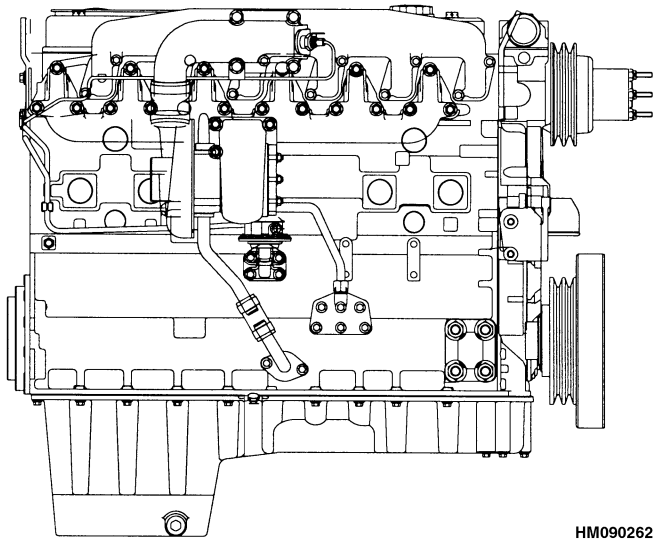
Yale

Maintenance

PERKINS DIESEL ENGINES

1004-42 (AR), 1006-60 (YG), 1006-60T (YH)

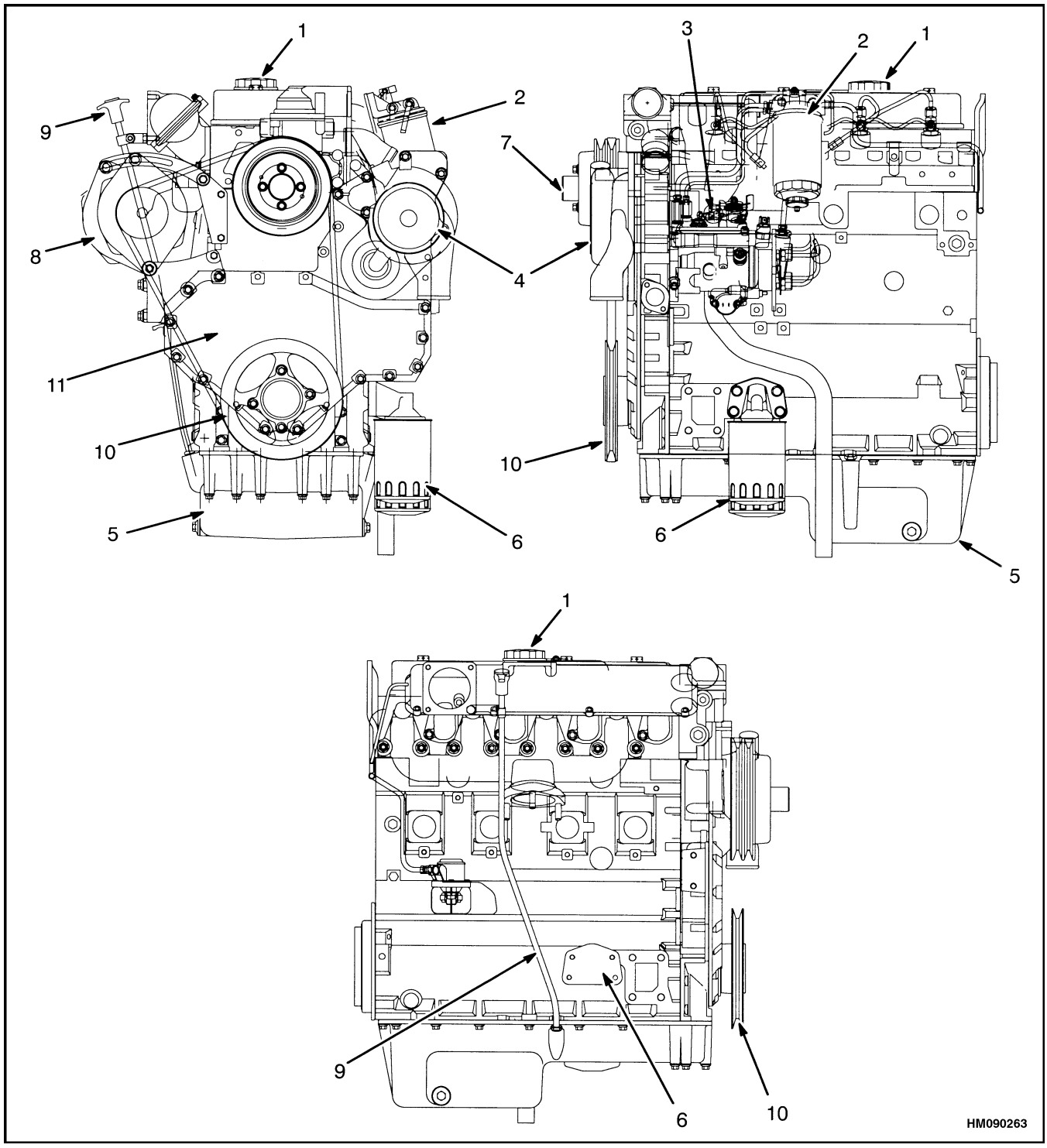
GC/GLC070-120MG [B818];
GDP60-70CA (GP/GLP/GDP135-155CA) [A878];
GC/GLC/GDC135-155CA [A879];
GP135-280DA [A876];
GP070-120LJ/MJ [C813];
GC070-120LJ/MJ [C818, D818];
GDP80-120DB (GP170-280DB) [B876];
GDP130-160EB (GP300-360EB) [B877]



HM090262

PART NO. 524150774

600 YRM 705



1. FILL CAP FOR ENGINE OIL
2. FUEL FILTER
3. FUEL INJECTION PUMP
4. COOLANT PUMP
5. OIL SUMP
6. OIL FILTER (CAN BE INSTALLED ON EITHER SIDE OF ENGINE)
7. FAN DRIVE
8. ALTERNATOR
9. DIPSTICK, ENGINE OIL (CAN BE INSTALLED ON EITHER SIDE OF ENGINE)
10. CRANKSHAFT PULLEY
11. TIMING CASE

Figure 1. Engine 1004-42 AR

10. Remove the return fuel line from the fuel injectors.

11. Remove the fuel injectors from the cylinder head. Keep the fuel injectors clean and prevent damage to the nozzles.

12. ENGINES YG and YH. If an air compressor is installed, remove the coolant pipe between the cylinder head and the compressor. Remove the coolant pipe between the bypass connection and the compressor.

13. Loosen the hose clamp and remove the coolant bypass hose from the cylinder head. Remove the capscrews and remove the coolant bypass connection and the hose.

14. Disconnect the coolant temperature sender.

15. ENGINE AR. Remove the oil cooler if it is integral with the cylinder block.

16. Remove the valve cover. See Valve Cover, Remove.

17. Remove the rocker arm assembly. See Rocker Arm Assembly, Remove.

18. Remove the push rods.

19. Loosen the capscrews for the cylinder head evenly in a reverse sequence from the sequence shown in Figure 15 or Figure 16.

20. Lift the cylinder head from the engine block. Do not use a pry bar between the cylinder head and the engine block that can cause damage to the gasket surfaces. See Figure 17.

21. Inspect the capscrews for the cylinder head with a straightedge. See Figure 18. Check that the capscrews are straight and do not have distortion. If there is a reduction in the diameter of the thread that has not been in engagement with the cylinder block, the capscrew must be discarded.

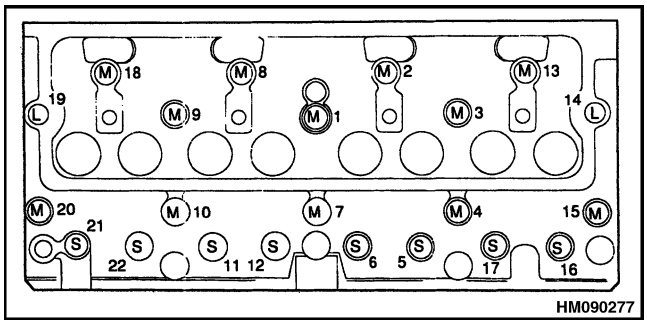


Figure 15. Cylinder Head Tightening Sequence, Four-Cylinder Engines

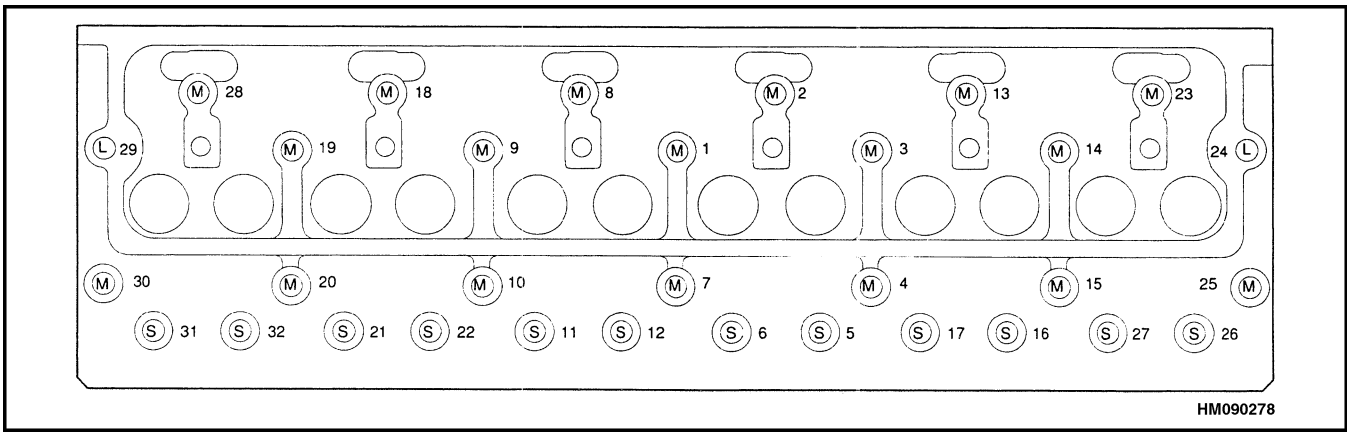
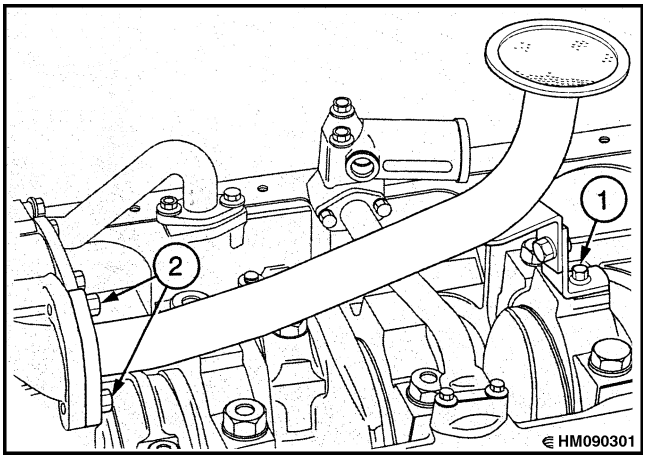


Figure 16. Cylinder Head Tightening Sequence, Six-Cylinder Engines

Remove

1. Drain the engine oil from the sump. Remove the oil sump. See Oil Sump, Remove.

2. Remove the suction pipe and oil strainer. See Figure 40. Remove the capscrew that holds the bracket to the main bearing cap. Remove the two capscrews from the flange of the suction pipe and remove the suction pipe and screen. Clean the faces of both flanges.



1. SUPPORT BRACKET, MAIN BEARING CAP
2. CAPSCREWS, FLANGE, SUCTION PIPE

Figure 40. Sump Screen Removal

3. Turn the crankshaft until the connecting rod to be removed is at the lowest position on the crankshaft.

CAUTION

Do not permit the connecting rods to hit the cooling jets for the pistons. If a cooling jet is hit, the alignment must be checked and the cooling jet replaced if necessary.

4. Connecting rods with capscrews. Loosen the capscrews for the bearing cap approximately four turns. Lightly hit the heads of the capscrews with a soft hammer to separate the connecting rod from the bearing cap. Remove the capscrews and the bearing cap.

   Connecting rods with nuts. Remove the nuts and remove the bearing cap.

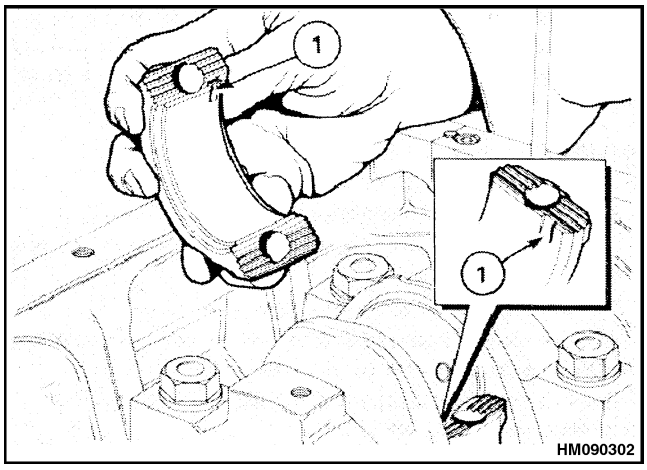
5. Remove the lower bearing half from the bearing cap. Keep the bearing half with its cap.

6. Carefully push the connecting rod up the cylinder bore just enough to permit access to the upper bearing half. Remove the upper bearing half from the connecting rod. Keep the bearing halves together.

Install

1. Clean the bearing surfaces of the connecting rod and the crankshaft. Make sure that the protrusion for the location dowels is 3.0 to 4.5 mm (0.12 to 0.18 in.) above the cap faces. Clean the bearing halves and lubricate them with clean engine oil.

2. Install the upper bearing half into the connecting rod. Make sure that the location tab is installed correctly into its position in the connecting rod. See Figure 41.



1. POSITION OF LOCATION TAB IN BEARING HALF AND CONNECTING ROD

Figure 41. Rod Bearings Position

3. Install the bearing cap on the connecting rod. Make sure that the assembly number on the bearing cap is the same as the number on the connecting rod. Make sure that the two assembly numbers are on the same side of the connecting rod as shown in Figure 42.

2. Clean the end of the crankshaft and the parts of the crankshaft pulley. Do not use a degreasing solution. See Figure 61. Do not make any changes to the inner ring or the outer ring.

3. Put the crankshaft pulley on the crankshaft so that the key is engaged. Push the pulley onto the crankshaft.

NOTE: If the rings are not installed correctly, the crankshaft pulley will be very difficult to remove again.

4. Install the spacer ring, inner ring, and the outer ring in the correct order.

5. Lightly lubricate the O-ring and the thrust faces of the capscrews with engine oil. Put the thrust block and the capscrews in position.

6. Gradually and evenly tighten the capscrews to push the crankshaft pulley on the crankshaft. Tighten the capscrews to 115 N•m (85 lbf ft).

7. Install the drive belts. See Drive Belts.

REAR OIL SEAL

Replace

Special Tools: Replacement tool for oil seal.

1. Remove the drive components from the rear of the engine.

2. Remove the flywheel and housing. See Flywheel, Remove.

3. Remove the capscrews and remove the seal housing and seal assembly. Clean the parts.

4. Inspect the oil seal for wear and damage. If there is any question about the condition of the oil seal, replace the oil seal.

5. Check that the oil seal area and outer circumference of the crankshaft flange are not worn or damaged.

6. Press the oil seal from the housing.

7. Lubricate the oil seal with engine oil and carefully press the oil seal into one of the positions in the housing. The spring in the seal goes toward the housing. The installation tool has two sides and will install the oil seal in the housing in either position 1 or position 2.

8. There are three positions in which the oil seal can be installed in the seal housing. See Figure 64.
   - Position "1" is used when a new seal is first fitted in service.
   - Position "2" is used when a new seal is fitted in service and the crankshaft flange is worn in position "1".
   - Position "3" can be used with a new seal in service, if a wet clutch is not used and the crankshaft is new or the crankshaft palm area has been corrected. Check that the seal is fitted square in the housing.

   If all positions have been used, the crankshaft must have a new surface ground on the crankshaft flange. See the Engine Specifications for the size limits.

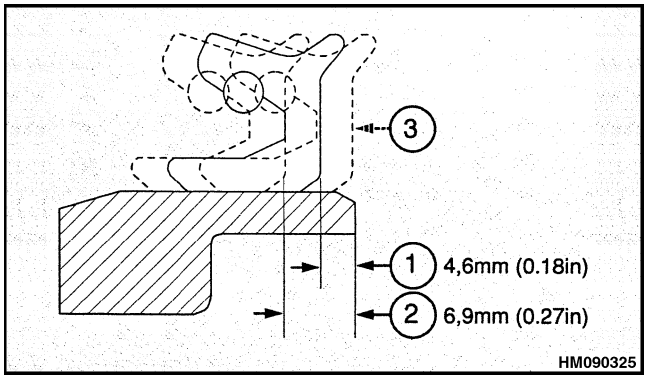
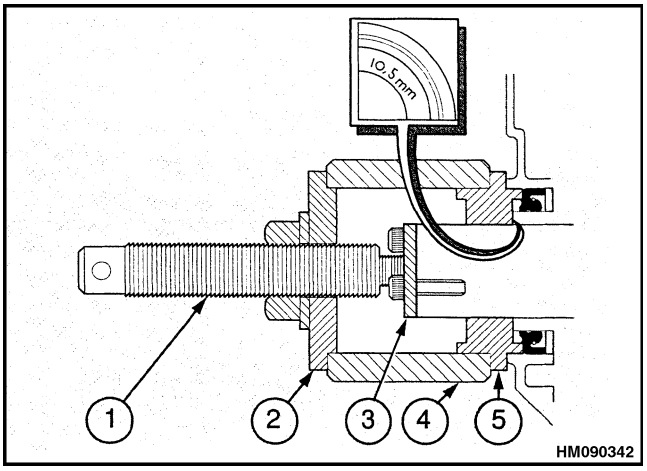


Figure 64. Oil Seal Positions

9. Make sure that the two position dowels are installed in the engine block. Use a new gasket. Do not use gasket compound on any of the surfaces.

10. Make sure the lip of the seal is lubricated with engine oil where it touches the crankshaft flange. This lubrication of the oil seal is necessary to prevent damage to the oil seal when the engine is first started.

11. Install a new gasket on the seal housing. Put the oil seal and housing on the seal guide. Carefully push the oil seal assembly into position on the crankshaft flange and onto the dowels. See Figure 65.



1. REPLACEMENT TOOL FOR FRONT OIL SEAL
2. PRESSURE PLATE
3. FASTENER PLATE
4. SLEEVE
5. SEAL ADAPTER

Figure 81. Front Oil Seal Installation

4. Install a rod through the hole in the end of the tool so that the tool will not turn. Turn the nut on the pressure plate with a wrench and the front oil seal will be pushed into the housing. Push the seal into the correct depth. Remove the installation tool.

5. Lubricate the seal area of the crankshaft pulley with engine oil. Install the crankshaft pulley. See Crankshaft Pulley.

6. Install the drive belts and adjust the belt tension.

7. Install the fan.

CRANKSHAFT PULLEY WEAR SLEEVE

Install

To renew a worn crankshaft pulley, a wear sleeve is fitted over the spigot. See Figure 82.

1. Remove the crankshaft pulley. See Crankshaft Pulley, Removal.

NOTE: Full instructions and a special tool to install the wear sleeve are in each service kit.

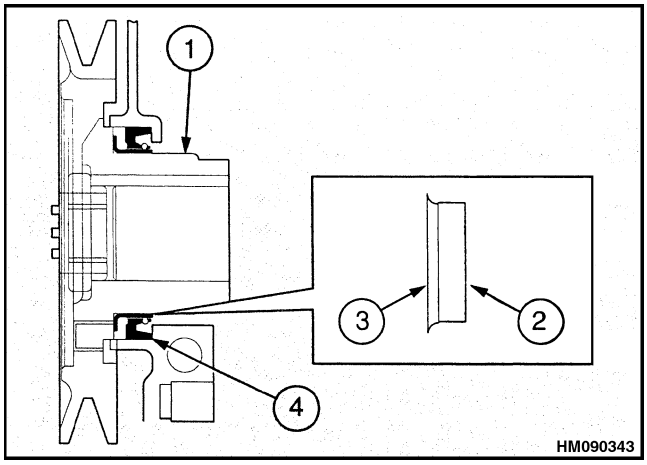
2. Install the wear sleeve, in accordance with the manufacturer's instructions.

It is not necessary to remove the flange of the wear sleeve after it has been fitted.

A new front oil seal must be used when a wear sleeve is fitted.

The dimension, to press the new oil seal into the timing case, with or without a wear sleeve fitted, is 9.3 mm (0.366 in.), from the front face of the timing case.

3. Install the crankshaft pulley. See Crankshaft Pulley, Installation.



1. SPIGOT
2. WEAR SLEEVE
3. FLANGE
4. OIL SEAL

Figure 82. Crankshaft Pulley Wear Sleeve

IDLER GEAR AND HUB

Remove

1. Remove the timing case cover. See Timing Case Cover, Remove.

2. Turn the crankshaft until the marked teeth of the crankshaft gear, the camshaft gear, and the gear for the fuel injection pump are aligned as shown in Figure 83. The marked teeth on the idler gear will not necessarily be aligned with the marked teeth of the other three gears because of the different speed of rotation of the idler gear.

CAUTION

Make sure that the crankshaft is not turned while the idler gear is removed. A piston can hit and damage a valve. The valve timing and the fuel injection pump timing will be lost if the crankshaft is turned.

3. Remove the three capscrews, remove the plate of the idler gear, and remove the idler gear. See Figure 84. Make a note of the position of the oil hole. The gear for the fuel injection pump will turn a small amount in the counterclockwise direction as the teeth become disengaged from the idler gear.

so that the connecting rods are separated from the crankshaft.

20. Make sure that the main bearing caps are marked with their position number. Remove the main bearing caps, lower bearing halves, and the upper and lower thrust washers. Keep all the parts in an arrangement so that the parts can be installed in their original positions.

21. Lift the crankshaft from the cylinder block. Remove the upper bearing halves and put each of them with their lower bearing half.

22. Carefully remove the pistons and connecting rod assemblies from the engine.

23. Remove the camshaft and tappets. See Camshaft and Tappets, Remove.

24. Remove the cooling jets for the pistons.

Inspect

1. Make sure all of the oil and coolant passages in the engine block are clean.

2. Check the engine block for cracks and damage.

NOTE: The top face of the cylinder block for the six-cylinder engines cannot be machined because the cylinder liners and pistons will not fit. The top face of the cylinder block for the four-cylinder engines cannot be machined because the pistons and connecting rods are matched for each cylinder.

3. Check the front bushing for the camshaft for wear. If a new bushing must be installed, use a puller to remove the old bushing. Make sure the oil hole for the new bushing is away from the engine when it is installed. Make sure the oil hole is aligned with the passage in the cylinder block when it is installed. Use a press to install a new bushing and align it in position in the cylinder block.

Assemble

1. Make sure all the parts are clean.

2. Remove the screw plugs from the cylinder block and clean the threads. Apply a sealant to the threads of the plugs and install them in the cylinder block.

3. Install the cooling jets for the pistons. See Piston Cooling Jets, Install.

4. Install the crankshaft and the rear oil seal assembly. See Crankshaft Assembly Repair section.

5. Install the flywheel housing and flywheel. See Flywheel section.

6. Install the tappets and the camshaft. See Camshaft and Tappets, Install.

7. Install the relief valve, oil pump, suction line, and oil strainer.

8. Install the timing case and the timing gears. See Timing Case and Timing Gears Repair.

9. Install the cylinder head assembly. See Cylinder Head Assembly, Install.

10. Install the starter motor.

11. Install the fuel pump.

12. ENGINE YH. Install the turbocharger. See Turbocharger - Engine YH Repair, Install.

13. Install the oil filter assembly and the oil sump. See Oil Sump, Install.

14. Install the oil cooler. See Oil Cooler (Six-Cylinder Engines).

15. Install the fuel injectors, fuel lines, fuel filter, and fuel injection pump. See Fuel System Repair section.

16. Install the coolant pump, fan drive pulley, and fan. See Cooling System Repair section.

17. Install the alternator and mount brackets.

18. Install the drive belts and adjust the tension. See Drive Belts.

19. Install the engine into the lift truck.

20. Remove the air from the fuel system before operating the engine. See Fuel System Air Removal.

CYLINDER BORE (FOUR-CYLINDER ENGINES)

To ensure the best performance during the life of the engine, it is important that worn or damaged cylinder bores are corrected.

The condition of a cylinder bore is decided by:
- The amount and location of any polished areas.
- Wear.
- Damage to the cylinder wall.

10. Make sure that there is no restriction in the duct from the air filter to the turbocharger. Install the duct on the turbocharger and tighten the fastener.

11. Check that the bearings in the turbocharger have an oil flow. Disconnect the electric stop control so that the engine cannot start. Use the starter motor to operate the engine until engine oil flows from the oil drain line from the turbocharger. Connect the hose to the oil drain line. Connect the electric stop control.

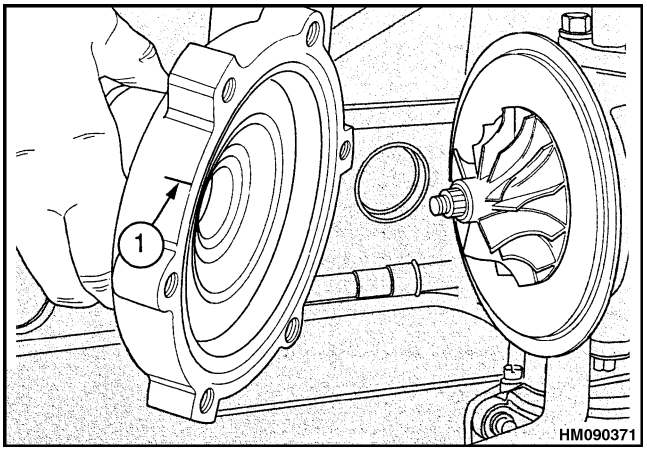
Impeller and Compressor Housing, Clean

NOTE: The compressor housing can sometimes be removed for cleaning without removing the turbocharger first. The compressor housing is held by a circlip and access to the circlip (large snap ring) is not always possible.

1. Clean the turbocharger. Remove the duct from the air filter where it connects to the inlet of the turbocharger.

2. Release the hose clamps and push the hose from the compressor outlet up the elbow of the induction manifold.

3. Make a reference mark on the compressor housing and the bearing housing as shown in Figure 112.



1. REFERENCE MARK

Figure 112. Compressor Housing Removal

4. Remove the capscrews and remove the lock plates. If the compressor casting is fastened with a circlip, remove the circlip that holds the compressor housing. Carefully remove the compressor housing from the turbocharger as shown in Figure 112. If the compressor housing is a tight fit, use a soft hammer. If the circlip is not accessible, the turbocharger must be removed for this process.

⚠ CAUTION

Be careful that the blades of the impeller are not damaged. If the impeller is damaged, the turbocharger must be replaced or repaired by a special repair service.

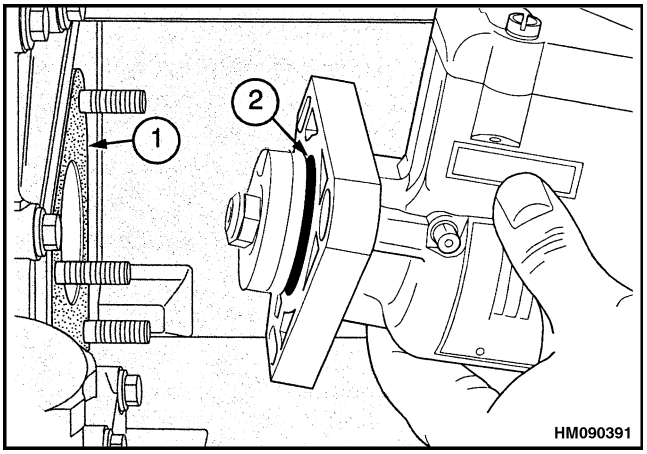
5. Put the compressor housing in a container with a solvent that is not caustic. When the dirt has loosened, use a hard brush or a soft scraper to clean the compressor housing. Use compressed air at low pressure to dry the compressor housing.

6. Clean the impeller with a soft brush.

7. Carefully push the impeller toward the bearing housing and turn the impeller with your hand. Check that the impeller turns freely and there is no noise that can indicate wear or damage. If there is a fault, the turbocharger must be replaced or repaired by a special repair service.

8. Install the compressor housing on the turbocharger. Make sure the reference marks are aligned. Install the circlip loosely on the bearing housing. Make sure that the face of the circlip with the bevel is toward the exhaust end of the turbocharger. Install the circlip in the groove.

9. Install the ducts on the inlet and outlet of the compressor housing and tighten the clamps.



1. GASKET 2. O-RING

Figure 134. Fuel Injection Pump Mount

Install

1. The engine must be set for the number one piston to TDC on the compression stroke. If the crankshaft needs to be rotated, the pump must be installed temporarily, or the loose gear could damage the timing case.

2. Install a new gasket and new O-ring as shown in Figure 134. Lubricate the O-ring with a thin coat of engine oil.

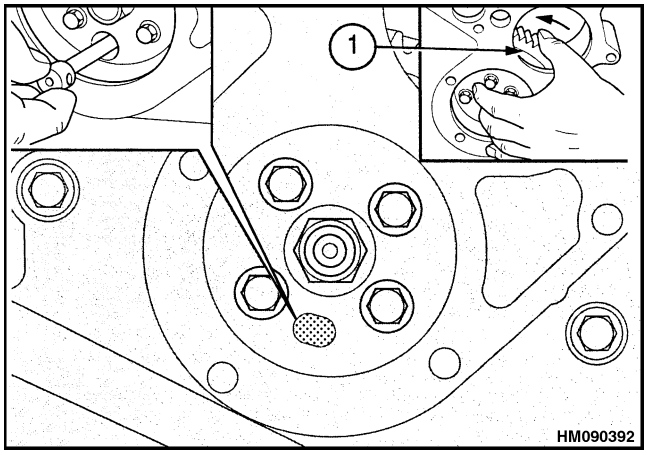
3. Install the fuel injection pump on the three studs and install the nuts. Tighten the nuts to 28 N•m (21 lbf ft).

NOTE: The fuel pump gear will only fit in one position. The gear is fitted with the letters C and M at the front.

4. Install the fuel pump gear onto the hub of the fuel pump. See Figure 132. The fasteners for the fuel pump gear should be in the center of the slots to allow for the removal of the backlash. Tighten the capscrews finger tight.

5. Insert the timing pin through the hole of the fuel pump gear and the slot of the hub until it can be pushed fully into the hole in the body of the fuel pump. See Figure 132. If the timing pin cannot be pushed into the pump body, check that the engine is correctly set at TDC on the number one cylinder.

6. Carefully turn the gear for the injection pump with your hand to remove the clearance between the gear and the idler gear. See Figure 135. Do not rotate the crankshaft or the shaft of the fuel injection pump. Tighten the capscrews for the gear for the fuel injection pump to 28 N•m (21 lbf ft).



1. REMOVE GEAR CLEARANCE WITH YOUR HAND

Figure 135. Gear for Fuel Injection Pump Installation

7. Remove the timing pin.

8. Install the coolant pump. See Coolant Pump, Install.

9. Connect the fuel lines. Use a second wrench to prevent movement of the union nuts when the fuel lines are connected. Do not tighten the union nuts greater than 22 N•m (16 lbf ft). If there is a leak, make sure the fuel line is correctly aligned. A union nut that is too tight can cause a restriction in the fuel line.

10. Connect the engine stop control and the control rod for the fuel injection pump.

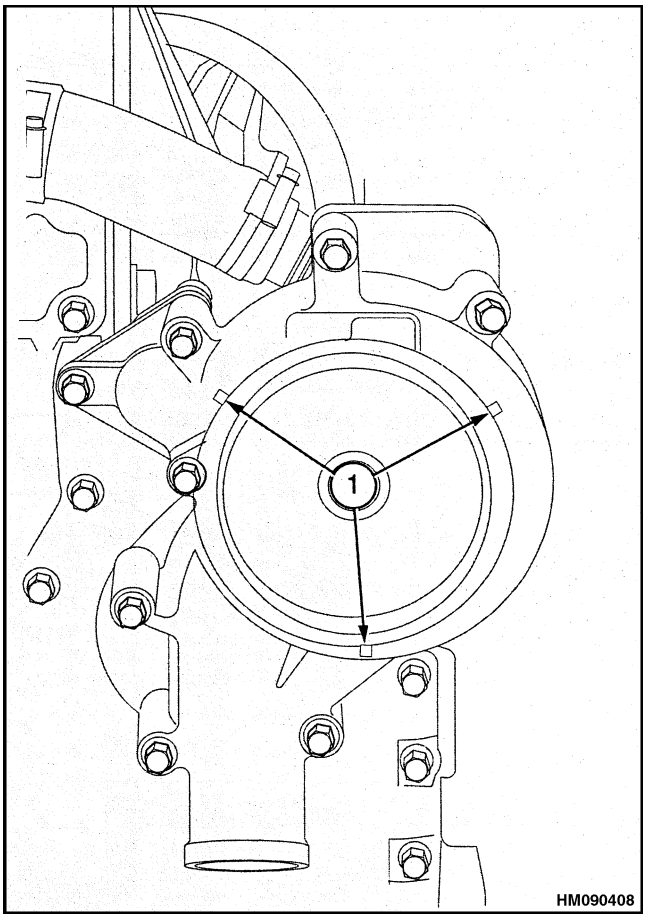
11. Remove the air from the fuel system. See Fuel System Air Removal.

12. When the engine can be operated, do Check and Adjust.

Check and Adjust

1. Operate the engine until it reaches normal operating temperature and check the idle speed. The idle speed can be adjusted with the idle adjustment screw shown in Figure 136.

6. Drill a 3.175 mm (0.125 in.) hole through the top of the oil seal. Install a 25.4 mm (1.00 in.) self-tapping screw in the hole. Insert a pry bar through the cooling inlet of the pump body and carefully apply the lever under the head of the self tapping screw. See Figure 152. Carefully slide the oil seal from the shaft. Discard the oil seal.



1. ACCESS SPACE FOR PRY BAR

Figure 151. Coolant Pump Cover Removal

CAUTION

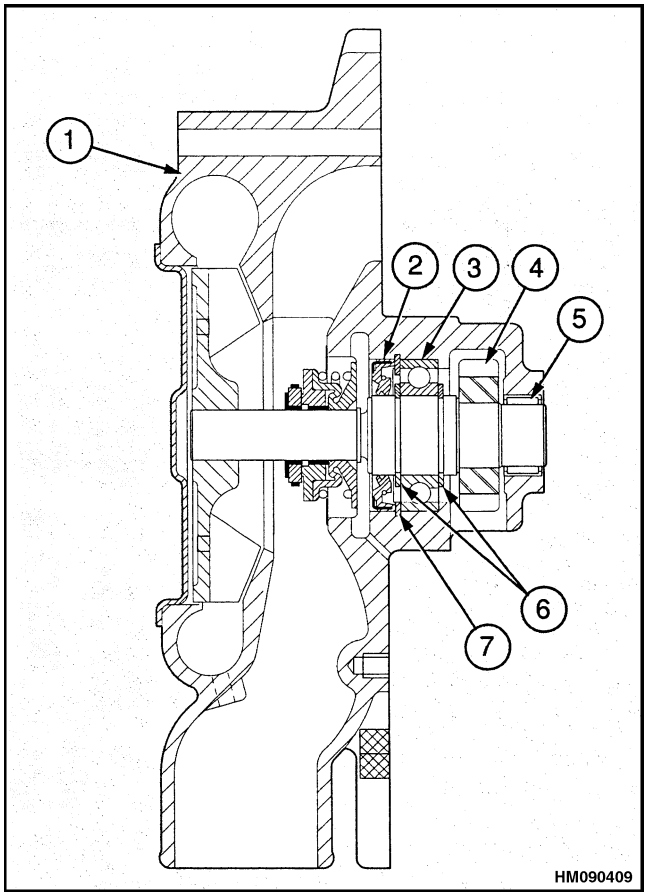
Do not damage the seal face in the pump body for the oil seal during removal of the seal.

7. Remove and discard the snap ring.

8. Put a support under the pump body so that it is not damaged. Use a press to push the shaft through the pump gear and the pump body until the shaft and the ball bearing assembly are released from the pump. Discard the ball bearing assembly, pump shaft, and the two snap rings. Remove the pump gear.

9. Inspect the pump gear for wear and damage. Replace a worn or damaged pump gear.

10. Use a press to push the needle roller bearing from the pump body. Discard the bearing.



1. COOLANT PUMP BODY
2. OIL SEAL
3. BALL BEARING
4. PUMP GEAR
5. NEEDLE ROLLER BEARING
6. SNAP RING (2)
7. SNAP RING

Figure 152. Coolant Pump Seals Removal

Assemble

1. Clean the pump body. Give special attention to the bore for the bearing and the bore for the water seal. Both of these bores and their chamfers must be clean and free of corrosion.

2. Install a new snap ring onto the shaft. See Figure 153.

3. Put the pump gear into position in the pump body and use a press to push the shaft into the pump gear. If the original pump gear is used, use Loctite

Engine Specifications

CYLINDER HEAD ASSEMBLY

Refer to the following tables and figures for specifications for the cylinder head assembly.

Table 1. Cylinder Head

Angle of valve seat ..... 46° (88° included angle)
or
31° (118° included angle)

Diameter of parent bore for valve guide

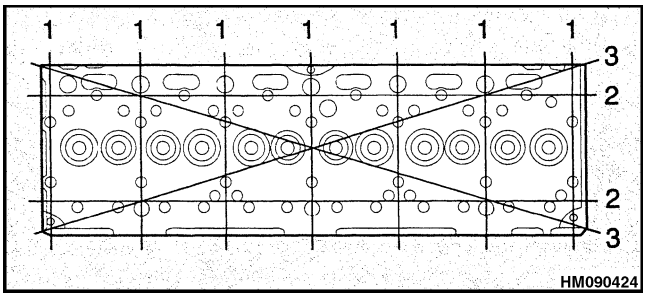
Inlet ..... 13.00 to 13.027 mm (0.5118 to 0.5128 in.)

Exhaust ..... 14.00 to 14.027 mm (0.5512 to 0.5522 in.)

Leak test pressure ..... 200 kPa (29 psi)

Head thickness ..... 102.79 to 103.59 mm (4.047 to 4.078 in.)

Maximum distortion of cylinder head. See Figure 170.



Engine AR:	Engines YG, YH:
1 = 0.08 mm (0.003 in.) 2 = 0.15 mm (0.006 in.) 3 = 0.15 mm (0.006 in.)	1 = 0.13 mm (0.005 in.) 2 = 0.25 mm (0.010 in.) 3 = 0.25 mm (0.010 in.)

Figure 170. Cylinder Head Distortion Check

Table 2. Valve Guides

Inside diameter (finished surface)..... 9.000 to 9.022 mm (0.3543 to 0.3552 in.)

Outside diameter

Inlet ..... 13.034 to 13.047 mm (0.5131 to 0.5137 in.)

Exhaust ..... 14.034 to 14.047 mm (0.5525 to 0.5530 in.)

Interference fit of valve guide in cylinder head..... 0.047 to 0.007 mm (0.0018 to 0.00027 in.)

Total length ..... 51.25 mm (2.018 in.)

Extension from bottom of recess for valve spring..... 14.85 to 15.15 mm (0.585 to 0.596 in.)

Table 3. Inlet Valves

Diameter, valve stem ..... 8.953 to 8.975 mm (0.3525 to 0.3533 in.)

Clearance in valve guide..... 0.025 to 0.069 mm (0.001 to 0.0027 in.)

Maximum clearance in valve guide

Production limit..... 0.089 mm (0.0035 in.)

Service limit..... 0.100 mm (0.004 in.)

Diameter, valve head

(Engine YG and YH) ..... 42.88 to 43.12 mm (1.688 to 1.698 in.)

(Engine AR)..... 44.88 to 45.12 mm (1.766 to 1.776 in.)

Angle of valve face ..... 45° or 30°

Table 27. Camshaft Gear (Continued)

Outside diameter, hub of camshaft	34.90 to 34.92 mm (1.3741 to 1.3747 in.)
Clearance fit, gear on hub	0.008 to 0.048 mm (0.0003 to 0.0019 in.)

Table 28. Gear for Fuel Injection Pump

No. of teeth	56
Bore	36.00 to 36.06 mm (1.417 to 1.419 in.)
Clearance fit, gear on hub	0.003 to 0.075 mm (0.0001 to 0.0030 in.)

Table 29. Crankshaft Gear

No. of teeth	28
Diameter, bore	47.625 to 47.650 mm (1.8750 to 1.8760 in.)
Diameter, hub for gear on crankshaft	47.625 to 47.645 mm (1.8750 to 1.8758 in.)
Press fit of gear on crankshaft	−0.020 to +0.048 mm (−0.0008 to +0.0019 in.)

Table 30. Idler Gear and Hub

No. of teeth	63
Diameter, gear bore	57.14 to 57.18 mm (2.2495 to 2.2512 in.)
Diameter, gear bore if equipped with needle roller bearings	69.01 to 69.03 mm (2.717 to 2.718 in.)
Width, gear with split bushing assembly	30.14 to 30.16 mm (1.186 to 1.187 in.)
Width, gear with flange bushing assembly	50.78 to 50.80 mm (1.9992 to 2.000 in.)
Outside diameter, hub	50.70 to 50.74 mm (1.9960 to 1.9975 in.)

Table 30. Idler Gear and Hub (Continued)

Outside diameter, hub if equipped with needle roller bearings	54.987 to 55.000 mm (2.1648 to 2.1654 in.)
Clearance, bushings on hub	0.04 to 0.10 mm (0.0016 to 0.0039 in.)
Axial movement:	
to Production limit	0.10 to 0.20 mm (0.004 to 0.008 in.)
to Service limit	0.38 mm (0.015 in.)
Axial movement if equipped with needle roller bearings	0.24 to 0.33 mm (0.009 to 0.013 in.)
to Service limit	0.38 mm (0.015 in.)
Gear clearance (all)	0.08 mm (0.003 in.)

ENGINE BLOCK ASSEMBLY

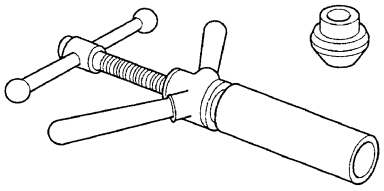
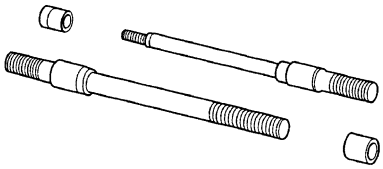
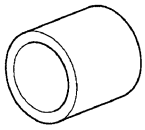
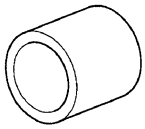
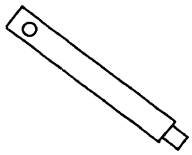
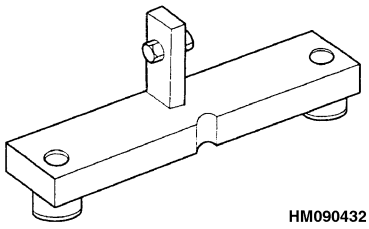
Refer to the following tables for specifications for the engine block assembly.

Table 31. Cylinder Block (Engine AR)

Height between top and bottom faces	441.12 to 441.33 mm (17.367 to 17.375 in.)
Diameter of cylinder bore	103.000 to 103.025 mm (4.055 to 4.0561 in.)
Maximum wear of cylinder bore	0.15 mm (0.006 in.)
Diameter of first oversize cylinder bore	103.500 to 103.525 mm (4.0748 to 4.0757 in.)
Diameter of second oversize cylinder bore	104.000 to 104.025 mm (4.0944 to 4.0954 in.)

NOTE: Two oversize pistons are available in service: 0.5 mm (0.020 in.) and 1.0 mm (0.040 in.)

Special Tools*

 HM090428	Remove and replace tool for valve guides.
 HM090429	Adapter tool for use with tool for valve guides.
 HM090430	Adapter tool (inlet valves) for use with tool for valve guides.
 HM090430	Adapter tool (exhaust valves) for use with tool for valve guides.
 HM090431	Timing pin for Lucas fuel injection pumps.
 HM090432	Gauge for piston height, valve depth, and cylinder liner flange; for use with dial gauge.
Contact your Perkins dealer for special tools.	

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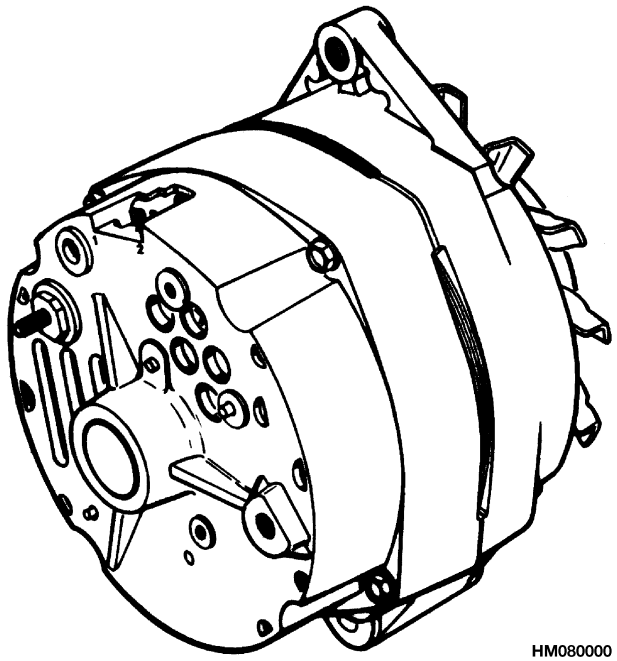
ALTERNATOR WITH REGULATOR

COVERS DELCO, MOTOROLA, AND LEECE-NEVILLE ALTERNATORS USED ON YALE LIFT TRUCKS



HM080000

PART NO. 524150791

2200 YRM 0002

5. On Delco alternators, install parts as follows:

   a. Install the brush and holder, voltage regulator, and diodes from the inside of the alternator. Make sure the insulator sleeves are on the screws for the brush holder. Install the capacitor.

   b. Install the stator in the rear housing. Connect the three wires from the stator to the diode bridge and fasten at the studs. Connect the wires from the diodes to the studs on the diode bridge. Install and tighten the three lockwashers and nuts.

   c. Install the brushes in the brush holders. To hold the brushes in position, put a pin through the hole in the brush holders. Apply a thin layer of oil to the lip of the seal for the bearing.

6. On Motorola alternators, install parts as follows:

   a. Install the diode bridge on the stator. Use pliers to keep the heat from the soldering iron away from the diodes.

   b. Install the capacitor, diode set, and terminal on the diode bridge. Align the marks made during removal and install the stator and bridge assembly in the rear housing.

7. Align the marks made during disassembly. Carefully install the stator and the rear housing over the rotor. Do not damage the seal while sliding the housing over the rotor shaft. Install the front housing.

8. Install the four screws to hold the alternator together. On Delco alternators, remove pin to release the brushes.

9. On Motorola alternators, install the brush holder and brushes. Make sure the washer is on the right-hand screw. Install the voltage regulator and tighten the screws.

10. On Leece-Neville alternators, install the brushes, voltage regulator, or diode set in the reverse order of removal.

Install

1. Install the alternator in the bracket on the engine, and adjust the tension of the belt.

2. Connect all wires and the connector according to the labels made during removal. Also see the schematic diagram for your alternator in Figure 2. Make sure all wires are connected correctly and all fasteners are tight. See Figure 3.

3. Check the indicator light or the ammeter to check the operation of the alternator. The indicator light for Type A alternators will only be ON if the battery is discharged.

Brushes Circuit Check

DELCO ALTERNATORS

1. Use an ohmmeter that has a 1.5-volt cell. (Use the lowest range scale.) Connect the ohmmeter from the clip for the brushes to the metal housing. Make the test, then connect the ohmmeter leads in the reverse direction and test again.

2. If both readings are zero, either the wire or the clip for the brushes has a short circuit to ground, or the voltage regulator has damage.

3. The cause of the problem can also be a missing washer, a missing sleeve on a screw, or a damaged insulator. See Figure 13. Remove the screw and inspect the insulator. If the insulator is in good condition, do Step 4, Step 5, and Step 6.

4. Connect the ohmmeter from the wire of the diodes to the housing.

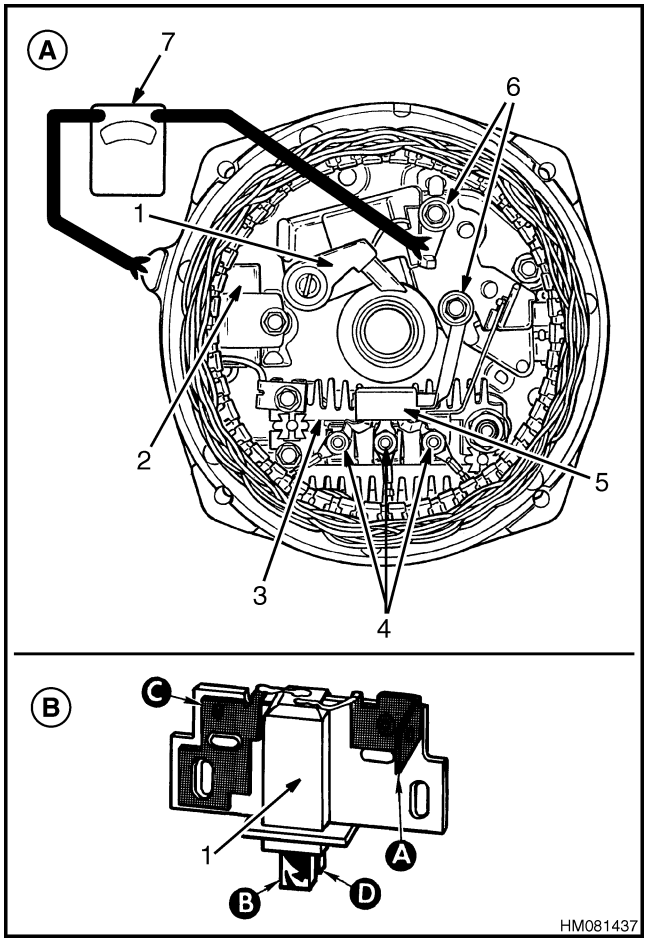
5. If the reading is zero on the ohmmeter, either the wire to the diodes has a short circuit to ground, or the voltage regulator has damage.

6. The cause of the problem can be a missing washer, a missing sleeve on a screw, or a damaged insulator. Remove the screw and inspect the insulator. If the insulator is in good condition, replace the voltage regulator.

MOTOROLA ALTERNATORS

1. Use an ohmmeter or a 12-volt test lamp to check the brushes as shown in Figure 13.

2. For correct operation, there must be continuity between A to B and C to D. There must be no continuity from A to D or from C to B. See Figure 13. If there is continuity, the brushes are connected to the wrong terminal.



A. DELCO **B.** MOTOROLA

1. BRUSH HOLDER
2. CAPACITOR
3. DIODE BRIDGE
4. NUTS
5. DIODES
6. INSULATOR WASHERS
7. OHMMETER

Figure 13. Brushes Circuit Check

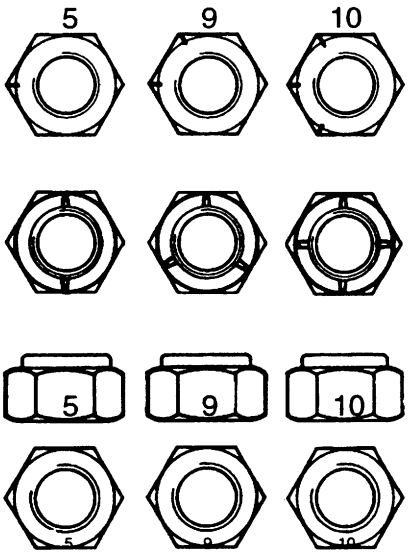
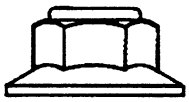
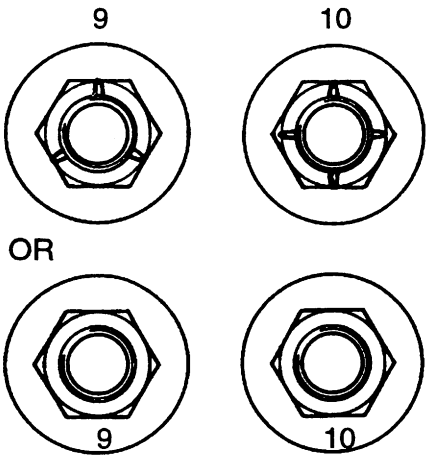
WARNING

Installing improper electrical accessories or installing an electrical accessory incorrectly can increase the risk of equipment damage, personal injury and fire. DO NOT install electrical accessories to the truck unless you have been trained and authorized to do so. Personnel installing the electrical accessories must document the changes made to the truck. DO NOT install accessories which affect the truck's compliance with standard EN 1175:2020.

WARNING

California Proposition 65 - Operating, servicing and maintaining a powered industrial truck can expose you to chemicals including engine exhaust, carbon monoxide, phthalates, and lead, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

Table 4. Torque Nuts With Nylon Insert

TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS	INCH FASTENERS STRENGTH LEVELS: SAE GRADES
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED HM210069

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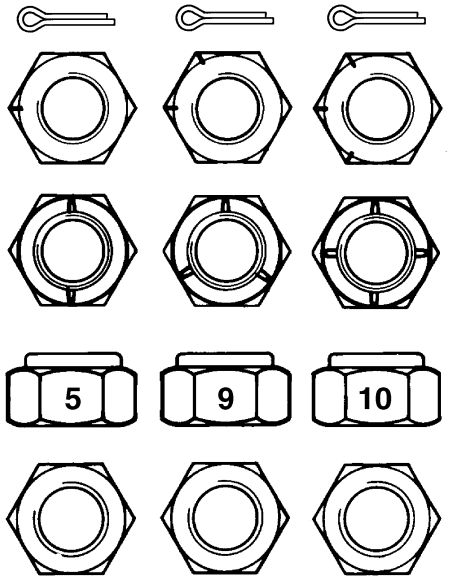
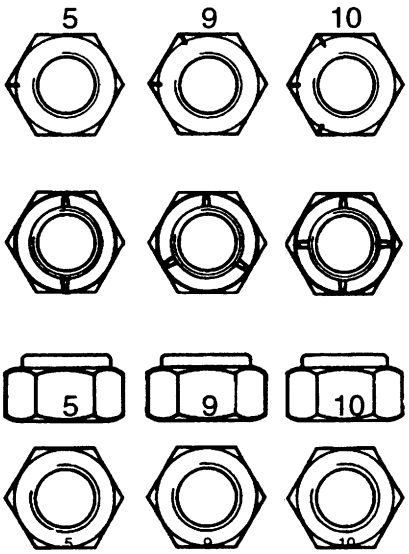
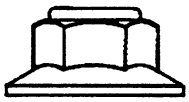
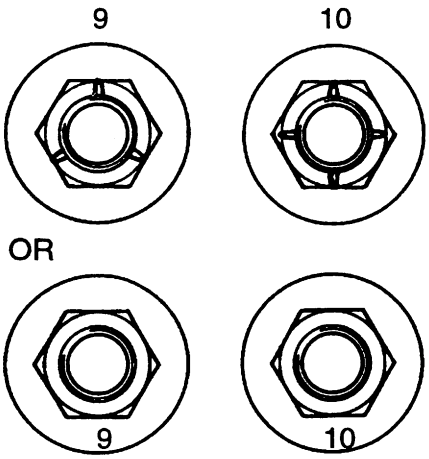
METRIC AND INCH (SAE) FASTENERS



HM210064

Table 4. Torque Nuts With Nylon Insert

TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS	INCH FASTENERS STRENGTH LEVELS: SAE GRADES
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED HM210069

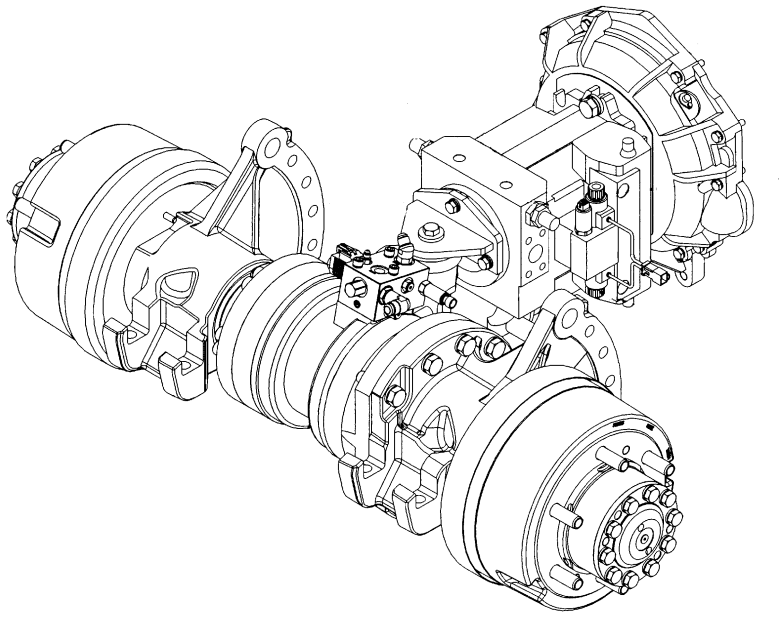
Yale

Maintenance

HYDROSTATIC TRANSMISSION

DESCRIPTION AND OPERATION

GLP/GDP35-55LJ/MJ [C813, E813]



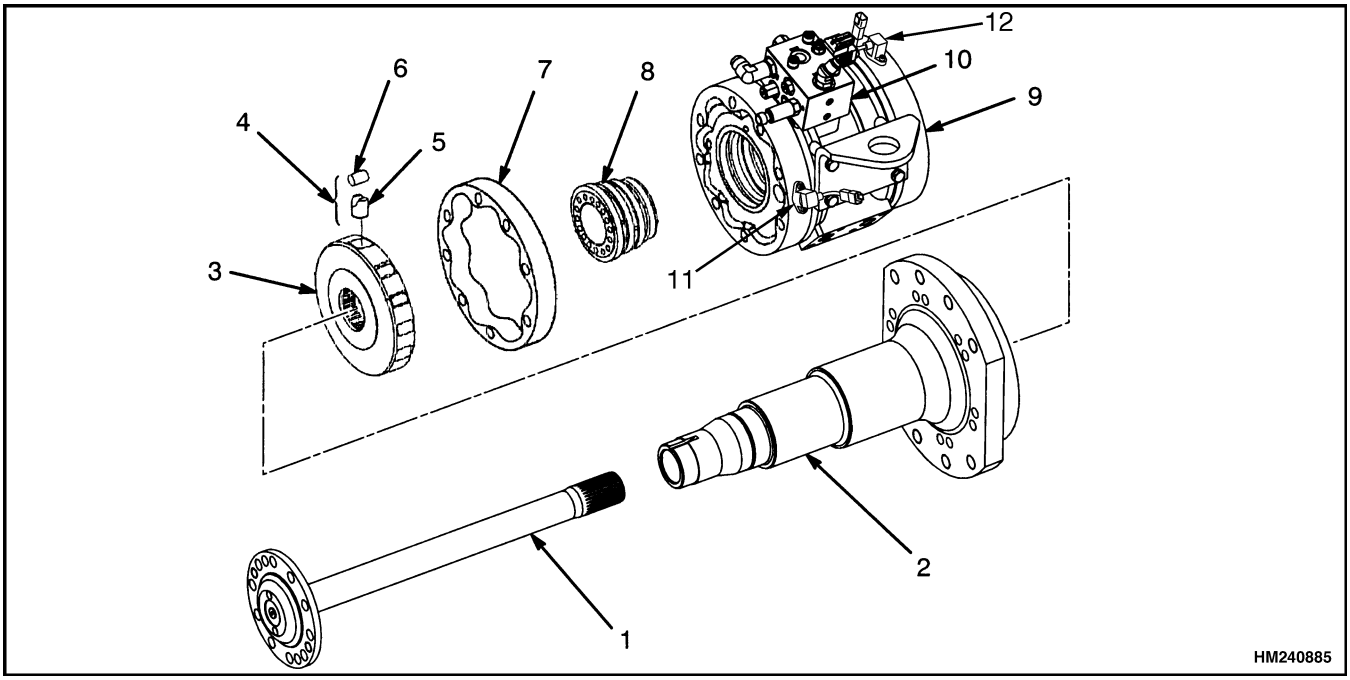
HM240604

PART NO. 524153601

1300 YRM 800

Legend for Figure 5

1. AXLE SHAFT
2. AXLE SHAFT HOUSING
3. CYLINDER BLOCK
4. PISTON ASSEMBLY
5. PISTON
6. SLIDE ROLLER
7. CAM
8. DISTRIBUTOR
9. AXLE HOUSING
10. AXLE VALVE



1. AXLE SHAFT
2. AXLE SHAFT HOUSING
3. CYLINDER BLOCK
4. PISTON ASSEMBLY
5. PISTON
6. SLIDE ROLLER
7. CAM
8. DISTRIBUTOR
9. AXLE HOUSING
10. AXLE VALVE
11. LEFT WHEEL SPEED SENSOR
12. RIGHT WHEEL SPEED SENSOR

Figure 6. Hydrostatic Drive Axle Components, Trucks With Perkins 1104C-44(RE) Diesel and GM 4.3L LPG Engines

The differential action of the drive axle is achieved by parallel hydraulic flow through the motors. The total input flow equals the total output flow, but within the axle, the oil can be divided between the motors as required to provide the differential action.

The axle valve is mounted to the drive axle assembly.

TRANSMISSION CONTROL MODULE (TCM)

Perkins 1004-42 Diesel Engine Trucks

The TCM is a control management system that receives the lift truck operator's control demands, monitors the drive system operating conditions, controls the pump pilot pressure to regulate the hydrostatic pump operation, and warns the operator if system malfunctions occur. If system damaging events occur, the control will reduce the transmission output or shut down the lift truck operation to protect the transmission from damage. See Figure 7 and Figure 9.

The TCM receives its power from the lift truck's 12 VDC battery and charging system. The key switch turns the system on so it can respond to the input signals. The electrical sensors send signals to the TCM, informing the control about the demands from the controls and the operating condition of the drive system. The directional control switches identify the required drive mode (**FORWARD/NEUTRAL/REVERSE**). The throttle pedal position sensor identifies the amount of power and speed the controls are demanding. The engine speed sensor

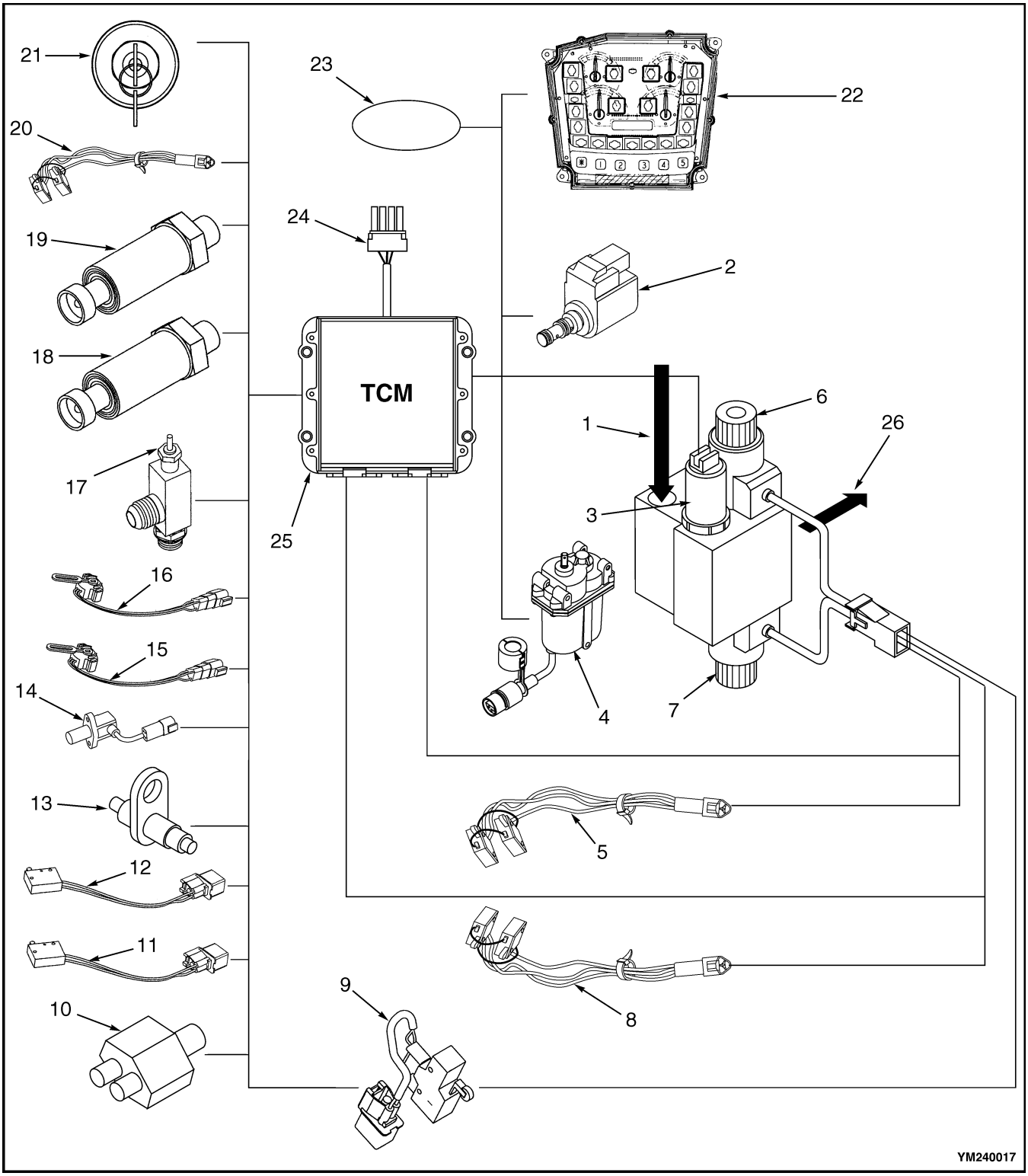
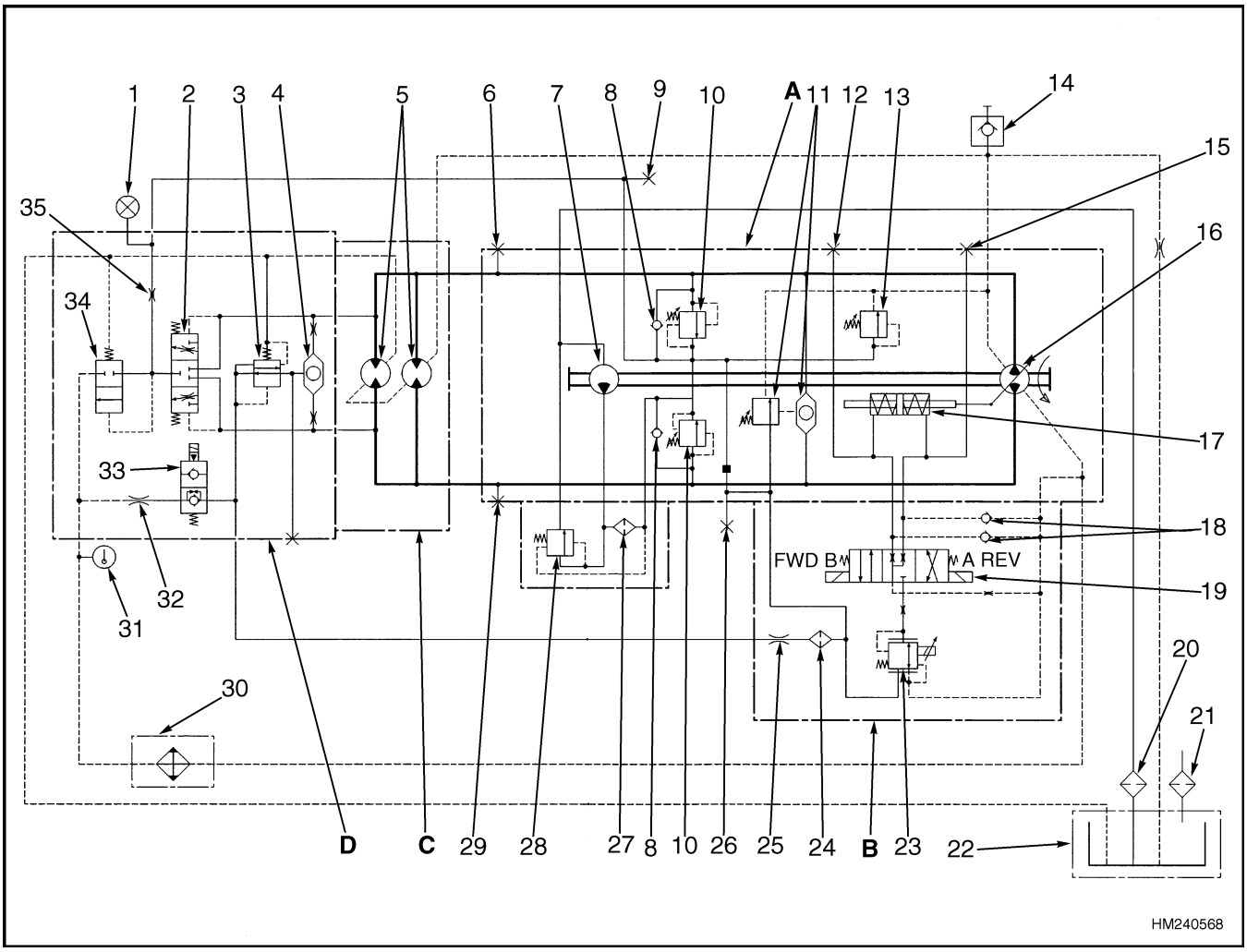


Figure 10. TCM Circuit, Perkins 1104C-44(RE) Diesel and GM 4.3L LPG Engine Trucks



A. HYDROSTATIC PUMP ASSEMBLY
B. PUMP VALVE ASSEMBLY

1. CHARGE PRESSURE SENSOR
2. HOT OIL SHUTTLE VALVE
3. PILOT SUPPLY PRESSURE REDUCING VALVE
4. LOOP TAPPING CHECK VALVE
5. DRIVE AXLE MOTORS
6. M_A REVERSE LOOP CHECK PORT
7. CHARGE PUMP
8. CHARGING CHECK VALVE
9. **G** CHARGE PRESSURE CHECK PORT
10. CROSS LINE RELIEF VALVE
11. PRESSURE OVERRIDE (POR) VALVE
12. X_1 REVERSE PILOT CONTROL PRESSURE CHECK PORT
13. CHARGE RELIEF VALVE
14. FILL/SAMPLING PORT
15. X_2 FORWARD PILOT CONTROL PRESSURE CHECK PORT
16. HYDROSTATIC DRIVE PUMP
17. SWASHPLATE CONTROL PISTON

C. DRIVE AXLE
D. AXLE VALVE

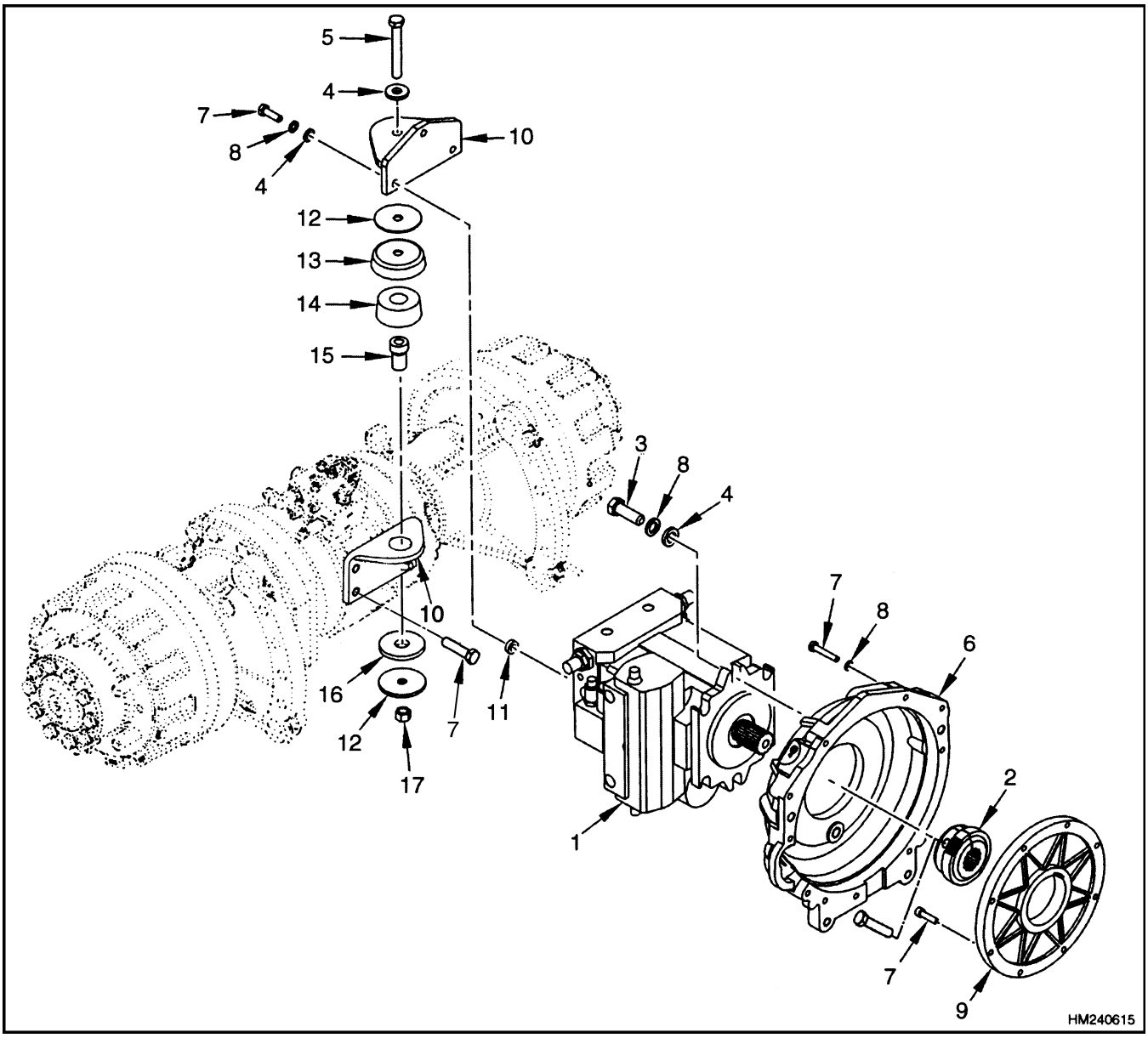
18. ANTICAVITATION CHECK VALVE
19. DIRECTIONAL CONTROL SOLENOID VALVE
20. FILTER SCREEN
21. BREATHER
22. HYDRAULIC TANK
23. PROPORTIONAL PILOT SOLENOID VALVE
24. FILTER SCREEN
25. FEED ORIFICE
26. P_S PILOT PRESSURE CHECK PORT
27. CHARGE FILTER
28. FILTER RELIEF VALVE
29. M_B FORWARD LOOP CHECK PORT
30. RADIATOR OIL COOLER
31. TEMPERATURE SENSOR
32. RETARD ORIFICE
33. RETARD SOLENOID VALVE
34. CHARGE SUPPLY REGULATOR
35. BYPASS ORIFICE

Figure 18. Hydrostatic Transmission Hydraulic Schematic

TABLE OF CONTENTS (Continued)

This section is for the following models:

GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) [C813, E813]



1. HYDROSTATIC PUMP
2. HUB
3. MOUNT BOLT
4. WASHER
5. FRONT DRIVE TRAIN MOUNT BOLT
6. COUPLING HOUSING (DIESEL SHOWN)
7. BOLT
8. LOCKWASHER
9. COUPLING FLANGE
10. MOUNT BRACKET
11. SPACER
12. LARGE WASHER
13. SNUBBING CUP
14. ISOLATOR
15. SPACER
16. BUMPER
17. NUT

Figure 11. Drive Axle and Hydrostatic Pump

WHEEL SPEED SENSORS, REPLACE

Lift Trucks With Perkins 1104C-44(RE) Diesel Engine and GM 4.3L LPG Engine Only

1. Disconnect the electrical connector from the speed sensor.
2. Remove the speed sensor from the hydrostatic housing by loosening the two M6 socket head capscrews. See Figure 15.
3. Install the new sensor. Ensure that the O-ring is installed. Tighten the securing capscrew to 10.5 N•m (93 lbf in).
4. Connect the electrical connector to the wheel speed sensor.

Axle Valve Repair

REMOVE

The axle valve is mounted on top of the drive axle housing. See Figure 14 and Figure 14.

1. Remove floor plates.
2. Pressure-wash hydrostatic drive axle and surrounding components to minimize the chance of contamination.
3. Drain hydraulic tank or clamp axle flush return line between pump and axle housing to minimize oil leakage. See Figure 4.

CAUTION

Do not permit any dirt or other contamination to enter the hydrostatic pump, axle, or hydraulic lines. Any dirt or particles in the fluid can seriously damage the system.

4. Disconnect four hydraulic lines at axle valve. See Figure 4. Put plugs in all open ports and fittings to prevent contaminants from entering the system.
5. Disconnect electrical connectors from axle valve.
6. Rotate cooler supply line fitting counterclockwise for clearance to access left socket head capscrew. See Figure 16.
7. Remove three socket head capscrews. Remove axle valve from axle housing.
8. Plug three holes on top of axle housing to minimize oil leakage and contamination to the system.

INSPECT

Disassemble axle valve. See Figure 16. Inspect all parts for wear or damage. Replace parts as needed and assemble axle valve.

INSTALL

1. Remove plugs from axle housing before installing axle valve. Make sure mating surfaces of axle valve and axle housing are clean and free of debris.
2. Install axle valve with new O-rings. Install three socket head capscrews. Tighten capscrews to 55 N•m (41 lbf ft).
3. Rotate cooler supply line fitting to its original position. See Figure 16.
4. Connect all hydraulic lines to axle valve. See Figure 4.
5. Connect electrical connectors to axle valve.
6. Fill hydraulic tank or remove clamp from axle flush return line.

REPLACE PRESSURE REDUCING VALVE

1. Remove axle flush return line and fitting. See Figure 16.
2. Remove pressure reducing valve.
3. Lubricate O-rings on new pressure reducing valve.
4. Install new pressure reducing valve.
5. Install fitting and axle flush return line.

Legend for Figure 24

1. MOTOR BRACKET
2. CLAMP
3. MOTOR CONNECTOR
4. THROTTLE SERVO MOTOR
5. FUEL INJECTOR
6. THROTTLE LINKAGE

INSPECT

1. Check throttle servo motor gears by rotating crank and checking for backlash and smoothness.

2. Inspect linkages for wear, damage and free play. Replace any parts that are worn or damaged.

INSTALL

Perkins 1104C-44(RE) Diesel Engine

1. Install throttle servo motor and bracket on engine. See Figure 24.

2. Connect throttle link between fuel pump and servo motor crank.

3. Connect electrical connectors to throttle servo motor.

4. Connect negative battery cable to battery.

5. Calibrate throttle system as described in the section Startup and Calibration.

GM 4.3L LPG Engine

1. Install throttle servo motor and bracket on engine. See Figure 25.

2. Connect throttle link between carburetor quadrant and servo motor crank.

3. Connect throttle return spring.

4. Connect electrical connectors to throttle servo motor.

5. Connect negative battery cable to battery.

6. Calibrate throttle system as described in the section Startup and Calibration.

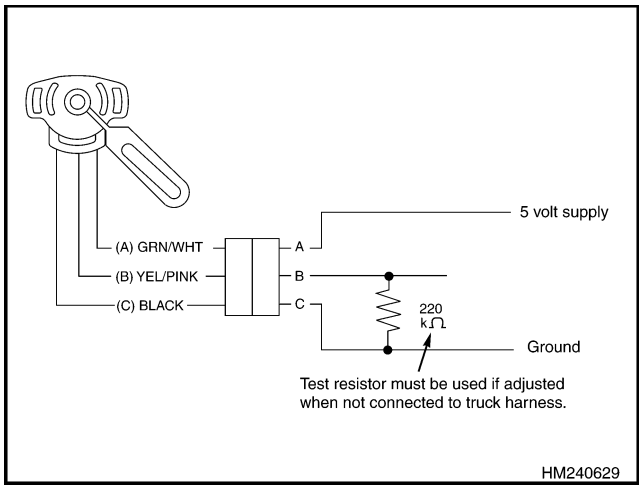


Figure 31. Engine Throttle-Up Position Sensor

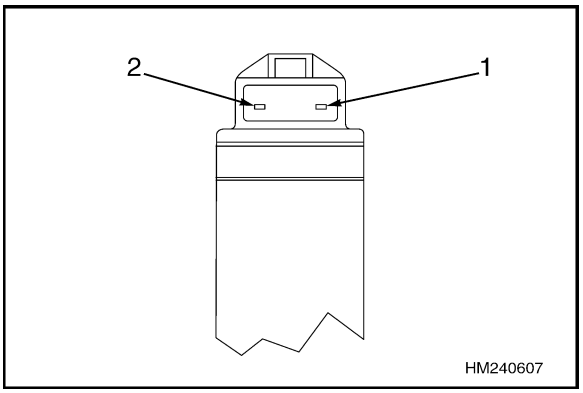
THROTTLE-UP MOTOR

NOTE: If available, use a computer equipped with Windows 95/98/2000/NT and the TransLink User Interface Software.

1. To check throttle motor without using TransLink User Interface Software, it is necessary to bypass TCM. Disconnect electrical connector at throttle motor.

2. Apply +12 volts to throttle motor terminal for wire No. 483. Apply chassis ground or battery negative voltage to throttle motor terminal for wire No. 479. See Figure 32. If throttle motor does not operate, replace throttle motor.

3. Connect electrical connector to throttle motor.



1. TERMINAL FOR WIRE NO. 483
2. TERMINAL FOR WIRE NO. 479

Figure 32. Throttle Motor Terminals

Throttle Servo Motor Checks and Adjustments

THROTTLE SERVO MOTOR POSITION SENSOR

NOTE: The procedures in this section apply only to lift trucks equipped with the Perkins 1104C-44(RE) diesel engine or the GM 4.3L LPG engine.

NOTE: If available, use a computer equipped with Windows 95/98/2000/NT/XP and the TransLink User Interface Software to check these components.

1. To check throttle servo motor position sensor without using TransLink User Interface Software, it is necessary to bypass the TCM. Disconnect electrical connector at throttle motor.

2. Apply five volts to throttle servo motor terminal for wire No. 447B (connector pin 7). Apply chassis ground or battery negative voltage to throttle motor terminal for wire No. 445B (connector pin 5). See Figure 33.

3. Measure voltage on terminal 484 (connector pin 6). Manually move the servo lever and verify that the voltage changes progressively with the movement of the lever. It must be close to 0.5 volts at maximum throttle and close to 4.5 volts at minimum throttle.

4. The position sensor should not operate at either end of its stroke range. Adjust the throttle linkage such that the mid position of the engine lever corresponds to the mid position of the throttle servo motor.

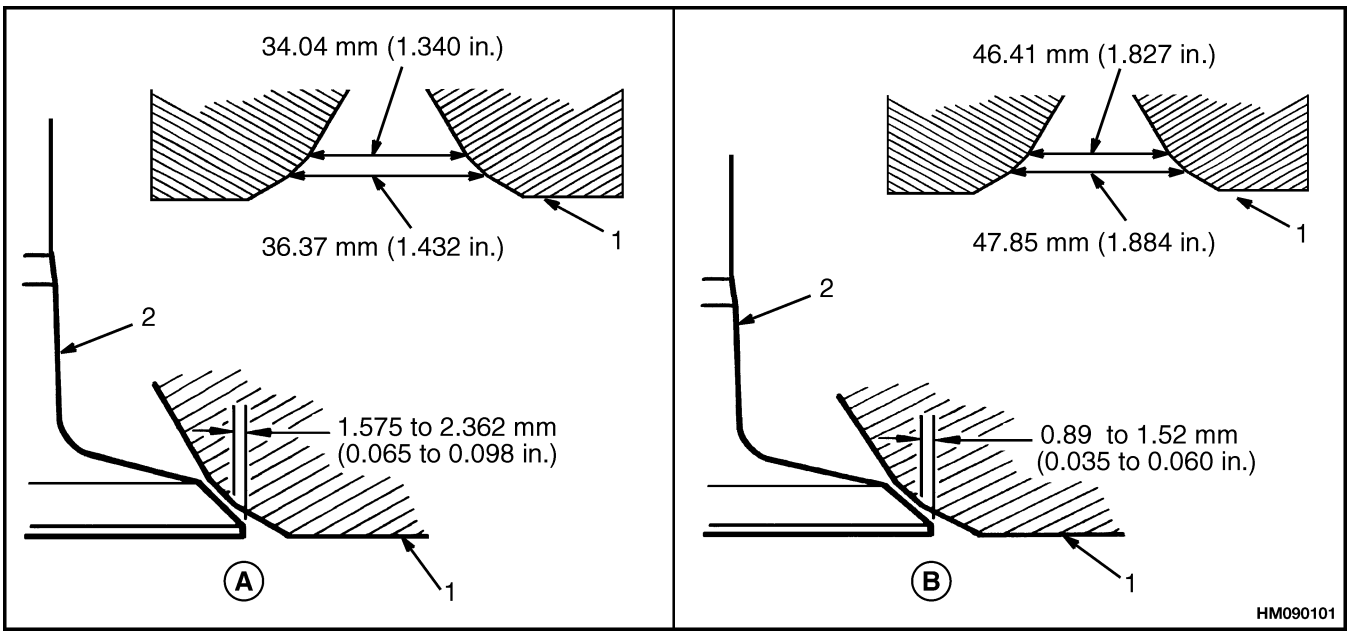
5. Connect electrical connector to throttle servo motor.

6. Calibrate throttle system as described in the section Startup and Calibration.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Event Code 45 Retard Valve Circuit Malfunction.	The retard valve electrical connector is disconnected.	Connect retard valve.
	The wiring to the retard valve is faulty.	Check wiring harness.
	The retard valve is damaged.	Install new retard valve.
	The TCM is damaged.	Install new TCM.
Event Code 46 Tachometer Sensor Circuit Malfunction.	The speed sensor electrical connector is disconnected.	Connect speed sensor.
	The speed sensor is loose.	Tighten speed sensor.
	The wiring to the speed sensor is faulty.	Check wiring harness.
	The speed sensor is damaged.	Check sensor as described in Engine Speed Sensor.
	The TCM is damaged.	Install new TCM.
Event Code 51 Hoist Lever Position Sensor Circuit Malfunction.	The lift lever position sensor electrical connector is disconnected.	Connect lift lever position sensor.
	The wiring to the lift lever position sensor is faulty.	Check wiring harness.
	The lift lever position sensor is damaged.	Check sensor as described in Lift Lever Position Sensor.
	The TCM is damaged.	Install new TCM.
Event Code 52 Engine Throttle Position Sensor Circuit Malfunction.	The engine throttle position sensor electrical connector is disconnected.	Connect engine throttle position sensor.
	The wiring to the engine throttle position sensor is faulty.	Check wiring harness.
	The engine throttle position sensor is damaged.	Check sensor as described in Engine Throttle Position Sensor.
	The TCM is damaged.	Install new TCM.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Event Code 65 Engine Speed High.	Engine speed exceeded 3100 rpm for more than 1 second.	Instruct operator to use brakes on excessive downgrades to reduce truck speed.
	The engine speed sensor is dirty.	Clean and inspect speed sensor.
	The wiring to the engine speed sensor is faulty.	Check wiring harness.
	The engine speed sensor is damaged.	Check speed sensor as described in Sensor Checks.
	The TCM is damaged.	Install new TCM.
Event Code 66 Pilot Solenoid Related Fault.	See **Event Code 61**.	Check actions for **Event Code 61**
Event Code 67 Throttle Pedal Circuit Malfunction.	Both the throttle pedal sensor and throttle pedal switch malfunction.	Check the actions for **Event Codes 27 and 57** to fix **Event Code 67**.
Event Code 71 Direction Solenoid Enable Fault	Malfunction related to the forward solenoid.	Check forward solenoid and related connector and wiring (wires 802 and 847).
	Malfunction related to the reverse solenoid.	Check reverse solenoid and related connector and wiring (wires 801 and 847).
	The TCM is damaged.	Install new TCM.
Event Code 72 Throttle Servo Motor Malfunction	The wiring to the throttle servo motor is faulty.	Check wiring harness.
	The throttle motor is damaged.	Check throttle motor function as described in Throttle Servo Motor Checks and Adjustments.
	The TCM is damaged.	Install new TCM.

The correct dimensions for the valve seat widths and valve/valve seat overlap are shown in Figure 6. The valve seat widths are the dimensions of the 46° face only. The valve/valve seat overlap is the distance from the edge of the seat to the outside edge of the valve.



A. EXHAUST VALVE

B. INLET VALVE

1. CYLINDER HEAD

2. VALVE

Figure 6. Valve Seat Widths and Valve/Valve Seat Overlap

Timing Cover, Timing Sprockets, Camshaft, and Valve Lifters

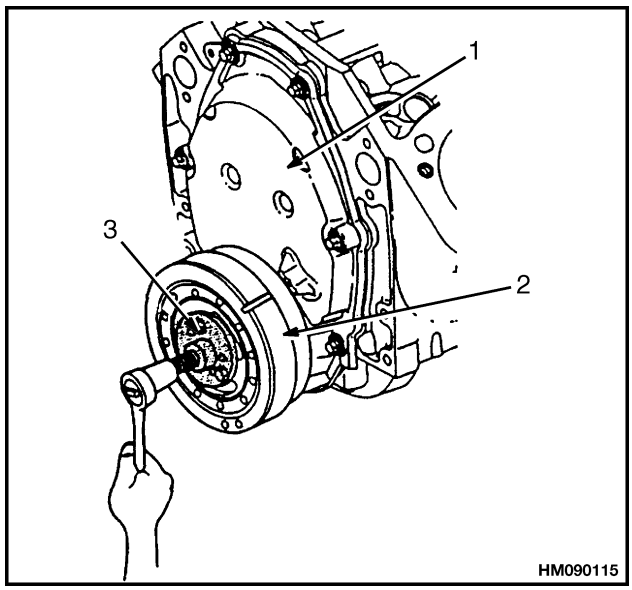
TIMING COVER

Remove

NOTE: For model GLP/GDP35-50LJ/MJ (GP/GLP/GDP070-120LJ/MJ), refer to the section **Cooling System** 0700YRM0740.

1. Remove fan assembly and belts.

2. Remove crankshaft pulley and vibration damper. See Figure 26. Use a tool that pulls on center of vibration damper. Do not pull on outside diameter of vibration damper.



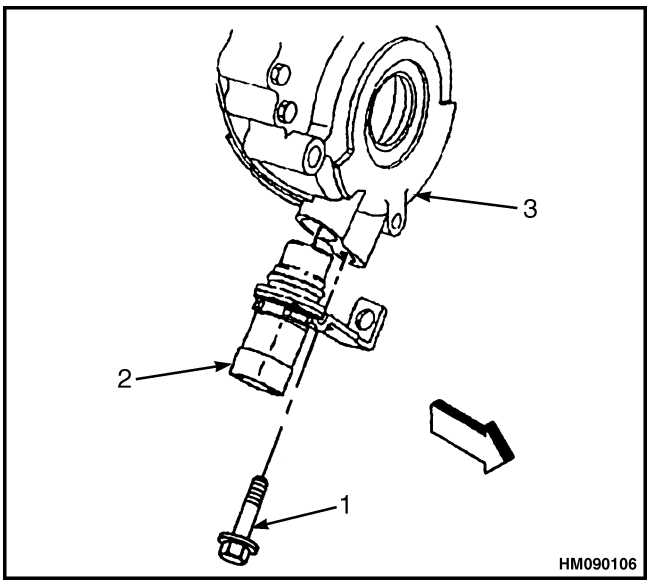
1. TIMING COVER
2. VIBRATION DAMPER
3. TOOL FOR REMOVING VIBRATION DAMPER

Figure 26. Timing Cover

3. Remove crankshaft position sensor from timing cover. See Figure 27.

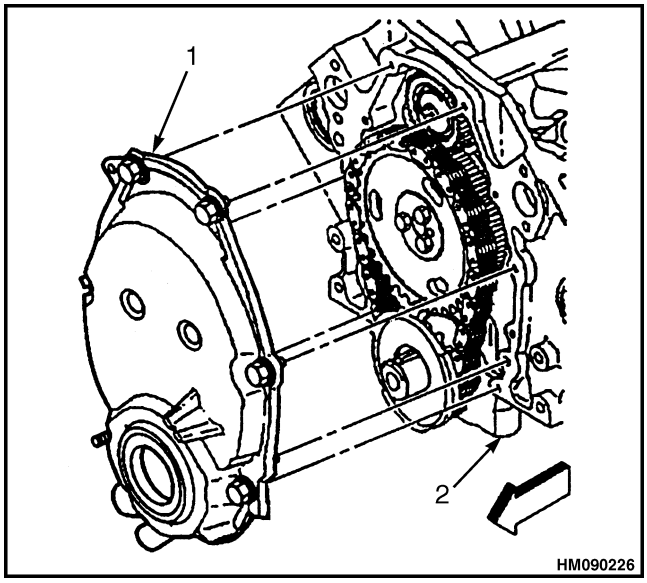
4. Remove capscrews and stud for timing cover. Remove timing cover from engine. See Figure 28.

5. Remove crankshaft position sensor reluctor ring from crankshaft. See Figure 29.



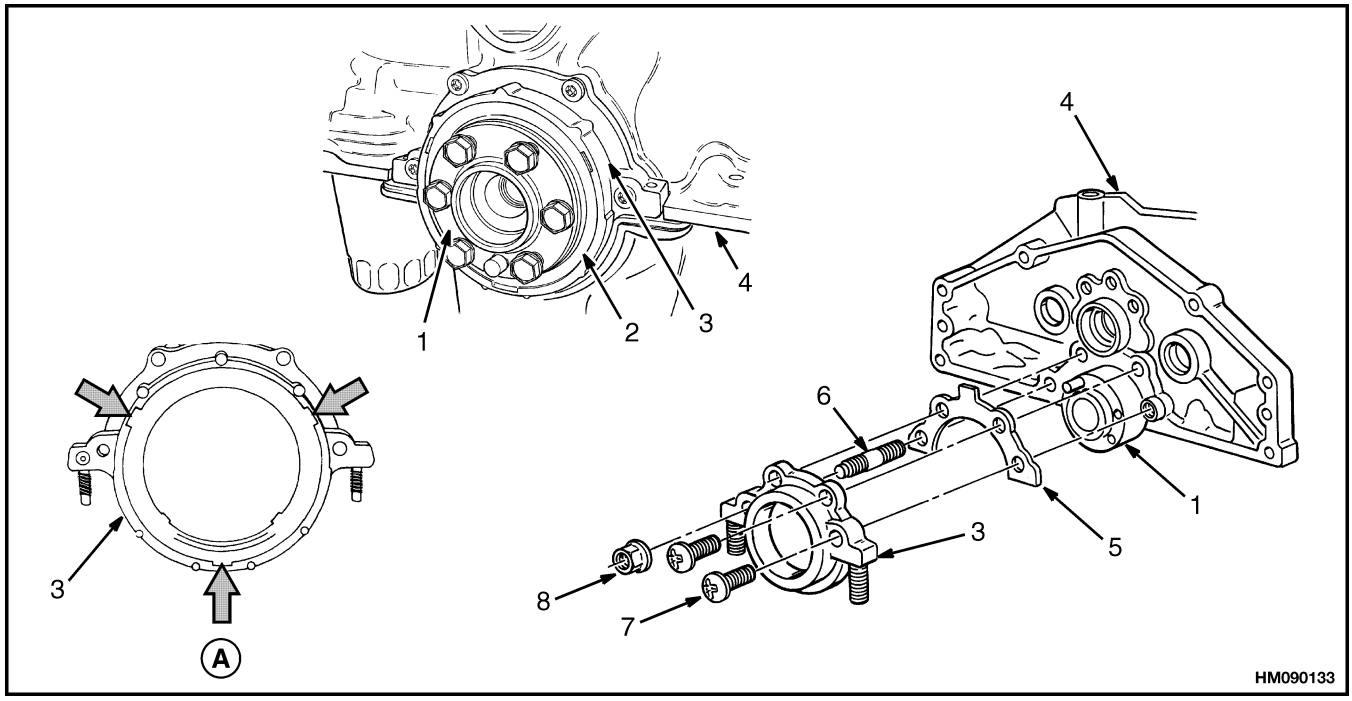
1. CRANKSHAFT POSITION SENSOR BOLT
2. CRANKSHAFT POSITION SENSOR
3. TIMING COVER

Figure 27. Crankshaft Position Sensor



1. TIMING COVER 2. ENGINE

Figure 28. Timing Cover



A. SEAL REMOVAL NOTCHES

1. CRANKSHAFT
2. OIL SEAL
3. SEAL RETAINER
4. ENGINE BLOCK
5. GASKET
6. STUD
7. SCREW
8. NUT

Figure 46. One-Piece Rear Seal

Piston and Connecting Rod Assemblies Repair

CONNECTING ROD BEARINGS, REPLACE

NOTE: Connecting rod bearings are insert bearings that do not use shims for adjustment. These bearings are available in a standard size and the following undersizes: 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.254 mm (0.010 in.), and 0.508 mm (0.020 in.). If a bearing on a journal is worn, both the upper and lower half of the bearing must be replaced.

1. Remove oil sump and oil pump.

2. Mark caps for connecting rods so they can be installed in their correct locations and positions.

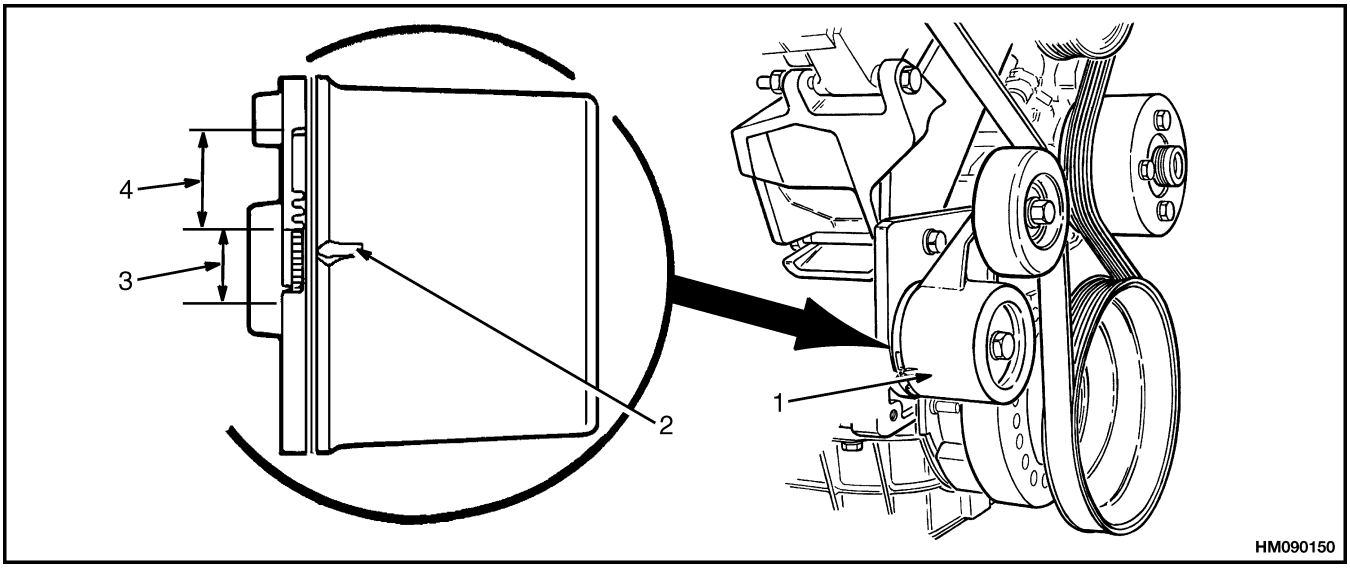
3. Push connecting rod away from crankshaft and remove upper bearing half. Wipe oil from bearing halves and bearing journal. Make sure all parts from each rod assembly remain together.

4. Use a micrometer to measure bearing journal. The bearing journal must be within the following specifications:

Out-of-round less than 0.0254 mm (0.001 in.)

Taper less than 0.0254 mm (0.001 in.)

If bearing journals are not within specifications, crankshaft must be removed and bearing journal ground to an undersize. If bearing journal cannot be repaired so bearing journal is a correct undersize, crankshaft must be replaced. See Engine Specifications, Crankshaft.



1. TENSIONER
2. INDICATOR
3. TENSION IS CORRECT
4. ADJUST TENSION OR REPLACE DRIVE BELT

Figure 62. Drive Belt Tension Check

Valve Clearance Adjustment (Early Models)

NOTE: The early models use rocker arm studs that are pressed into the head.

1. Disconnect negative cable at battery. Remove rocker covers.

2. Rotate engine until mark on vibration damper or crankshaft pulley is aligned with 0 timing mark on timing tab. Make sure valves for No. 1 cylinder are closed. If valves are moving as 0 timing mark is reached, engine is in firing position for No. 4 cylinder; rotate crankshaft one more turn to reach firing position for No. 1 cylinder. See Figure 63.

3. When engine is in No. 1 firing position, adjust valves for the following cylinders:

Inlet Valves for Numbers: 1, 2, and 3 and Exhaust Valves for Numbers: 1, 5, and 6.

4. Adjust valve clearance by loosening nut for rocker arm until push rod is loose.

Tighten nut for rocker arm until there is no clearance at push rod. Check clearance by rotating push rod while tightening nut. When there is no clearance at push rod, tighten nut for rocker arm one full turn. The additional turn of the nut will put the push rod in the seat of the valve lifter.

5. After the valves are adjusted in Step 3, rotate engine one full turn. Make sure timing marks are aligned. The valves on the No. 4 cylinder will be closed. When engine is in this position, adjust valves for the following cylinders:

Inlet Valves for Numbers. 4, 5, and 6 and Exhaust Valves for Numbers. 2, 3, and 4.

6. Install valve covers. Connect battery cable. Start engine and check for correct operation.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
	Water pump worn or damaged.	Install new water pump.
	Exhaust system has restrictions.	Check the exhaust system. Remove restrictions.
The bearings in the engine are damaged.	There is not enough oil in the engine.	Add oil to full mark on dipstick.
	Oil in the engine is dirty.	Make sure dirt is not entering engine through air inlet system. Drain and fill with clean oil. Reduce time interval for oil and filter change.
	Oil in the engine is the wrong type.	Drain and fill with correct oil.
	Oil pump is worn or damaged.	Install new oil pump.
	Connecting rod(s) and bearings have damage.	Check and repair crankshaft. Install new connecting rods and bearings.
	Camshaft and bearings have damage.	Install new camshaft and bearings.
	Passages for oil have restrictions.	Remove restrictions or overhaul engine.
	Bearings are not installed correctly.	Install new bearings or overhaul engine.

Steering Wheel and Column Assembly Repair

The upper end of the steering shaft has splines for the steering wheel. A large nut holds the steering wheel onto the steering shaft. The horn button is the cover for the center of the steering wheel. The lower end of the steering shaft has splines to engage the steering control unit. Contacts at the horn button, a wire in the column, and slip ring contacts in the column assembly allow for horn operation by the operator (see Figure 1).

The steering column assembly is adjustable and held in position by a latch. The assembly position can be changed as needed for operator comfort. See Figure 2.

REMOVE AND DISASSEMBLE

CAUTION

Disconnect the negative battery cable on internal combustion trucks. Disconnect the battery before removing any covers.

1. Attach a tag on the battery connector or negative cable stating DO NOT CONNECT BATTERY. Move steering column to most forward position.
2. Remove screws that fasten column housing to bracket. Remove front housing from steering column assembly. See Figure 2.
3. Remove horn button. Loosen screw that connects horn wire to horn button and remove wire from horn button. Remove nut and steering wheel.
4. Disconnect microswitch on shift lever. Remove the four bolts holding shift lever assembly to bracket. Remove shift lever assembly by sliding it up steering column. If necessary, disassemble direction control lever as described in **Single-Speed Powershift Transmission - Repairs** 1300 YRM 397 for lift truck models GC070-120LJ/MJ. For lift truck models GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) see the sections **Single-Speed Powershift Transmission - Troubleshooting and Repairs** 1300 YRM 752 or **Two-Speed Powershift Transmission - Troubleshooting and Repairs** 1300 YRM 728.

NOTE: To aid in installation, tag hydraulic hoses at steering control unit during removal.

5. Disconnect hydraulic hoses from bottom of steering control unit. Install caps on hoses and plugs in ports to prevent dirt from entering hydraulic system. Remove steering control unit.
6. Remove screws, washers, and lockwashers that fasten steering column and steering control unit to bracket.
7. If necessary, disassemble steering control unit as shown in Steering Control Unit, Disassemble.
8. Remove steering column. Remove horn wire cover on side of steering column. Pull horn wire out of steering column.
9. If necessary, remove all parts of latch from bracket. If necessary, remove all parts of spring mechanism and pivot to remove bracket from cowl of lift truck.

ASSEMBLE AND INSTALL

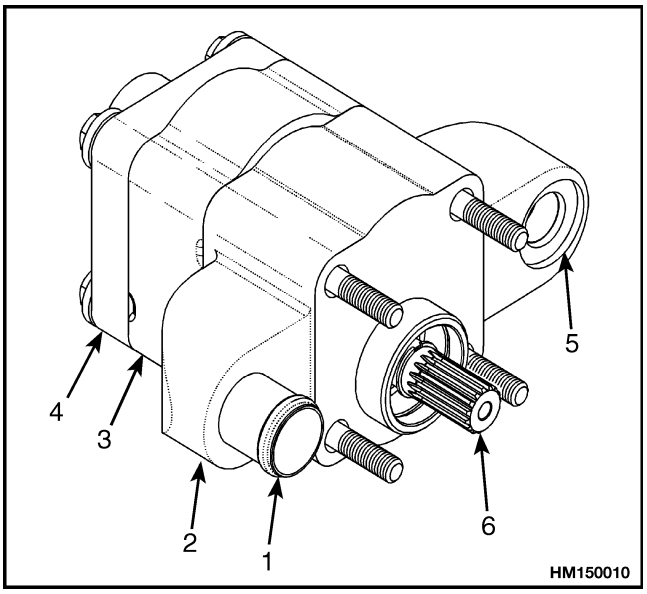
1. If removed, install bracket, pivot, and spring mechanism on cowl of lift truck. If removed, install latch on bracket. See Figure 2.
2. Push horn wire through hole in lower end of steering column. Install screws that fasten the wire harness cover to steering column. Attach horn wire to horn.
3. If necessary, assemble steering control unit as shown in Steering Control Unit, Assemble.
4. Install steering column and steering control unit in the bracket. Install screws, washers, and lockwashers that fasten steering column and steering control unit to bracket.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Steering tires do not move when steering wheel is turned. (Cont.)	Hydraulic hoses not connected or have damage.	Check for leaks. Tighten connections. Install new components as necessary.
Slow or difficult steering.	Relief valve for steering system is damaged or not adjusted correctly.	Replace relief valve.
	Low oil pressure from hydraulic pump.	Check for restrictions. See Troubleshooting Chart in section, **Hydraulic System** 1900 YRM 743.
	Seal in steering cylinder has a leak.	Repair cylinder. Install new seal or new cylinder.
	Hydraulic lines are too small or have restrictions.	Remove restrictions. Install larger or new hydraulic lines.
	Steering control unit is worn, not assembled correctly or has damage.	Repair or install new control unit.
Steering wheel turns tires in the wrong direction.	Hydraulic lines are not connected correctly at steering cylinder or at steering control unit.	Connect lines correctly. Remove air from system.
Steering function continues after steering tires stop.	Steering control unit is assembled wrong or has damage.	Repair or install new control unit.
Steering operation is not smooth.	Oil level in tank is low.	Fill tank. Check for leaks.
	Air was not removed after repair to hydraulic system.	Remove air from system.
	Steering control unit is assembled wrong or has damage.	Repair or install new control unit.
	Hydraulic pump has a leak at the inlet.	Fix leaks. Remove air from system.

Operation

HYDRAULIC PUMP GLP/GDP 3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ)

The hydraulic pump has several sections with a single set (single stage) of gears. See Figure 3. The pump has two covers and the gear housing with the gears. Seals are used to prevent leaks between the sections. The inlet and outlet ports are on the input shaft end cover. The input shaft is splined to a fan pulley. The fan pulley is connected to a drive shaft that is driven by the engine crankshaft.



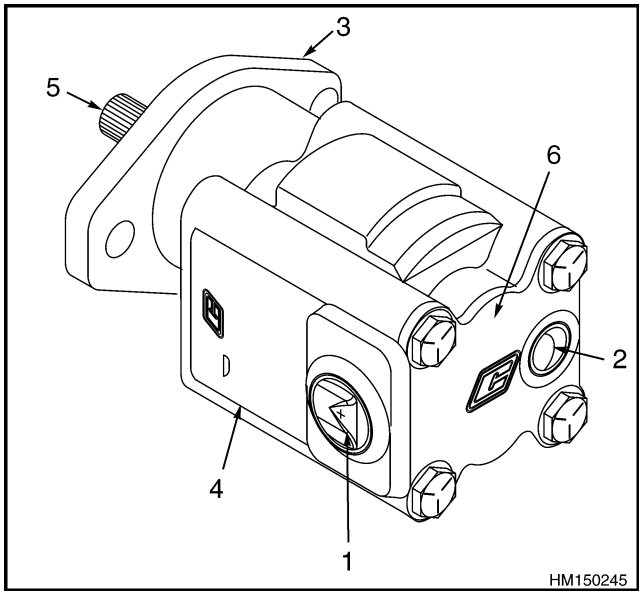
1. INLET PORT
2. INPUT SHAFT END COVER
3. GEAR HOUSING
4. PORT END COVER
5. OUTLET PORT
6. INPUT GEAR SHAFT

Figure 3. Hydraulic Pump GLP/GDP 3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ)

The hydraulic pump gets its oil supply from the hydraulic tank. Oil from the outlet port goes to the main control valve. Refer to the Specifications chart for the rate of flow to the main control valve.

HYDRAULIC PUMP GC070-120LJ/MJ

The hydraulic pump has several sections with a single set (single stage) of gears. See Figure 4. The pump has two covers and the gear housing with the gears. Seals are used to prevent leaks between the sections. The inlet port is located on the side of the pump and the outlet port is located on the back cover. The input shaft is splined to the hydraulic pump drive located on the flywheel end of the engine.



1. INLET PORT
2. OUTLET PORT
3. INPUT SHAFT END COVER
4. GEAR HOUSING
5. INPUT GEAR SHAFT
6. OUTLET PORT COVER

Figure 4. Hydraulic Pump GC070-120LJ/MJ

The hydraulic pump gets its oil supply from the hydraulic tank. Oil from the outlet port goes to the main control valve. Refer to the Specifications chart for the rate of flow to the main control valve.

MAIN CONTROL VALVE

The main control valve controls the lift, tilt, and attachment functions of the mast and on a priority basis, provides steering flow to the steering control unit. See Figure 5 and Figure 6. The control valve receives oil from the hydraulic pump. The main relief valve (lift circuit) is set at 21.4 MPa (3100 psi) GLP/GDP 3.5-5.5LJ/MJ (GP/GLP/GDP80-120LJ/MJ) and 22.4 MPa (3250 psi) GC070-120LJ/MJ. The secondary relief valve (tilt and auxiliary circuits) is set at 15.5 MPa (2250 psi). The drain circuit from the main control valve is connected to the hydraulic tank and flows through an internal filter.

TABLE OF CONTENTS

This section is for the following models:

GP/GLP/GDP70-120LJ/MJ [C813, E813];
GC070-120LJ/MJ [C818, D818]

1. Inspect spools and bores for defects. If spool or bores have damage, replace control valve section.
2. Coat spools with clean hydraulic fluid and make sure spools move freely in bores.
3. Inspect relief valve for damage. If relief valve is damaged, it must be replaced.

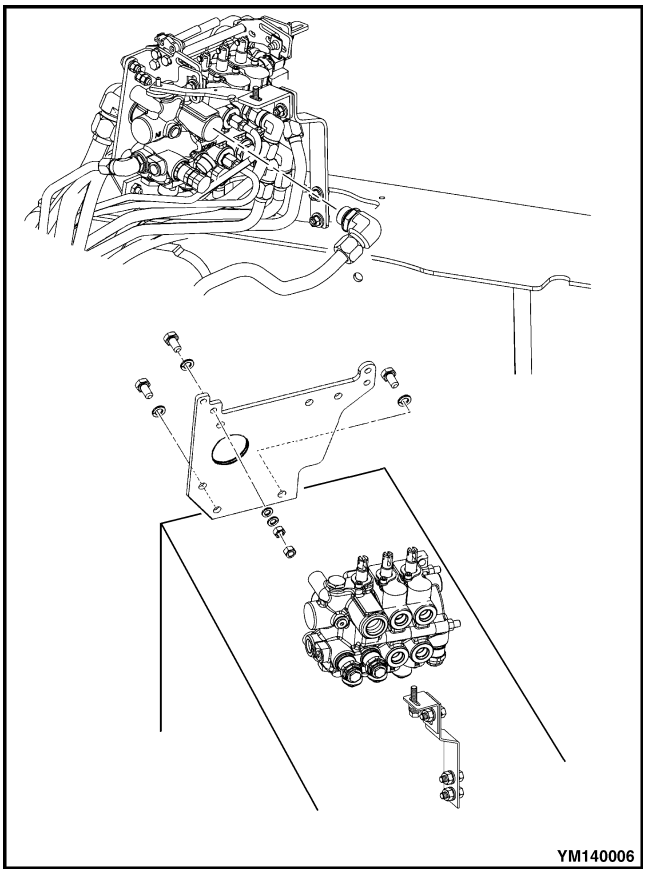


Figure 9. Control Valve Removal, Newer Model GP/GLP/GDP70-120LJ/MJ (C813) Lift Trucks and GP/GLP/GDP70-120LJ/MJ (E813) Lift Truck Models

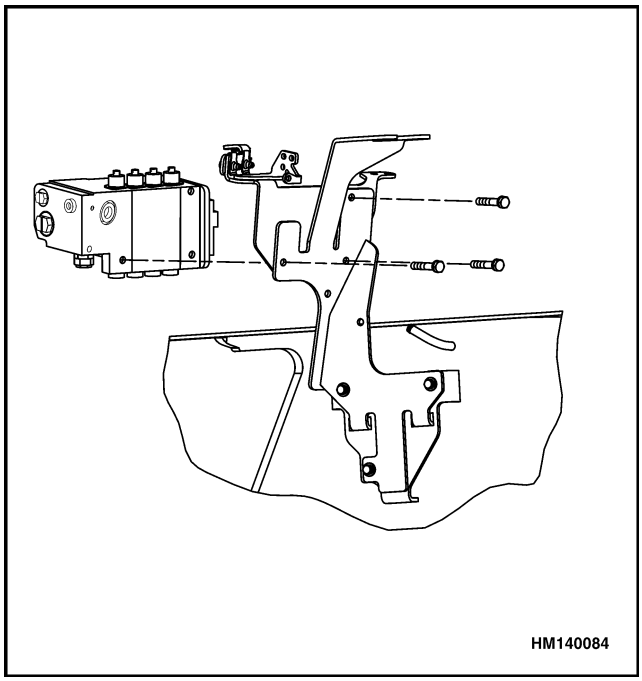


Figure 10. Control Valve Removal GC070-120LJ/MJ (C818) Lift Truck Models

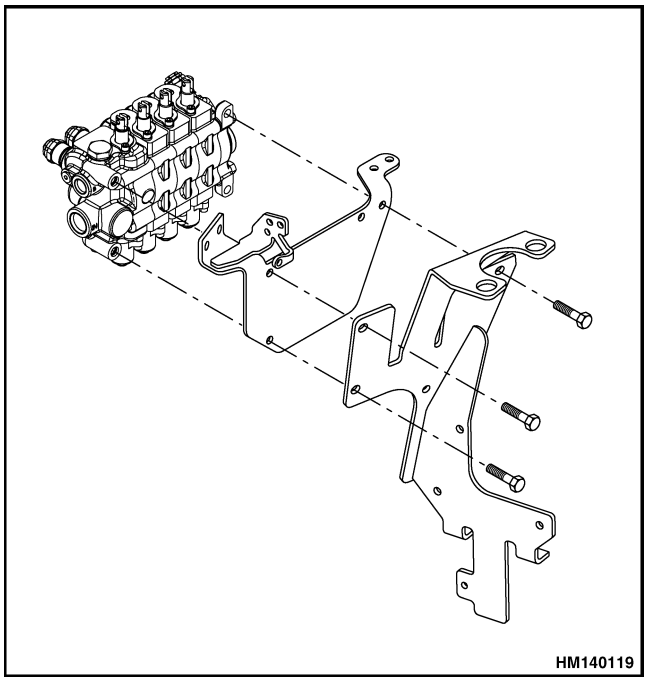
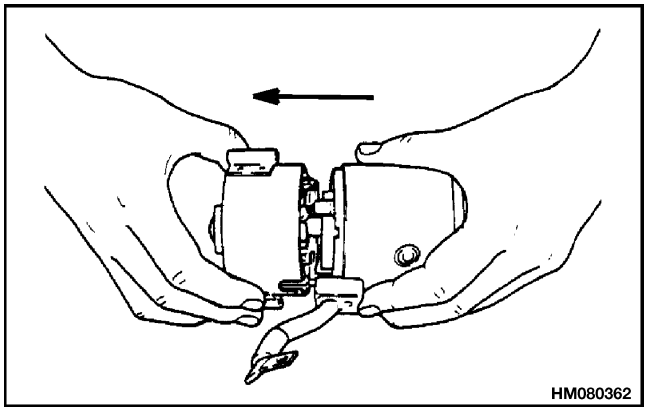
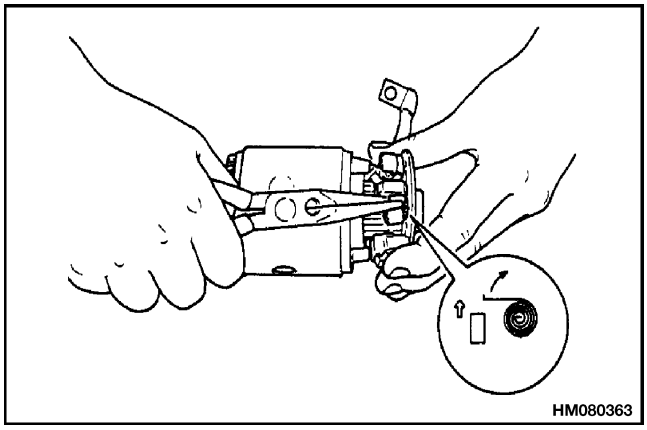


Figure 11. Control Valve Removal GC070-120LJ/MJ (D818) Lift Truck Models

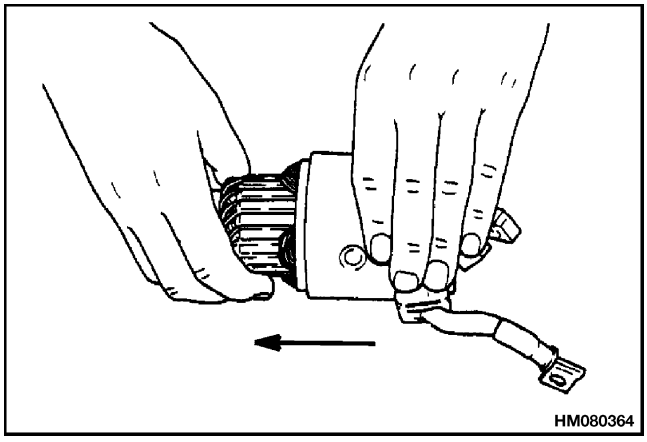
STEP 4.
Remove end frame from yoke.



STEP 5.
Remove brushes from brush holder and remove brush holder.



STEP 6.
Remove armature from yoke.

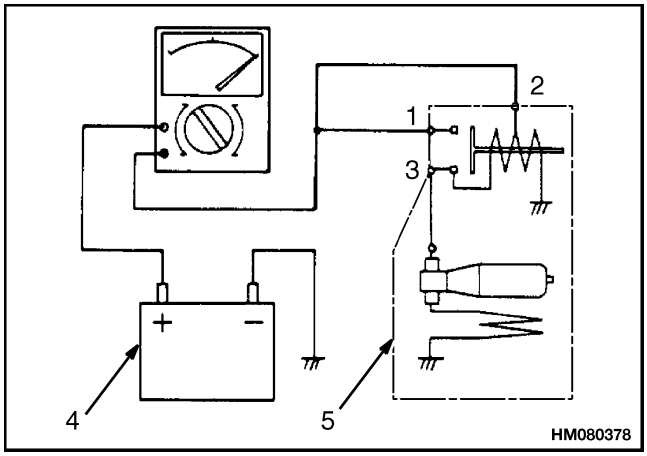


Performance Tests

Perform the following tests after reassembling the starter.

NO-LOAD TEST

1. Clamp starter securely in a vise and connect battery and ammeter as shown in Figure 11.
2. Connect negative lead to starter body.
3. Make sure pinion extends and starter shows smooth and steady rotation.



1. MAIN TERMINAL
2. STARTER TERMINAL
3. COIL TERMINAL
4. BATTERY
5. STARTER

Figure 11. No-Load Test

Troubleshooting

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The starter will not turn; no noise at the magnetic switch.	Battery is discharged or has damage.	Replace battery.
	A fuse is burned out.	Replace fuse.
	A wire in the control circuit is disconnected.	Connect wire.
	The key switch has damage.	Install new parts.
	The neutral start switch has damage.	Install new parts.
	The battery is discharged or has damage.	Recharge or replace battery.
	The cable connections are bad.	Install new parts.
	The magnetic switch has damage.	Replace magnetic switch.
	The starter brushes are worn or dirty.	Replace brushes.
	The magnetic switch has damage.	Replace magnetic switch.

Description

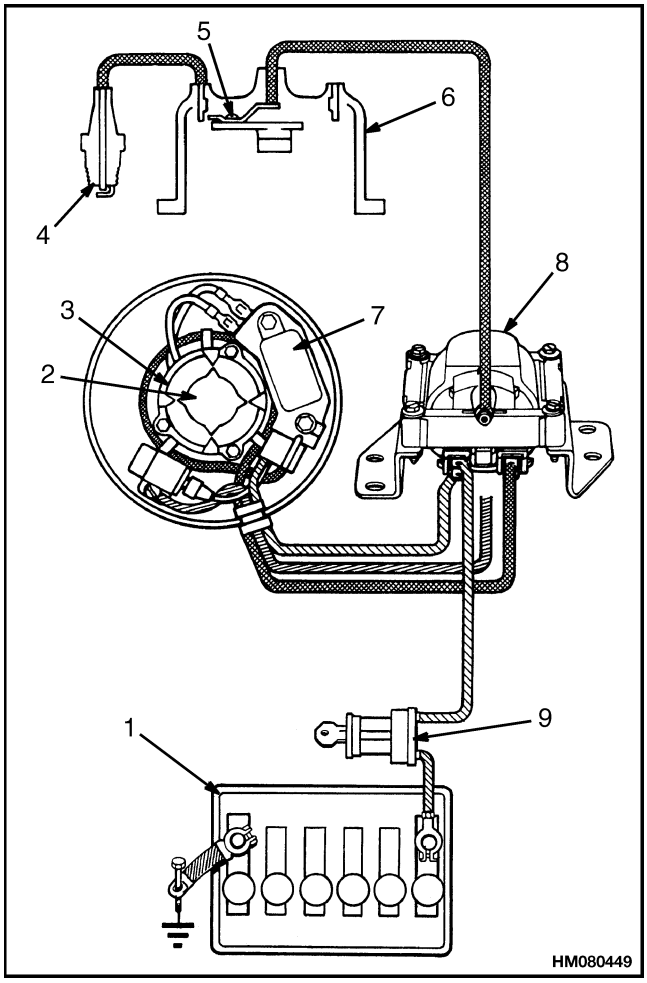
This section has a description and the service procedures for the High Energy Ignition (HEI) system for General Motors engines. See Figure 1.

The High Energy Ignition (HEI) system generates the spark which starts combustion. The main parts of the system are: the battery, key switch, distributor, ignition coil, spark plugs, and the wires. If the engine is starting or running, current flows from the battery to the key switch, primary winding of the ignition coil, electronic module and returns to the battery. A magnetic field is generated in the primary winding of the coil when current flows through it. The pole piece and sensing coil sends a signal to the electronic module to interrupt primary current. When the current flow in the primary windings are interrupted, the decreasing magnetic field generates a high voltage in the secondary windings of the coil.

The distributor rotor applies the secondary (high) voltage to the correct spark plug at the correct time. The secondary voltage is applied to the rotor. The rotor transfers this high voltage to one of the terminals in the distributor cap. When the high voltage is applied through the high voltage wire to the spark plug, the spark in the spark plug starts combustion in the cylinder.

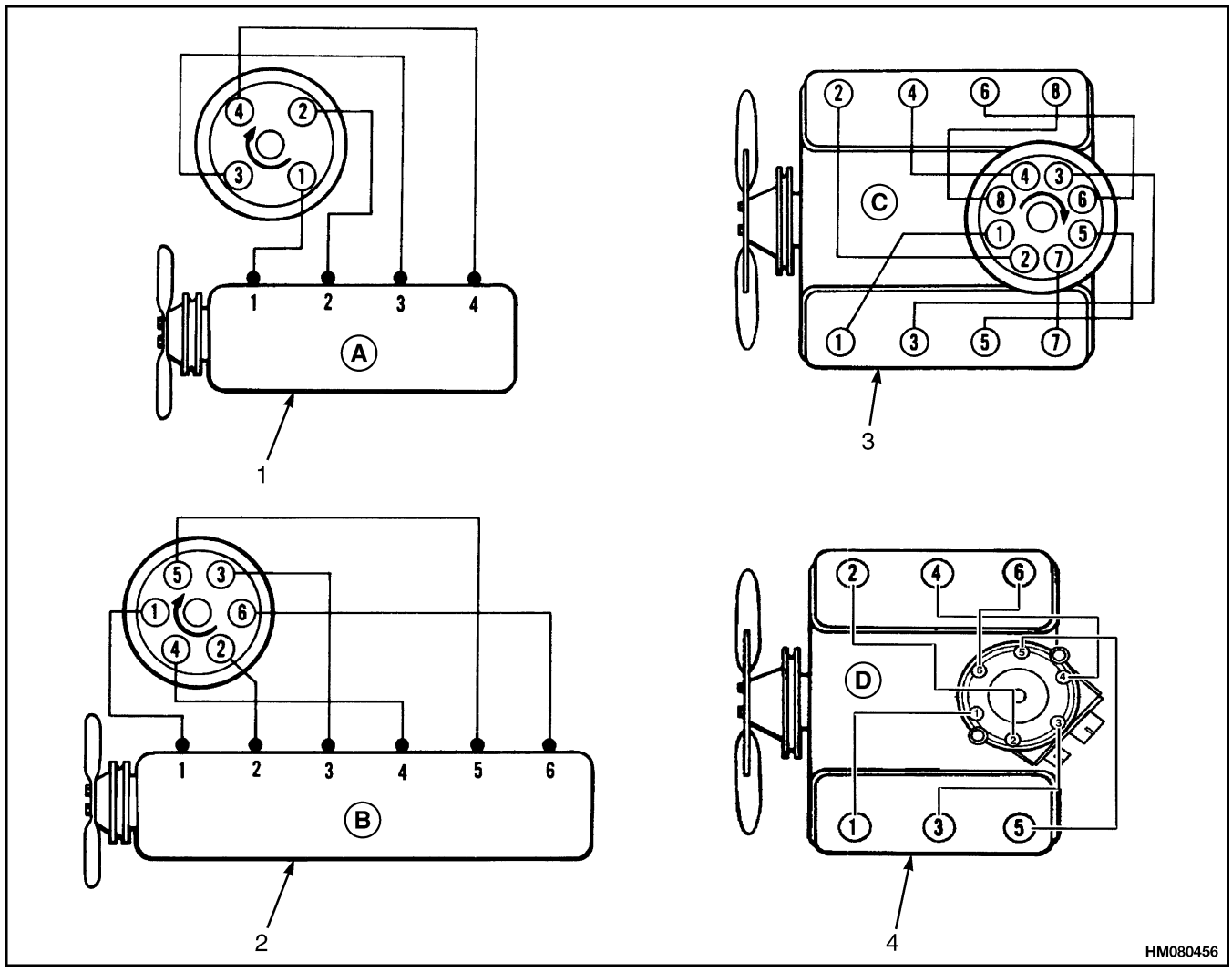
The parts that generate the voltage signal for the electronic module are shown in Figure 2. The timer core of the distributor shaft has a tooth for each cylinder in the engine. The pole piece also has a tooth for each cylinder. A permanent magnet is fastened under the pole piece. A sensing coil is put in the center of the magnet and pole piece. When the teeth are aligned, the magnetic field from the permanent magnet will have a path. The magnetic field generates a voltage signal in the sensing coil. When the teeth are not aligned, the magnetic path is removed. This disables the magnetic field and the voltage signal.

The electronic module is an electronic switch which controls the current in the primary of the ignition coil. The basic circuit is shown in Figure 3. When the electronic module receives a voltage signal from the sensing coil, the electronic module activates **ON**. Current now flows through the primary winding of the ignition coil. The flow of current generates a magnetic field around both windings. When the sensing coil removes the voltage signal, the electronic module deactivates **OFF**. Current stops flowing in the primary winding. The magnetic field decreases quickly. This changing magnetic field generates a high voltage in the secondary winding.



1. BATTERY
2. TIMER CORE
3. POLE PIECE/SENSING COIL
4. SPARK PLUG
5. ROTOR
6. DISTRIBUTOR CAP
7. ELECTRONIC MODULE
8. IGNITION COIL
9. KEY SWITCH

Figure 1. HEI System



A. FIRING ORDER 1-3-4-2
B. FIRING ORDER 1-5-3-6-2-4
C. FIRING ORDER 1-8-4-3-6-5-7-2
D. FIRING ORDER 1-6-5-4-3-2

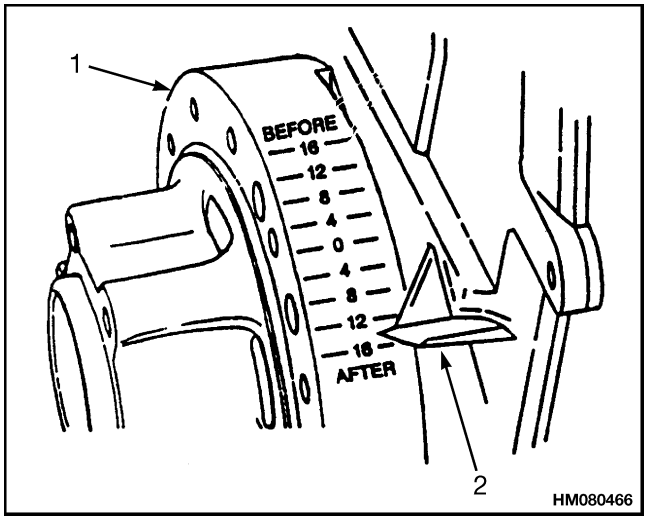
1. FOUR CYLINDER
2. SIX CYLINDER
3. V8
4. V6

Figure 8. Firing Order

GM V8-366 (6-liter) Ignition System Check

Check spark plugs. Replace worn spark plugs and distributor contacts. The correct spark plug gap is 0.89 to 1.1 mm (0.035 to 0.043 in.).

Check ignition timing. See Figure 18. Adjust timing according to specifications.



1. CRANKSHAFT DAMPER
2. TIMING TAB

Figure 18. GM V8 Timing Marks

GM V6-LPG (4.3 liter) GM V6-LPG (4.3 liter) Ignition Timing and Idle Speed Adjustment

For ingnition timing and idle speed adjustment for the GM V6 (4.3-liter) with EPIC LPG System, see **Carbureted Engine Management System Open Loop Carbureted Engine Management System (CEMS)** 2200 YRM 744.

For ingnition timing and idle speed adjustment for the GM V6 (4.3-liter) on lift trucks equipped with MSTS, see **MSTS GM V6-4.3L (Later Control Modules) Microprocessor Spark Timing System (MSTS)**, **Late Model** 2200 YRM 765

Specifications

Item	Specifications
Spark Plugs	See Parts Manual
Electrode gap	0.89 to 1.1 mm (0.035 to 0.045 in.)
Torque	
Gasket type	35 to 40 N•m (26 to 30 lbf ft)
Tapered seat	14 to 27 N•m (10 to 20 lbf ft)
Firing Order	
Four cylinder	1-3-4-2
Six cylinder (in-line)	1-5-3-6-2-4
V-6	1-6-5-4-3-2
V-8	1-8-4-3-6-5-7-2

General

The gauges and meters provide information to the operator on the condition of various systems. Gauges may be either direct reading (mechanical) or indirect (electrical). Unlike mechanical gauges, electrical gauges have electrical meter movements, light emitting diode (LED), or digital displays inside the case. These meters receive an electrical signal from a sender unit, usually in the engine or transmission case. The indicators of electric lift trucks receive an electrical signal from a sensor (motor temperature) or a control board. This section only describes the electrical gauges, meters, senders, and instrument panel displays. Gauges will be referred to as meters.

The meters and displays are used to provide operator information on the status of many systems including: engine coolant temperature, engine or transmission oil pressure or temperature, fuel level, battery current (ammeter), and battery voltage (voltmeter). See Figure 1.

Description

INSTRUMENTS AND SENDERS

WARNING

If any of the instruments do not operate as described, report the problem immediately. DO NOT operate the lift truck until the problem is corrected.

Many meters have meter movements that move an indicating needle attached to a shaft or pin. The shaft rotates to swing the needle when current flows through the movement. The movement operates on the same electromagnetic principle that causes a motor shaft to rotate. However, shaft rotation of a meter is limited to much less than one full revolution. The amount of rotation or deflection of the needle is directly related to the amount of current flow through the meter movement. Meter faces are calibrated to indicate a range of values that are converted from a directly proportional current flow through the sender. For examples of meter faces and indicators, see Figure 1 and Table 1.

Meters such as voltmeters and the hourmeter are able to convert this proportional current within the meter case. Other meters and displays require a separate sender. See Table 2. Senders convert a specific pressure, temperature, or fluid level into a current flow that is directly related to a given voltage (electrical system voltage) applied.

The display panel has a password function that permits operation of the lift truck. The lift truck cannot be started without first entering the password code. The password function can be disabled by the supervisor.

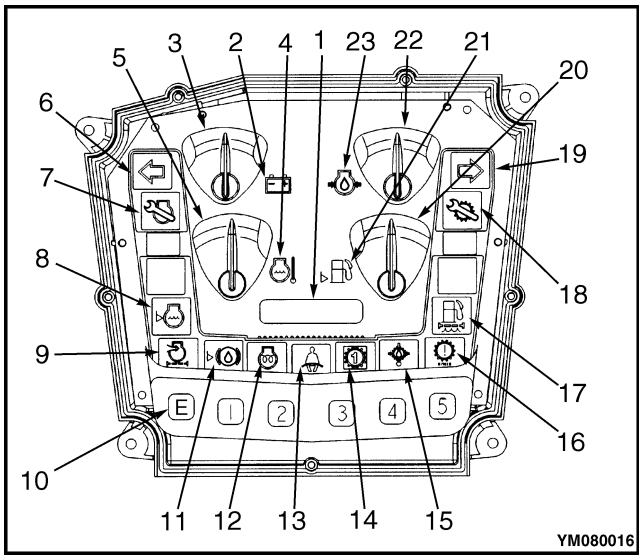


Figure 1. Instrument Cluster

SEAT SENSOR, OPERATOR PRESENCE SYSTEM (OPS)

Remove

1. Disconnect the battery.
2. Disconnect seat harness from chassis harness.
3. Remove the four capscrews, washers, and seat from the hood.
4. Disconnect the seat harness from the seat sensor. See Figure 5.
5. Remove two capscrews and seat sensor from the seat.

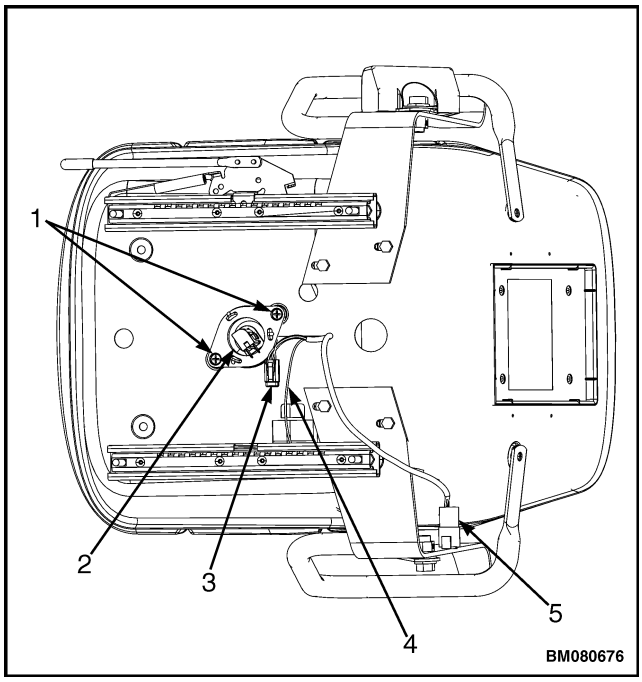


Figure 5. Seat Sensor Location

Legend for Figure 5

1. CAPSCREWS
2. SEAT SENSOR
3. SEAT SENSOR ELECTRICAL CONNECTOR
4. SEAT GROUND WIRE
5. TO CHASSIS HARNESS

Install

1. Using two capscrews, install seat sensor on the bottom of the seat. See Figure 5.
2. Connect seat sensor to seat harness.
3. Install seat onto hood using four capscrews and washers. Tighten capscrews to 18 N•m (156 lbf in).
4. Connect seat harness to chassis harness.
5. Connect battery.

OPERATOR PRESENCE SYSTEM MODULE REPLACEMENT

NOTE: Remove the Operator Presence System Module only when directed to do so as a result of troubleshooting the Operator Presence System.

Remove

1. Disconnect the negative battery terminal.
2. Remove the dash cover from the cowl. See Display Panel Replacement.
3. Disconnect the Operator Presence System Connector from the Operator Presence System Module. See Figure 6 and Figure 7.

Table 5. Troubleshooting Procedure for the Operator Presence Module (Continued)

Symptom	Cause	Check	Result	Investigate
		With power **ON** and engine **OFF**. Plug the Operator Presence System connector in, and with operator in the seat, check for approximately 3.0 to 4.5 volts on Operator Presence System connector pin 11 (+) and pin 12 (–).	Greater than 4.5 volts > Yes> 3 to 4.5 volts > yes > (next step below)	Check circuit 431 for short to 5 volts or short to battery. Repair or replace.
Truck does not move with Operator Present.	Operator Presence System does not reset.	With power **ON**, engine **OFF**, service brake applied, and the Operator Presence System connector unplugged, check for battery voltage on Operator Presence System connector pin 3 and pin 1.	Battery voltage >No> Battery voltage >yes> (next step below)	Check ground and power wiring for open circuits. Check connectors, service brake switch, and brake light relay for an open circuit. Check fuses for an open circuit. Repair or replace.
		With power **ON**, engine **OFF**, service brake not applied, and the Operator Presence System connector unplugged, check for battery voltage on Operator Presence System connector pin 3 and pin 1.	Battery voltage >yes>	Check power wiring or connectors for short to battery. Service Brake switch circuit shorted. Repair or replace.
Truck can move without Operator Present.	Operator Presence System is detecting a false seat presence signal.	With power **ON** and engine **OFF**. Plug the Operator Presence System connector in and with no operator in the seat, check for approximately 3.0 to 4.5 volts on Operator Presence System connector pin 11 (+) and pin 12 (–).	3 to 4.5 volts > Yes> 3 to 4.5 volts >No> (next step below)	Stuck seat mechanism Repair Stuck seat sensor Replace
Truck can move without Operator Present.	Direction solenoids can be operated.	With power **ON** and engine **OFF**. Unplug Operator Presence System connector, release the park brake and select a direction. Check for battery voltage on Operator Presence System connector pin 5 (+) and pin 1 (–). Repeat for other direction selection.	Battery voltage >Yes> Battery voltage >No> (next step below)	Circuit 833 short to battery Repair or replace.
Truck can move without Operator Present.	No Operator Presence System Interlock.	With power **ON** and engine **OFF**. Plug the Operator Presence System connector in, with no operator in the seat, check for battery voltage on Operator Presence System connector pin 5 (+) and pin 1 (–).	Battery voltage >Yes>	Operator Presence System faulty. Replace

General

This section has the description for lift cylinders used on the masts for model lift trucks ERC070-120HG (A839), GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP070-120LJ/MJ), ERC35-55HG (ERC70-120HH) [B839], and GC070-120LJ/MJ and the instructions for their repair. The operation and repair procedures for the different lift cylinders are similar. See the section **Lift Cylinders** 4000 YRM 135 for lift cylinders used on other units.

Description

All lift cylinders for the masts are single-action hydraulic cylinders. The hydraulic force is applied only in one direction. When hydraulic oil enters one end of the lift cylinder, the hydraulic force extends the piston rod. When the force is removed, the weight of the carriage and inner mast causes the piston rod to retract.

A common maintenance problem is the repair of oil leaks. If the bore of the shell of the lift cylinder is damaged and cannot be repaired, the lift cylinder must be replaced.

The two-stage and three-stage masts have two main lift cylinders. The free-lift mast has two main lift cylinders and a shorter free-lift cylinder. See Figure 2 and Figure 3.

Spacers are used in some cylinders to limit the stroke of the piston rod. Worn spacers must be replaced with the same size spacer.

The free-lift cylinder has a single-lip seal on the piston to prevent hydraulic oil leaks past the piston and retainer. The piston rod has a smaller diameter than the piston.

During operation, some hydraulic oil will leak past the piston area to the rod end of the lift cylinder. Small leaks are permitted if the internal leak rate of the hydraulic system is not greater than the specification. An internal check valve is installed in the piston of the free-lift cylinders. When the piston rod extends, the pressure increases more quickly on any oil in the rod end of the lift cylinder. The hydraulic oil transfers through the check valve to the piston end of the free-lift cylinder. This action prevents hydraulic damage to the single-lip seal and the wiper ring. See Figure 4.

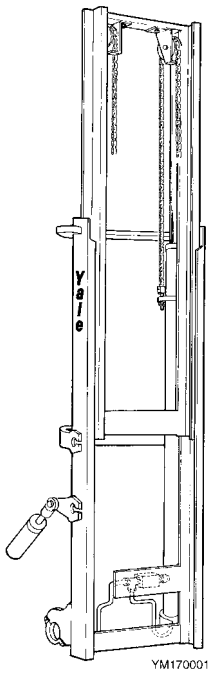
LOWERING CONTROL VALVE (VELOCITY FUSE)

A lowering control valve is installed in the hydraulic line to the bases of the main lift cylinders and at the inlet port of each lift cylinder. The lowering control valves (velocity fuses) permit easy entry of hydraulic oil into the cylinders, but give a restriction when the rods retract. This restriction controls the maximum speed at which a load on the forks can be lowered. The lowering control valves (velocity fuses) prevent a load on the forks from freely falling if a hydraulic hose breaks.

MASTS

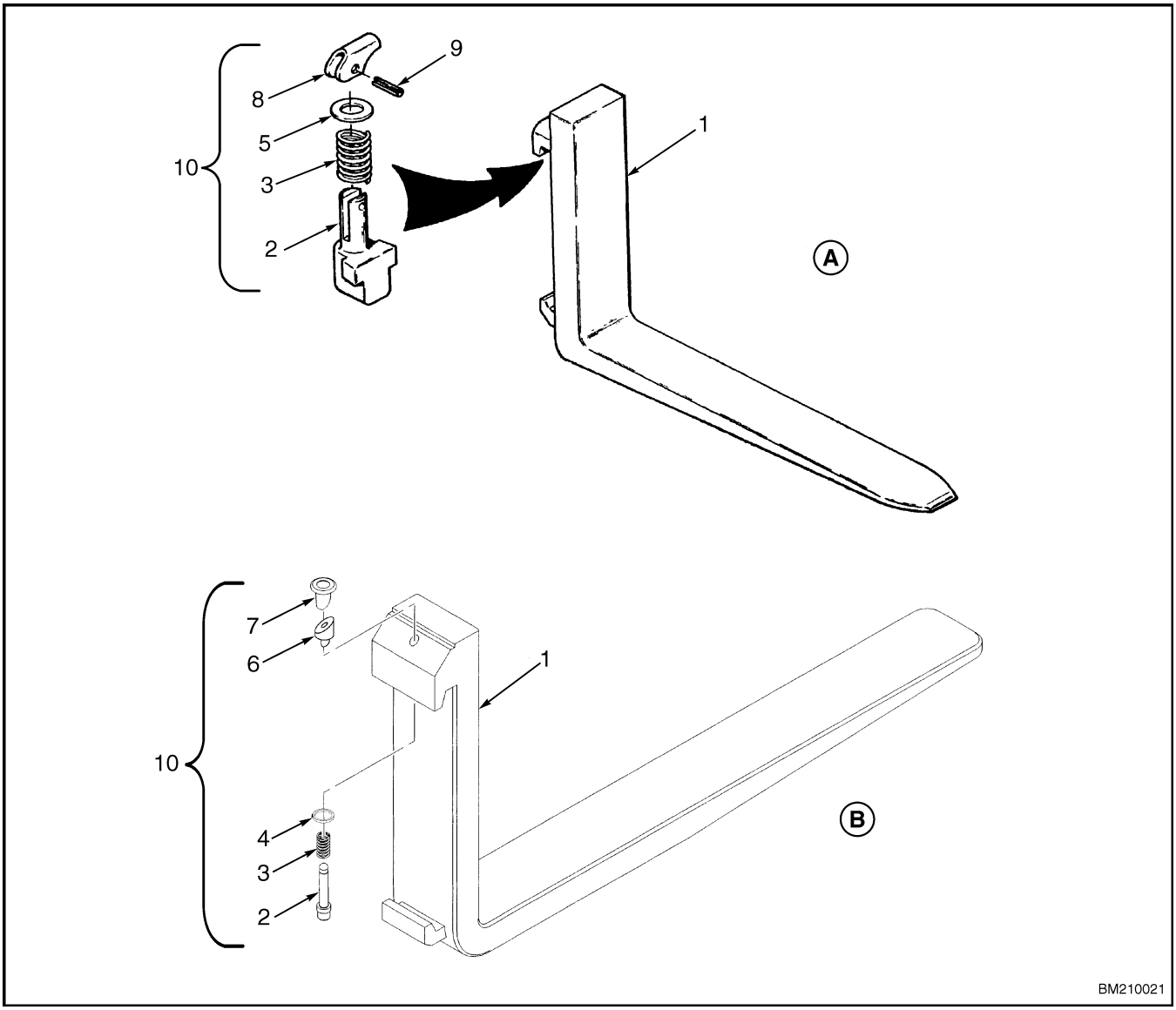
DESCRIPTION AND REPAIRS

ERC070-120HG [A839];
ERC35-55HG (ERC70-120HH) [B839];
GLP/GDP3.5-5.5LJ/MJ
(GP/GLP/GDP070-120LJ/MJ) [C813/E813];
GC070-120LJ/MJ [C818/D818]



Fork Replacement

The identification of a fork describes how the fork is connected to the carriage. The series of lift trucks covered in this section have hook-type forks. See Figure 6.



A. OLD STYLE LOCK PIN ASSEMBLY

1. FORK
2. LOCK PIN
3. SPRING
4. WASHER
5. WASHER

B. NEW STYLE LOCK PIN ASSEMBLY

6. WEDGE
7. KNOB
8. LEVER
9. COTTER PIN
10. LOCK PIN ASSEMBLY

Figure 6. Fork Lock Pin Assembly

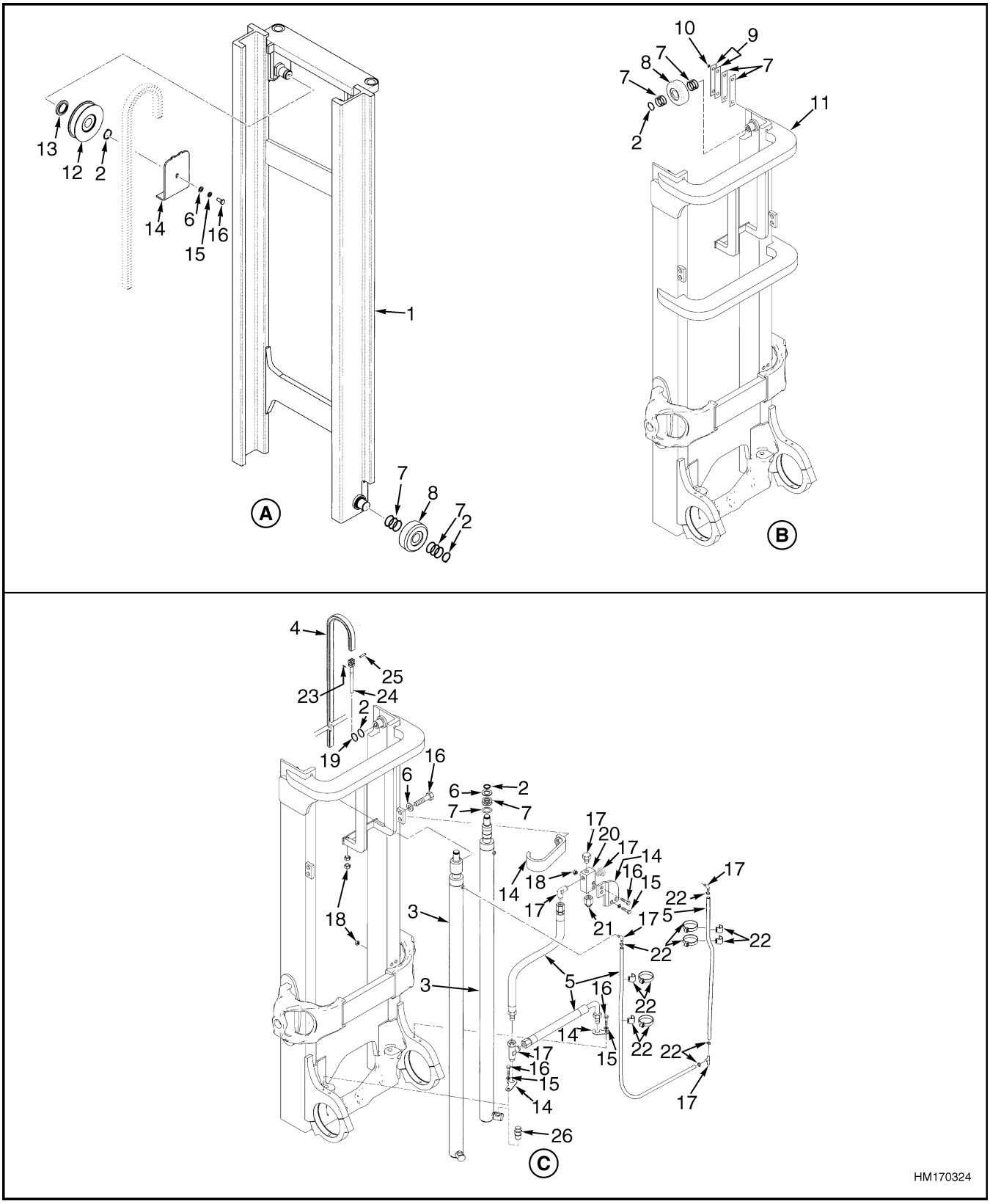


Figure 13. Two-Stage Mast With Limited Free-Lift GC070-120LJ/MJ, ERC070-120HG (A839), and ERC35-55HG (ERC70-120HH) (B839) Lift Truck Models

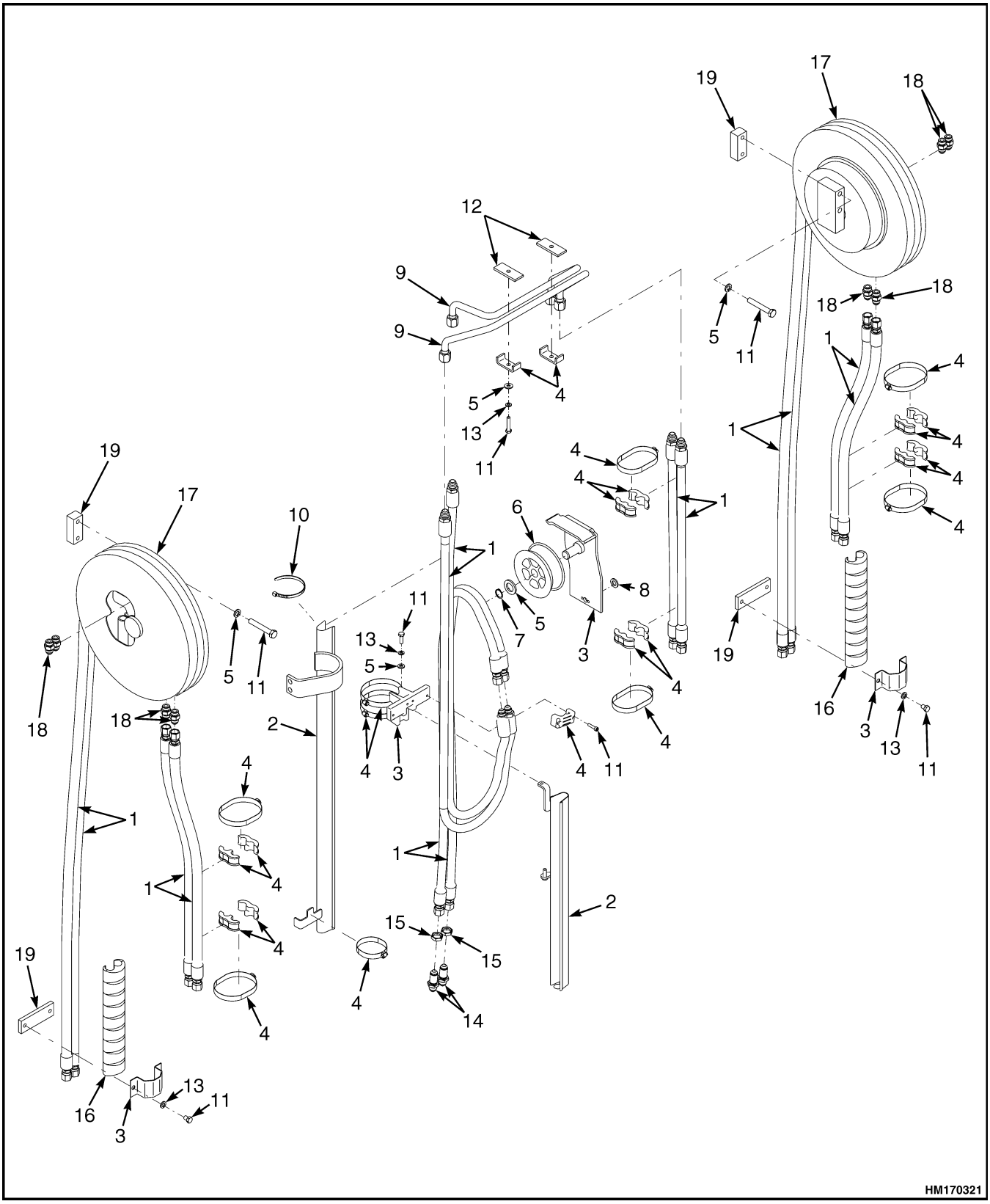
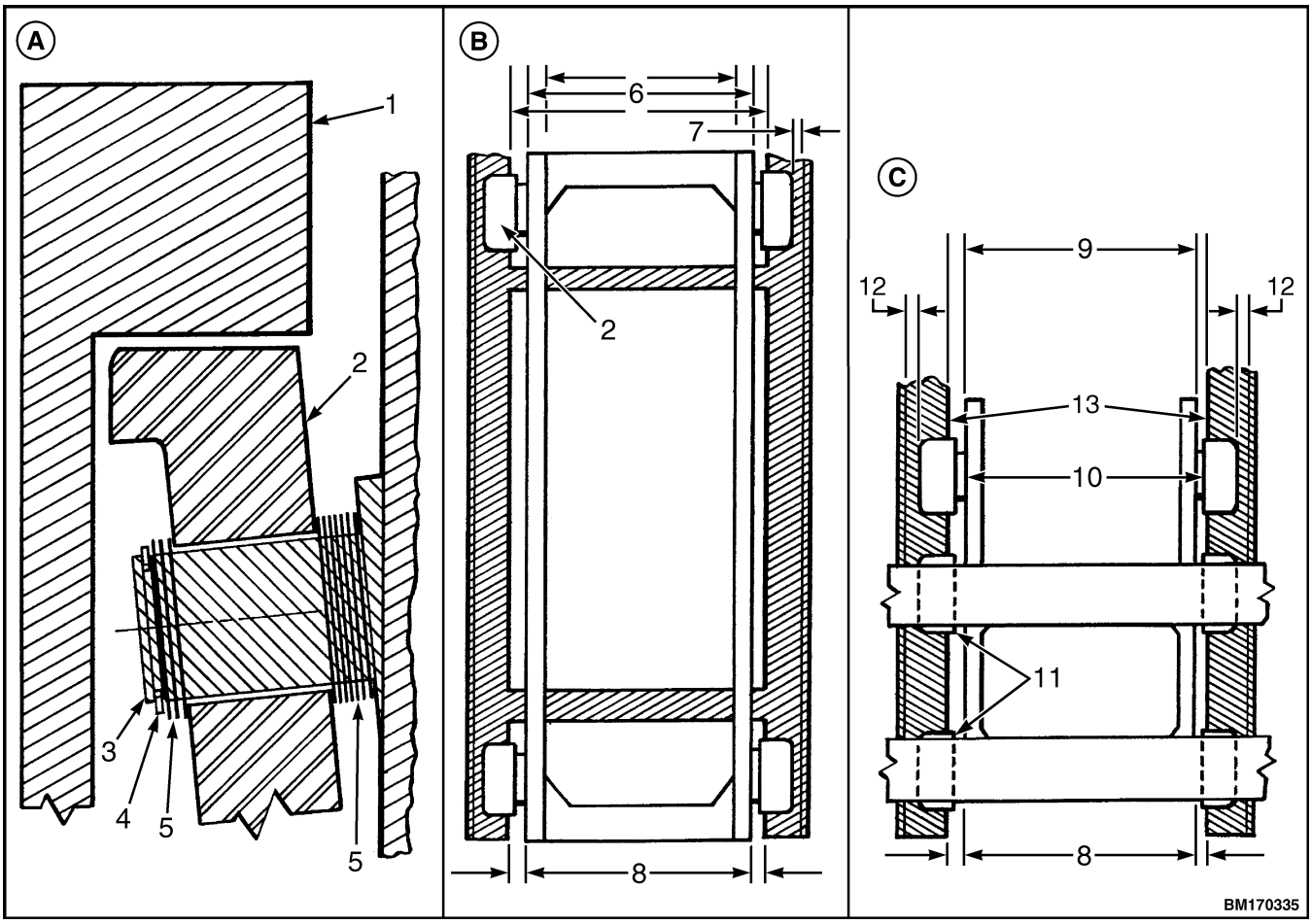


Figure 20. Two-Stage Mast With Full Free-Lift Header Hoses GC070-120LJ/MJ, ERC070-120HG (A839), and ERC35-55HG (ERC70-120HH) (B839) Lift Trucks

Legend for Figure 25

NOTE: FOR LIFT TRUCK MODELS ERC35-55HG (ERC70-120HH) (B839/C839) THE HOSE HEADER ARRANGEMENT SHOWN IN FIGURE 25 DOES NOT COVER MAST HEIGHTS OF 5240 mm (17 ft) AND 5500 mm (18 ft). SEE FIGURE 26.

1. HYDRAULIC HOSES
2. NUT
3. BRACKET
4. HOSE SHEAVE
5. WASHER
6. SNAP RING
7. CLAMP
8. CAPSCREW
9. LOCKWASHER
10. PIN
11. FITTING
12. SPACER
13. STRAIN RELIEF
14. HOSE REEL
15. PLATE



NOTE: USE SHIMS TO KEEP CARRIAGE AND MAST WELDMENTS PARALLEL, TO GIVE APPROXIMATELY EQUAL SPACE BETWEEN BOTH SIDES OF CARRIAGE AND WELDMENTS AND TO GIVE CORRECT CLEARANCE AT TIGHTEST FIT.

A. TOP VIEW
B. UPRIGHT FRONT VIEW
C. CARRIAGE FRONT VIEW

1. CHANNEL (WELDMENT)
2. LOAD ROLLER
3. STUB SHAFT
4. SNAP RING
5. SHIMS*
6. PARALLEL
7. 0.1 to 0.8 mm (0.004 to 0.030 in.)
8. EQUAL SPACE WITHIN 1.5 mm (0.060 in.)
9. PARALLEL
10. INSTALL ALL SHIMS ON OUTSIDE OF ROLLER UNDER SNAP RING
11. USE SHIMS TO ADJUST 0.13 to 0.5 mm (0.005 to 0.020 in.) AT POINT OF TIGHTEST FIT*
12. CARRIAGE LATERAL MOVEMENT 2.5 mm (0.10 in.)
13. CHECK CARRIAGE LATERAL MOVEMENT HERE

*MOVE SHIMS FROM ONE SIDE OF ROLLER TO OTHER SIDE TO CHANGE POSITION OF ROLLER ON STUB SHAFT.

Figure 33. Mast and Carriage Adjustments

TABLE OF CONTENTS

Legend for Figure 5

A. PERKINS DIESEL 1004.42

1. COVER
2. HOOD
3. COUNTERWEIGHT
4. RADIATOR
5. HOSE
6. HOSE

B. GM 4.3L V-6

7. CLAMP
8. RADIATOR SUPPORT PLATE
9. COOLANT RECOVERY RESERVOIR HOSE
10. COOLANT RECOVERY RESERVOIR
11. OVERHEAD GUARD LEG
12. LOWER RADIATOR MOUNTING PLATE

Exhaust System Repair

MUFFLER

Remove

WARNING

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: mast, drive axle, engine and transmission, and counterweight. When the lift truck is put on blocks, put additional blocks in the following positions to maintain stability:

a. Before removing the mast and drive axle, put blocks under the counterweight so the lift truck cannot fall backward.

b. Before removing the counterweight, put blocks under the mast assembly so the lift truck cannot fall forward.

The surface must be solid, even, and level when the lift truck is put on blocks. Make sure that any blocks used to support the lift truck are solid, one-piece units.

1. Remove the overhead exhaust pipe from the counterweight. See Figure 6 or Figure 7.

2. Remove the counterweight. See Counterweight Repair, Remove in this YRM.

3. Remove the lower exhaust pipe from the muffler and disconnect the upper exhaust pipe from the muffler.

4. Remove the muffler from the mounting bracket.

Install

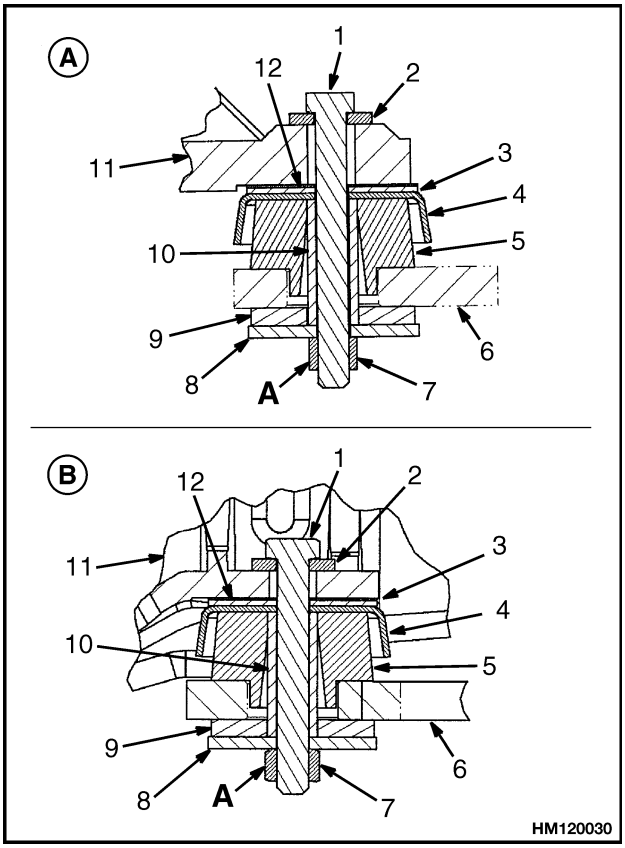
1. Install the muffler on the mounting bracket. Tighten bolts until all clearance has been removed; then tighten one additional turn. See Figure 6 or Figure 7.

2. Connect the upper exhaust pipe to the muffler and install the lower exhaust pipe on the muffler.

3. Install the counterweight on the lift truck. See Counterweight Repair, Install in this YRM.

4. Install the overhead exhaust pipe in the counterweight. Tighten the capscrews to 38 N•m (28 lbf ft).

master cylinder. Connect the wires to the brake switch.



NOTE: A = 165 N•m (122 lbf ft).

A. ENGINE MOUNTS (DIESEL SHOWN)
B. ENGINE MOUNT (GAS/LPG SHOWN)

1. CAPSCREW
2. WASHER
3. WASHER
4. SNUBBING CUP
5. ISOLATOR
6. ENGINE MOUNT
7. NUT
8. REBOUND WASHER
9. BUMPER
10. SPACER
11. FRAME
12. SHIM*

*ROTATE ENGINE AROUND DRIVE AXLE CENTERLINE UNTIL LH OR RH MOUNT CONTACTS. USE A MAXIMUM OF THREE SHIMS (12), ON THE OTHER SIDE TO LESS THAN 1.0 mm (0.03937 in.).

Figure 11. Engine Mounts

h. Install the Foot Directional Control or accelerator pedal to the frame. Connect the wiring harness and throttle cable for the Foot Directional Control pedal or accelerator.

i. Install the steering wheel or install the steering column and steering control unit to the bracket on the frame. Connect the four hydraulic hoses to the steering control unit as noted during removal. Connect the horn wire at the steering column.

j. Connect the hydraulic hoses as noted during removal to the steering control unit.

k. Remove the lift truck from the blocks.

2. Install the engine only as described in the following steps:

a. Connect a lifting device to the engine. Make sure the lifting device has a capacity of at least 450 kg (1000 lb).

b. Carefully install the engine in the frame.

c. Bar the engine over at the crankshaft and install new torque converter flex plate bolts. Tighten bolts to 38 N•m (28 lbf ft).

d. Install the engine mount capscrews and washers at the fan end of the engine. Tighten the capscrews to the correct torque values as shown in Figure 11.

e. Connect the exhaust pipe to the muffler. Install the air filter housing on the frame.

f. Connect the engine wiring harness to the main wiring harness.

g. Install the capscrews for the universal joints from the hydraulic pump drive line at the crankshaft.

h. Install the pedal assembly for the accelerator or Foot Directional Control pedal in the frame. Connect the wiring harness and throttle cable.

i. Install the brake pedal assembly as follows (see Figure 10): Install the pedal assembly in the lift truck. Install the four capscrews at the top of the pedal bracket. Install the return spring on the inching pedal. Install the spring from the inching link. Connect the inching link at the transmission. Connect the brake lines at the brake booster/master cylinder. Connect the wires at the brake switch.

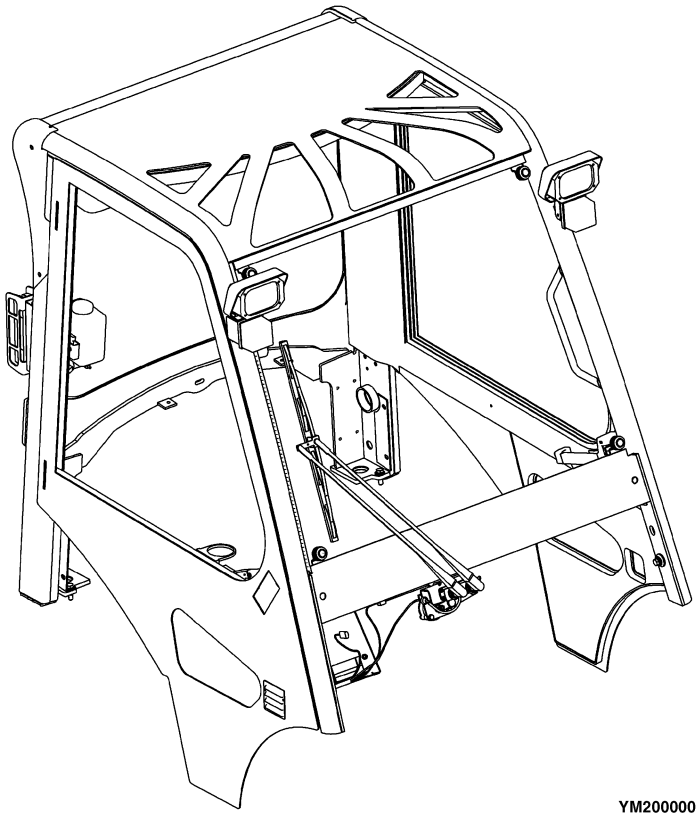
3. Connect the hydraulic line between the main control valve and the hydraulic oil tank.

Yale

Maintenance

OPERATORS CAB

GLP/GDP3.5-5.5LJ/MJ
(GP/GLP/GDP70-120LJ/MJ) [C813, E813]



YM200000

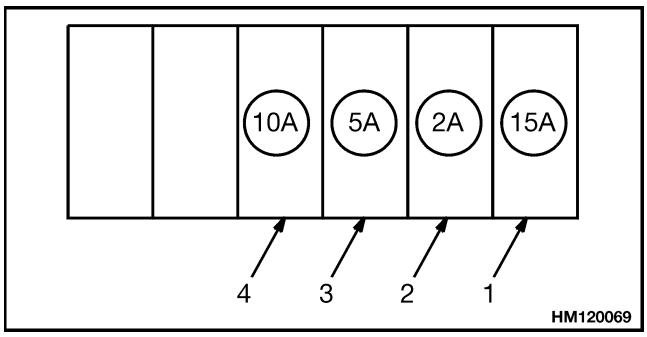
PART NO. 524173801

100 YRM 778

Fuse Panel

The fuse panel with the fuses for the window wipers, lights, fan, and heater system are inside the operator cab. This fuse panel is located in the upper right rear corner of the cab. The fuse arrangement is shown in Figure 8.

The fuse panel can be pulled away or removed from the mount by loosening two capscrews, then disconnecting the fuse panel from the wire harness.



1. WIPER FRONT/REAR
2. DOMELIGHT
3. FAN/RADIO
4. HEATER/BLOWER

Figure 8. Fuse Panel

Heater Assembly

REMOVE

WARNING

If the truck has been run for awhile, the heater hoses will be hot and the water can cause severe burns. Make sure that the hoses are cool before removal.

CAUTION

When the engine heater hoses must be replaced in the cab, make sure to use heater hoses of the correct material and size. Order Yale part number 504323758 for the engine supply hose and 504323755 for the return hose.

All hoses must conform to SAE Specification 20R3 Class C or 20R3 Class D-2.

NOTE: If the heater fails, replace the heater assembly as a complete unit.

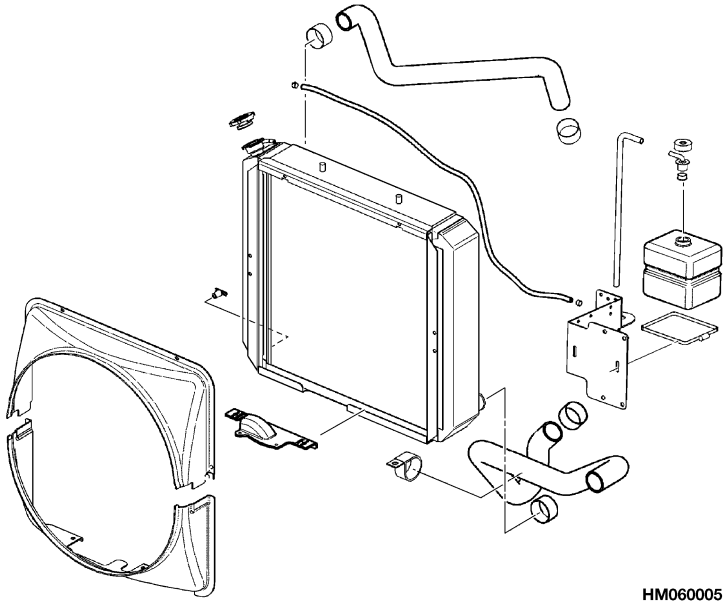
1. Disconnect the two preformed heater hoses from the heater. See Figure 9.
2. Disconnect the heater electrical connector.
3. Open the right-hand cab door and remove the two screws that fasten the heater duct to the bracket.
4. Remove the four screws that fasten the heater to the bracket and remove the heater assembly.

INSTALL

1. Attach the heater assembly to the mounting bracket with four screws and washers. See Figure 9.
2. Attach the heater duct to the mounting bracket with two screws and washers. Make sure that the duct mates with the heater input opening.
3. Make sure that the seal on the door side of the duct is installed correctly.
4. Connect the heater electrical connector.
5. Connect the two preformed heater hoses to the heater. See Figure 9.

COOLING SYSTEM

GLP/GDP3.5-5.5LJ/MJ
(GP/GLP/GDP70-120LJ/MJ) [C813, E813]



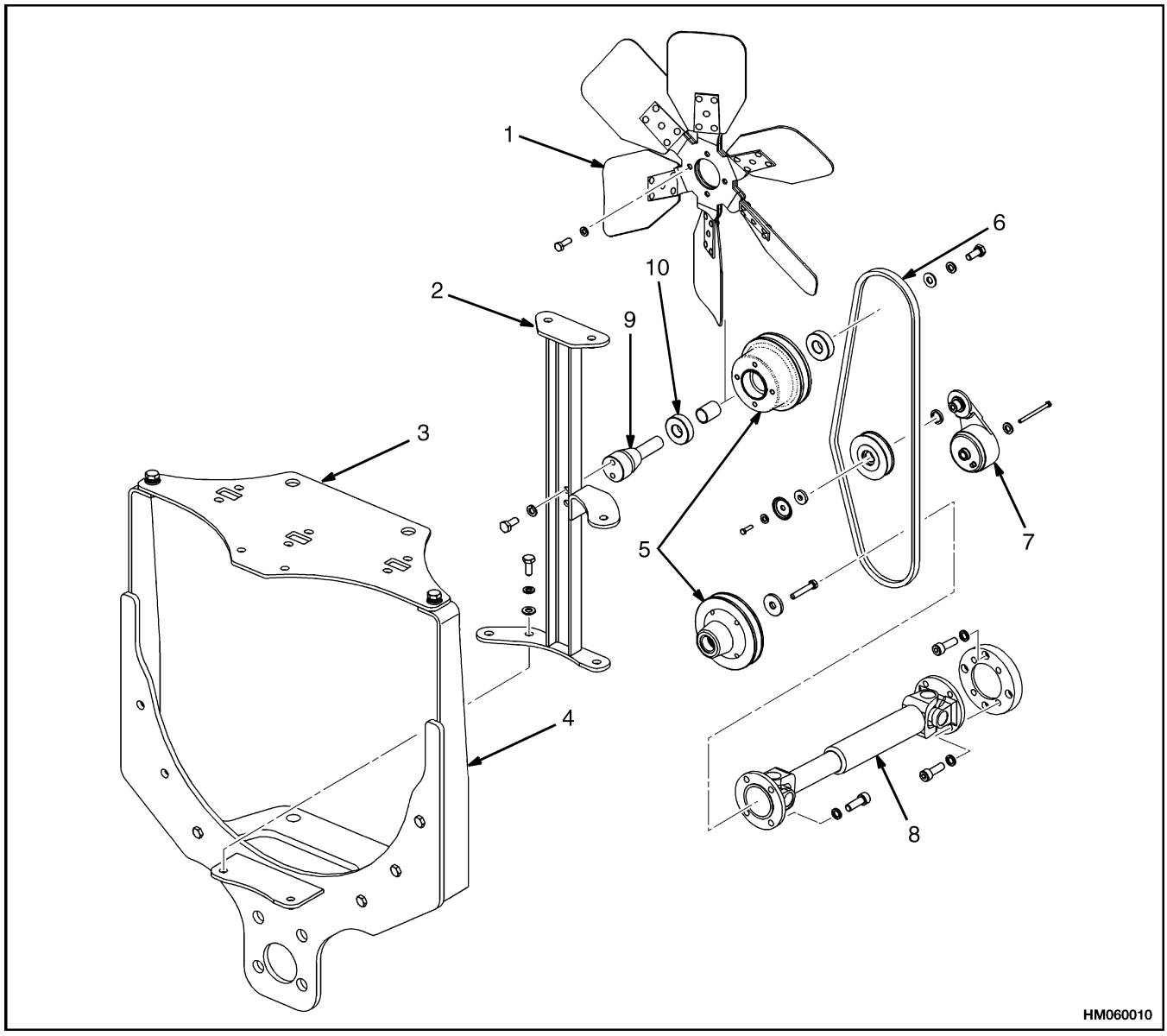
HM060005

Legend for Figure 4

A. 1800 TO 1830 MM WHEELBASE TRUCK

B. 2100 MM WHEELBASE TRUCK

1. SAFETY SCREEN



1. FAN
2. FAN MOUNT BRACKET
3. PLATE
4. MODULAR FAN MOUNT BRACKET
5. PULLEYS
6. FAN BELT
7. TENSIONER
8. DRIVE SHAFT
9. FAN PIN
10. BEARINGS (2)

Figure 5. Fan Assembly

General

This section has the description, operation, and repair procedures for the parts of the LPG fuel system used on the GM V-6 engines.

Description and Operation

The LPG fuel system has the following parts (see Figure 1):

- Fuel Tank
- Fuel Filter and Fuel Valve Unit
- LPG Convertor Vaporizer (IMPCO) or LPG Controller (Dana EPIC/Teleflex-GFI)
- Carburetor
- Governor
- Two-Way Valves (open-loop system)
- O.E. Tune Valve (closed-loop system)

FUEL TANK

The fuel tank is the reservoir for the LPG system. See Figure 2 and Figure 3. The fuel tank keeps the fuel in the liquid condition. The pressure of the fuel is 1.7 MPa (250 psi) when the tank is full at an ambient temperature of 27°C (80°F). The tank has a pressure relief valve that is set at 3.4 MPa (490 psi). The inlet tube for the pressure relief valve is in the vapor area at the top of the tank.

The tank has a fuel gauge that measures the percentage of fuel in the tank. A liquid level valve near the pressure relief valve is used to indicate the maximum liquid level that is permitted. The tank is filled until liquid fuel flows from the liquid level valve. One end of the outlet tube inside the tank is near the lower surface of the tank. The other end of the tube is fastened to the outlet port. A fuel valve is connected to the outlet port of the tank. The fuel valve can prevent fuel from leaving the tank when the outlet line is disconnected. A quick-disconnect fitting is installed for easy tank removal. The tank has a guard to protect the valves and fittings from damage. The guard has a hole for the alignment dowel on the mount. The tank is fastened to the lift truck by metal straps with latches.

FUEL FILTER AND FUEL VALVE UNIT

A fuel line connects the fuel tank to the fuel filter. See Figure 4. The fuel filter prevents dirt from entering the vaporizer and has a fuel valve that is operated by engine vacuum. The fuel valve prevents fuel from entering the vaporizer unless the engine is being started or is running. The fuel valve has a leaf spring that holds a polyurethane pad against the seat. A diaphragm is used to open the fuel valve. Air pressure pushes on the vent side of the diaphragm. The other side of the diaphragm has carburetor vacuum with a lever and plunger that open the fuel valve. When the engine starts, the air pressure on the lever side of the diaphragm decreases. Then the air pressure on the vent side of the diaphragm moves the diaphragm, lever, and pin to move the valve pad from the seat. Liquid LPG then flows through the fuel valve to the vaporizer.

LPG CONVERTOR VAPORIZER (IMPCO)

The function of the vaporizer is to change the liquid fuel to a vapor (gas) and to control the pressure of the vapor. See Figure 5 and Figure 6. The LPG fuel changes from a liquid to a vapor inside the expansion chamber. A liquid needs heat to change to a gas. Heat is removed from the vaporizer when the pressure of the liquid LPG is quickly decreased in the expansion chamber. The vaporizer must be heated by the engine coolant to replace the heat lost to the fuel. Coolant passages in the vaporizer prevent the vaporizer from being too cold to operate.

The vaporizer also controls the pressure of the gas that goes to the carburetor. On fuel systems without Low Emissions, the pressure reducer valve keeps the pressure of the gas in the expansion chamber at −38 mm (−1.5 in.) of water. On fuel systems with Low Emissions, the pressure reducer valve keeps the pressure of the gas in the expansion chamber at −13 mm (−0.5 in.) of water. When gas is required at the carburetor, there is a vacuum in the vapor chamber. The vacuum opens the vapor valve and permits the gas to flow to the carburetor.

Liquid fuel enters the vaporizer inlet from the filter unit. The pressure reducer valve has a polyurethane pad and a seat. When the pad is against the seat, the liquid fuel cannot enter the expansion chamber.

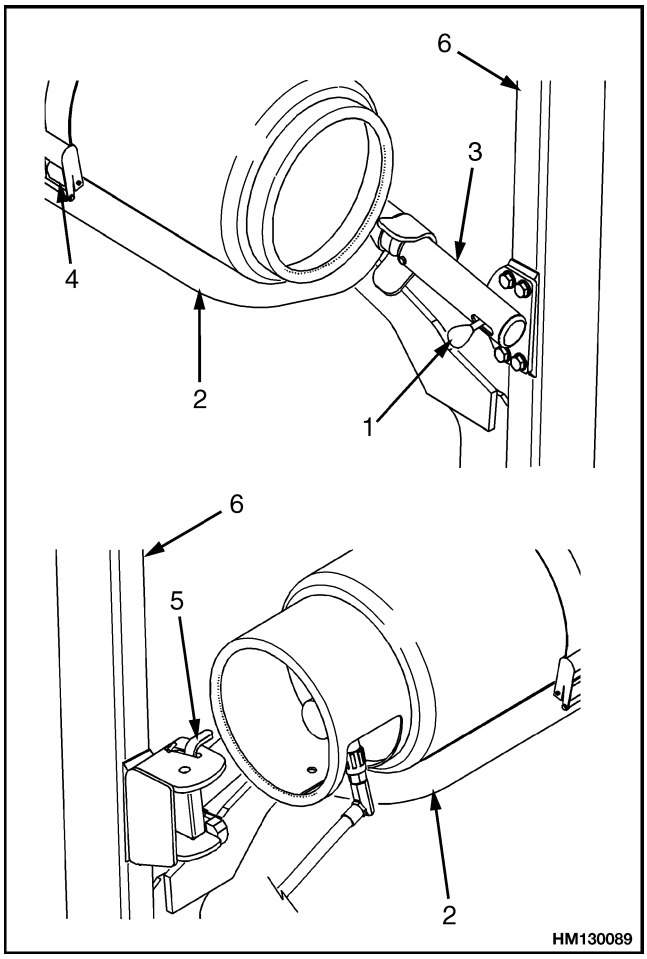
4. Move the release lever up and swing LPG tank mounting arm completely to right side of lift truck until it is latched in bracket. See Figure 15.

5. Turn fuel valve counterclockwise to open fuel valve.

WARNING

The fuel valve on the tank must be closed when the truck is not being used.

6. Inspect fuel system for leaks when fuel valve is open. Frost on the surface of the tank, valves, or fittings or a strong odor of LPG fuel indicates a leak.



1. LATCH
2. LPG TANK MOUNTING ARM
3. BRACKET
4. STRAP
5. RELEASE LEVER
6. OVERHEAD GUARD

Figure 15. LPG Tank Mounting

Hydrostatic Relief Valve Repair

REMOVE AND INSTALL

WARNING

LPG can cause an explosion. Do not cause sparks or permit flammable material near the LPG system. Close the fuel valve on the tank. Disconnect the negative battery cable to prevent sparks.

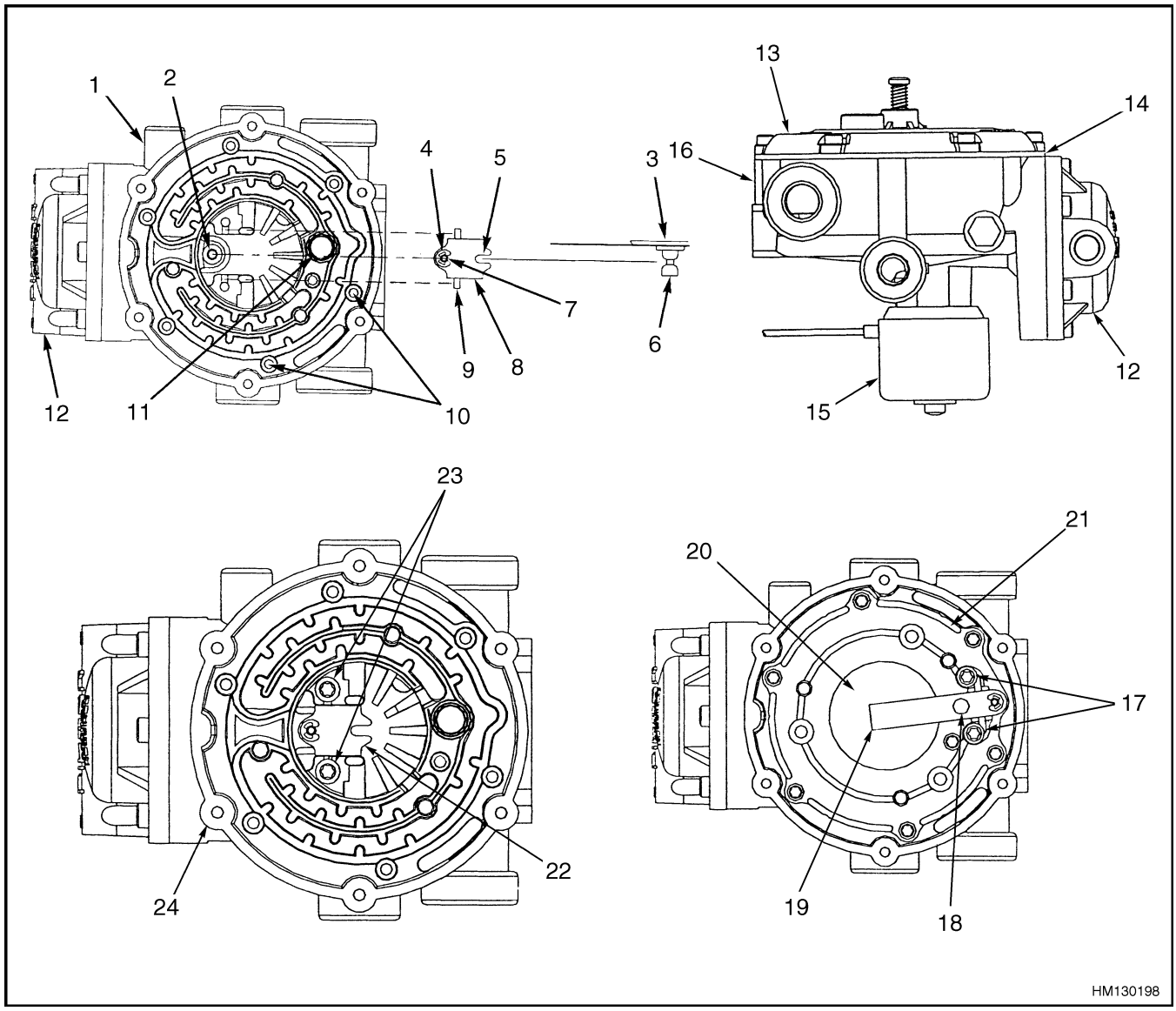
1. Close shutoff valve on tank.

WARNING

LPG is flammable. Make sure there are no sparks or open flames in the area when the fuel lines are drained.

2. Slowly loosen hose fitting for relief valve. Let fuel drain from fitting before removing relief valve. See Figure 3.

3. The valve cannot be repaired. If the valve has a defect, install new valve. After installation, open fuel valve slowly and inspect system for leaks.



1. 1/8" TEST PORT
2. PRIMARY CHAMBER INLET ORIFICE
3. PRIMARY DIAPHRAGM
4. RETAINING RING
5. SLOT
6. LINK
7. SEAT PAD ASSEMBLY
8. PRIMARY LEVER
9. LEVER PIVOT PIN
10. PRIMARY COVER SCREWS
11. SECONDARY SPRING POCKET
12. INLET FILTER COVER
13. SECONDARY COVER ASSEMBLY
14. SECONDARY DIAPHRAGM ASSEMBLY
15. COIL ASSEMBLY AND LOCK-OFF SECTION
16. CONVERTER BODY
17. SECONDARY LEVER SCREWS
18. SECONDARY SPRING (LOCATED BENEATH LEVER)
19. SECONDARY LEVER ASSEMBLY
20. PRIMARY SPRING (LOCATED BENEATH PRIMARY COVER)
21. PRIMARY COVER
22. PRIMARY LEVER ASSEMBLY
23. PRIMARY LEVER MOUNTING SCREWS
24. SECONDARY COVER ATTACH HOLES

Figure 18. Converter Section Disassembly

Vaporizer Check

PRESSURE REDUCER VALVE

Connect a pressure gauge that can measure with accuracy a pressure below 35 kPa (5 psi) to the test port of the vaporizer. The gauge must indicate −10.5 kPa (−1.5 psi) when the engine is at idle. If the gauge indicates a pressure greater than −10.5 kPa (−1.5 psi), the pressure reducer valve has a defect. See Figure 17.

VAPOR VALVE

1. Run engine until it is warm.
2. To check for leaks, stop engine and disconnect hose from fuel inlet port at carburetor. Put end of hose just below surface of water in a container. If bubbles are seen, the vapor valve has a defect or is dirty.
3. To check the vapor diaphragm, remove inlet hose to vaporizer. Remove inlet hose at carburetor. Put end of hose below surface of water in a container. Remove balance line from carburetor and apply air pressure to line. If bubbles continue to be seen in the water, the diaphragm has a defect.

Carburetor Adjustment

NOTE: Adjustments to the carburetor can only be performed on carburetors used on fuel systems without closed-loop. Carburetors used on fuel systems with closed-loop cannot be adjusted.

IDLE MIXTURE

1. When engine is not running, turn idle mixture screw clockwise until it stops. In this position, the idle mixture screw prevents air from entering the air tube through the idle air port. See Figure 24.
2. Turn idle mixture screw four turns counterclockwise. Start engine. Adjust screw as needed until idle is smooth. Turning the screw counterclockwise increases the ratio of air to fuel.
3. Stop engine. Restart engine. If the engine does not start easily, turn idle mixture screw clockwise one-half turn and restart engine. Continue this procedure until engine starts easily.

IDLE SPEED

The engine idle speed is managed by the ECU through the ISCV, which is part of the governor assembly. See **Carbureted Engine Management System** 2200 YRM 744 for the correct adjustment procedure. See Figure 24.

Throttle Linkage Adjustment

1. Make sure throttle linkage at pedal assembly is in the correct position. See Figure 26.
2. Depress throttle pedal until it stops against floor plate. Adjust throttle cable so pedal stops on floor plate as throttle plates reach the wide open position. Use the nuts at both ends of cable housing to change adjustment of cable.
3. Adjust pedal stop so pedal and throttle lever reach full return positions at the same time.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Freezing or frosting of converter (LPG controller).	Restricted coolant lines.	Repair or replace with larger lines.
	Antifreeze level in coolant is low.	Add antifreeze.
	Low coolant level.	Add coolant.
	Defective water pump.	Replace water pump.
	Restriction in converter coolant passage.	Clean and remove restriction.
	Defective or missing thermostat.	Replace thermostat.

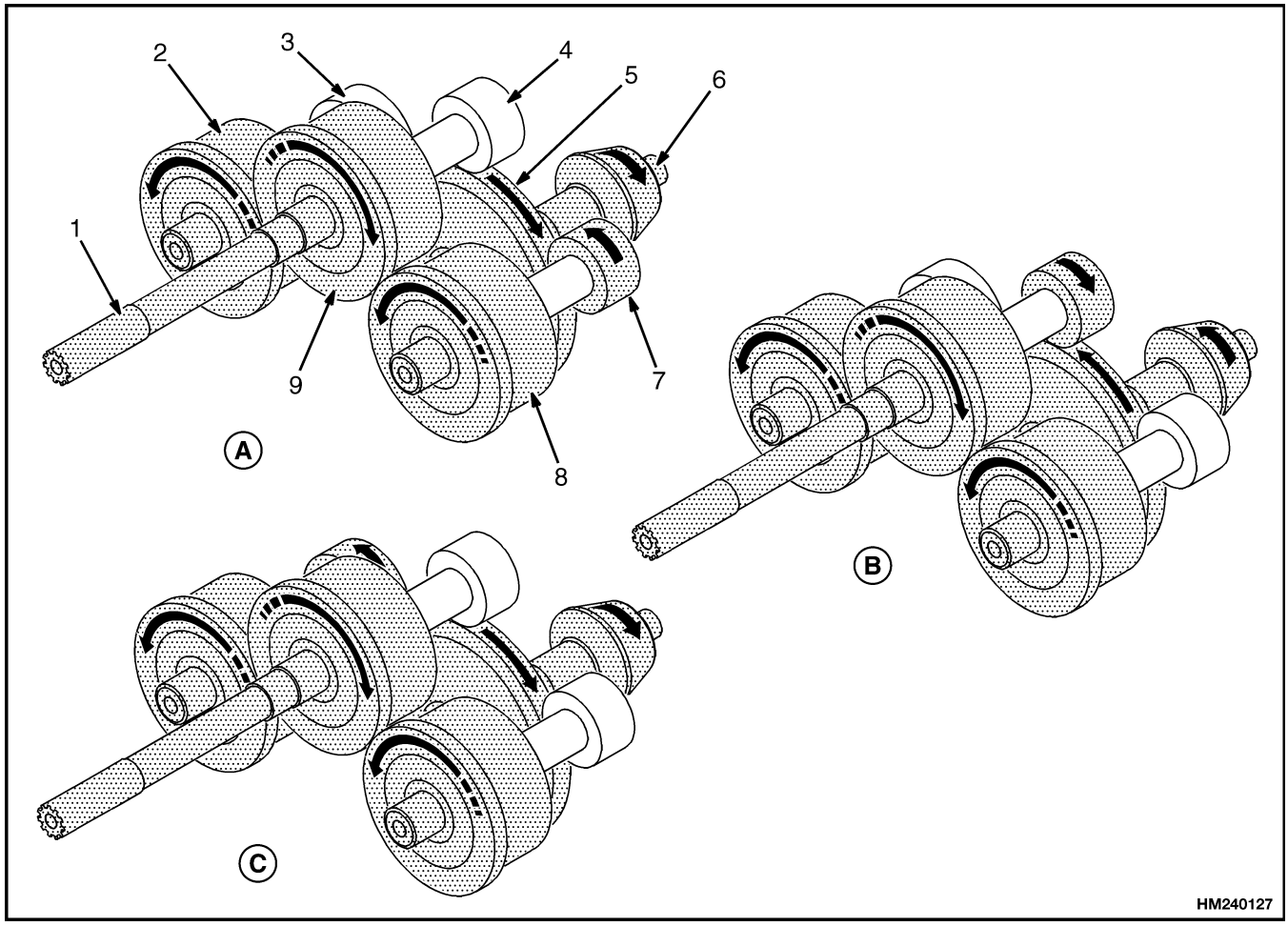
friction discs rotate freely when a clutch assembly is not engaged.

OUTPUT GEAR AND PINION

The output gear and pinion are installed below the clutch assemblies. The output gear is in constant contact with the gears of the direction clutches. See Figure 3.

ELECTRONIC CONTROL UNIT

The electronic control unit (ECU) is a circuit board that is mounted on the cowl, under the right-hand dash panel. A controller in the ECU analyzes the signals for the forward and reverse solenoids, the speed sensor, and the high-speed solenoid.



A. COUNTER (FORWARD-LOW)
B. INPUT (REVERSE)
C. COUNTER (FORWARD-HIGH)

1. INPUT SHAFT
2. COUNTER (FORWARD-HIGH) CLUTCH
3. COUNTER (FORWARD-HIGH) HUB
4. INPUT (REVERSE) HUB
5. OUTPUT GEAR
6. PINION
7. COUNTER (FORWARD-LOW) HUB
8. COUNTER (FORWARD-LOW) CLUTCH
9. INPUT (REVERSE) CLUTCH

Figure 3. Clutch Assemblies Operation

3. When the oil pressure in the circuit between the modulator valve and the modulator piston decreases to zero, the spring at the modulator valve moves the modulator valve to close the path to the sump. The oil must now flow through the orifice in the spool of the modulator valve to the modulator piston. When the pressure in the modulator circuit is approximately 552 kPa (80 psi), the oil pressure begins to push the modulator piston in the bore. As the pressure increases, the movement of the modulator piston increases the force of the spring between the modulator piston and the modulator regulator. The modulator regulator moves to keep a constant difference in pressure of 130 kPa (19 psi) across the orifice in the modulator valve. This constant difference in pressure permits the modulator piston to move at a constant rate and causes the controlled application of the clutch. See Figure 12.

4. When the modulator piston pushes the modulator regulator closed [approximately 655 kPa (95 psi)], the path to the sump is completely closed. The oil pressure then increases rapidly to the normal clutch pressure of 862 to 958 kPa (125 to 139 psi). The transmission is engaged to move the lift truck. See Figure 12.

FORWARD-LOW

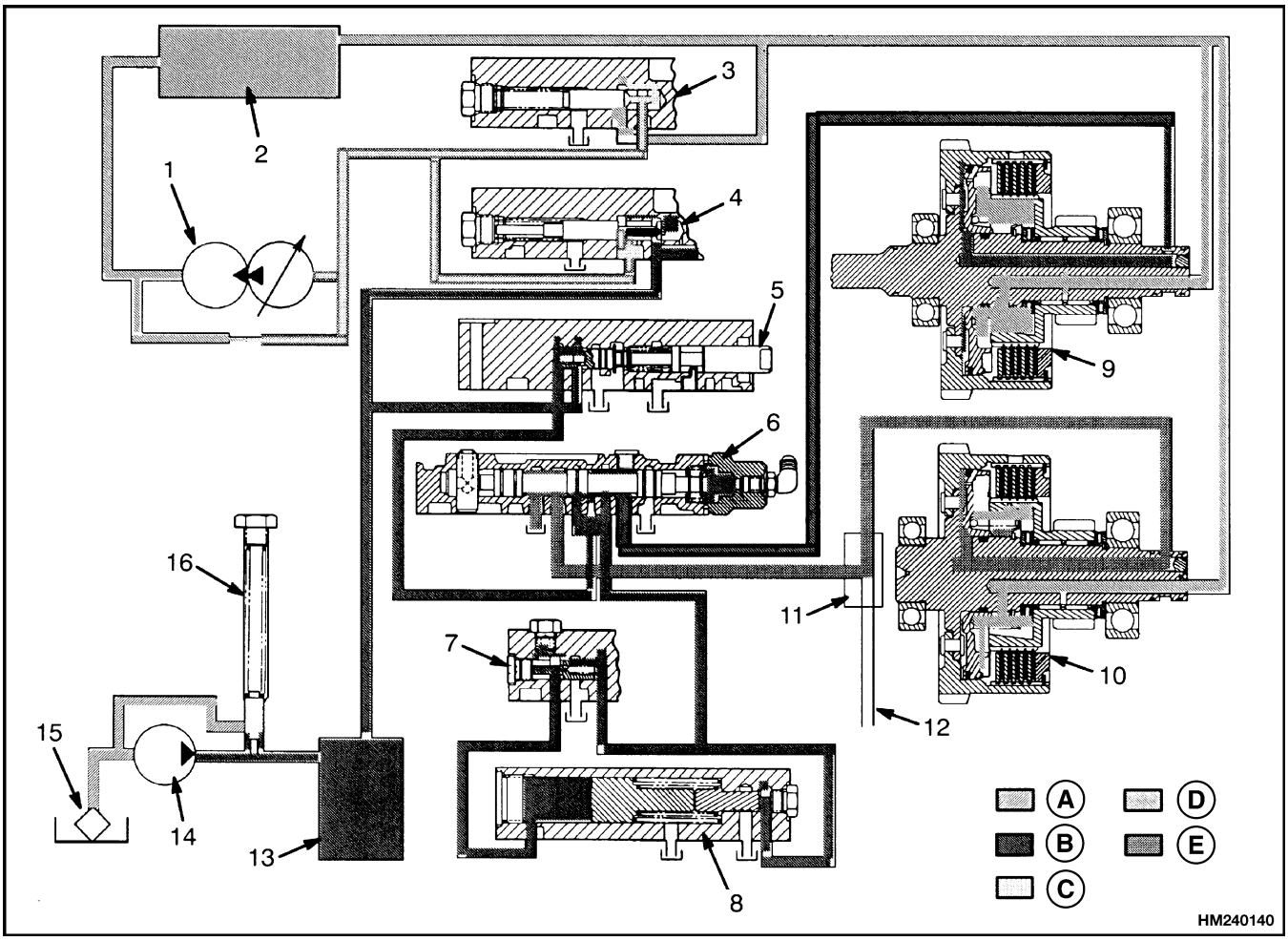
When the direction spool is moved to the FORWARD position, oil from the inching spool flows past the direction spool. The oil then flows to the drain spool, modulator spool, and the range spool. See Figure 13. At the range spool, the oil flows to the counter (forward-low) clutch and the lubrication regulator for that clutch assembly. The oil flow at the clutch assembly pushes on the piston to engage the clutch. The oil flow at the lubrication regulator pushes on the regulator to open the lubrication circuit to the counter (forward-low) clutch. See Figure 14.

When the direction spool is moved from NEUTRAL to FORWARD position, oil pressure is now available to the counter (forward) clutch circuit and the modulator circuit. The modulator circuit controls clutch engagement to cause a smooth change in direction and reduce the stress in the drive train. Operation of the modulator circuit is described in Figure 12.

The hydraulic operation in REVERSE is similar to FORWARD except for the position of the direction spool and the clutch that is applied.

FORWARD-LOW-INCHING

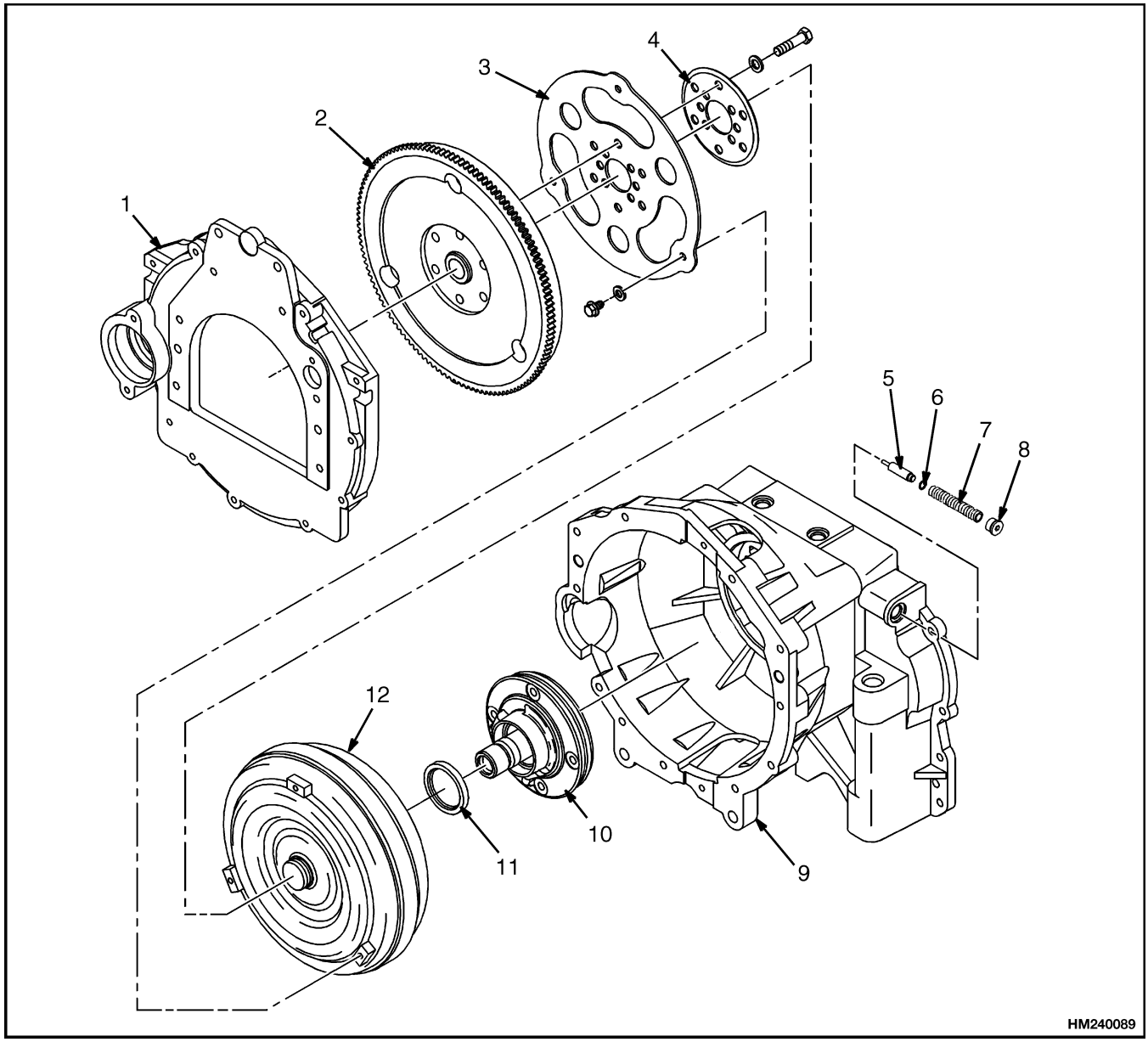
Pushing on the inching pedal while the lift truck is moving decreases the flow of oil to the direction spool. The decrease in oil pressure that engages the counter (forward-low) clutch lets the clutch partially disengage. The clutch completely disengages when the inching plunger is fully extended. The inching operation lets the operator move the lift truck slowly while keeping a high engine speed. See Figure 15.



A. SUCTION
B. SYSTEM PRESSURE
C. TORQUE CONVERTER PRESSURE
D. LUBRICATION
E. DRAIN

1. TORQUE CONVERTER
2. OIL COOLER
3. TORQUE CONVERTER REGULATOR
4. CLUTCH PRESSURE REGULATOR
5. INCHING SPOOL
6. DIRECTION SPOOL
7. QUICK DUMP VALVE
8. MODULATOR REGULATOR
9. INPUT (REVERSE) CLUTCH
10. COUNTER (FORWARD-LOW) CLUTCH
11. HIGH-LOW VALVE
12. TO COUNTER (FORWARD-HIGH) CLUTCH
13. FILTER
14. PUMP
15. SCREEN
16. PUMP RELIEF VALVE

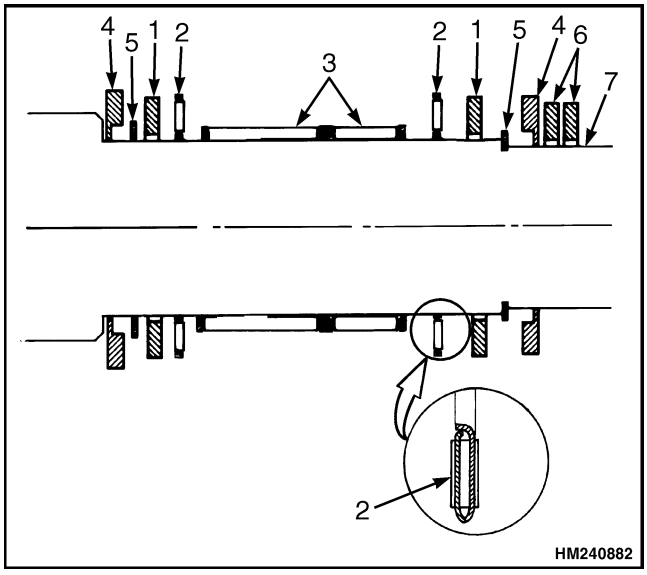
Figure 18. Reverse Oil Flow



1. ENGINE ADAPTER
2. FLYWHEEL
3. DRIVE PLATE
4. RETAINER
5. SPOOL, PUMP RELIEF VALVE
6. SNAP RING
7. SPRING
8. PLUG
9. TORQUE CONVERTER HOUSING
10. OIL PUMP
11. OIL SEAL
12. TORQUE CONVERTER

Figure 2. Torque Converter

STEP 4. (Cont)



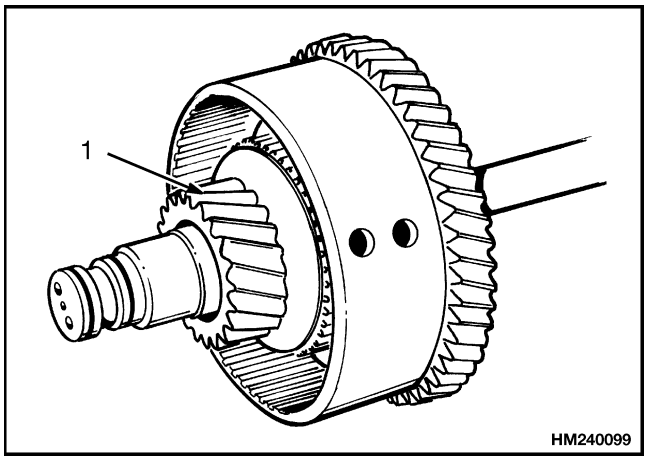
NOTE: Arrangement shown for lift trucks with Exedy clutch assemblies.

***ARRANGEMENT OF BEARING IN CLUTCH**

1. THRUST NEEDLE BEARING
2. THRUST WASHER
3. NEEDLE BEARING
4. SPECIAL WASHER
5. SNAP RING
6. SEAL RINGS
7. CLUTCH SHAFT

STEP 5.

Install the hub gear for the input (reverse) and counter (forward-low) clutches. Install the second thrust washer and thrust needle bearing. Install the snap ring and outer thrust washer. See the thrust washer and thrust bearing arrangement in STEP 4.



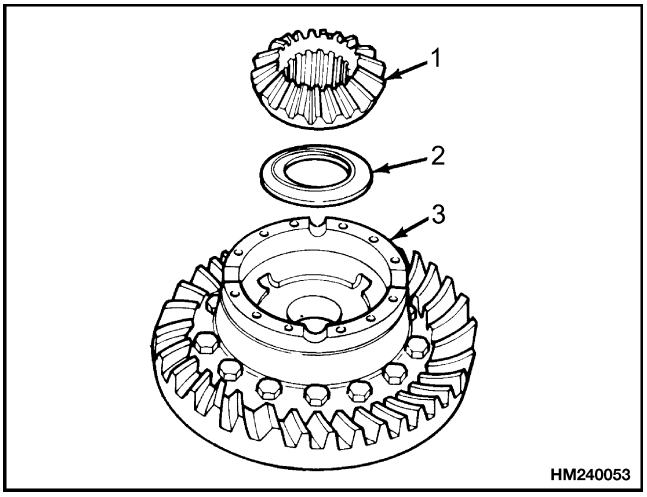
1. HUB AND GEAR

Differential and Ring Gear Assembly, Assemble

1. If the ring gear was removed from the differential case, put the ring gear in hot water that is 82 to 105°C (180 to 220°F) for approximately 10 minutes. Remove the ring gear from the water and put it on the differential case. Do not use a press or a hammer to install the ring gear. Tighten the bolts in a cross pattern. Tighten the bolts to 140 N•m (105 lbf ft).

NOTE: Install bronze side of thrust washers facing the side gear.

2. Lubricate and install a side gear and thrust washer in the differential case as shown in Figure 12.



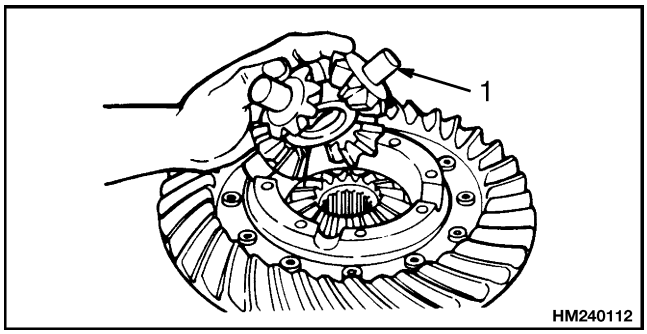
1. SIDE GEAR
2. THRUST WASHER
3. DIFFERENTIAL CASE

Figure 12. Thrust Washer and Side Gear Installation

3. Install the spider, differential pinions, and thrust washers into the differential case as shown in Figure 13.

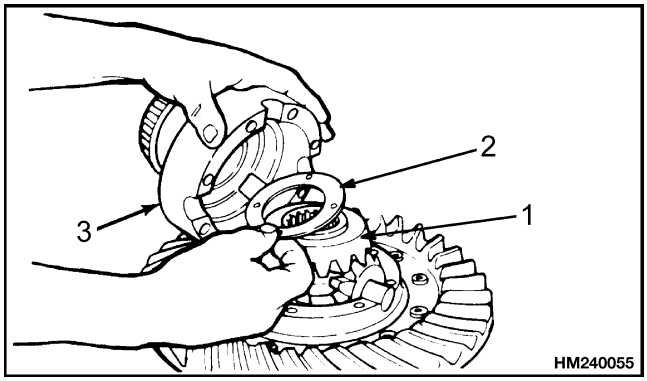
4. Install the second side gear and thrust washer over the spider and differential pinions as shown in Figure 14.

5. Put the second half of the differential case over the first half and the gears as shown in Figure 15. Make sure the marks are aligned.



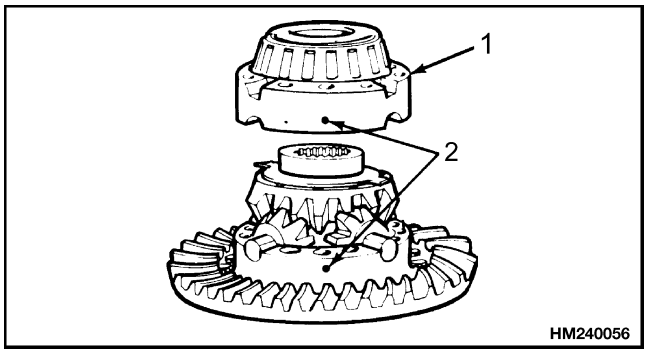
1. SPIDER, GEARS, AND THRUST WASHERS

Figure 13. Spider, Gears, and Thrust Washers Installation



1. SIDE GEAR
2. THRUST WASHER
3. DIFFERENTIAL CASE

Figure 14. Second Side Gear and Thrust Washer Installation



1. DIFFERENTIAL CASE
2. ALIGNMENT MARKS

Figure 15. Second Half of Differential Case Installation

c. Push on the FORWARD side of the pedal. Put the dial indicator on the Forward side of the pedal pad as shown. Loosen the lock nut and rotate the screw for the magnet counterclockwise until it stops. Set the dial indicator to zero. Rotate the screw for the magnet clockwise until the gauge needle moves 0.25 mm (0.01 in.) from zero. This adjustment makes sure the magnet is in contact with the plate in the pedal pad. Rotate the screw for the magnet counterclockwise until the gauge needle indicates zero. Rotate the screw for the magnet clockwise until the gauge needle indicates 0.05 mm (0.002 in.) movement. Tighten the lock nut to 5.2 N•m (46 lbf in) without changing the adjustment.

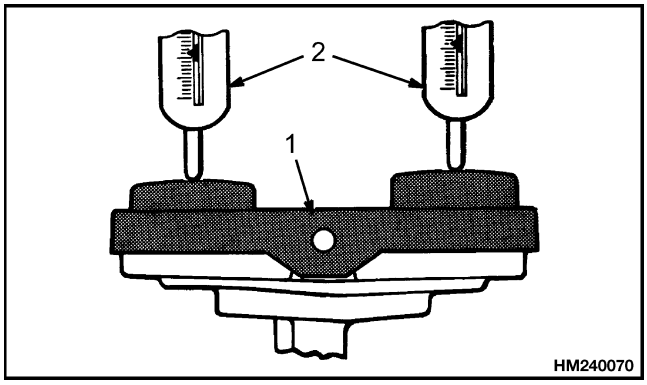
d. Use an ohmmeter to check the operation of the switches. When the FORWARD side of the pedal is depressed, there must be a complete circuit between the red (battery) and black (forward solenoid) wires. When the REVERSE side of the pedal is depressed, there must be a complete circuit between the red (battery) and yellow (reverse solenoid) wires.

e. Push on the FORWARD side of the pedal. Put the dial indicator on the FORWARD side of the pedal pad as shown. Connect an ohmmeter between the red and black wires. Check that there is a complete circuit between the wires. Push on the REVERSE side of the pedal. The pedal must move 1.00 mm (0.039 in.) minimum from the FORWARD position before the circuit is disconnected.

NOTE: It is important for the correct operation of the Foot Directional Control pedal that the magnets have the correct strength.

4. Test the strength of the magnets as follows:

a. Put the pedal assembly in a vise. Use a spring scale to change the pedal from the FORWARD and REVERSE positions as shown in Figure 30.



1. PEDAL PAD 2. SPRING SCALE

Figure 30. Foot Directional Control Pedal Magnets Check

b. When pushing on the spring scale, it must take 13.3 to 31.1 N (3.6 to 7.0 lb) to change from FORWARD to REVERSE and REVERSE to FORWARD positions. If the force is not within the specifications, replace the magnet(s).

5. With the pad located in either FORWARD or REVERSE, check to assure a minimum of 2.0 mm (0.079 in.) total pad travel when changed to the opposite position. If 2.0 mm (0.079 in.) is not obtained, do the adjustment again. If the 2.0 mm (0.079 in.) is still not obtained, replace the pedal pad.

6. Install the capscrew, washers, tube, and nut that hold the pedal assembly to the bracket. Connect the link between the pedal and the crank as shown in Figure 31.

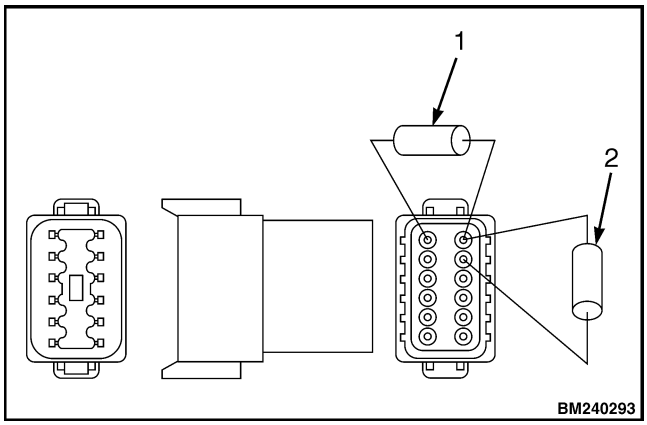
7. Install the pedal return springs. Make sure the throttle cable is connected to the correct position as shown in Figure 31.

2-Speed Transmission Will Not Shift

With the truck in a safe working area and the wheels jacked up off the ground, perform the following checks:

NOTE: The transmission will not shift into second speed at 2100 rpms.

1. Check the governed rpm with the throttle wide open. It should read approximately 2200 rpms.
2. Using either a test light or a voltmeter attached to the two wires at the 2-speed solenoid on top of the transmission (wire 101 - positive wire when the key is in the **ON** position and wire 818 - battery negative wire from the 2-speed transmission controller), start the truck with the forward direction engaged and the accelerator at full throttle.
3. Did the test light come on?
   - **a.** Yes, the problem is either in the 2-speed solenoid or in the transmission.
   - **b.** No, the problem is in the electrical system.
4. With the wires unhooked from the 2-speed solenoid, run two wires to the solenoid using one wire for battery positive hooked to the battery. Using the second wire as battery negative and holding this wire in your hand, start the truck, engage forward direction, accelerate up to about half throttle, then touch the negative wire in your hand to battery negative.
5. Did the transmission shift into 2nd speed?
   - **a.** Yes, there is an electrical problem.
   - **b.** No, the 2-speed solenoid should be inspected or the problem may be in the transmission.
6. Test the 2 speed sensor mounted to the side of the transmission. See Figure 36. Unplug the wiring harness from the 2-speed ECU and using a multimeter and resistors as illustrated, check the 2-speed sensor for proper functioning. This can be done with the key switch turned **ON** and rotating one tire using your foot. If the sensor checks OK, then replace the transmission ECU. If, after replacing the ECU, the transmission will still not shift, there is a wiring issue somewhere in one of the harnesses. Use standard test procedures for troubleshooting wiring to locate the problem.
7. Unplug the connector from the transmission controller. Insert 300Ω resistor in Pin #1 and Pin #12. Insert 10,000Ω resistor in Pin #11 and in Pin #12. Measure voltage across the 10,000Ω resistor to verify it goes from 0 to 9 volts as the wheels are turned to check the signal from the speed sensor. See Figure 36.



1. 300Ω RESISTOR
2. 10,000Ω RESISTOR

Figure 36. 2-Speed Sensor

TABLE OF CONTENTS

This section is for the following models:

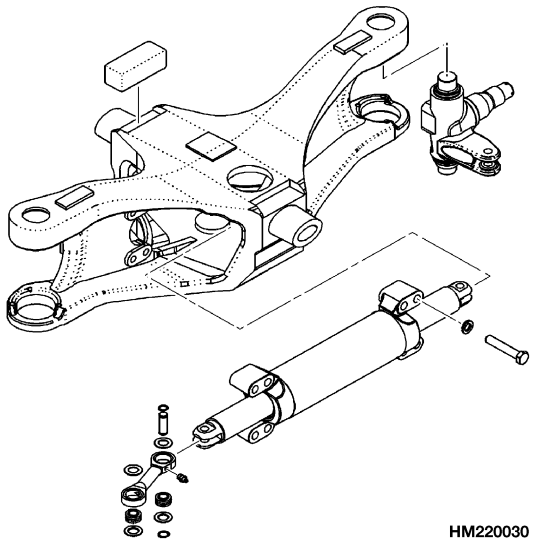
GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) [C813, E813]

Yale

Maintenance

STEERING AXLE

GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) [C813, E813]



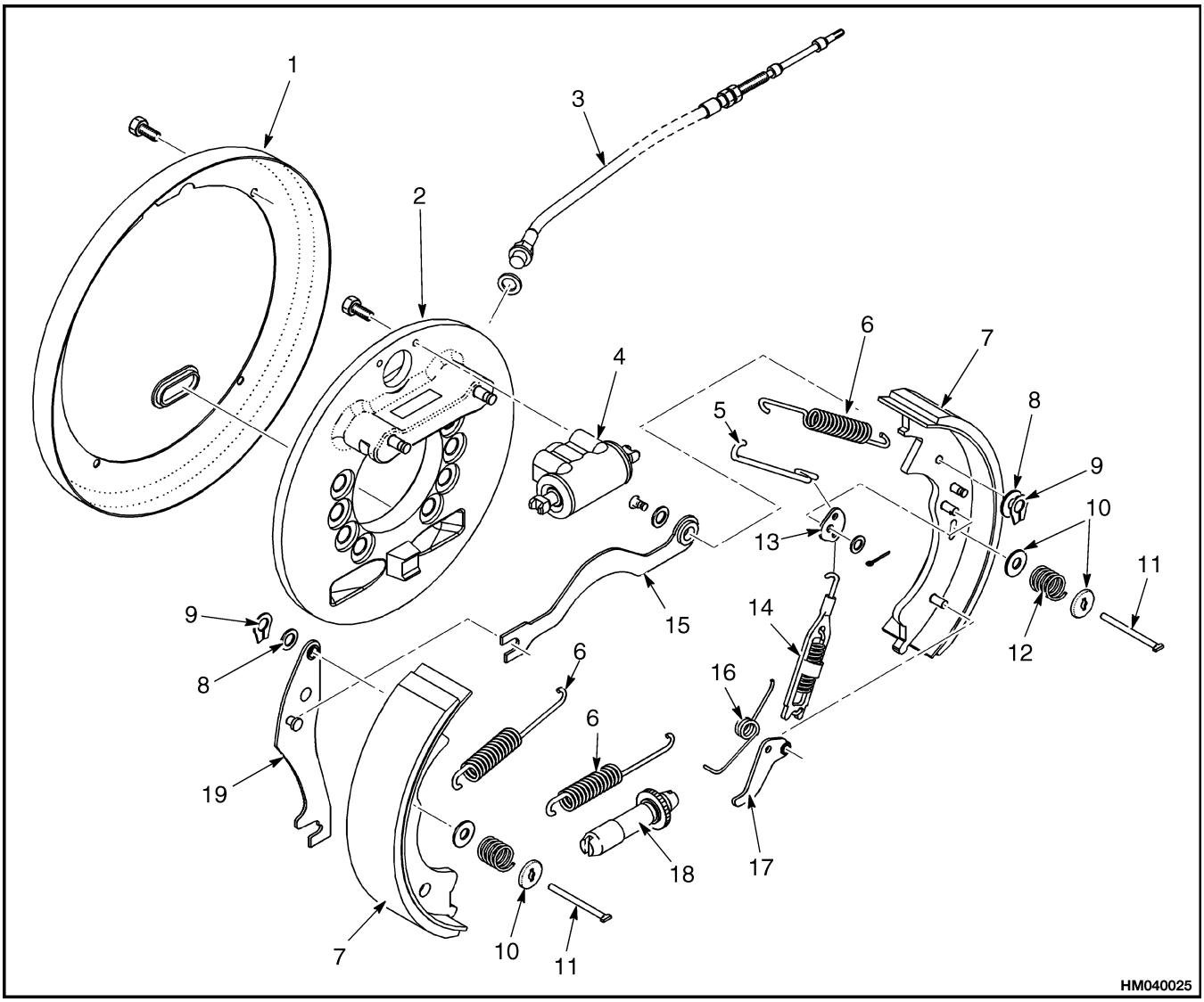
Troubleshooting

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The steer wheels do not move when the steering wheel is turned.	The oil level is low or there is no oil in the tank.	Fill tank. Check for leaks.
	The steering control unit is damaged.	Repair or install new control unit.
	No oil flow from the steering control unit to the steering cylinder.	Repair or install new components. Check for leaks.
Slow or difficult steering.	Relief valve for the steering system needs adjustment.	Adjust or install new relief valve.
	Low oil pressure from the hydraulic pump.	Check for restrictions.
	Seal in the steering cylinder has a leak.	Install new seal.
	Steering control unit is worn or has damage.	Repair or install new control unit.
Steering wheel turns the tires in the wrong direction.	The hydraulic lines are not connected correctly at the steering cylinder or at the steering control unit.	Connect lines properly. Remove air from system.
Steering function continues after the steering wheel stops.	The steering control unit was assembled wrong or has damage.	Repair or install new control unit.
There is air in the steering system.	The oil level in the tank is low.	Add hydraulic oil as necessary.
	Air was not removed after repair to the hydraulic or steering system.	Remove air from system.
	The hydraulic pump has an air leak at the inlet.	Check for leaks.

Legend for Figure 2

NOTE: LEFT-HAND SIDE SHOWN.

1. SHIELD
2. BACKPLATE
3. PARKING BRAKE CABLE
4. WHEEL CYLINDER
5. RETURN SPRING
6. BRAKE SHOE
7. PIVOT
8. SPRING
9. SPRING GUIDE
10. ADJUSTER LINK
11. PIN
12. SPRING
13. CONNECTOR
14. ADJUSTER
15. PARKING BRAKE LEVER



NOTE: LEFT-HAND SIDE SHOWN.

1. SHIELD
2. BACKPLATE
3. PARKING BRAKE CABLE
4. WHEEL CYLINDER
5. LINK
6. RETURN SPRING
7. BRAKE SHOE
8. WASHER
9. RETAINER
10. SPRING GUIDE
11. PIN
12. SPRING
13. LINK PIVOT
14. SPRING LINK
15. CONNECTOR
16. ADJUSTER SPRING
17. ADJUSTER LEVER
18. ADJUSTER
19. PARKING BRAKE LEVER

Figure 3. Service Brakes GLP/GDP4.5-5.5MJ (GP/GLP/GDP100-120MJ)

Parking Brake Switch Test (Foot Directional Control Pedal Only)

When the parking brake assembly and cables have been adjusted, the parking brake switches must be tested for correct operation.

WARNING

If the brake switches are not adjusted correctly, the engine can be started with the parking brake released. The purpose of the left-hand switch (Foot Directional Control only) is to prevent the starter motor from being energized when the parking brake is not applied. The right-hand switch de-energizes the direction solenoids to put the transmission in Neutral (Foot Directional Control only) when the parking brake is applied.

1. Put the lift truck on blocks so that the drive wheels do not touch the ground or any other object. Put blocks at both sides of the steering tires to prevent movement of the lift truck.
2. Release the parking brake. The right-hand, two-circuit microswitch closes the electric circuit for the Foot Directional Control pedal (energizes the solenoids for the powershift transmission). The left-hand switch de-energizes the starting circuit.
3. Turn the ignition switch to the **START** position. If the parking brake switch operates correctly, the starter will not energize. Turn the ignition switch to the **OFF** position.
4. Apply the parking brake with the parking brake lever. The right-hand, two-circuit microswitch opens the Foot Directional Control circuit (de-energize the solenoids for the transmission). The starting circuit is energized by the ignition switch through the left-hand switch.
5. Turn the ignition switch to the **START** position. The starter operates when the parking brake switch operates correctly. Turn the ignition switch to the **OFF** position.
6. Check the wires for the parking brake switches if the conditions from the results of Step 2 through Step 5 are not correct.
7. Apply the parking brake and start the engine. Push the parking brake lever toward the released position, but do not push the release button. The parking brake will stay in the ON position and locked. The transmission must be in NEUTRAL any time the parking brake lever is applied. If the results of the test are not correct, check for wear and damage. Make repairs as necessary and repeat Step 1 through Step 7.

Brake Shoes Adjustment

The brake shoes are automatically adjusted when the brakes are applied while the truck travels in reverse. Use the procedure that follows to manually adjust the brakes after you make repairs.

NOTE: If the automatic brake adjusters adjust the brake shoes too much or too little, refer to Assemble and Install in this section for the brake shoes.

1. Put the lift truck on blocks so that the drive wheels do not touch the ground. See the section **Periodic Maintenance** 8000 YRM 737 for the correct procedures. Make sure that the blocks do not prevent access to the backplates of the brakes.
2. Remove the plugs in the slots in the backplates.
3. Use a tool for brake adjustment in the slot nearest the teeth of the adjuster screw wheel. Push up on the teeth and turn the adjuster screw wheel until the brake shoes touch the brake drum.
4. Put a small screwdriver through the slot in the backplate. Move the automatic adjustment lever away from the adjuster screw wheel.
5. Turn the adjuster screw wheel with the tool for brake adjustment. Push down on the teeth to turn the adjuster screw wheel in the opposite direction. Turn the adjuster screw wheel 1 1/2 revolutions for the necessary clearance between the brake shoes and the drum. Rotate the drive wheel to check for clearance.
6. Repeat Step 3, Step 4, and Step 5 at the other brake assembly. Install the plugs in the backplates.
7. Remove the lift truck from the blocks. Drive the lift truck in forward and reverse. Use the brakes to stop ten times in each direction.

General

This section has the description, repair, and troubleshooting procedures for the hydraulic gear pump.

Description

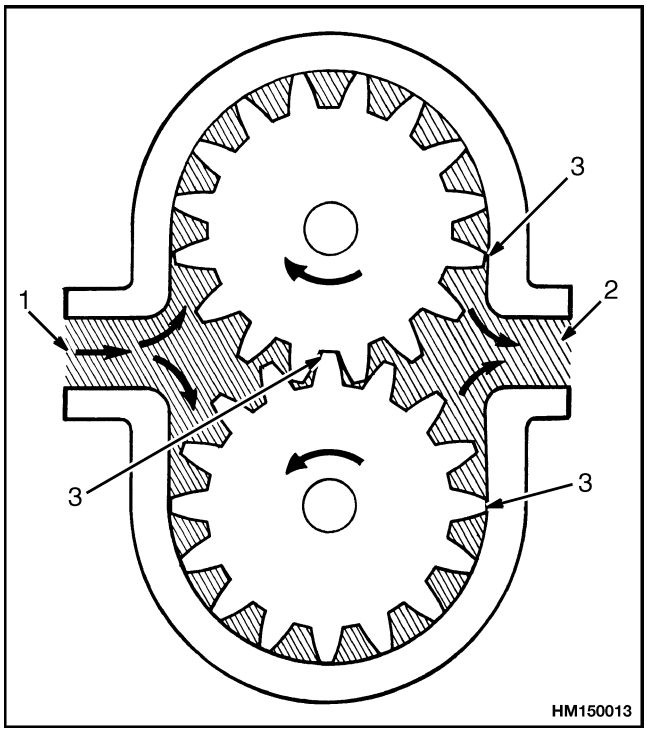
The gear pump has several sections with a single set (single stage) of gears. See Figure 2. The pump has two covers and the gear housing with the gears. Seals are used to prevent leaks between the sections. The inlet and outlet ports are on the input shaft end cover. The input shaft is splined to a fan pulley. The fan pulley is connected to a drive shaft that is driven by the engine crankshaft.

The gear pump has devices that keep the thrust clearance at a minimum when the pressure increases. When the pressure is low, the clearance increases to prevent wear. To prevent leakage when the pressure is high, the oil from the outlet side of the pump is transferred to a wear plate. The oil pushes the wear plate against the gears.

Operation

The gear pump has gears with teeth that engage in the center of the pump. When the input shaft is turned, the drive gear turns the driven gear. See Figure 1. The oil in the inlet chamber is moved out from the center by the teeth of rotating gears. The oil between the teeth is moved around the pumping chamber to the outlet chamber. The oil is pushed from the outlet chamber by the gear teeth that are beginning to engage.

The gears and bearings are lubricated by oil from the outlet side of the pump. A small amount of oil flows past the gears and into the bearings and front seal cavity.



1. INLET
2. OUTLET
3. SEAL MADE BY GEAR TEETH

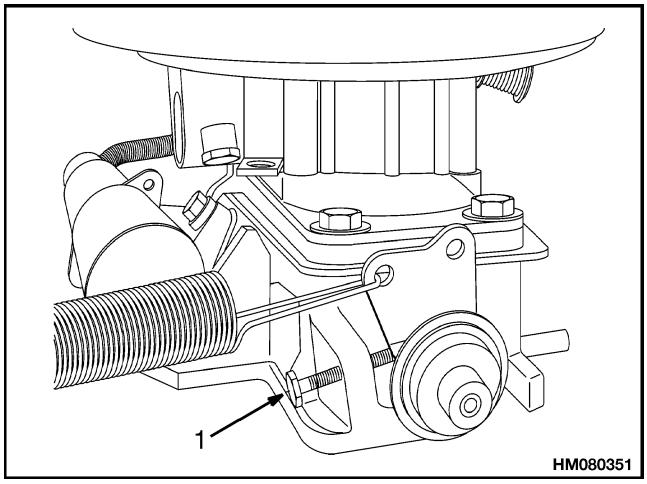
Figure 1. Gear Pump Operation

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Tilt cylinder movement is slow or not smooth. (Cont.)	Spool is not fully extended or retracted.	Adjust linkage to spool.
	Tilt control spool is damaged.	Repair control valve.
The tilt cylinders permit the mast to move when the Tilt control lever is in the Neutral position.	There are leaks in the hydraulic lines.	Tighten fittings or repair leaks.
	Seals in tilt cylinder are damaged.	Replace seals and inspect cylinder bore for damage.
	Tilt cylinders have internal damage.	Repair or replace cylinder.
	Tilt control spool is damaged.	Repair control valve.

3. Adjust idle screw so that engine is running at 625 rpm (100 rpm below the programmed Idle Set Point of 725 rpm). See Figure 4.

4. Reconnect the ISC electrical connector.

5. Reset Check Engine Light by removing main power supply fuse, or disconnect negative battery cable for a minimum of 5 minutes. Verify that no diagnostics codes (other than the 10 flash ECU "OK" code) appear. If diagnostic codes are present, repeat removing main power supply fuse for a minimum of 5 minutes. See Diagnostic System for detailed procedure.



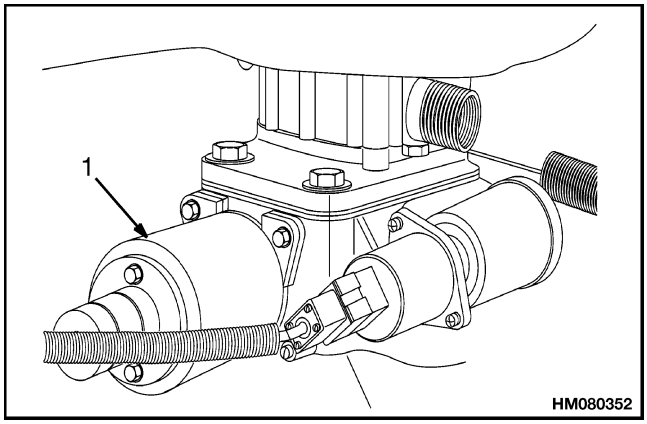
1. CURB IDLE ADJUSTMENT SCREW

Figure 4. Curb Idle Adjustment Screw

Governor Control System

The Governor Control System utilizes an electronic governor motor connected to the throttle shaft. The accelerator pedal is not connected directly to the throttle shaft. The pedal connects to the throttle shaft via a lost motion linkage system. This lost motion system allows driver demand to control acceleration and engine speed, but allows the governor motor to override driver demand in the event of any engine overspeed condition. The factory-programmed governed engine speed is 2200 rpm.

The Governor Motor (Figure 5) is an electronic actuator, which is controlled by the ECU. Engine governor speeds are programmed at the factory for the optimum combination of performance, safety, and engine life. The Governor Motor must be connected for proper engine operation. In the event the Governor Motor system fails or is intentionally disconnected or bypassed, the Diagnostic System will trigger the check engine light. If the engine speed exceeds factory-authorized limits (2975 rpm), factory-programmed high rpm limit will cause the fuel to the engine to be immediately shut off by the ECU, via closing the Low-Pressure (or optional High-Pressure) fuel lock-off. As soon as engine speed is reduced to the factory-programmed level of 1800 rpm, the LPG fuel lock-off will be reopened. This will result in a noticeably harsh engine speed oscillation if attempts to operate the engine in the overspeed condition persist.

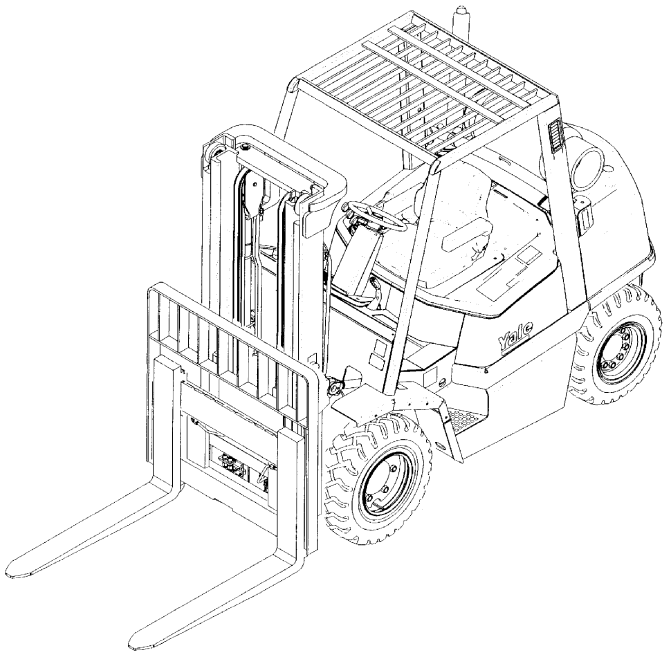


1. GOVERNOR MOTOR

Figure 5. Governor Motor

PERIODIC MAINTENANCE

GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) [C813, E813]



PART NO. 524173814

8000 YRM 737

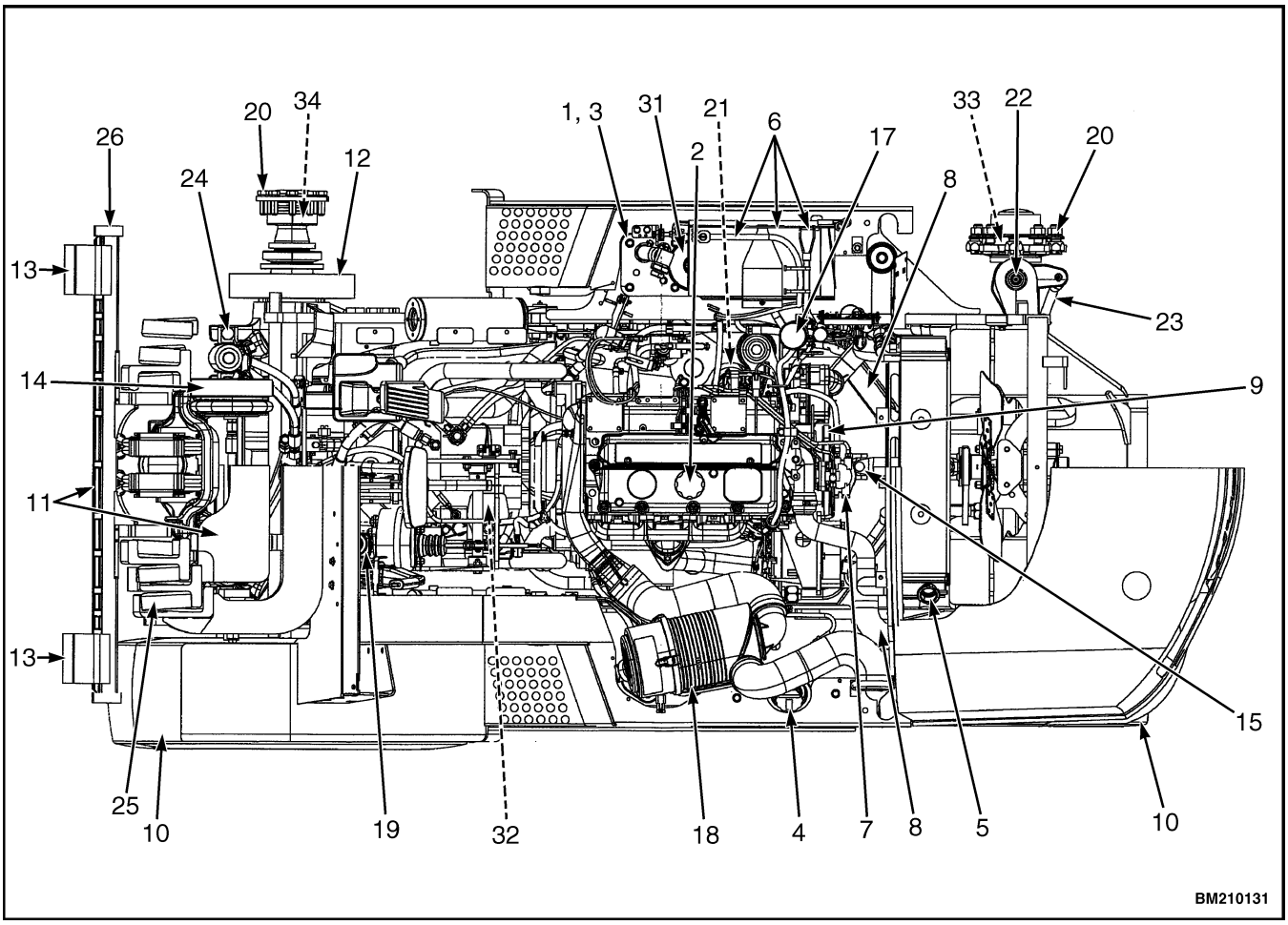


Figure 5. Maintenance Points, Hydrostatic Transmission Equipped Lift Trucks, GDP3.5-5.5LJ/MJ (GDP70-120LJ/MJ) [E813] Trucks With Perkins 1104C-44(RE) Diesel Engine

Table 1. Maintenance Schedule (Continued)

Item No.	Item	8 hr/ Daily	250 hr/ 6 wks	500 hr/ 2 mo	1000 hr/ 6 mo	2000 hr/ 1 yr	Procedure or Quantity	Specification
NOTE 2: Check fuel system for leaks prior to any service or maintenance activity.								
NOTE 3: Multipurpose Grease with 2 to 4% Molybdenum Disulfide.								
NOTE 4: Very dirty conditions require daily check and clean.								
NOTE 5: In dirty or dusty environments, change at 1,000 hours.								
NOTE 6: After changing filter, operate engine at idle speed for 5 minutes before moving lift truck.								
NOTE 7: See **Capacities and Specifications** 8000 YRM 738.								
NOTE 8: Replace after 3000 hours. Use hour interval only.								
X=Check C=Change L=Lubricate								

Maintenance Procedures Every 8 Hours or Daily

HOW TO MAKE CHECKS WITH ENGINE STOPPED

WARNING

EXHAUST GASES

Exhaust from internal combustion engines contains carbon monoxide and other harmful chemicals. Carbon monoxide is a colorless, odorless poison and can cause unconsciousness or death without warning. Long term exposure to exhaust or chemicals in the exhaust can cause cancer, birth defects, and other reproductive harm. Avoid exposure to engine exhaust.

If engines are operated in confined spaces, maintain adequate ventilation or vent exhaust to the outside. Do not exceed applicable air contaminant limits.

Follow the inspection and maintenance schedule and procedures in this manual. Do not alter exhaust, ignition, or fuel systems.

FIRE HAZARD

The hot engine surfaces and exhaust of internal combustion engine powered lift trucks can present fire hazards when operating in areas containing flammable gases, vapors, liquids, dusts, or fibers. Engine and exhaust component surface temperatures can exceed the ignition temperatures of common solvents, fuels, oil, paper, and other organic materials (wood, wheat, cotton, etc.). Exhaust emitted sparks can ignite these materials as well. Engine and exhaust surface temperatures increase after engine shutoff, presenting increased fire hazard. Check the engine compartment immediately following truck operation in areas containing combustible dusts, fibers, or paper, and remove any foreign material.

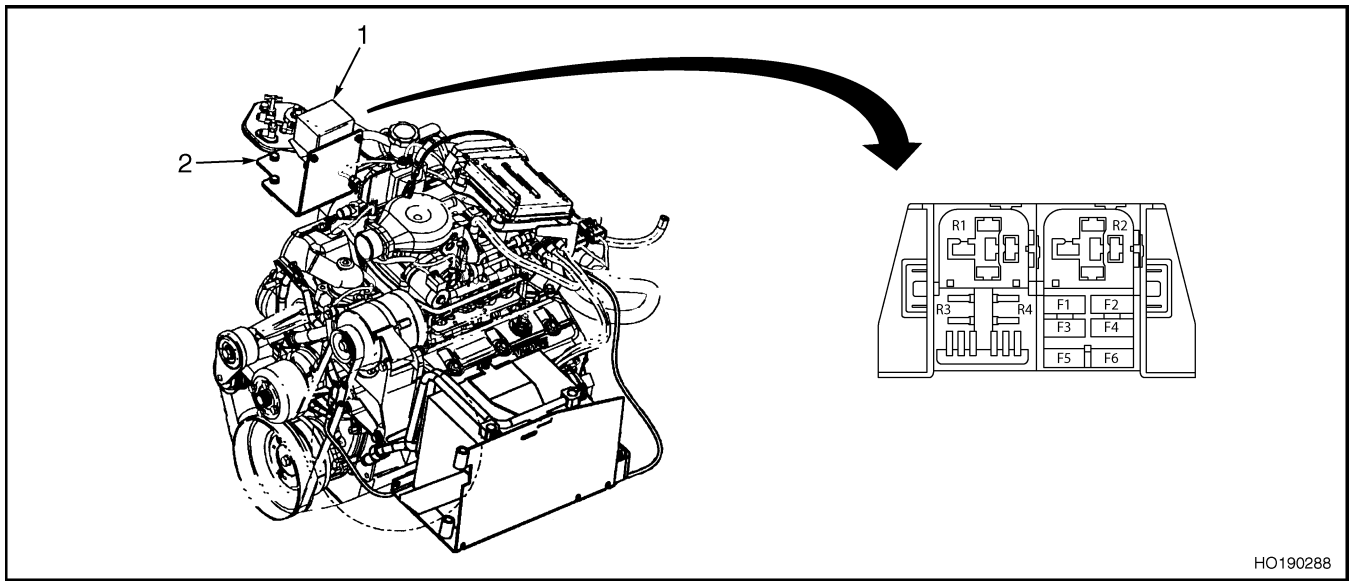
Operate the lift truck only in areas that have been approved for lift truck operation.

Check all hydraulic and LP gas hoses and connections for cracks, damage, and leaks that can cause injury or fire.

WARNING

Do not operate a lift truck that needs repairs. Report the need for repairs immediately. If repair is necessary, put a DO NOT OPERATE tag in the operator's area. Remove the key from the key switch.

Put lift truck on a level surface. Lower carriage and forks, stop engine, and apply parking brake. Open hood and check for leaks and conditions that are not normal. Clean any oil or fuel spills. Make sure that lint, dust, paper, and other materials are removed from engine compartment.



1. FUSE PANEL
2. MOUNTING BRACKET

F1 20 AMPS
F2 5 AMPS
F3 15 AMPS
F4 15 AMPS
F5 SPARE
F6 SPARE

R1 STARTER RELAY
R2 POWER RELAY
R3 FUEL PUMP RELAY
R4 SPARE

Figure 19. Engine Compartment Fuses and Relays, GM 4.3L EPA Compliant Engine GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) (E813) Trucks Only

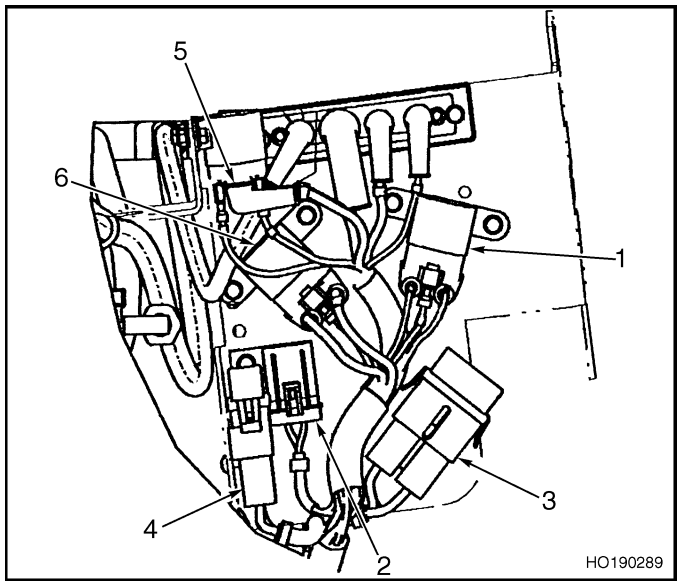
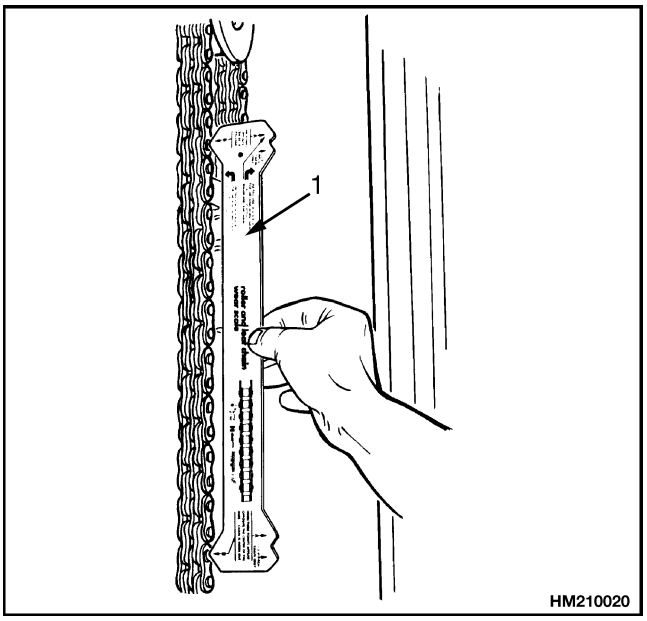


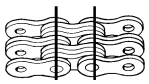
Figure 20. Engine Compartment Fuses and Relays, Perkins 1104C-44(RE) Diesel Engine GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) (E813) Trucks Only

Legend for Figure 20

1. LIFT PUMP RELAY
2. LIFT PUMP FUSE (10A)
3. ALTERNATOR FUSE (60A)
4. GLOW PLUG FUSE (60A)
5. STARTER RELAY
6. GLOW PLUG RELAY



NOTE: THE INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON THE CHAIN WEAR SCALE.

Pitch 	Total Length of 20 Links (Pitch) of New Chain	Wear Limit - Maximum Length of 20 Links
25.4 mm (1.00 in.)	508 mm (20.0 in.)	523 mm (20.6 in.)
31.8 mm (1.25 in.)	635 mm (25.0 in.)	654 mm (25.7 in.)
38.1 mm (1.50 in.)	762 mm (30.0 in.)	785 mm (30.9 in.)
44.5 mm (1.75 in.)	889 mm (35.0 in.)	915 mm (36.0 in.)

1. CHAIN WEAR SCALE

Figure 32. Lift Chain Check

FORKS, WEAR AND DAMAGE CHECK

WARNING

Never repair damaged forks. Do not heat, weld, or bend the forks. Forks are made of special steel using special methods. Replace damaged forks.

1. Check heel and attachment points of forks with a penetrant or magnetic particle inspection. See Figure 13.

2. Measure thickness of the forks at a vertical section where there is no wear. This thickness is dimension X. Now measure thickness at heel of fork. If thickness of heel is not greater than 90% of dimension X, replace fork.

MAST, LUBRICATION

WARNING

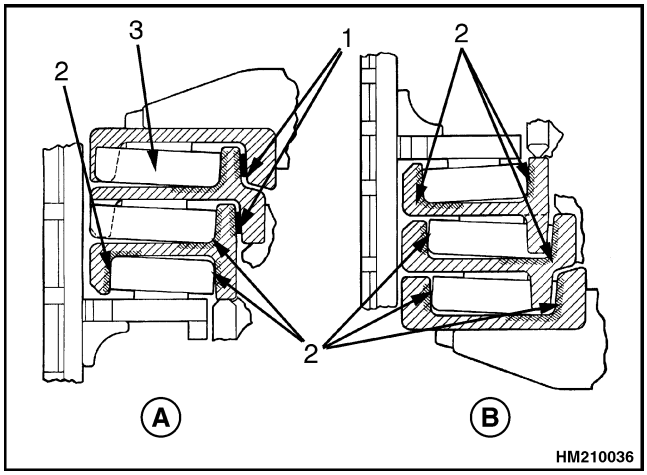
Do not work under a raised carriage. Lower the carriage or use a safety chain. Use the safety chain to prevent the carriage and the inner or intermediate weldments from lowering when servicing the mast and lift chains. Make sure the moving parts are attached to parts that cannot move.

NOTE: The load rollers and sheaves have sealed bearings and do not need additional lubrication.

1. Lubricate sliding surfaces and load roller surfaces along full length of channels as shown in Figure 33. Apply lubricant only to the indicated surfaces.

2. Lubricate pivot pins for mast at grease fittings on pivot pins. Use multipurpose grease.

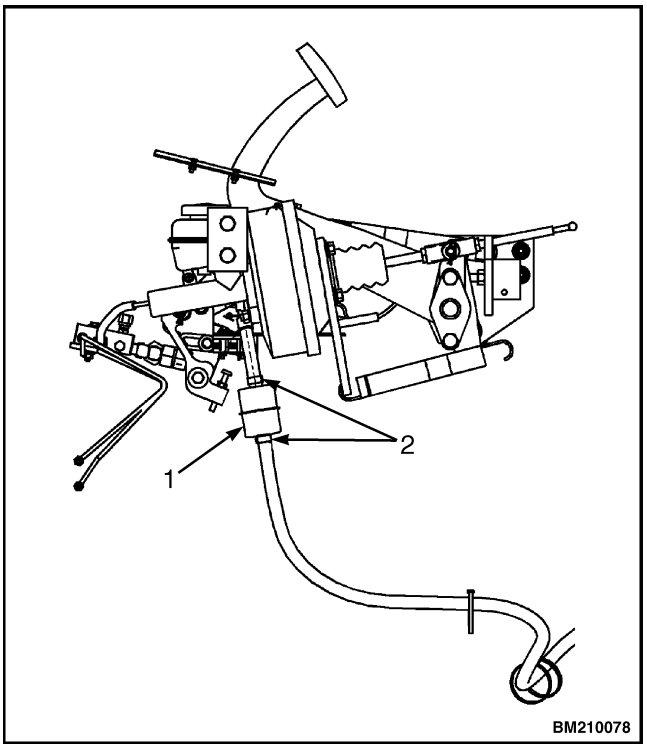
3. If a sideshift carriage is installed, lubricate fittings for rollers or sliding surfaces with multipurpose grease.



A. UPPER LOAD ROLLERS
B. LOWER LOAD ROLLERS

1. LUBRICATE STRIP BEARINGS SURFACES
2. LUBRICATE LOAD ROLLER SURFACES
3. LOAD ROLLER

Figure 33. Mast Lubrication



1. BRAKE BOOSTER FILTER
2. CLAMPS

Figure 42. Brake Booster Filter

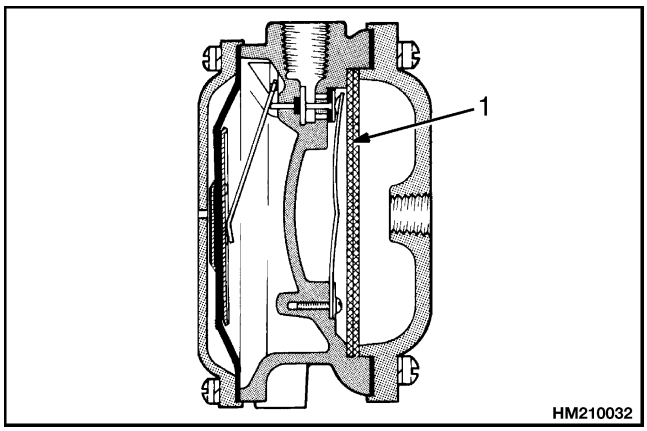
LPG FILTER, REPLACE (PRE-2004)

WARNING

LPG is flammable. Make sure there are no sparks or open flames in the area when the fuel line is drained.

1. Close fuel valve on tank. Run engine until all fuel is gone and engine stops. Slowly loosen hose fitting to filter. Let any fuel drain from fitting before disassembling filter unit.

2. Remove screws and filter cover. Replace filter element. See Figure 43.



1. FILTER ELEMENT

Figure 43. LPG Fuel Filter (Pre-2004)

GASOLINE FUEL FILTER, REPLACE

1. Replace gasoline filter. Make sure fuel lines do not leak when they are connected again. For location of the fuel filter, refer to Figure 2.

2. Install cover and gasket. Tighten screws for cover and tighten hose fitting.

OPERATOR RESTRAINT SYSTEM

The seat belt, hip restraint bracket, seat, seat mount, hood, latches, and floor plates are all part of the operator restraint system. Each item must be checked to make sure it is attached securely, functions correctly, and is in good condition. See Figure 16.

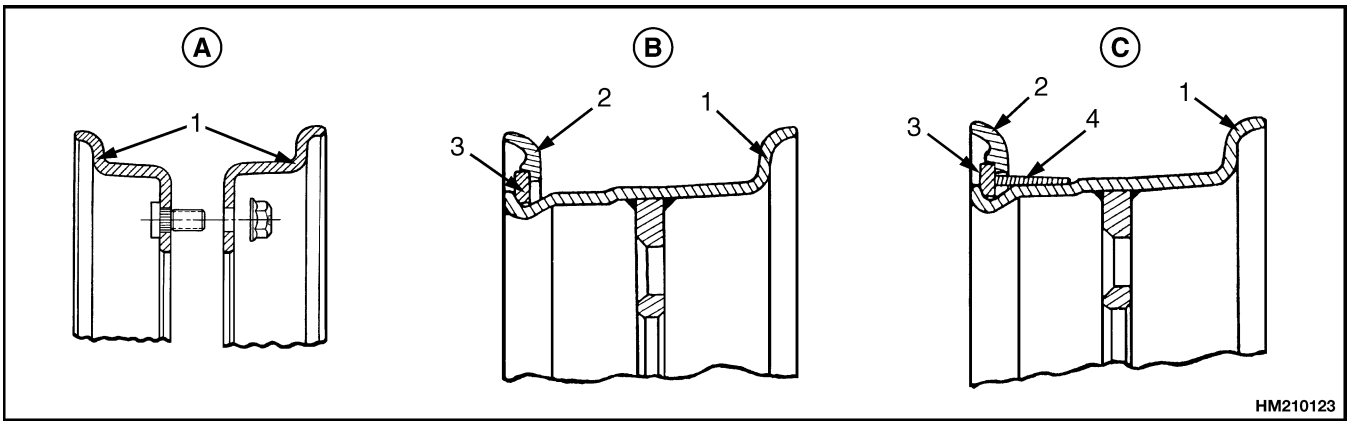
The seat belt must fasten securely. Make sure the seat belt extends and retracts smoothly and is not frayed or torn. If the seat belt is damaged or does not operate properly, it must be replaced.

Make sure seat rails and latch striker are not loose. The seat rails must lock securely in position but move freely when unlocked. The seat rails must be securely attached to the mounting surface. The hood must be fully closed. Lift on the hood to make sure it is closed and will not move.

Adjust hood, hood latch, and latch striker when any of the parts of the operator restraint system are installed or replaced. See the section **Frame** 100 YRM 726 for repair procedures for the hood.

Remove Wheel From Tire

NOTE: When you disassemble the wheels, see Figure 49. There are several types of wheels used on this series of lift trucks.

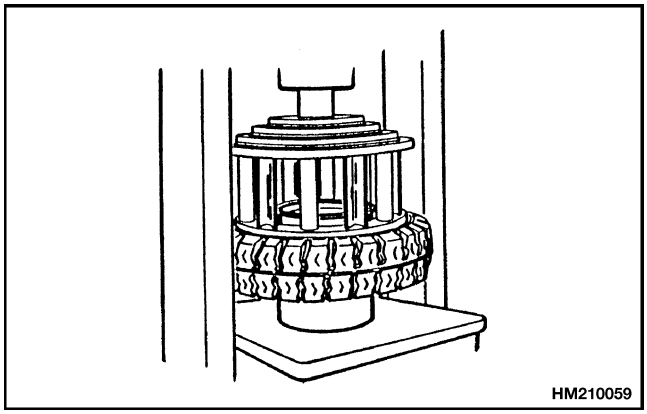


A. TWO-PIECE WHEEL
B. THREE-PIECE WHEEL
C. FOUR-PIECE WHEEL

1. WHEEL RIM
2. SIDE FLANGE
3. LOCK RING
4. FLANGE SEAT

Figure 49. Types of Wheels

STEP 4.
Put cage in position on tire. Use press to push tire from wheel rim.



WHEEL, TIRE INSTALL

NOTE: There are several types of wheels used on this series of lift trucks. See Figure 49.

WARNING

Failure to follow these procedures will cause damage to the tire and wheel assembly and can cause an injury.
- **Clean and inspect all parts of the wheel before installing the tire.**
- **DO NOT use any damaged or repaired wheel parts.**
- **Make sure all parts of the wheel are the correct parts for that wheel assembly.**
- **DO NOT mix parts between different types or manufacturers of wheels.**
- **DO NOT mix types of tires, type of tire tread, or wheel assemblies of different manufacturers on any one lift truck.**

Do not use a steel hammer on the wheel. Use a rubber, lead, plastic, or brass hammer to put parts together. Make sure the side ring is in the correct position. The ends of the side ring must not touch. The clearance at the ends of the lock ring will be approximately 13 to 25 mm (0.5 to 1.0 in.) after it is installed. If the clearance is wrong, the wrong part has been used.

CAUTION

Too much lubricant can cause the tire to slide and move around the wheel rim.

STEP 1.
Lubricate wheel rim and inner surface of tire with lubricant or soap.

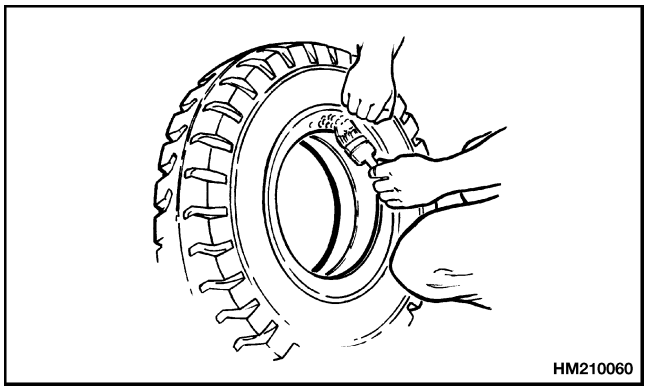


TABLE OF CONTENTS

This section is for the following models:

GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) [C813, E813]

POWERSHIFT TRANSMISSION

Control Valve Capscrews
19 N•m (14 lbf ft)

Front Cover Capscrews
38 N•m (28 lbf ft)

Oil Pump Capscrews
38 N•m (28 lbf ft)

Torque Converter Housing Capscrews
38 N•m (28 lbf ft)

Torque Converter Housing to Flywheel Housing Capscrews
38 N•m (28 lbf ft)

Torque Converter Drive Plate Capscrews
38 N•m (28 lbf ft)

Transmission to Drive Axle Capscrews
66 N•m (50 lbf ft)

STEERING SYSTEM

Axle Mount Capscrews
72 to 80 N•m (53 to 59 lbf ft)

Bearing Cap for Spindle
45 to 50 N•m (33 to 37 lbf ft)

Steering Cylinder Mount Capscrews
245 to 270 N•m (181 to 199 lbf ft)

Wheel Bearings
200 N•m (148 lbf ft) Initial
34 N•m (25 lbf ft) Final

Wheel Nuts
610 to 680 N•m (450 to 502 lbf ft)

TILT CYLINDERS

Piston Nut
400 to 440 N•m (295 to 325 lbf ft)

Retainer
400 to 500 N•m (295 to 369 lbf ft)

Rod End Lock Capscrews
66 to 73 N•m (49 to 54 lbf ft)

HYDROSTATIC COMPONENTS

Axle Valve Socket Head Capscrew
52 to 57 N•m (38 to 42 lbf ft)

Left Axle Hangar Bolts
320 to 350 N•m (236 to 258 lbf ft)

Pump Mounting Screw
320 N•m (236 lbf ft)

Pump Mounting Front Bracket To Axle
38 N•m (28 lbf ft)

Pump Mounting Front Bracket To Pump
66 N•m (49 lbf ft)

Coupler Hub
90 N•m (66 lbf ft)

Plastic Adapter To Flywheel Drive Plate
52 N•m (38 lbf ft)

Loop Tube To Hose
136 N•m (100 lbf ft)

Loop Tube To Pump
110 N•m (81 lbf ft)

Loop Tube To Clamp
38 N•m (28 lbf ft)

Loop Hose To Axle
71 N•m (52 lbf ft)

Left Axle Hanger Pins
555 to 610 N•m (409 to 450 lbf ft)

Pump Valve Capscrews
8 N•m (70 lbf in)

Charge Pump Socket Head Capscrews
24 N•m (212 lbf in)

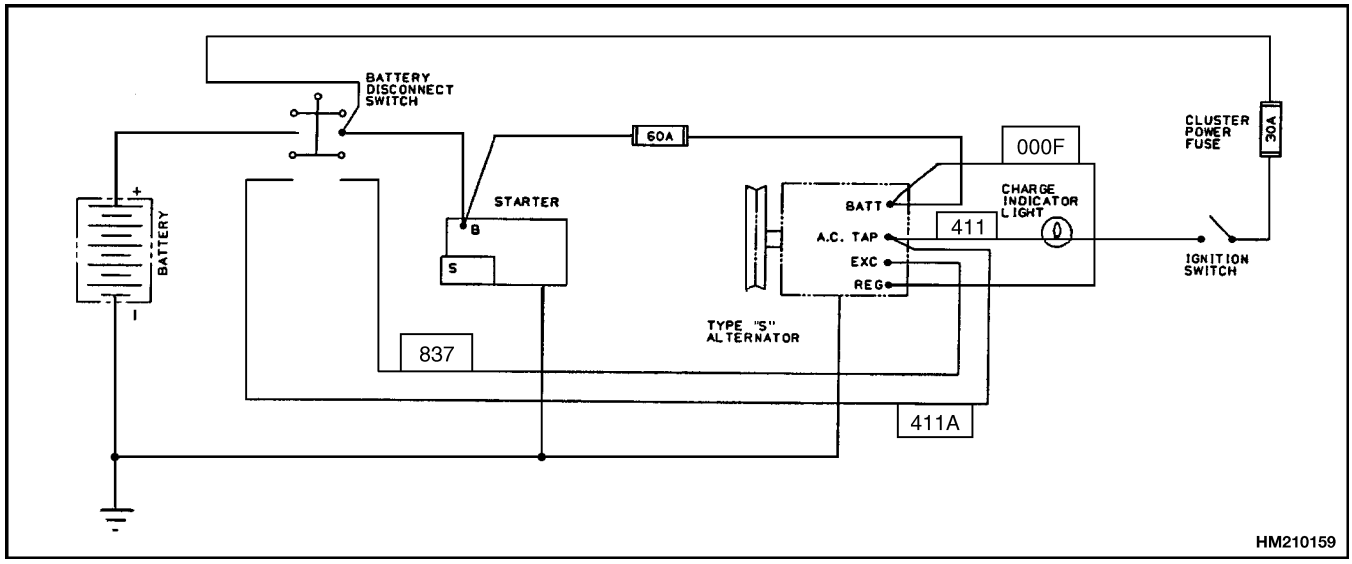


Figure 3. Type S Option Electrical Schematic

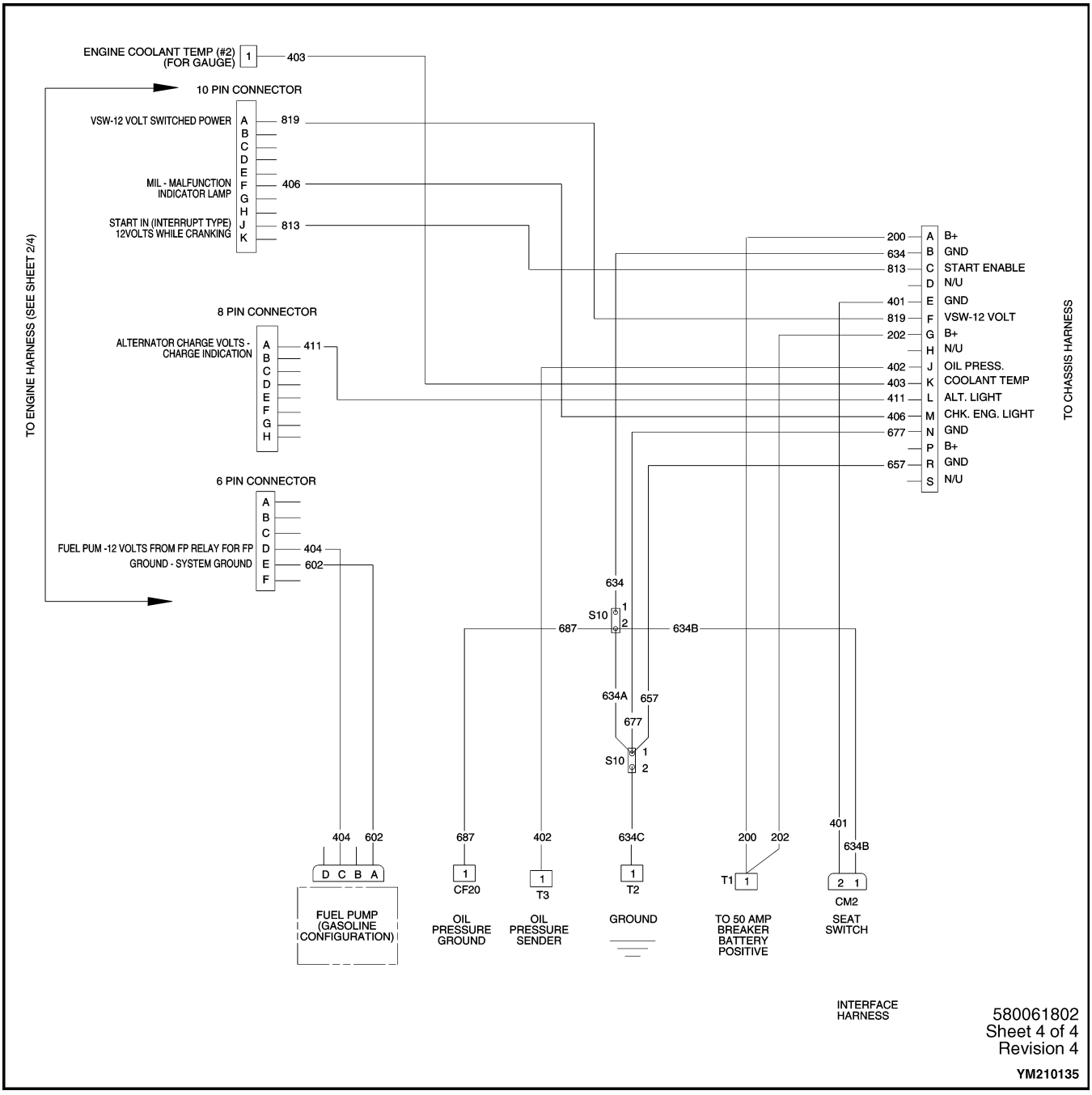
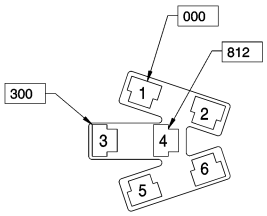
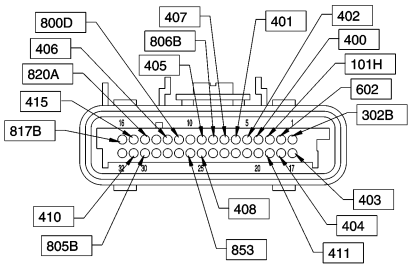
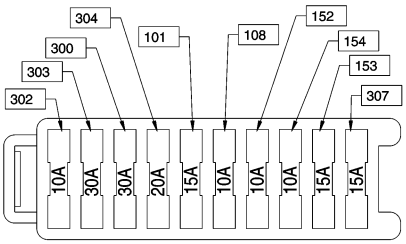
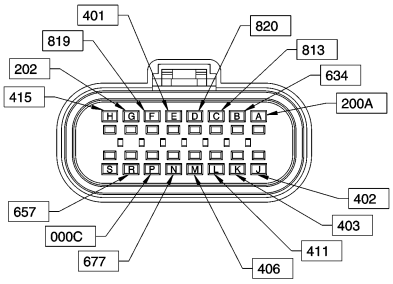
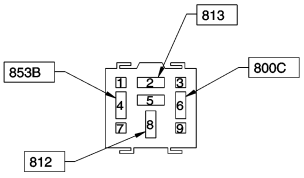
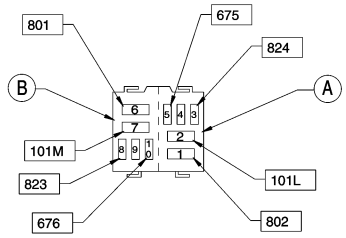
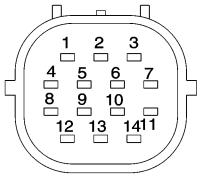
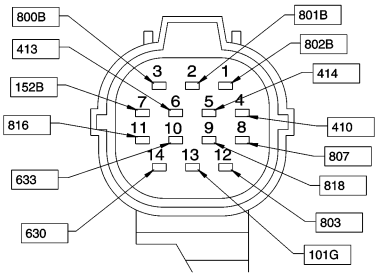


Figure 7. GM V-6 Gas and LPG Engine Electrical Schematic (E813) (Sheet 4 of 4)

DETAIL	DESCRIPTION	FACE VIEW	DETAIL	DESCRIPTION	FACE VIEW
1	5 WAY START SWITCH CONNECTOR		2	32 WAY INSTRUMENT CLUSTER CONNECTOR	
3	FULL FUSEBOX POWERSHIFT		4	16 WAY ENGINE CONNECTOR	
5	9 WAY SINGLE RELAY BASE	 START INHIBIT RELAYS SHOWN	6	10 WAY DUAL MICRO RELAY BASE	 FORWARD & REVERSE RELAYS SHOWN
7	14 WAY TRANSMISSION HARNESS TRANSMISSION SIDE	 SEE DETAIL 8 FOR WIRE NUMBERS	8	14 WAY TRANSMISSION HARNESS MODULE SIDE	

8532479
Sheet 4 of 5
Revision 0

BM210440

Figure 10. Operator Compartment Electrical Schematic (Powershift Transmission) (E813), After November 2005 (Sheet 4 of 5)