. Tighten the wheel nuts to 200 N.m(150 lbf ft).

WHEELS AND TIRES

E20-30BS

H. Fill the axle housing to the fill and check plug with gear oil. Wait five minutes for the oil to flow to the hubs before checking the oil level again.

The E20-30BS series of lift trucks use cushion tires. The tire tread can be either smooth or with lugs. Do not mix types of tread on the lift truck. See Figure 3 for the tire sizes and part numbers.

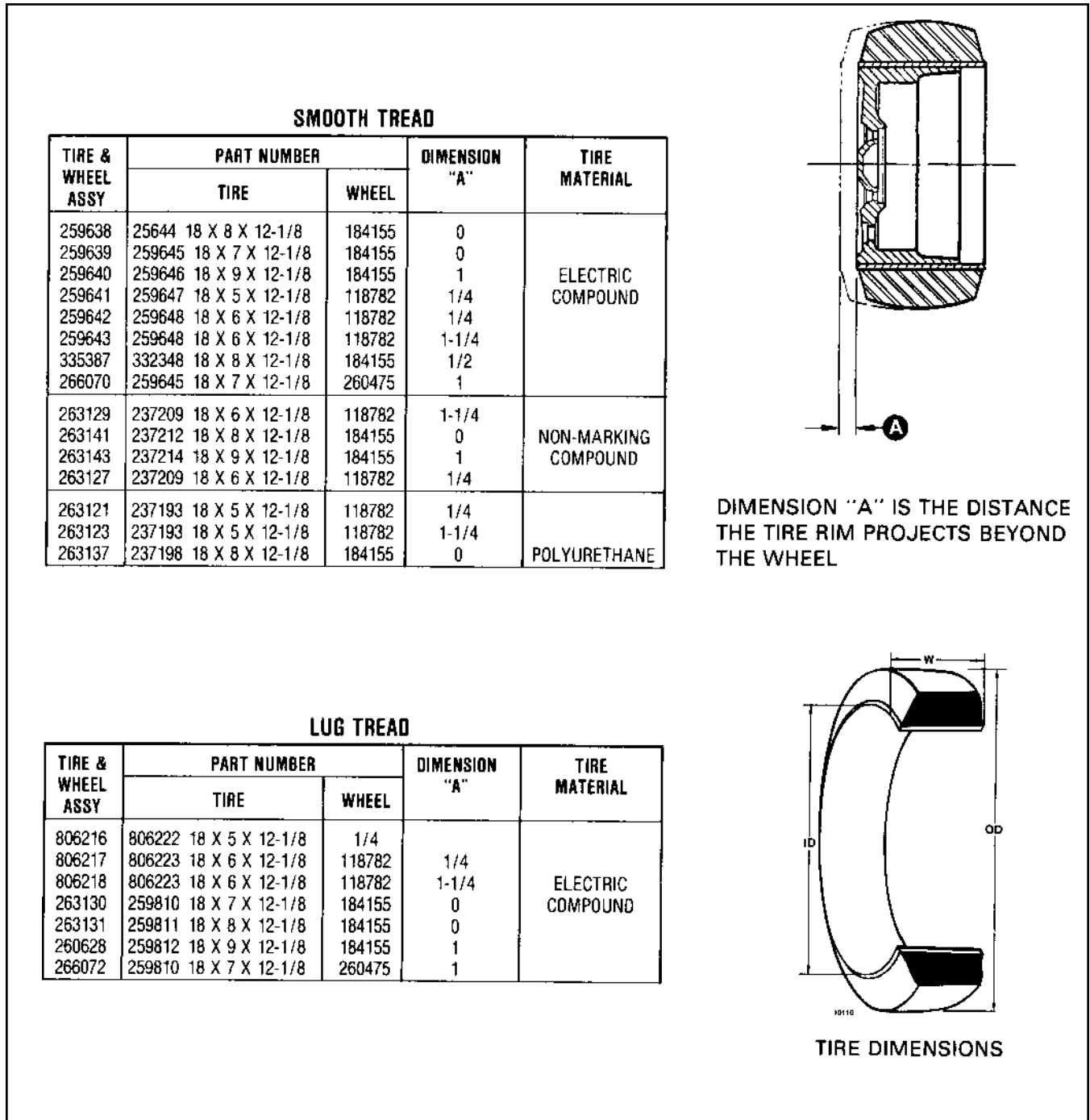


FIGURE 3. CUSHION TIRES SIZES (E20-30BS)

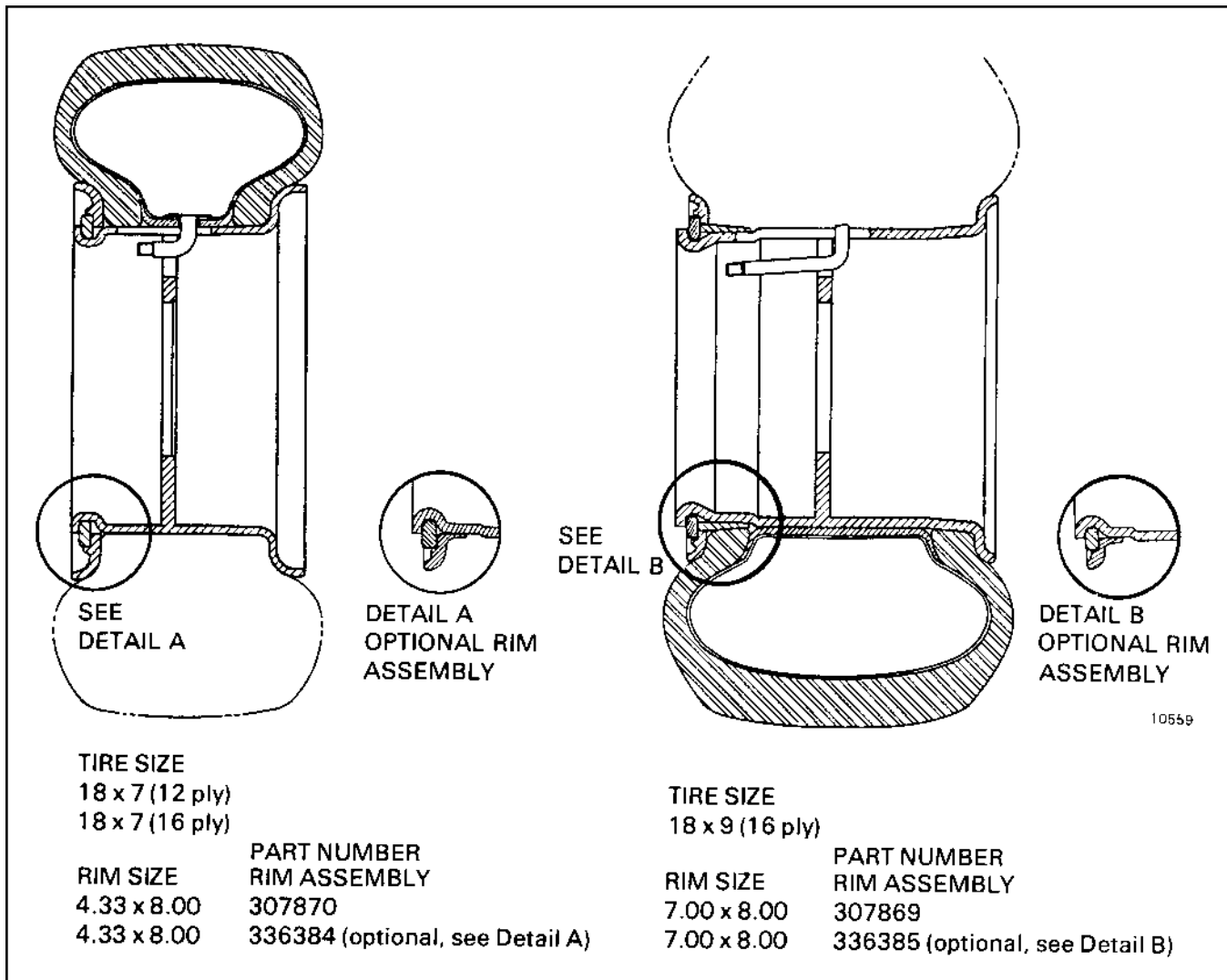


FIGURE 4. PNEUMATIC AND SOLID PNEUMATIC TIRE SIZES

E20-30BH

The E20-30BH series of lift trucks use pneumatic tires or solid tires that look like pneumatic tires. The tire can have either lug tread or traction tread. Do not mix types of tread or types of tires on a lift truck. See Figure 4 for the tire sizes.

REMOVAL OF THE SPEED REDUCER AND DIFFERENTIAL

NOTE

The normal procedure is to remove the complete drive assembly when making

repairs to the differential or speed reducer. The hub assembly and axles can be removed without removing the complete drive assembly.

A. Remove the battery as described in the section PERIODIC MAINTENANCE.

B. Remove the carriage and upright assembly as described in the section UPRIGHTS.

C. Put the lift truck on blocks. Put the blocks under the frame so that the drive assembly can be removed. Do not remove the wheels. See Figure 1.

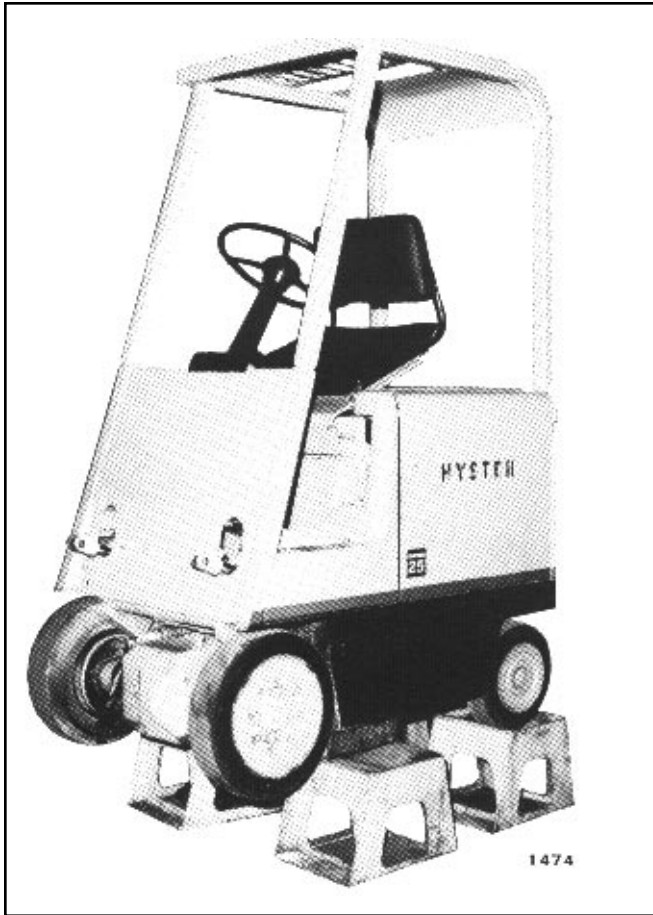


FIGURE 5. PUT THE LIFT TRUCK ON BLOCKS

WARNING



**PUTTING THE LIFT TRUCK ON
BLOCKS OR STANDS**

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the following assemblies will cause large changes in the center of gravity: counterweight, battery, upright, drive axle and transmission. When the lift truck is put on blocks, put additional blocks in the following positions:

1. If the counterweight is not removed, put the blocks under the counterweight.
2. If the counterweight is removed, put blocks under the upright assembly.

Make sure the lift truck will not fall from the blocks or stands. Make sure the lifting devices used during repairs can lift the weight of the parts and assemblies.

D. Remove the motor access plate in the battery compartment. Make a note of the order of connection and disconnect the four electrical cables to the traction motor. Disconnect the spring for the parking brake linkage at the traction motor.

E. Drain the oil from the axle housing.

F. Disconnect the hydraulic brake lines at the hub assembly.

WARNING



Use a floor jack or a lifting device with a capacity of at least 500 kg (1000 lb).

G. Put a floor jack or a lifting device to hold the drive assembly in position. Remove the capscrews that hold the axle housing to the frame.

The hub assembly and axles must be removed before the differential and speed reducer can be disassembled. See The Drive Axle in this section for more information.

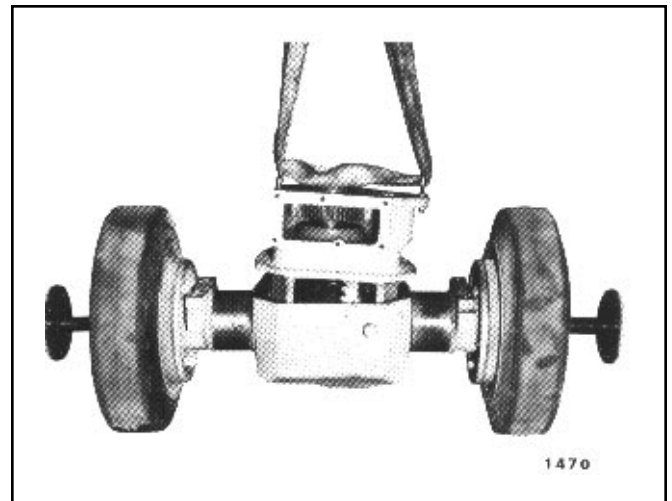
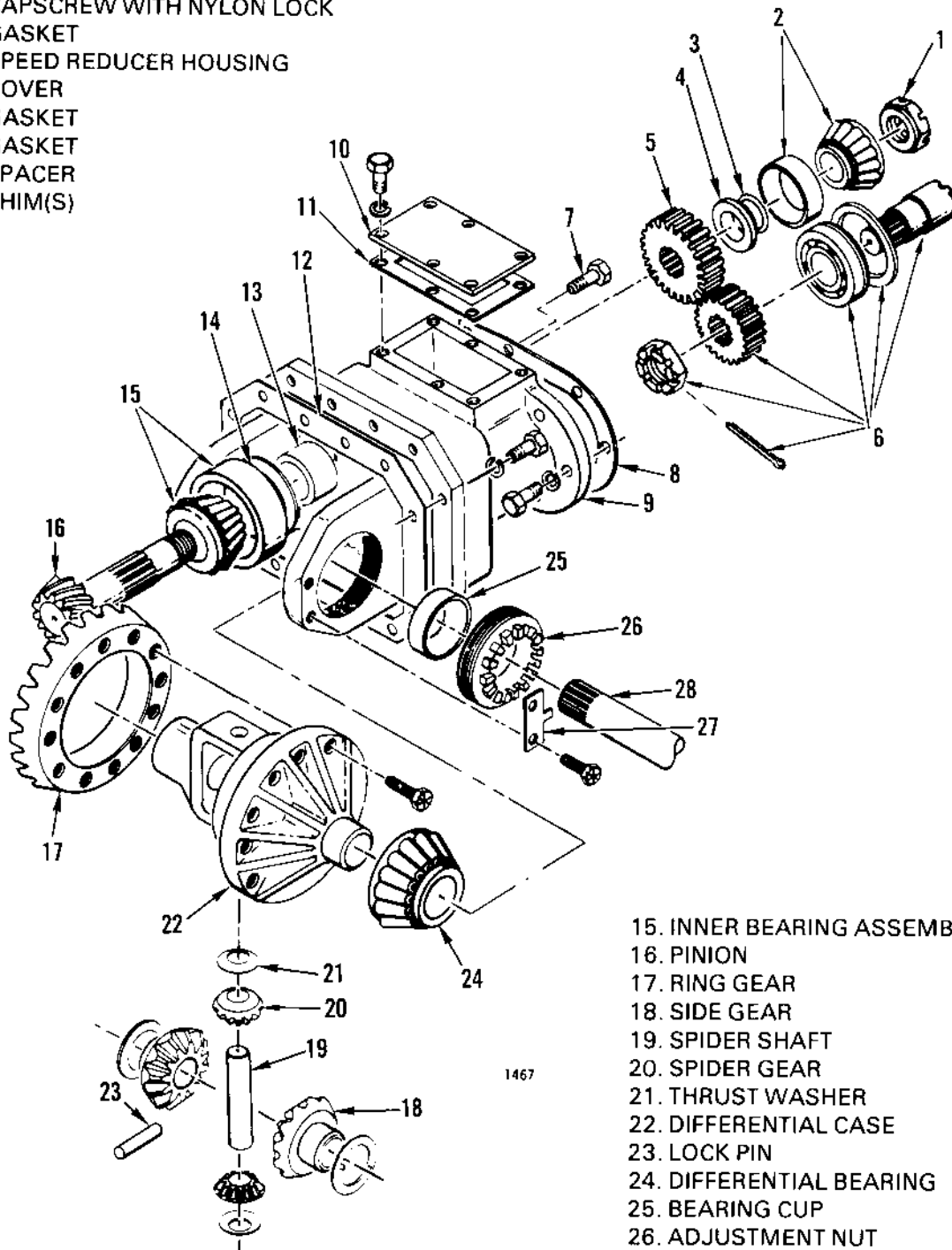


FIGURE 6. REMOVE THE SPEED REDUCER
AND DIFFERENTIAL ASSEMBLY

1. PINION NUT
2. OUTER BEARING ASSEMBLY
3. SHIM(S)
4. SPACER
5. SPEED REDUCER GEAR
6. PART OF TRACTION MOTOR ASSEMBLY
7. CAPSCREW WITH NYLON LOCK
8. GASKET
9. SPEED REDUCER HOUSING
10. COVER
11. GASKET
12. GASKET
13. SPACER
14. SHIM(S)



15. INNER BEARING ASSEMBLY
16. PINION
17. RING GEAR
18. SIDE GEAR
19. SPIDER SHAFT
20. SPIDER GEAR
21. THRUST WASHER
22. DIFFERENTIAL CASE
23. LOCK PIN
24. DIFFERENTIAL BEARING
25. BEARING CUP
26. ADJUSTMENT NUT
27. LOCK PLATE
28. AXLE

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FIGURE 7. SPEED REDUCER AND DIFFERENTIAL ASSEMBLY

WARNING



The traction motors have a weight of approximately 100 kg (220 lb).

- A. Connect a crane and sling to the traction motor. Remove the traction motor from the drive assembly.
- B. Remove the wheels and tires.
- C. Remove the brakes. See the section THE BRAKE SYSTEM, 1800 SRM .
- D. Disassemble the hub assembly and remove the axles.
- E. Connect a crane and sling to the speed reducer and differential assembly. Remove the capscrews and lift the assembly from the axle housing.

DISASSEMBLY

- A. Inspect the ring gear set. If the ring gear and pinion will not be replaced, measure the gear clearance. If the clearance is within 0.08 mm (0.003 in) of the value indicated on the ring gear, adjust for the same clearance during assembly. If the gear clearance is not within 0.08 mm (0.003 in), adjust the clearance to the correct value during assembly. See the Checks and Adjustments part of this section (Figure 11).
- B. Remove the two lock plates that prevent the adjustment nuts from turning.
- C. Make marks with a punch on the housing and adjustment nuts. The housing and adjustment nuts must be reassembled again in the same position.
- D. Remove the adjustment nuts.
- E. Remove the ring gear and differential from the housing.
- F. Disassemble the ring gear and the differential assembly as needed for repairs. If necessary to remove the bearings from the differential, use a puller or a press.

Speed Reducer and Pinion

- A. Remove the cover from the speed reducer housing.

B. Put a piece of hard wood between the speed reducer gear and the housing to prevent the pinion from turning.

C. Remove the pinion nut. A large amount of torque will be needed to remove the pinion nut. The pinion nut was tightened to a torque of 270 N.m (2001bf ft) and locked in position with a punch.

D. Make a note of the shim arrangement when you push the pinion from the speed reducer gear. Slide the pinion assembly from the housing. There are normally two sets of shims. One set of shims is found between the inner bearing cup and the housing. This set of shims controls the tooth contact between the pinion and ring gear. This set of shims cannot be seen until the inner bearing cup is pressed out of the housing. Another set of shims is found between the outer bearing and the speed reducer gear. This set of shims controls the bearing preload of the pinion assembly.

Differential

- A. Use a hammer and punch to remove the lock pin from the differential case. Remove the shaft for the spider gears.
- B. Rotate the spider gears in the differential case until the spider gears and thrust washers can be removed through the openings. Remove the side gears and thrust washers.
- C. Remove the 12 place bolts and remove the ring gear from the differential case.
- D. Remove the adjustment rings from the speed reducer housing. Remove the differential. Use a puller to remove the differential bearings from the differential case. Use a brass driver to remove the bearing cups from the adjustment nuts.

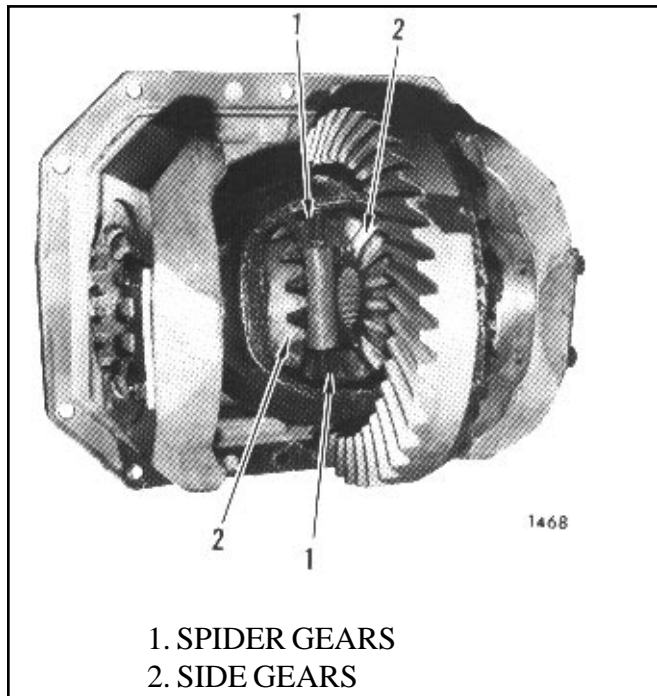
Inspection

Careful inspection of parts before assembly is very important. Inspect all bearings, cups and cones, and other parts of the drive unit. Replace all bearings, cups and cones if the rollers or cups are worn or damaged. Remove parts needing replacement with a puller or press.

- A. Inspect the hypoid gear and pinion for wear and damage. The ring gear and pinion must be replaced as a complete set.

B. Inspect the differential assembly for wear and damage. Thrust washers must be replaced in complete sets. Differential pinions and side gears must be replaced in complete sets. Make sure that the bores where the spider fits in the differential case are not worn. See Figure 8.

C. Inspect axle shafts for cracks, damage, or wear. Axle shafts must be straight



1. SPIDER GEARS
2. SIDE GEARS

FIGURE 8. DIFFERENTIAL

D. Inspect housing for cracks, damage or loose studs. Make repairs before assembly. The threads must be clean to make accurate adjustments.

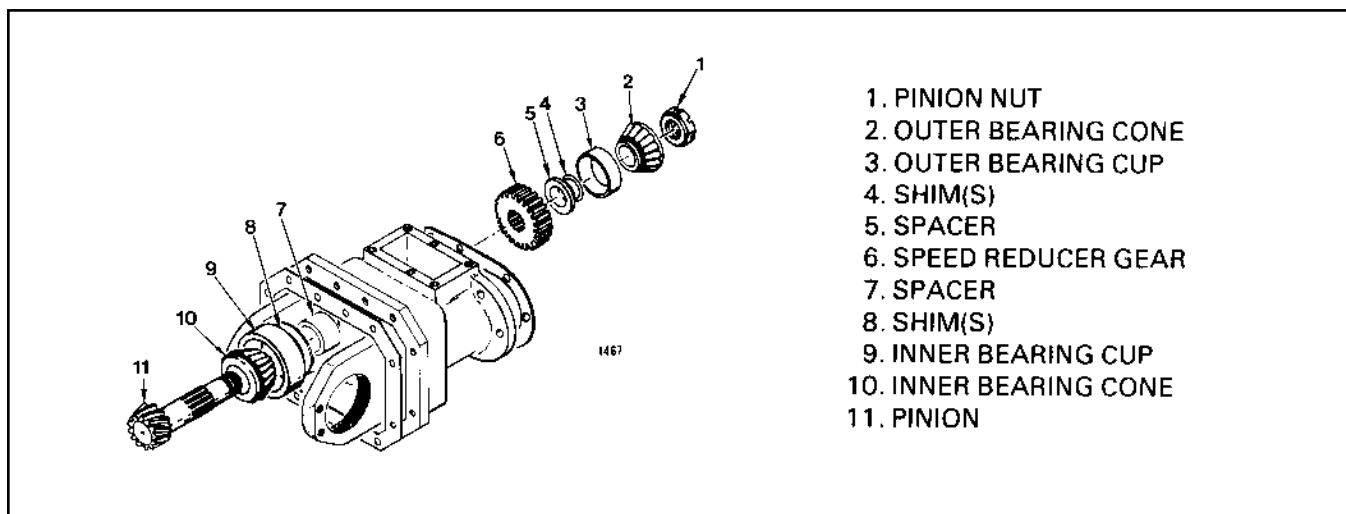
ASSEMBLY

Speed Reducer and Pinion

Each pinion normally has a number indicated on the end of the shaft. (An example is +0.008 or -0.010.). This plus or minus difference will indicate the total gauge distance necessary during assembly. For example, a +0.008 number indicates that 0.008 in. (0.20 mm) must be added to the 3.0625 (77.79 mm) gauge distance. The total gauge distance for this example is 3.0705 in (77.99 mm). A -0.010 number indicates that 0.010 in (0.25 mm) must be subtracted from the 3.0625 in (77.79 mm) gauge distance. The total gauge distance for this example is 3.052 in (77.51 mm). Shims must be added or subtracted to get the total gauge distance within 0.001 in (0.025 mm).

If the original ring gear, pinion, and inner pinion bearing are to be used, install the original shim arrangement.

If a new inner pinion bearing must be installed, install the original shim arrangement. The gauge distance will be checked later in the assembly procedure. A gauge similar to the one used by the manufacturer is



1. PINION NUT
2. OUTER BEARING CONE
3. OUTER BEARING CUP
4. SHIM(S)
5. SPACER
6. SPEED REDUCER GEAR
7. SPACER
8. SHIM(S)
9. INNER BEARING CUP
10. INNER BEARING CONE
11. PINION

FIGURE 9. PINION ASSEMBLY

not available to many service persons. The correct clearance will be checked when adjusting the ring gear and pinion tooth contact.

A. Put the pinion assembly in the housing. (See Figure 5.) Put a piece of hard wood between the speed reducer gear and the housing to prevent the gear from rotating. Tighten the pinion nut to 270 N.m (200 lbf ft). **DO NOT** use a punch to lock the pinion nut now because of possible adjustments to the shim arrangement. Remove the piece of wood.

B. Check the preload on the pinion bearings. Use a socket and a beam torque wrench to check the rotating torque. The correct torque is 0.6-1.1 N.m (5-10 lbf in). Add or remove shims between the outer bearing and the spacer to adjust the preload.

Differential

A. Assemble the differential gear assembly. Install the side gears and thrust washers in the differential case. Install and align the spider gears and thrust washers.

B. Install the shaft for the spider gears. Make sure the hole for the lock pin is aligned with the holes in the differential case. The shaft for the spider gears fits tightly in the differential case. Install the lock pin. Use a punch to lock the lock pin in the differential case.

C. If the differential bearings are replaced, press the new bearing cones on the differential case.

D. If the ring gear was removed from the differential, install the ring gear on the differential case. Tighten the twelve 1/2-20 UNF x 1 1/4 in place bolts to 105 N.m (80 lbf ft).

E. Put the differential assembly in position in the housing. Install the bearing cup and adjustment nut for each bearing. Make sure each adjustment nut is installed in its original position.

CAUTION



When adjusting the adjustment nuts, do not move the ring gear into heavy contact with the pinion. You can cause damage to the gears and the measurements for gear clearance will be wrong.

F. Loosen the adjustment nut that is toward the tooth side of the ring gear. Tighten the other adjustment nut until the ring gear is fully engaged in the pinion and the metal surfaces just touch. The ring gear and pinion must have no gear clearance. Tighten the adjustment nut that is toward the tooth side of the ring gear until the bearing cup is against the bearing cone. Then tighten the same adjustment nut two more notches. This action adjusts the preload of the bearings and sets the ring and pinion gear clearance.

G. Fasten a dial indicator to the housing so that the movement of the ring gear can be measured. Rotate the ring gear 360°. Check with the dial indicator that the ring gear does not make a variation of more than 0.08 mm (0.003 in). If the variation is more than 0.08 mm (0.003 in), remove the differential assembly and correct the problem.

H. Adjust the dial indicator to measure the gear clearance. See Figure 10. Prevent the pinion from turning and slowly move the ring gear backward and forward. The indication of gear clearance must be the value indicated on the ring gear. If the clearance must be adjusted, move the adjustment nuts equally to that the preload of the bearings is not changed.

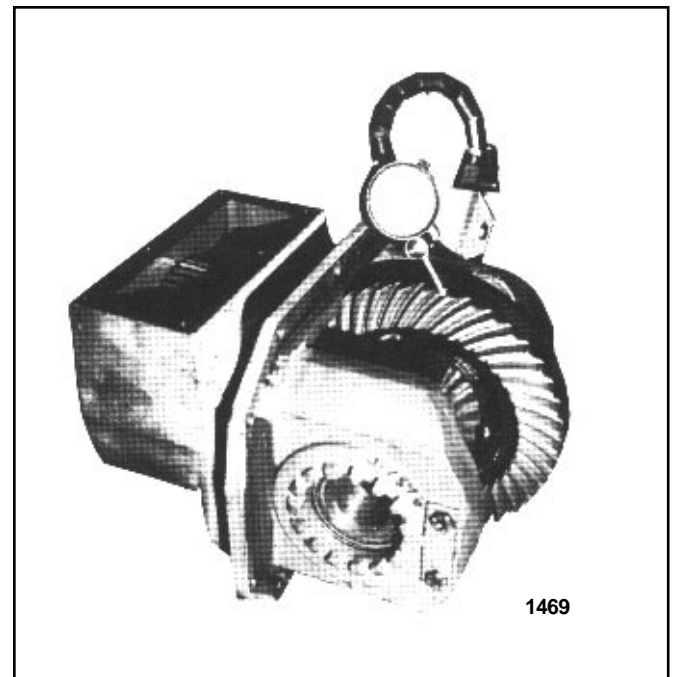


FIGURE 10. MEASURE THE GEAR CLEARANCE

I. Apply a thin layer of grease to approximately 12 of the ring gear teeth. See Figure 11. Apply a friction load to the edge of the ring gear so that the ring gear does not turn easily. Rotate the ring gear one revolution by turning the pinion.

J. Check the ring gear and pinion tooth contact. See Figure 11. If the tooth contact is not correct, remove the differential assembly from the housing. Disassemble the pinion assembly and add or subtract shims at the inner bearing to give the correct tooth contact. Begin the assembly and adjustment procedure again.

K. After adjusting the pinion depth, adjust the gear clearance and check the tooth contact pattern again. When the tooth contact pattern and gear clearance are correct, install the lock plates and capscrews that lock the adjustment nuts. Tighten the capscrews for the lockplates to 48 N.m (35 lbf ft). Use a punch to lock the pinion nut to the pinion shaft.

L. Install the speed reducer and differential assembly in the axle housing. Use a new gasket. Tighten the 12 capscrews to 31 N.m (23 lbf ft).

Traction Motor

A. If the speed reducer gear was removed, install the gear and spacer on the motor shaft. Tighten the 7/8 in UNF nut to 165 N.m (120 lbf ft). Use the parking brake or a strap wrench to prevent the motor shaft from turning when tightening the nut. Install the cotter pin.

B. Use a new gasket. Install the traction motor on the drive axle. Rotate the armature of the traction motor a small amount to engage the two gears of the speed reducer. Tighten the seven capscrews to 31 N.m (23 lbf ft).

NOTE

The capscrew with the nylon lock is installed in the top center hole in the speed reducer housing.

C. Install the cover on the speed reducer. Use a new gasket and tighten the four capscrews to 31 N.m (23 lbf ft).

D. Install the axles and hub assemblies. See the drive axle section.

E. Install the wheels and tires.

INSTALLATION OF THE DRIVE ASSEMBLY

WARNING



Use jacks and lifting devices with a capacity of at least 500 kg (1000 lb).

A. Put the drive assembly under the lift truck. Lift the drive assembly into the correct position on the frame. Install the four capscrews that fasten the axle housing to the frame. Tighten the four capscrews to 220 N.m (160 lbf ft).

B. Connect the hydraulic lines. Remove the air from the brake system. See the section THE BRAKE SYSTEM, 1800 SRM for more information.

C. Connect the four electrical cables to the traction motor in the correct order.

D. Connect the linkage for the parking brake. Install the access plate in the battery compartment.

E. Remove the blocks from under the lift truck.

F. Fill the axle housing to the fill and check plug with SAE 85-140 EP or SAE 80W-90EP oil. Wait five minutes for the oil to flow to the hubs before checking the oil level again.

G. Install the carriage and upright assembly as described in the section UPRIGHTS.

H. Install the battery.



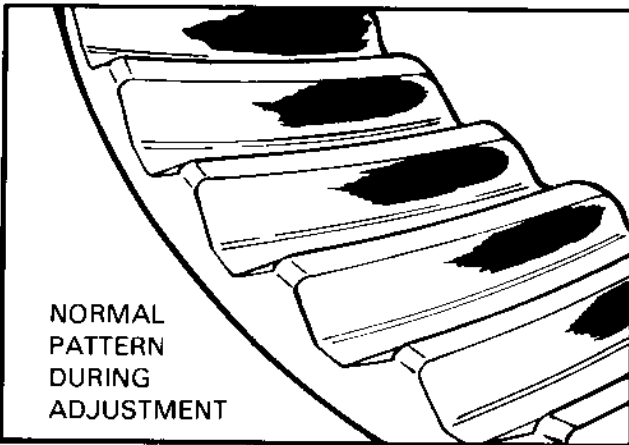
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Step 1. Apply a colored dye or grease to approximately 12 of the ring gear teeth.

Step 2. Apply a small friction load to the edge of the ring gear so that the ring gear does not turn easily. Rotate the ring gear one revolution by turning the pinion.

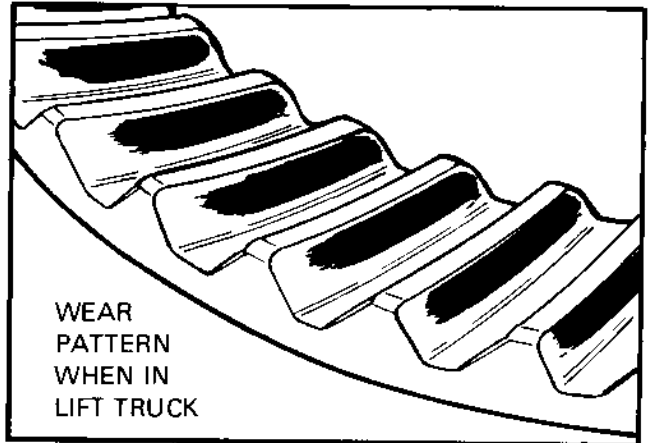
Step 3. Check the tooth contact pattern on the ring gear. Make sure that the pattern is checked on the side of the tooth where the pinion applies the force.

CORRECT TOOTH CONTACT



NORMAL
PATTERN
DURING
ADJUSTMENT

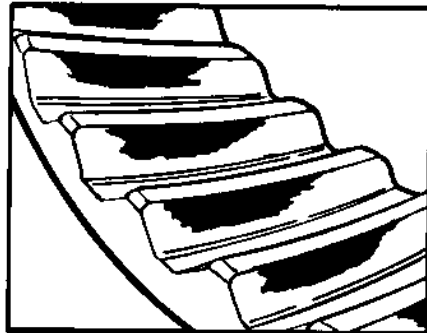
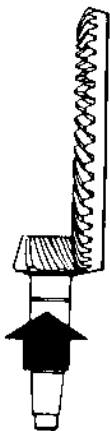
The area of contact is in the center between the top and bottom of the tooth. The area of contact is toward the inner circumference of the gear



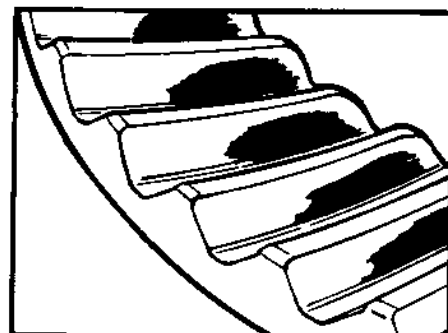
WEAR
PATTERN
WHEN IN
LIFT TRUCK

The area of contact is the center between the top and the bottom of the tooth. The area of contact will be almost the full length of the tooth.

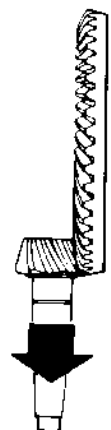
WRONG TOOTH CONTACT



The pinion is too far from the center of the ring gear. Remove shims and adjust backlash for correct adjustment.



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The pinion is too close to the center of the ring gear. Add shims and adjust backlash for correct adjustment.

FIGURE 11. ADJUSTING THE RING GEAR AND PINION TOOTH CONTACT

TROUBLESHOOTING

PROBLEM	CAUSE
Lift truck will not move	Broken axle.
	Ring and pinion damaged.
	Differential case damaged.
Gear noise	Low oil level.
	Damaged speed reducer gears.
	Damaged ring and pinion gears.
	Ring and pinion clearance not correctly adjusted.
	Worn bearings.
	Loose differential housing.
	Loose ring gear bolts.
Gear noise only when turning	Worn spider gears.
	Worn side gears or thrust washers.
	Worn differential case.
Shocks felt when changing direction	Worn ring and pinion.
	Worn differential case.
	Worn spider.
	Axle or side gear splines worn.
	Loose ring gear bolts.
	Worn bearings.
Gear noise only in "REVERSE"	Loose pinion nut.
Loss of oil	Drain or fill plug loose.
	Axle seals are damaged.