

SKYTRAK[®]

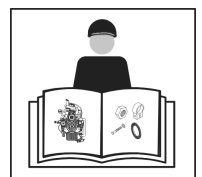
Service Manual

Model 6036

S/N 9B0500 thru 14833

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SECTION 1

SAFETY PRACTICES

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1.1 INTRODUCTION

Practically all SERVICE work involves the need to drive the forklift. The Operator's Manual, supplied with each forklift, contains detailed safety practices relating to driving and operating. These practices apply to the service technician and should be read, understood, and practiced.

Prior to performing any service on the forklift, consideration should be given to factors that may have an effect upon safety; not only on the mechanic, but also the bystanders.

1.2 SIGNAL WORDS



This symbol means "**Attention! Become Alert! Your Safety is Involved !**" The symbol is used with the following signal words to attract your attention to safety messages found on safety decals and throughout this manual. The message that follows the symbol contains important information about **Safety**. To avoid injury and possible death, carefully read the message! Be sure to fully understand the causes of possible injury or death.

Signal Word:

Is a distinctive word on safety decals and throughout this manual that alerts the viewer to the existence and relative degree of the hazard.



Danger

The signal word "Danger" means an extremely hazardous situation exists on or near the machine which would result in high probability of death or serious injury if proper precautions are not taken.



Warning

The signal word "Warning" means a hazard exists on or near the machine which can result in serious injury or death if the proper precautions are not taken.



Caution

The signal word "Caution" is a reminder of safety practices or directs attention to unsafe practices on or near the machine which could result in personal injury if the proper precautions are not taken.

IMPORTANT: *The information in this manual does not replace any safety rules used in your area. Before operating this forklift, learn the rules and laws for your area. Make sure the machine has the correct equipment according to these rules and laws.*

Your safety and the safety of others in the work area depend on your knowledge of correct operating procedures for the machine.

1.3 PERSONAL CONSIDERATIONS

Item	What to do	Why
Clothing	Do not wear loose clothing or jewelry.	Improper clothing can catch on controls or moving parts and cause accidents and/or injury.
Eye Protection	Always wear appropriate eye protection when chiseling, grinding, discing, welding, painting, when repairing hydraulic systems, or checking, testing or charging the battery.	Permanent eye damage can be caused if foreign matter enters the eye.
Breathing Protection	Wear respiratory protection if grinding or painting.	Fumes, dust and paint spray are harmful when inhaled.
Hearing Protection	Always wear ear protection if noise is excessive.	Continuous loud noise can damage your hearing.
Foot Protection	Wear protective footwear with reinforced toe caps and oil-resistant soles.	To protect feet from falling objects and to prevent slipping.
Lifting	Make sure you are capable of lifting an object. Get help or use a sling on large components.	To avoid injury through incorrect handling of heavy components.

1.4 EQUIPMENT CONSIDERATIONS

Item	What to do	Why
Operator's Cab	Before using the forklift, be sure the operator's cab and rear window are secure and serviceable.	The cab protects the operator from possible serious injury or death.
Lifting Equipment	Check all lifting equipment (chains, brackets, hooks, etc.), before use. Be sure equipment is the proper capacity.	To prevent serious injury or death due to falling objects.
	Never stand under a suspended load or raised implement.	To prevent serious injury or death.
	Do not work on equipment which is supported only by a hoist or jacks. Always support equipment with blocks or approved stands	To prevent serious injury or death.
Compressed Air	Always use a general purpose nozzle to blow dust, filings, dirt, etc., from work area. Always wear eye protection when using compressed air to clean a work area.	To prevent serious injury to operator and/or co-workers.
	Look around before using an air hose.	To prevent injury to other personnel in the work area.

1.4 EQUIPMENT CONSIDERATIONS (CONT.)

Item	What to do	Why
Hand Tools	Always use the proper tool for the job.	Many cuts, abrasions, and/or injuries are caused by defective or improper tools.
	Always keep tools clean and in good working order.	Well maintained tools work better and may prevent injury.
	Always use the Special Service Tools recommended.	These tools will reduce the work, labor and costs.

1.5 GENERAL CONSIDERATIONS

Item	What to do	Why
Solvents	Use only approved cleaning fluids and solvents that are known to be safe.	Certain types of fluid cause damage to components and may cause skin irritation.
Housekeeping	Clean and remove all hazards from the area.	To prevent accidents and injuries.
First Aid	Do not overlook any cut, abrasion, or burn. Have it cleaned and dressed properly.	What appears at first to be trivial, could become painful and injurious.
	<u>Make sure you know the location of the First Aid Box.</u>	Quick application of first aid procedures.
Cleanliness	Plug all hose ends and connections when removing components. Clean exterior of all parts before repairing. A high pressure or steam cleaner is recommended. Always wear eye protection when steam cleaning.	To prevent dirt and foreign material from entering the system. Dirt and abrasive dust can reduce the efficiency and working life of a component and lead to costly replacement. Permanent eye damage can be caused if foreign matter enters the eye.

1.6 OPERATIONAL CONSIDERATIONS

Item	What to do	Why
Engine	Stop the engine if at all possible before performing any service.	To prevent serious injury and/or death.
Dangerous Start	Place a warning sign on forklifts that are dangerous to start. Disconnect battery leads if leaving the unit unattended.	To prevent serious injury and/or death.

1.6 OPERATIONAL CONSIDERATIONS (cont.)

Item	What to do	Why
Ventilation	Avoid prolonged running of the engine in a closed area with inadequate ventilation.	Exhaust fumes are highly toxic and can kill.
Radiator Cap	Always turn the radiator cap slowly to the first stop to relieve pressure.	Escaping coolant can burn you seriously.
Soft Ground	Never work on a forklift on soft ground. Check for additional ballast. Seek assistance and install suitable supports if necessary.	To prevent serious injury and/or death.
Supports and Straps	Make sure safe and stable supports or straps are installed beneath or around a component or structural member that may fall before commencing work.	To prevent serious injury and/or death.
Oil Pressure	Before loosening hoses or tubes, turn off the engine and operate the controls several times to relieve pressure.	A pressure explosion will cause serious injury.
Pressure Testing	Make sure all test equipment is in good condition. Use only gauges specified. Comply with test procedure specified.	To prevent damage to the system or the equipment, and to eliminate the possibility of personal injury.
Leaving Forklift	Lower carriage to the ground.	To prevent accidental injury.
Parking	Do not park or attempt to service forklift on an incline. If unavoidable, block all wheels.	To prevent serious injury and/or death.
Wheels and Tires	Keep tires inflated to correct pressure. Do not over-inflate tires.	To prevent dangerous travel and load handling. Over-inflation can cause tires to burst and result in personal injury.

1.7 FINAL WORD

The safety precautions and practices in this manual are extremely important. Not following them can cause personal injury or death. Read this section carefully and be sure you understand all the precautions and practices noted before attempting to service the forklift. It is not possible to anticipate every possible circumstance that can involve a potential hazard.

SECTION 2 GENERAL INSTRUCTIONS

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2.1 INTRODUCTION

Appropriate service methods and proper repair procedures are essential for safe, reliable operation of the forklift and safety of the individual doing the work. This maintenance manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will assure reliability.

There are many variations in procedures, techniques, tools, and parts for servicing vehicles, as well as work skills. This manual cannot possibly anticipate all such variations and provide advice or cautions for each one. Accordingly, anyone who intends to depart from the instructions in this manual must first consider personal safety and then vehicle integrity.

2.2 CLEANING

Clean the exterior of all parts before repairing. Dirt and abrasive dust reduce the efficient working life of the part and lead to costly replacement.

Use cleaning fluids and solvents which are suitable for cleaning parts and do not risk the safety of the user. Certain types of fluids damage rubber parts and/or cause skin irritation.

The following precautions must be observed to insure hydraulic cleanliness:

1. Flush hose and tube assemblies with a solvent compatible with hose assemblies. Blow out excess solvent with shop air.
2. Cap hydraulic fittings and protect threads until installation.
3. Cap hoses and tube assemblies until installation.
4. Flush hydraulic reservoir, fuel tank, and gear housing with a suitable solvent to remove paint, metal chips, welding shot, etc.
5. Protect system components from airborne contaminants. Plug all cylinder, valve, reservoir, tank, and pump openings until installation.
6. Use clean, filtered oil when filling the system.
7. System cleanliness level must be a minimum ISO code 18/15 particle ratio count.

2.3 REPLACEMENT

Replace O-rings, seals, and gaskets whenever they are disturbed. Never mix new and old seals or O-rings regardless of condition. Always lubricate new seals and O-rings with hydraulic oil before installation.

When replacing parts, **use the correct tool.**

2.4 HOSES AND TUBES

2.4.1 Inspection

1. If the hose end fittings are damaged, always replace hoses and tubes. Damaged, dented, crushed, or leaking hose fittings restrict oil flow and the operation of the parts being served. Fittings showing signs of movement from their original position have failed and must be replaced.
2. Be sure hoses are in good condition. If in doubt, replace them.
3. Replace hoses if the following occur:
 - chafed outer cover
 - concealed corrosion of wire reinforcement.
 - ballooning (**replace immediately!**)
 - kinked, crushed, stretched, or deformed.

2.4.2 Installation

1. When installing a new hose, loosely connect each end and make sure the hose takes up the designed position before tightening the connection. Clamps should be tightened sufficiently to hold the hose without crushing and to prevent chafing.
2. If a hose is replaced on a moving part, be sure it does not foul by moving the part through its complete range of travel.
3. Be sure any hose which has been installed is not kinked or twisted.
4. Free moving, unsupported hoses must never touch each other or related work surfaces. This causes chafing reducing hose life.

2.5 BEARINGS

2.5.1 Removal

1. **Bearings should never be removed unless absolutely necessary.** Always use the recommended puller to reduce the risk of bearing or related component damage.
2. When bearings or bushings are removed, check that the bearing is free from discoloration, nicks, scuffing, and signs of overheating. If in doubt, replace the bearing or bushing.

2.5.2 Cleaning

Bearings acceptable for service should be cleaned in a suitable solvent and immersed in clean lubricating oil until needed.

2.5.3 Installation

1. Be sure bearings are installed with care during servicing, maintenance and repair.
2. Install bearings in either of the following two ways:
 - press fit on rotating parts such as shafts and gears, and
 - push fit into static locations such as reduction gear housings.
3. When possible, always install the bearing into the rotating part first.
4. Use the proper tools or a press when installing a bearing or bushing.
5. In the absence of the proper tools or press, heat the bearings and/or casing in hot oil to assist in the installation.

2.6 PRESSURE TESTING AND ADJUSTMENT

Prior to pressure testing or adjustment, be sure all hoses are in good condition and all fittings tight.

Use a pressure gauge with a range that is large enough to measure the specified pressure.

Comply with the correct procedure to prevent damage to the system or the equipment and to eliminate the possibility of injury.

Be sure that hydraulic oil is at operating temperature, 80 to 120° F (27 to 49° C), before adjusting relief valves, pressure reducing valve or sequence valve. If necessary, operate the machine to raise

the oil temperature. The oil temperature can be checked by placing a hand against the side or the bottom of the reservoir. If the tank is too hot for you to keep your hand against the reservoir, the oil temperature is acceptable.

2.7 TORQUES

2.7.1 Fasteners

All fasteners are plated and equal to SAE grade 5 (PC8.8) unless otherwise specified.

2.7.2 Bolts and Nuts

Unless otherwise specified the following grade 5 (PC8.8) torque values ($\pm 10\%$) apply:

Size	Torque		Size	Torque	
Inch	lb-ft	Nm	mm	Nm	lb-ft
1/4	9	12	6.0	10	7
5/16	18	24	8.0	25	18
3/8	31	42	10.0	50	37
7/16	50	68	---	---	---
1/2	75	102	12.0	80	59
9/16	110	150	14.0	130	95
5/8	150	203	16.0	200	146
3/4	250	340	20.0	360	263
7/8	380	515	22.0	510	372
1.0	585	793	24.0	650	475

2.7.3 Flared Fittings (37°, steel)

1. Align tube and fitting
2. Tighten nut to the following torque:

SAE Size	Torque	
	lb-ft	Nm
4	8-12	11-16
6	19-23	26-31
8	38-46	52-62
10	50-58	68-79
12	84-92	114-125
14	100-108	136-146
16	117-129	159-175
20	176-200	239-271
24	251-283	340-384

2.7.4 Straight Thread O-ring Fitting (non-adjustable)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Lubricate O-ring with light coating of oil.
3. Torque as follows:

SAE Size	Torque	
	lb-ft	Nm
4	22-26	30-35
6	46-54	62-73
8	95-105	129-142
10	125-135	170-183
12	165-175	224-237
16	245-255	332-346
20	270-290	366-393
24	365-385	495-522

2.7.5 Straight Thread O-ring Fitting (adjustable)

1. Inspect and correct both mating parts for burrs, nicks, scratches, or any foreign particles.
2. Lubricate O-ring with light coat of oil.
3. Back off locknut as far as possible.
4. Screw fitting into the port by hand until the backup washer contacts the face of the port and is pushed all the way towards the locknut.
5. To position the fitting, unscrew by the required amount, but not more than one full turn.
6. Hold the fitting in the desired position and torque the locknut as follows:

SAE Size	Torque	
	lb-ft	Nm
4	14.5-17.5	20-24
6	37-43	50-58
8	75-85	102-115
10	115-125	156-170
12	155-165	210-224
16	225-235	305-319
20	260-280	353-380
24	340-360	461-488

2.8 PAINTING

Unless otherwise specified, paint all components as follows:

2.8.1 Orange Paint

Use orange paint on all components except as specified in paragraphs 2.8.2 and 2.8.3.

P/N 8528074 1 gallon service paint
P/N 8528071 16 oz Spray can

2.8.2 Black Paint

Use P/N 8528036 16 oz spray can

Boom Angle Indicator Pointer

Wheels (Early Models)

Brake Pedal

Radiator

Seat Adaptor Plate

Radiator Shroud

Transmission Oil Cooler

Axles

Drive Shafts

Drop Box

Forks

Mirrors and their Brackets

Dash Panels

Instrument Mounting Plate

Air Cleaner

Steering Column

Joystick Panel

Cab Door Handle

2.8.3 White Paint

Use P/N 8528040 16 oz spray can

Boom Extend Cylinder

Wheels (Later Models)

2.9 AFTER SERVICE STARTUP AND CHECKS

2.9.1 Starting After Servicing

NOTE: Refer to Owners/Operators Manual for engine cold start procedure.

1. Check fluid levels.
2. Connect negative cable to batteries if it had been disconnected before equipment was serviced.
3. Start engine at idle. Check for leaks from hydraulic components, engine, axles, transmission, brakes and reservoirs.
4. Purge systems of air by operating functions.
5. Check for proper operation.
6. Retract all cylinders. Shut down and check reservoir levels. Recheck levels when oil is cold.
7. Replace hydraulic filter if required.

2.9.2 After Electrical/Electronic Component Servicing

1. Check torque on fastening hardware of components being replaced.
2. Check wiring connections to components.
3. Be sure wiring connections are dry and free of moisture.
4. Check for broken or loose wires at connector.
5. Check for brittle and frayed wire shielding.
6. Connect negative (–) cable to the batteries.
7. Start forklift and bleed hydraulic system of air.
8. Recalibrate sensors; refer to the Owners/Operators Manual for the Total Load Control System.
9. Check operation.

2.9.3 After Hydraulic Component Servicing

1. Check torque on fastening hardware of components being replaced.
2. Check that hoses are in place and tightly connected.

3. If a hydraulic component failed and contaminated the system, flush the system, clean the reservoir and replace the filter.
4. Following normal hydraulic component servicing, check hydraulic fluid level and replenish as required.
5. Start forklift and bleed systems of air.
6. Recalibrate sensors; refer to the Owners/Operators Manual for the Total Load Control System.
7. Check operation.

2.9.4 After Brake System Servicing

1. Check level of TRAK wet disc brake oil in wheel ends and replenish as required.
2. Bleed brakes.
3. Check wheel end brake pressure.
4. Check operation.

2.9.5 After Fuel System Servicing

1. Drain fuel tank if it was contaminated.
2. Bleed fuel system.
3. Fill tank with clean fuel as required.

2.9.6 After Replacing Transmission

1. Check transmission fluid level and replenish as required.
2. Replace transmission filter.
3. Check torque on drive shaft yoke hardware.
4. Refer to the Clark Maintenance Manual for "Servicing Machine After Transmission Overhaul".

2.9.7 After Tire Servicing

1. Check hydrofill mixture, air pressure and weight of tire (empty and full).
2. Check wheel nut torque.

2.9.8 After Engine Servicing

Consult the qualified service agent for proper procedure before startup.

2.9.9 After Boom Servicing

1. Check wear pads.
2. Check chain tension adjustment.
3. Lubricate all grease points.

2.9.10 After Axle Servicing

1. Check fluid levels.
2. Check torque of drive shaft yoke hardware.
3. Check wheel nut torque.
4. Check toe-in if required.
5. Lubricate all grease points.
6. Refer to Dana Service Manual for "SECTION 1 - General Information".

2.10 FLUID LEVELS AND LUBRICATION

2.10.1 Wheel Ends

Use the following procedure to check fluid level on the wheel ends:

1. Be sure that arrow on the wheel end housing is pointing down. Level the vehicle, ground the carriage, place the travel select lever in (N) Neutral, engage the emergency brake switch and shut off engine.
2. Clean the area around the magnetic drain plug and remove the plug and check fluid level. Add oil (refer to "IMPORTANT" statement and tables on this page) as required to bring level up even with the plug hole (for temperatures below -15° F (-26° C) 75W gear oil can be used).
3. Clean and install drain plug.

TABLE 1 Recommended oils for DANA SPICER® axles P/N 070BP126-13 (front axle) and 070BP139-2 (rear axle) w/graphite based friction discs.	
BRAND	DESCRIPTION
Amoco	Amoco 1000
Case IH (J.I. Case & International Harvester)	MS-1207 (Hy-Tran® Plus) MS-1210/JIC145 (TCH Fluid)
John Deere	JDM J20C (Hy-Gard®)
Ford-New Holland	ESN-M2C134-D (Hydraulic Oil 134)
Massey-Ferguson	M-1141 (Permatran®III) M-1135 Massey-Ferguson
Mobil	424
FRICITION MODIFIER BRAND	PART NUMBER
TRAK	8522043 (32 oz)
Ford	C8AZ19B546A (4 oz)

TABLE 2 Recommended oil for DANA SPICER® axles P/N 070BP126-2 (front axle) and 070BP139-1 (rear axle) with paper based friction discs.	
OIL BRAND	PART NUMBER
TRAK Wet Disc Brake Oil	8522042

IMPORTANT: All wheel ends are factory filled with oil that contains friction modifier. **DO NOT** add additional friction modifier to factory filled wheel ends. The addition of friction modifier to a factory fill will dilute the properties of the oil and can reduce braking ability.

To assure a quiet brake condition when servicing wheel end oil, use only recommended oils as defined in Table 1 or Table 2 above.

If a noisy brake condition exists after a fresh fill from oils listed in Table 1 only, add 6 ozs. (0,18 ltr) of friction modifier per wheel end. **NEVER** add more than 6 ozs. (0,18 ltr) of friction modifier to any wheel end as too much modifier can reduce braking ability.

NEVER add friction modifier to the recommended oil listed in Table 2. This oil already contains friction modifier and additional friction modifier can reduce braking ability.

2.10.2 Hydraulic Reservoir

With the oil cold and the forklift on a level surface and all hydraulic cylinders retracted, check the sight gauge on the right side of the main frame. The oil level should be visible in the gauge window. If it is not, open the locked hydraulic fill access door. Remove the fill cap and add MIL-L-2104C Oil as required to bring the oil level up to the minimum oil level line on the adjacent decal.

2.10.3 Engine Oil

Oil level should be between the full and add mark on the dipstick. Refer to Sections 8 and 8A for the type of oil to add.

2.10.4 Cooling System

Check level of coolant in overflow bottle. When coolant is hot, bottle should be 3/4 full to full. When coolant is cool, bottle should be 1/4 to 1/2 full. Add coolant as required through the overflow bottle (50/50 mixture of ethylene glycol and water).

2.10.5 Splines

Transmission input shaft splines must be coated with a molybdenum disulfide or Molykote compound.

2.10.6 Drop Box

Remove level plug in drop box and check level of oil. Add fluid as required through the level plug hole with a squeeze bottle. Bring the oil level up even with the level plug hole and install the level plug. Refer to Section 6 for the type of fluid to add.

2.10.7 Grease Fittings

1. Lubricate the following grease fittings with a multi-purpose lithium-based grease:
 - Hydraulic cylinder pins 10 points
 - Drive shaft slip joints 3 points
 - Boom chain sheaves 1 or 2 points
 - Boom pivot pins 2 points
 - Carriage pivot pin 2 points
 - Axle pivot pins 4 points
 - Boom Attachments All points
 - Axle steer knuckles 8 points
 - Axle tie rod ball joints 4 points
 - Axle steer cylinder ball joints 8 points
2. Wipe off excess grease.

Notes

SECTION 3 BOOM

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3.1 BOOM ASSEMBLY

The boom assembly, Fig. 3.1, consists of inner, intermediate, and outer booms. The intermediate boom slides in the outer boom and the inner boom slides in the intermediate boom. As the boom extend/retract cylinder extends or retracts the intermediate boom, a pair of extend chains and one retract chain moves the inner boom in the same direction.

IMPORTANT: The inner, intermediate and outer boom replacement instructions in paragraphs 3.1.1 through 3.1.3 must be completed in sequence. Replacement of two or more booms as a unit requires special considerations that are not covered in these instructions.

3.1.1 Inner Boom Replacement

a. Removal

1. Park forklift on level surface, engage park lock and retract boom.

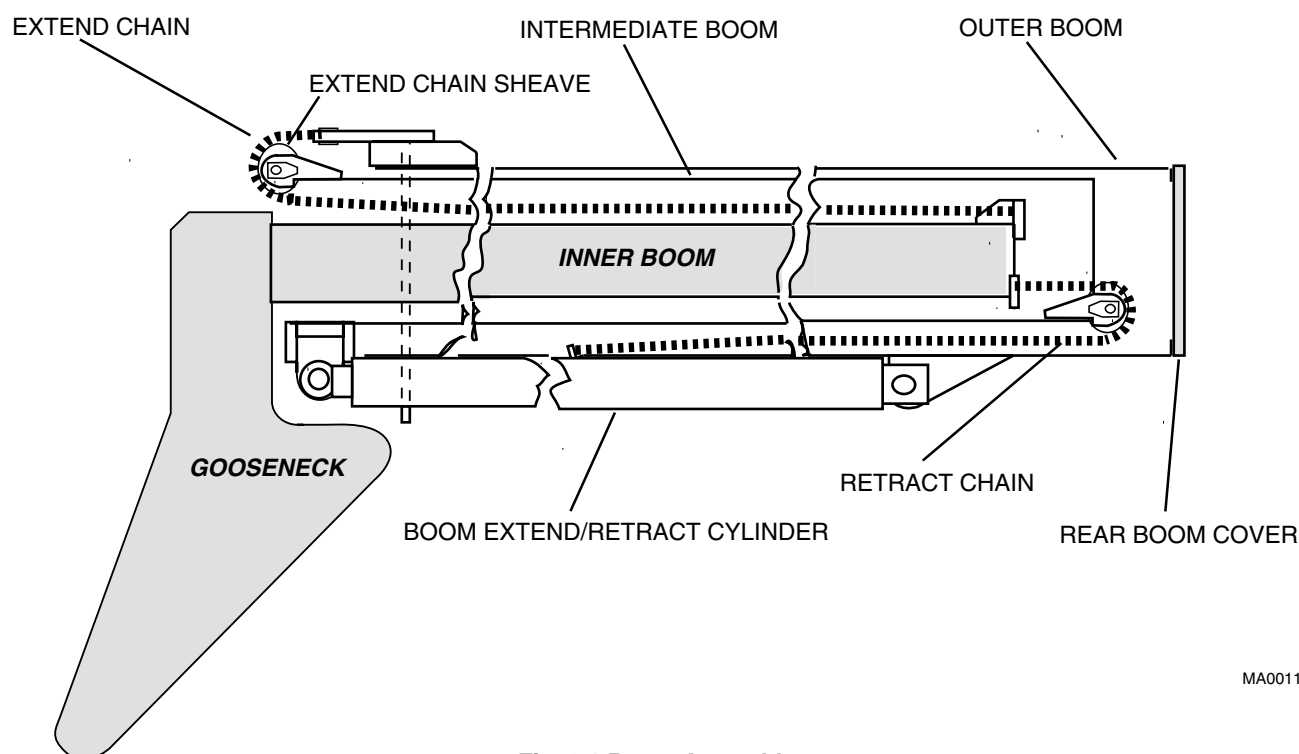


Fig. 3.1 Boom Assembly

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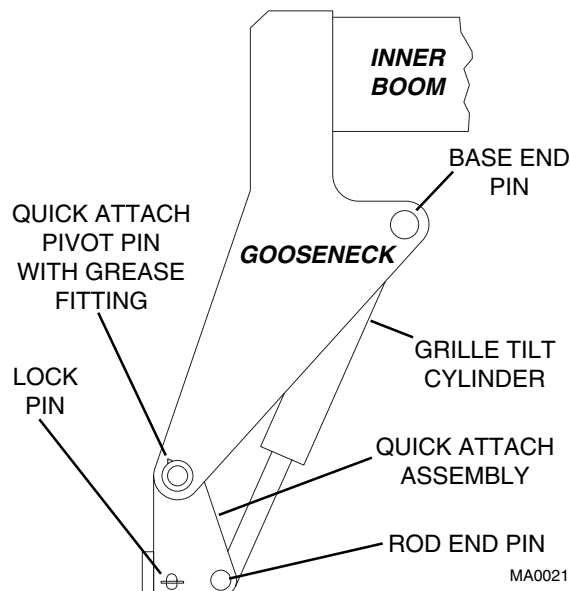


Fig. 3.2 Gooseneck

2. Prepare to replace the inner boom, Fig. 3.2, by removing the grille tilt cylinder as described in paragraph 9.5.8.a.
3. Remove the quick attach pivot pin, Fig. 3.2, and quick attach assembly from the gooseneck.
4. Remove the rear boom cover, Fig. 3.1.
5. Pull the grille tilt cylinder hoses and auxiliary hydraulics (if so equipped) out the rear boom cover opening.
6. Working from the rear boom cover opening, record the number of shims beneath each wear pad as you remove the side and top wear pads from the inner boom, Fig. 3.3.
7. Refer to Fig. 3.1 and remove the locknut and washer or shoulder screw and locknut that attaches the retract chain to the inner boom. Disconnect the extend chains from the outer boom section. Remove the chain sheave from the front of the intermediate boom.
8. Use a sling and a suitable hoist to slide the inner boom out the front of the intermediate boom.
9. Refer to Fig. 3.3 and remove bottom wear pad from the rear of the inner boom.

b. Inspection and Replacement

1. Inspect the boom and welds and contact JLG if structural damage is detected.
2. Inspect hoses and replace if damaged.
3. Inspect and replace wear pads as described in paragraph 3.1.8.

c. Installation

1. Refer to Fig. 3.3 and install the bottom wear pad on the inner boom. Install a new pad if it is excessively worn (refer to paragraph 3.1.8). Apply Loctite® Removable Threadlocker 242 to the capscrews and torque them to 31 lb-ft (42 Nm).
2. Connect the extend chains at the top rear of the inner boom; temporarily secure the other end of the chains to the top front of the inner boom.
3. Use slings and a suitable hoist to slide the repaired or new inner boom and extend chains into the intermediate boom.
4. Working through the rear cover opening, temporarily install the top and side inner boom wear pads on the inner boom, Fig. 3.3. Replace pads that are excessively worn. Use the same amount of shimming as used when the pads were removed.

IMPORTANT: The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).

5. Check the wear pad gap between the inner boom side and top wear pads and the intermediate boom. The gap should be 0.07 to 0.13" (1,8 to 3,3 mm) and equal for all top and side wear pads. Install or remove shims as required.
6. Install the wear pads by applying Loctite 242 to the capscrews and torquing them to 31 lb-ft (42 Nm).
7. Secure the retract chain to the inner boom with washers and locknuts (S/N 2515 & Before) or shoulder screw and locknut (S/N 2516 & After). Make sure the chain is not twisted. Be sure the extend chains are in place under the chain sheave at the front of the intermediate boom and then reassemble the chain sheave to the mounts. Reconnect the extend chains to the outer boom, Fig. 3.1.
8. Tie the grille tilt cylinder hoses together and push them through the inner boom to the opening at the inner boom gooseneck.
9. Refer to Fig. 3.2 and install the quick attach assembly on the gooseneck with the quick attach pivot pin. Position pin with grease holes facing UP.
10. Using grease fittings at the ends of the pin, lubricate the quick attach pivot pin.
11. Install the grille tilt cylinder as described in paragraph 9.5.8.f.

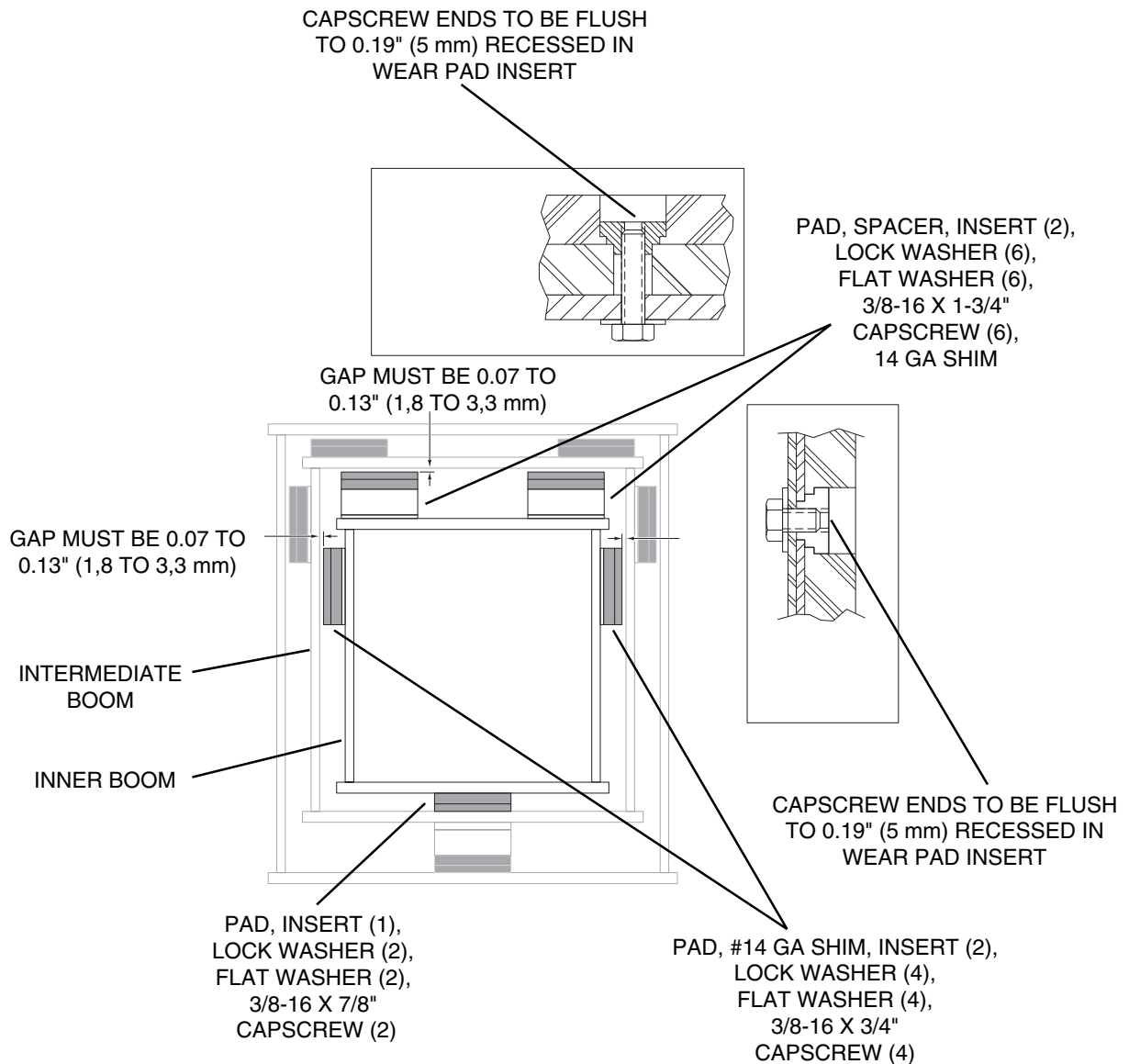


Fig. 3.3 Rear Wear Pads Attached to Inner Boom

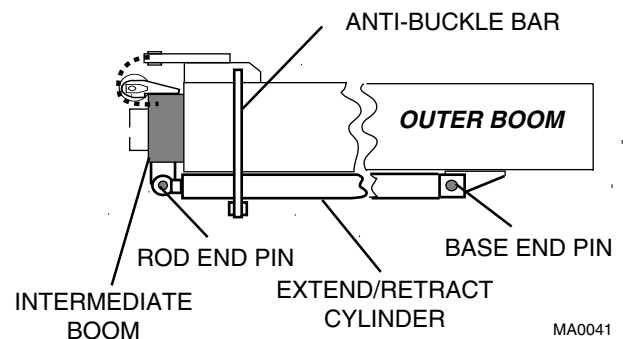
MA0031

12. Adjust hose tension as described in paragraphs 3.1.9.
13. Check and adjust chain tension as described in paragraphs 3.1.6 and 3.1.7.
14. Refer to Fig. 3.1 and install the rear boom cover.
3. Working from the rear boom cover opening, record the number of shims beneath each wear pad as you remove the side and top wear pads from intermediate boom, Fig. 3.6.

3.1.2 Intermediate Boom Replacement

a Removal

1. Refer to paragraph 3.1.1.a and remove the inner boom.
2. Remove the rod end pin, Fig. 3.4, and retaining rings that attach the rod end of the boom extend/retract cylinder to the intermediate boom. Lower the rod end to the anti-buckle bar.



MA0041

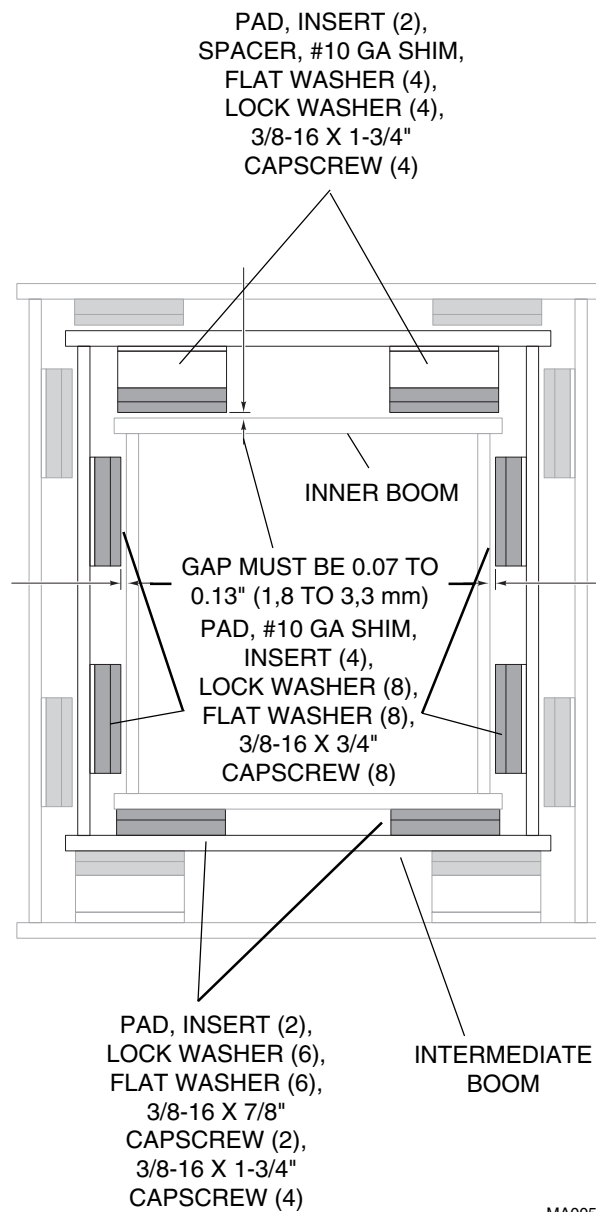
Fig. 3.4 Extend/Retract Cylinder

4. Use a sling and a suitable hoist to slide the intermediate boom out the front of the outer boom.
5. Record the number of shims beneath each wear pad as you remove the rear bottom, Fig. 3.6, and all front wear pads, Fig. 3.5, from the intermediate boom.
6. Examine the chain sheaves for wear and replace if necessary.

b. Inspection and Replacement

1. Inspect the boom and welds and contact JLG if structural damage is detected.

Fig. 3.5 Front Wear Pads Attached to Intermediate



MA0051

Boom

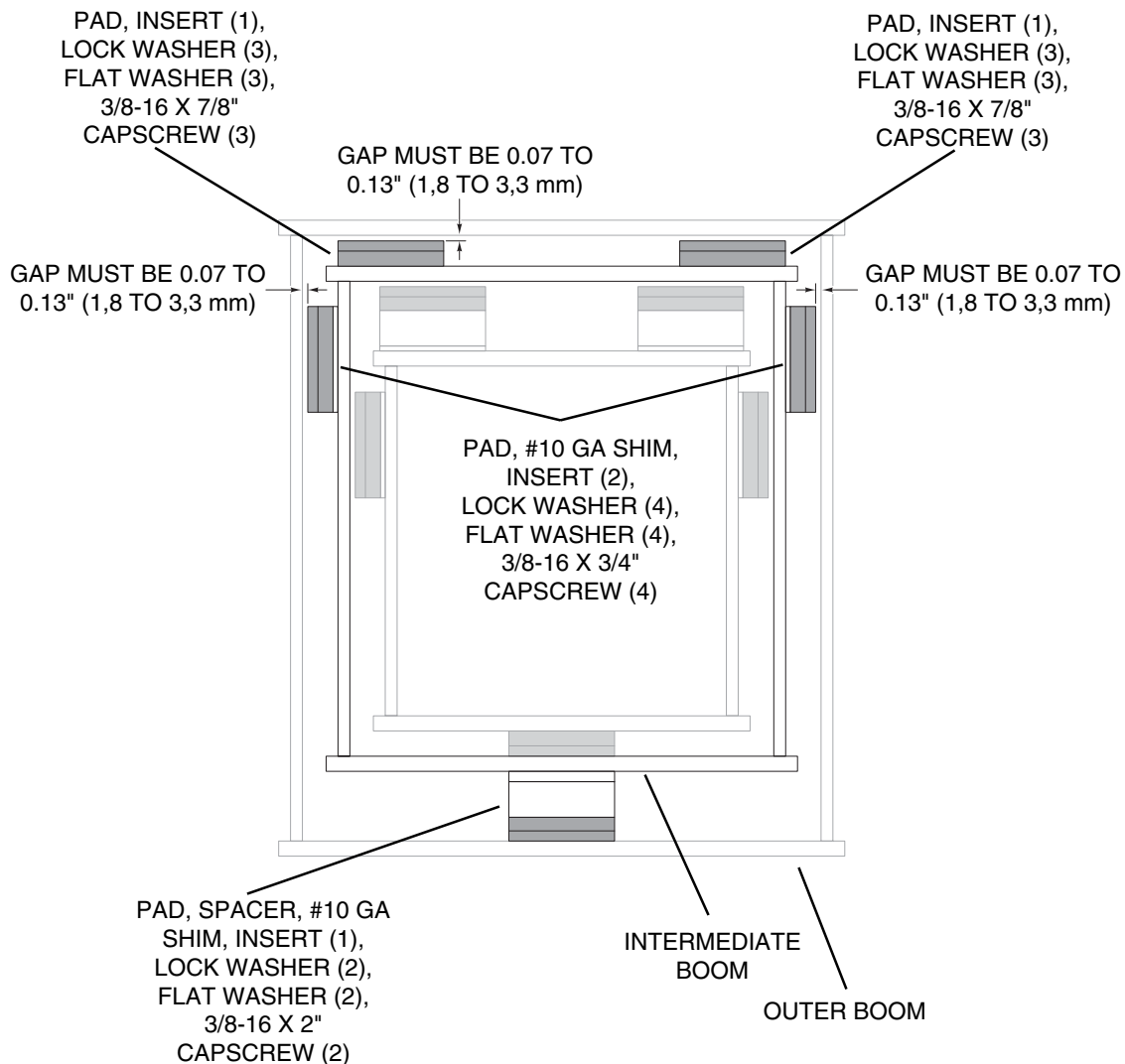
2. Inspect hoses and replace if damaged.
3. Inspect and replace wear pads as described in paragraph 3.1.8.

c. Installation

1. Refer to Fig. 3.6 and install the rear bottom wear pad, Fig. 3.6, on the intermediate boom. Install a new pad if it is excessively worn (refer to paragraph 3.1.8). Apply Loctite® Removable Threadlocker 242 to the capscrews and torque them to 31 lb-ft (42 Nm).
2. Using a sling and a suitable hoist, slide the repaired or new intermediate boom into the outer boom.
3. Working through the rear boom cover opening, refer to Fig. 3.6 and temporarily install the rear top and side wear pads on the intermediate boom. Replace pads that are excessively worn. Use the same amount of shimming as used when the pads were removed.

IMPORTANT: The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).

4. Refer to paragraph 3.1.1.c and install the inner boom.
5. Connect the extend chains at the front of the outer boom.
6. On the front of the intermediate boom, check the gap between the intermediate boom side and top wear pads and the inner boom, Fig. 3.5. The gap should be 0.07 to 0.13 inches (1,8 to 3,3 mm) and equal on all sides. Remove or install shims as required.
7. Working through the rear boom cover opening, refer to Fig. 3.6 and check the gap between the intermediate boom side and top wear pads and the outer boom. The gap should be 0.07 to 0.13 inches (1,8 to 3,3 mm) and equal on all sides. Remove or install shims as required.
8. Install the wear pads by applying Loctite 242 to the capscrews and torquing them to 31 lb-ft (42 Nm).
9. Refer to Fig. 3.4 and apply anti-seize compound to the rod end pin. Secure the rod end of the boom extend/retract cylinder to the intermediate boom with the rod end pin, Fig. 3.4 and retaining rings.



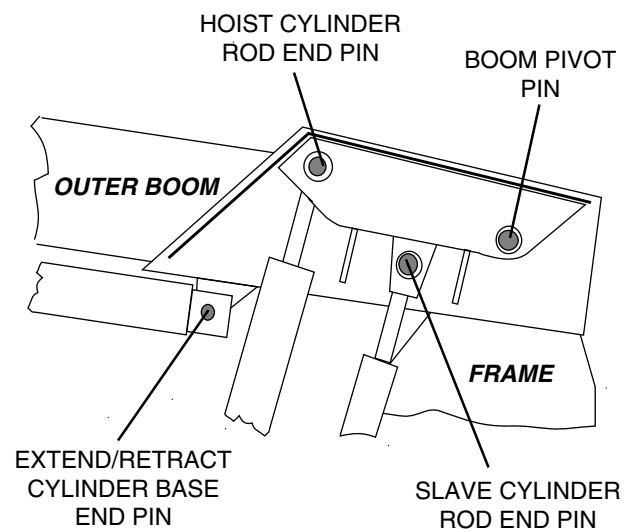
MA0061

Fig. 3.6 Rear Wear Pads Attached to Intermediate Boom

3.1.3 Outer Boom Replacement

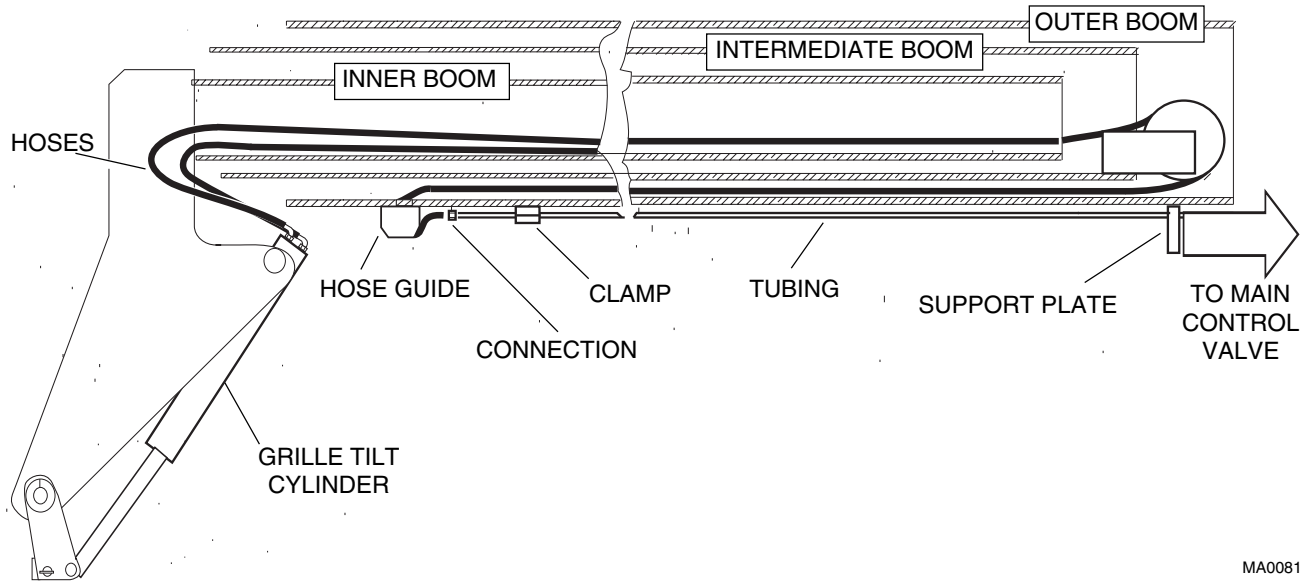
a. Removal

1. Refer to paragraphs 3.1.1.a and 3.1.2.a and remove the inner and intermediate booms.
2. Disconnect and remove the retract chain from the outer boom. Check the condition of the chain and replace if worn or damaged.
3. Refer to paragraph 9.5.4.a and remove the boom extend/retract cylinder.
4. Refer to Fig. 3.7 and remove the locknut and capscrew that secures the slave cylinder rod end pin. Remove the pin. Check the condition of the bearing in the cylinder rod end; replace bearing if worn or damaged.
5. Refer to Fig. 3.8 and disconnect the grille tilt cylinder hoses from the tubing at the hose guides and remove the hoses from the boom.



MA0071

Fig. 3.7 Outer Boom Pivot Pins



MA0081

Fig. 3.8 Grille Tilt Cylinder Hoses

6. Disconnect and cap or plug the grille tilt cylinder tubing, extend cylinder tubes and bulkhead fittings in support plate, Fig. 3.8, below the rear opening of the boom.
7. Loosen clamps that hold the tubing to the bottom of the outer boom and remove the tubing from the outer boom.
8. Attach slings and a suitable hoist to the approximate center of gravity of the outer boom and remove all slack from hoist cable.

NOTE: The approximate center of gravity of the outer boom will be closer to the rear of the outer boom.

9. Refer to Fig. 3.7 and remove the locknuts and capscrews that secures the hoist cylinder rod end pins. Remove the pins. Check the condition of the bearings in the cylinder rod ends; replace bearings if worn or damaged.
10. Refer to Fig. 3.7 and remove the capscrews and lock washers securing boom pivot pins to the outer boom.
11. Remove both boom pivot pins and washer spacers from the outer boom and main frame.
12. Using the hoist, remove the outer boom from the main frame of the forklift.
13. Check the condition of both boom pivot main frame bearings; replace if worn or damaged.

14. If the front outer boom wear pads, Fig. 3.9, are excessively worn, temporarily replace them with new pads. Use the same amount of shimming as used when the pads were removed.

IMPORTANT: The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).

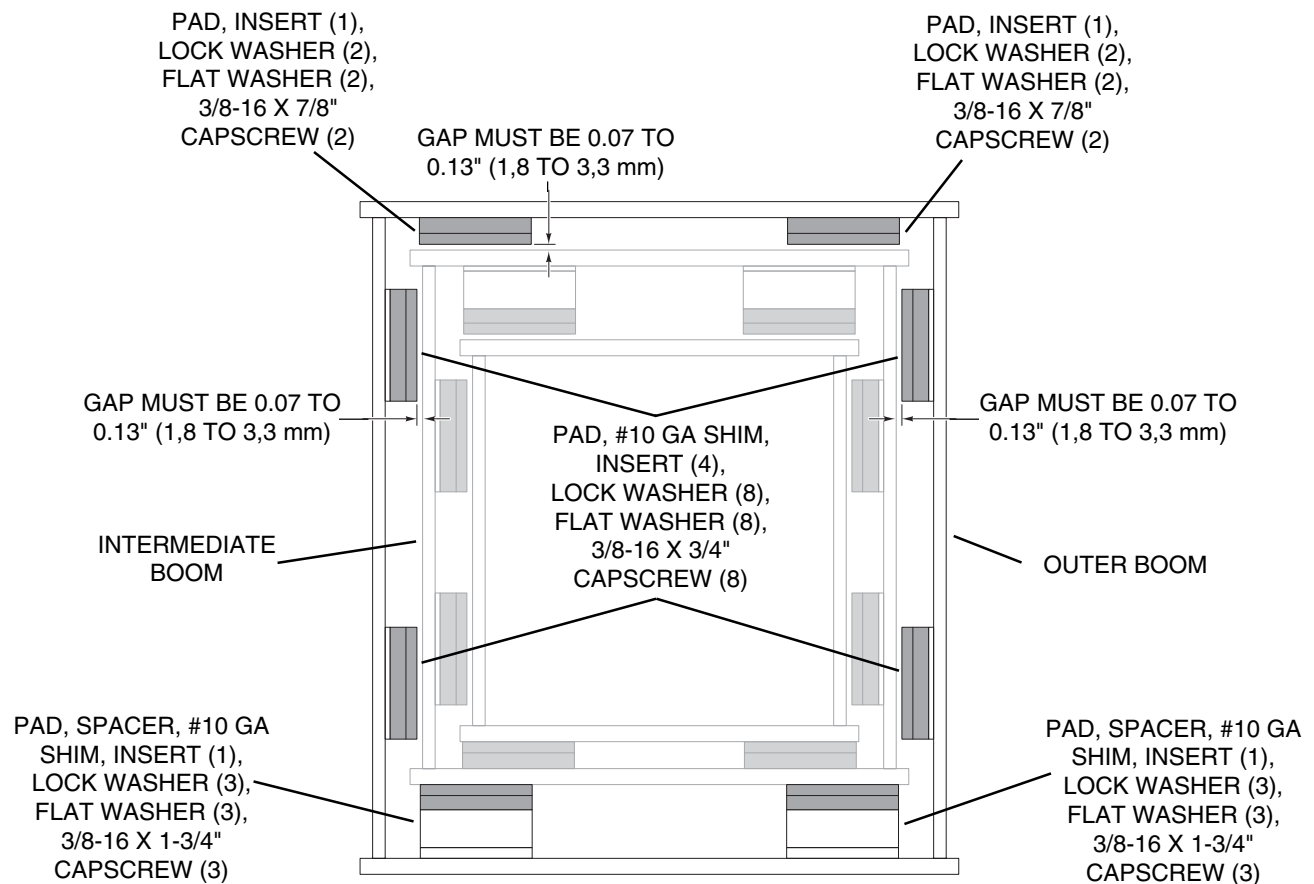
b. Inspection and Replacement

1. Inspect the boom and welds and contact JLG if structural damage is detected.
2. Inspect hoses and replace if damaged.
3. Inspect and replace wear pads as described in paragraph 3.1.8.

c. Installation

1. Using slings and a suitable hoist, align the outer boom pivot collars with the main frame bearings.
2. Install the boom pivot pins and washer spacers, placing the spacers on the inside of the frame bearing, Fig. 3.10. Using No. 10 and/or 14 gauge shims, shim to maintain a gap between the frame bearing and outer boom of 0.07 to 0.13" (1,8 to 3,3 mm).

Fig. 3.9 Front Wear Pads Attached to Outer Boom



(Rear Wear Pads are Attached to Intermediate Boom)

3. Install the capscrews and lock washers locking the boom pivot pins to the outer boom.
4. Rest the front of the boom on cribbing so it is not solely supported by the hoist.
5. Install the grille tilt cylinder tubing in clamps on the bottom of the outer boom, (Fig. 3.8), and connect each tube, extend tubes and bulkhead fittings to fittings at the support plate. Connect main valve hoses. Tighten the tube clamps.
6. Refer to Fig. 3.8 and connect the grille tilt cylinder hoses to the tubing. Route the hoses around hose guide bracket and into the outer boom. Continue pushing the hoses until they come out the rear boom cover opening.
7. Install the base end of the boom extend/retract cylinder on the outer boom with a pivot pin, Fig. 3.7, and retaining rings. Coat the pin with antiseize compound.
8. Reattach tubes to extend cylinder ports.
9. Attach the rod end of the slave cylinder to the outer boom with a pivot pin and lock the pin in place with a capscrew and locknut.
10. Attach the rod end of each hoist cylinder to the outer boom with a pivot pin and lock the pin in place with a capscrew and locknut.

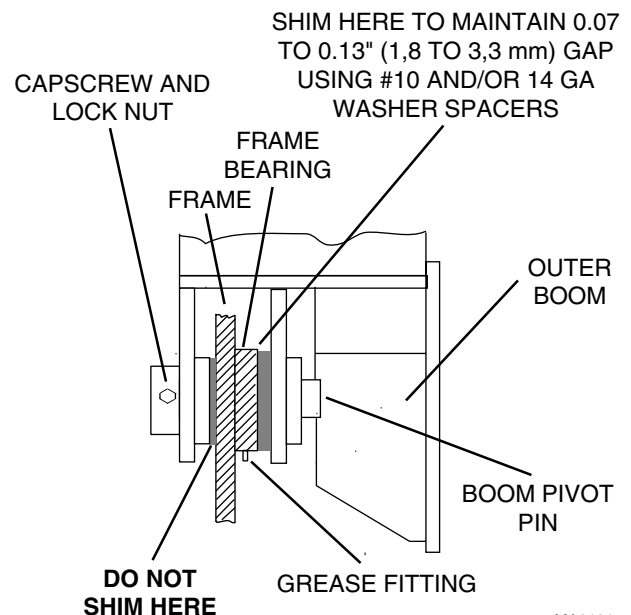


Fig. 3.10 Boom Pivot Pin Shimming

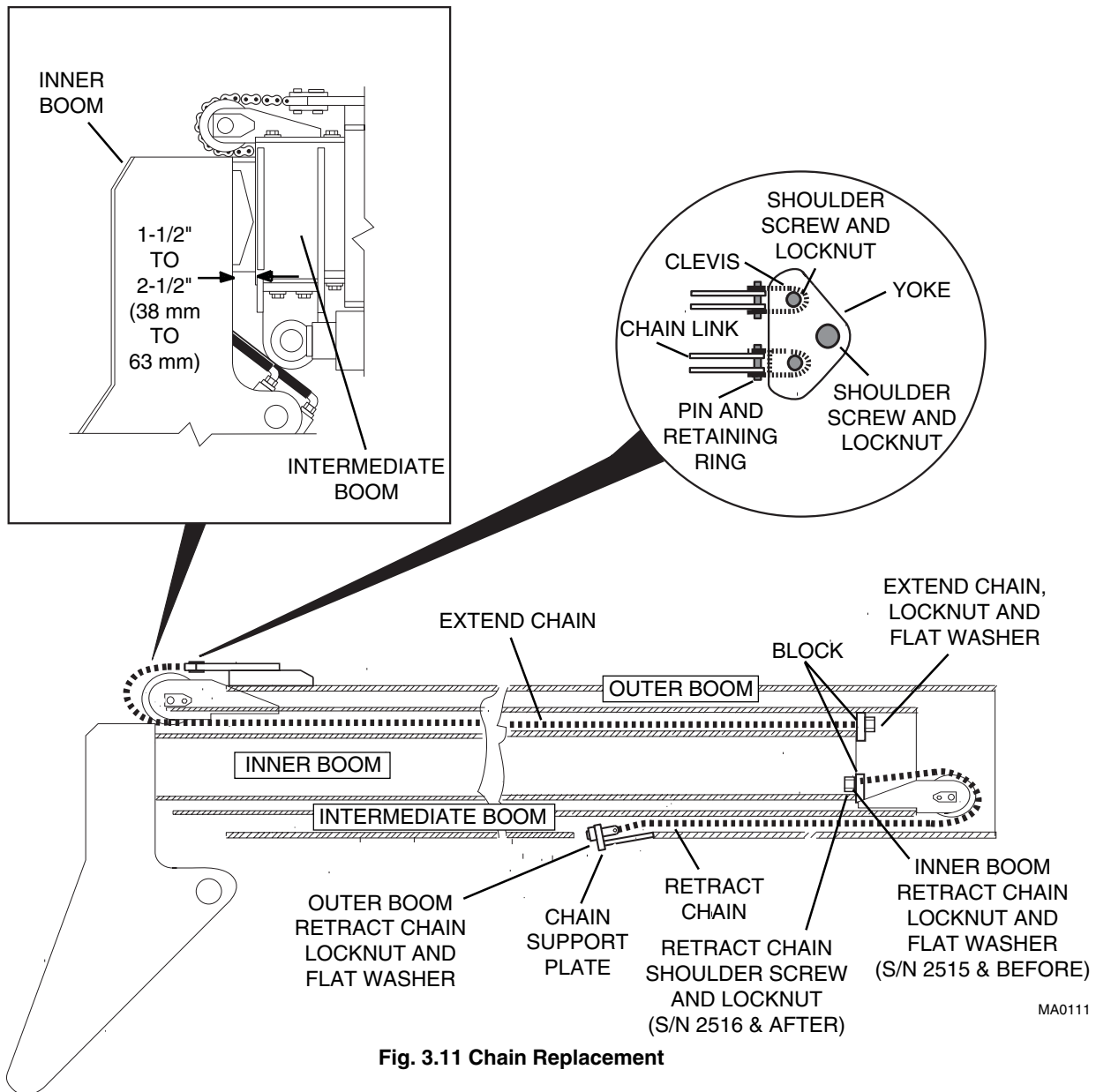


Fig. 3.11 Chain Replacement

11. Attach the two extend chains at the chain yoke, Fig. 3.11, on top of the boom. Allow the remaining ends of the chains to hang free until the intermediate boom has been installed.
 12. Attach the retract chain at the chain support plate, Fig. 3.11, and route it along the bottom of the outer boom to the rear boom cover opening.
 13. Remove hoist and sling from outer boom.
 14. Remove cribbing from front of boom.
 15. Refer to paragraphs 3.1.2.b and 3.1.1.b and install the intermediate and inner booms.
 16. Refer to Fig. 3.9 and check the wear pad gap between the front outer boom side and top wear pads and the intermediate boom. The gap should be 0.07 to 0.13" (1,8 to 3,3 mm) and equal on all sides. Remove or install shims as required.
- IMPORTANT:** The ends of wear pad attaching capscrews must not protrude beyond the wear pad insert; the ends must range from flush to 0.19" (5 mm) recessed in the wear pad insert (refer to Fig. 3.3).
17. Install the wear pads by applying Loctite 242 to the capscrews and torquing them to 31 lb-ft (42 Nm).
 18. Lubricate the outer boom pivot pins, Fig. 3.7, with multi-purpose lithium based grease.

3.1.4 Chain Replacement

Two chains extend the inner boom and one chain retracts it.

Extend Chains

IMPORTANT: Replace extend chains in pairs or sets *ONLY*.

a. Removal

1. Fully retract the boom.
2. Remove the rear boom cover.
3. Refer to Fig. 3.11 and remove the extend chain locknut and flat washer securing each chain clevis to a block at the upper rear of the inner boom.
4. Remove the locknut and shoulder screw that attaches each extend chain to the yoke at the front of the boom.
5. Pull the chains out the front of the boom.
6. Remove a chain clevis at both ends of each chain.

b. Installation

1. Be sure the boom is fully retracted.
2. Install a chain clevis on both ends of each chain.
3. Working from the rear boom cover opening, remove both top intermediate boom wear pads to gain access to rear boom chain connection.
4. Using a long rod or other suitable tool, route the chains between the upper plates of the inner and intermediate booms to the front boom opening. Make sure chains are not twisted.
5. Route the chains over the chain sheave and attach the chains to the front yoke with a shoulder screw and locknut. Tighten the locknut completely, then back off 1/4 turn.
6. Secure the rear of the chain to a block at the upper rear of the inner boom with a flat washer and locknut. The elastic collar on the locknut must engage the chain clevis by at least one full thread. Be sure locknuts are tightened equally.
7. Check the position of the chain yoke at the front of the outer boom. The front of the yoke must be parallel to the front face of the outer boom. If not, adjust the locknuts accordingly.

8. Refer to paragraph 3.1.5 and lubricate the chain.
9. Refer to paragraphs 3.1.6 and 3.1.7 and check and adjust the chains.

Retract Chain

a. Removal

1. Fully retract the boom.
2. Remove the rear boom cover.
3. On the underside of the outer boom, remove the outer boom retract chain locknut and flat washer, Fig. 3.11, securing the retract chain to a chain support plate at the underside of the outer boom.
4. Remove the inner boom retract chain locknut and flat washer (S/N 2515 & Before) attaching the retract chain clevis to a block at the lower rear of the inner boom. For S/N 2516 & After remove the shoulder screw and locknut from the mount plates.
5. From the rear outer boom cover opening, pull the retract chain from the space between the outer and intermediate booms.
6. Remove a chain clevis from each end of the chain.

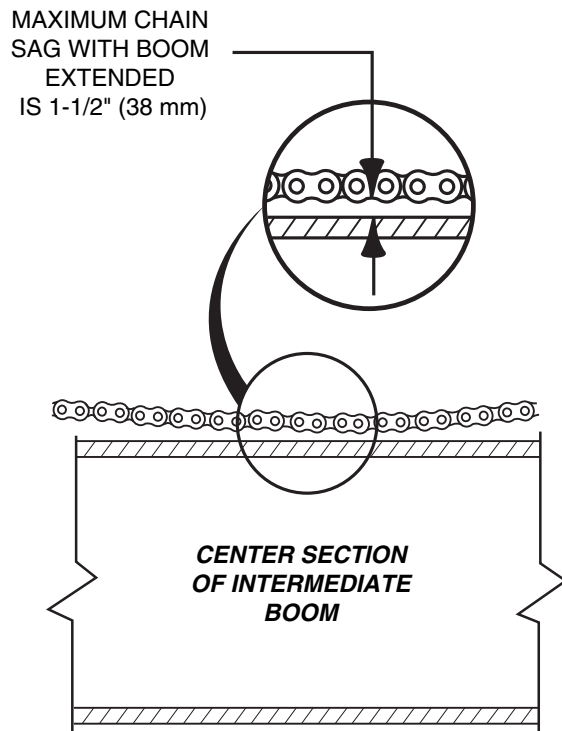
b. Installation

1. Be sure the boom is fully retracted.
2. Install a chain clevis on each end of the chain.
3. Refer to paragraph 3.1.5 and lubricate the chain.
4. Secure the rear of the chain to a block at the lower rear of the inner boom with a flat washer and locknut (S/N 2515 & Before). Route the chain around the chain sheave. The elastic collar on the locknut must engage the chain clevis by at least one full thread. For S/N 2516 & After secure the chain clevis to the mount plates with a shoulder screw and a locknut.
5. Using a long rod or other suitable tool, route the chain between the lower plates of the outer and intermediate booms to the chain support plate opening, Fig. 3.11, on the bottom of the outer boom.
6. Secure chain clevis to the chain support plate using a flat washer and locknut. Torque the locknut to 35 to 40 lb-ft (47,5 to 54,2 Nm).
7. Refer to paragraphs 3.1.6 and 3.1.7 and check and adjust the chain.

3.1.5 Chain Lubrication

250 Hour Intervals

1. Remove the rear boom cover from the outer boom.
2. Extend and retract the boom several times applying Aerosol .0002 Waxy Film Rust Inhibitor, TRAK part number 8526405.
3. With the boom fully extended, apply multi-purpose lithium based grease to the extend chain using a brush or grease gun.
4. Install the rear boom cover on the outer boom.



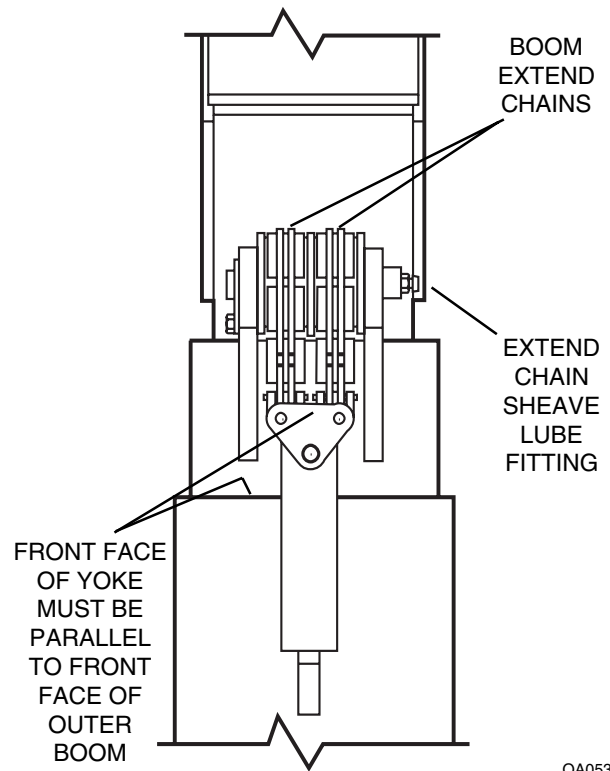
OA0491

Fig. 3.12 Maximum Extend Chain Sag

3.1.6 Chain Tension Check

250 Hour Intervals

Check tension of boom extend chains after the first 50 hours of operation and at 250 hour intervals thereafter.

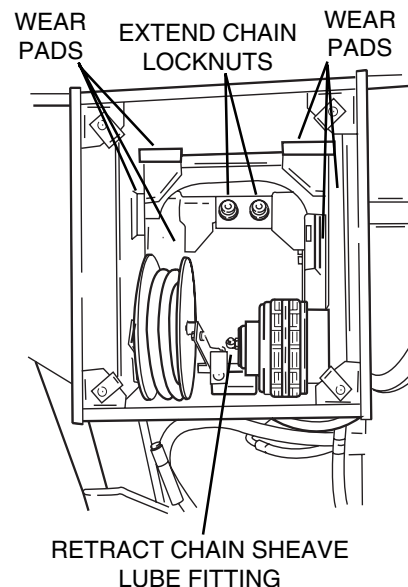


OA0531

Fig. 3.13 Yoke and Extend Chains

Adjust the chains so that:

- the inner boom extends 1-1/2 to 2-1/2" (38 to 64 mm) from the front of the intermediate boom when the boom is retracted, Fig. 3.11, and
- the extend chains are no closer to the intermediate boom than 1-1/2" (38 mm) when the boom is extended, Fig. 3.12, and
- the front face of the yoke, Fig. 3.13, is parallel to the front face of the outer boom.



OA0521

Fig. 3.14 Rear Boom Cover Opening

Adjustment is accomplished using extend chain adjustment locknuts, Fig. 3.14.

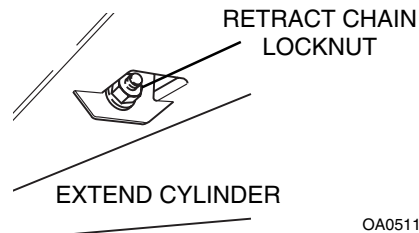
a. Chain Locknut Functions

Loosen extend chain locknuts to extend the inner boom and increase extend chain sag.

Tighten outer boom retract chain locknut to retract the inner boom and decrease extend chain sag.

b. Adjusting Procedure

1. Raise the boom to a horizontal (level) position. Fully extend the boom, then retract it 2", which is 1" per section (51 mm which is 25,5 mm per section).
2. Measure sag in the extend boom chains between the bottom of the chains and the top of the intermediate boom at their closest point, Fig. 3.12. Acceptable boom extend chain sag is between 1-1/2 & 2-1/2" (38 & 64 mm). If the measurement is less than 1-1/2" (38 mm), adjust the boom chains as described in the following steps.



OA0511

Fig. 3.15 Retract Chain Adjustment Locknut

3.1.7 Chain Tension Adjustment

1. Retract the boom completely to check the position of the inner boom, Fig. 3.11. If the distance between the front edges of the intermediate and inner booms is between 1-1/2 & 2-1/2" (38 & 64 mm) and the extend chain is no closer than 1-1/2" (38 mm) from the intermediate boom, proceed no further, the boom chains are adjusted correctly.
2. If the distance between the front edges of the intermediate and inner booms is 2" or more but less than 2-1/2" (51 mm or more but less than 64 mm):
 - (a) Tighten the locknut, Fig. 3.15, on the bottom of the outer boom. This retracts the inner boom and takes up the sag in the extend chains.
 - (b) Cycle the boom in and out; then, with the boom horizontal (level), fully extend the boom and retract it 2" which is 1" per section (51 mm which is 25,5 mm per section).

- (c) Measure the chain sag, Fig. 3.12. Acceptable boom extend chain sag is between 1-1/2 & 2-1/2" (38 & 64 mm). If the chain sag is less than 1-1/2" (38 mm) repeat steps (a) through (c).

3. If the distance measured in Step 1 is less than 2" but greater than 1-1/2" (less than 51 mm but greater than 38 mm):

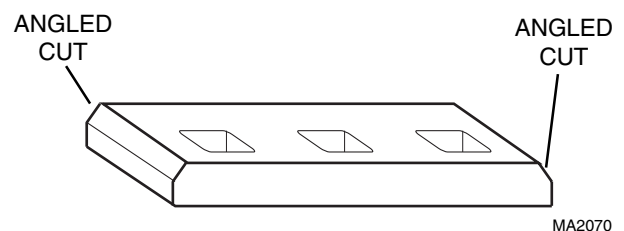
- (a) Remove the rear cover from the outer boom and adjust the top extend boom chains.
- (b) Tighten the locknuts, Fig. 3.14, for each chain. Be sure each locknut is tightened equally so that chain maintains the same tension. Equal chain tension can be checked by observing the position of the yoke on the outer boom, Fig. 3.13. The front of the yoke should be parallel with the front edge of the boom.
- (c) Cycle the boom in and out; then, with the boom horizontal (level), fully extend the boom and retract it 2" which is 1" per section (51 mm which is 25,5 mm per section).
- (d) Measure the chain sag. Acceptable boom chain sag is between 1-1/2 and 2-1/2" (38 and 64 mm). If chain sag is less than 1-1/2" (38 mm), repeat steps (a) through (d).
- (e) Replace the rear cover of the outer boom.

3.1.8 Wear Pad Replacement

After the first 50 hours of operation or when severe wear is suspected

There are 26 wear pads (Fig's 3.3, 3.5, 3.6 and 3.8) between the outer, intermediate, and inner booms. Five are attached to the inner boom, thirteen to the intermediate boom, and eight to the outer. Four additional wear pads may be used in severe twist applications.

The wear pads and wear pads with spacers are shimmed to maintain a gap between the wear pads and the booms of 0.07 to 0.13" (1,8 to 3,3 mm).



MA2070

Fig. 3.16 Boom Wear Pads

IMPORTANT: *Inspect the pads as follows:*

- *Replace wear pads that are less than 0.375" (9,5 mm) thick.*
- *Each boom wear pad is manufactured with a convenient wear pad indicator. This is the angled cut at each end of all wear pads, Fig. 3.16. The total thickness of a new wear pad is .625" (15,9 mm), the angled cut will provide a total wear thickness of .25" (6,4 mm). This will leave approximately .375" (9,5 mm) of total unused material. The wear pads must never be worn past the angled cut indicator because the metal pad insert that holds the pads in place will begin to wear into the boom pad sliding surfaces. If pads are worn past this point it will cause gouging on boom plate surfaces which will result in premature wear of any new wear pads installed if the surfaces are not ground smooth again.*
- *When you install a wear pad on one side (including top or bottom) of boom, replace the corresponding wear pad on the other side of the boom. Usually shimming will remain the same when installing new wear pads on corresponding sides of the boom.*
- *Apply Loctite® 242 to all wear pad screws and torque them to 31 lb-ft (42 Nm).*

a. Inner Boom Wear Pads (Fig. 3.3)

1. All inner boom wear pads can be removed by working through the rear boom cover opening.
2. The bottom pad may be removed by first removing the top pads. Use a wooden wedge between the inner and intermediate boom to provide clearance for removing the bottom pad.
3. Inspect the wear pads removed as described in the preceding **IMPORTANT** notice.

b. Intermediate Boom Wear Pads (Fig. 3.5 and 3.6)

1. The rear wear pads can be removed by working through the rear boom cover opening.
2. The rear bottom pad may be removed by first removing the top pads, by using a wooden wedge between the inner and intermediate boom, thereby providing clearance for removing the bottom pad.
3. Front pads can be removed at the front of the boom.

4. The front bottom pad may be removed by first removing the top pads. Lower the gooseneck end of the inner boom to the ground until the intermediate boom raises up to provide clearance for removing the bottom pad.
5. Inspect the wear pads removed as described in the preceding **IMPORTANT** notice.

c. Outer Boom Wear Pads (Fig. 3.9)

1. All outer wear pads can be removed working at the front of the boom.
2. The front bottom pad may be removed by first removing the top pads. Lower the gooseneck end of the inner boom to the ground until the intermediate boom raises up, thereby providing clearance for removing the bottom pad.
3. Inspect the wear pads removed as described in the preceding **IMPORTANT** notice.

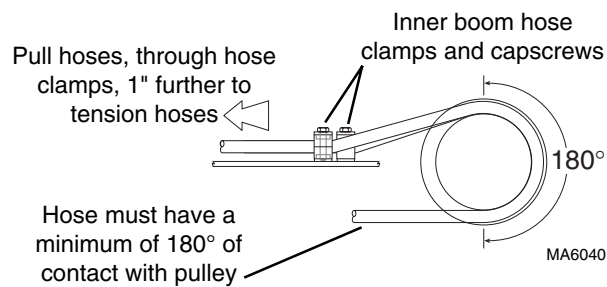
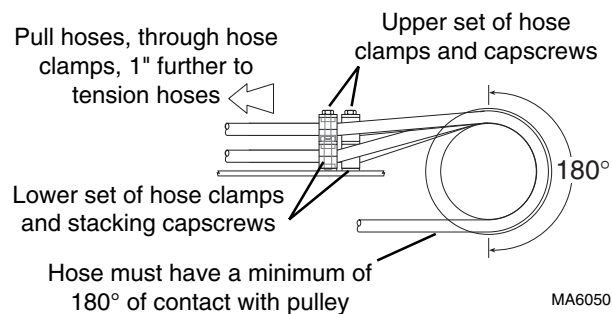
3.1.9 Hose Tensioning

100 Hour Intervals

Adjust grille tilt cylinder hose or auxiliary hydraulic hose tension whenever the boom is disassembled, a hose is changed, or whenever proper hose adjustment is in question. Check hose tension as part of general maintenance every 100 hours.

IMPORTANT: *Before you begin tensioning the hoses make sure that the hoses are not twisted within the boom. Keep the hose manufacturers marking in line as a guide.*

1. Park forklift on level surface, engage park lock and fully retract and level the boom.
2. Remove the rear boom cover, Fig. 3.1.
3. If the vehicle has auxilliary hydraulics there will be four hoses in hose clamps, Fig. 3.17b, with the auxilliary hose clamps stacked on top of the grille tilt cylinder hose clamps, Fig. 3.17a. Remove the capscrews and hose clamps, holding upper hoses in place, Fig. 3.17b, and move aside to gain access to the lower capscrews and hose clamps.
4. Loosen capscrews securing the hose clamps to the inner boom, Fig. 3.17a or Fig. 3.17b.
5. Manually remove all hose slack between the pulley and the inner boom hose clamps and the pulley and the outer boom tubes. Pull the hoses through the hose clamps, towards the front of the boom, until there is 180° of hose in contact with the pulley.

**Fig. 3.17a Cylinder Hose Tensioning**

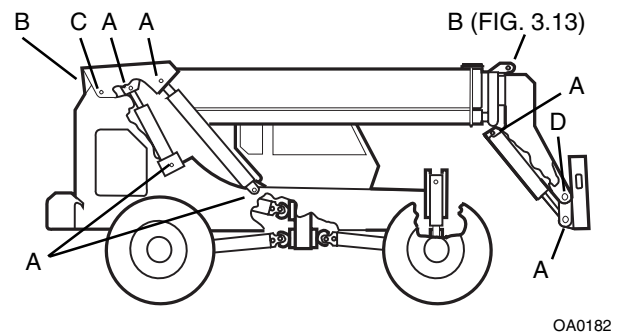
When vehicle has auxilliary hydraulics option, remove upper clamps in stack and tension lower hoses first and then tension top hoses

Fig. 3.17b Cylinder Hose Tensioning

6. Pull the hoses 1" further into the hose clamps so the hose achieves more than 180° of contact with the pulley and at the same time tighten the clamp capscrews.
7. If the vehicle has auxilliary hydraulics, replace the upper hoses and clamps onto the lower hose clamps. Do not fully tighten the cap-screws. Repeat steps 4 through 6 for the upper hoses and clamps.
8. Replace the rear boom cover.

3.1.10 Long Term Storage Preparation

Remove rust and corrosion from sliding surfaces and coat with grease.

**Fig. 3.18 Forklift Lubrication Points**

3.1.11 Boom Lubrication Points

Lubricate the following grease fittings using Multi-Purpose Grease (MPG) **every 50 hours**. Refer to Fig. 3.18.

- A. Hydraulic cylinder pins (8 points)
- B. Boom chain sheaves (2 points)
- C. Boom pivot pins (2 points)
- D. Carriage pivot pin (2 points)

Lubricate the boom extend and retract chains using Aerosol .0002 Waxy Film Rust Inhibitor, TRAK part number 8526405 **every 250 hours**.

1. Prepare to grease the chains by removing the rear cover from the outer boom.
2. Apply MPG to retract chain using a brush or grease gun.
3. Extend and retract the boom several times to permit grease to penetrate the entire chain.
4. With the boom extended fully, apply MPG to the extend chain using a brush or grease gun.
5. Replace the rear outer boom cover.

3.2 EMERGENCY BOOM LOWERING

3.2.1 Loss of Engine Power or Hydraulic Pump Failure

If you lose engine power or hydraulics with an elevated boom, lower the boom to the ground by using the following procedure:



Warning

DO NOT get under a raised boom unless the boom is blocked up. Always block the boom before doing any servicing which requires the boom to be up.

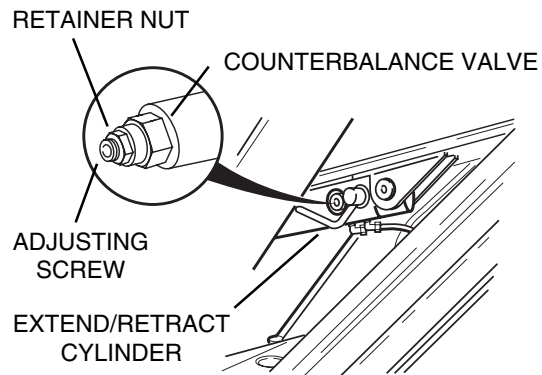
IMPORTANT: If the boom has been extended, you must first retract the boom before you attempt to lower the boom.

To retract the boom proceed as follows:

1. Block the boom so it cannot be lowered.
2. At the base end of the extend/retract cylinder, locate the counterbalance valve cartridge, Fig. 3.19. Loosen the retainer nut and turn the adjusting screw in (clockwise) until it bottoms out. Doing this will render the counterbalance valve inoperative.
3. Clear the area around the machine of all personnel and return to the operators cab.
4. Move the boom control lever to the left and retract the boom.

After the boom has been retracted fully, proceed as follows:

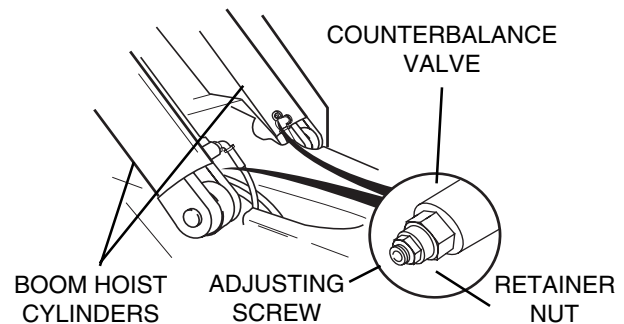
1. At the base of each hoist cylinder, locate the counterbalance valve cartridges, Fig. 3.20.
2. Remove the blocking that is supporting the boom.
3. Clear the area around the machine of all personnel and return to the operators cab.
4. Move the boom control lever forward to lower the boom.



OA0542

Fig. 3.19 Counterbalance Valve on Boom Extend/Retract Cylinder

Loosen the retainer nut on each cartridge and turn the adjusting screws in (clockwise) until they bottom out. Doing this will render each counterbalance valve inoperative.



OA0552

Fig. 3.20 Counterbalance Valves on Boom Hoist Cylinders

IMPORTANT: This procedure is to be used in emergency situations only. By turning the counterbalance cartridge adjusting screws to make the valve inoperative, the pressure settings of the cartridge have been altered. **DO NOT** attempt to reset these cartridges. Remove and replace all three cartridges with new parts. Failure to replace these cartridges with new parts will result in erratic (extreme bouncing) lowering action, which may cause damage to other components.

3.2.2 Hydraulic Line Failure



Warning

In the event of a hydraulic line failure in any of the boom control circuits, extreme CAUTION must be taken when attempting to lower an elevated load. Hydraulic oil under high pressure will escape through the fault in the line which may result in the boom retracting or lowering at a rapid rate. DO NOT perform this procedure unless you are absolutely sure of what you are doing. Consult your local JLG Distributor or the JLG Service Department before proceeding.

IMPORTANT: *If the boom has been extended, you must first retract the boom before you attempt to lower the boom.*

1. Block the boom so it cannot be lowered.
2. If the line failure is isolated to the hoist circuitry only, boom retraction can be performed by operating the boom control lever in the normal fashion.
3. If the line failure is in the boom extend line the boom must be retracted by following the next step:
 - (a) At the base of the extend/retract cylinder, locate the counterbalance valve cartridge, Fig. 3.19. Loosen the retainer nut and control the rate of retraction by turning the adjusting screw into the cartridge **very slowly** clockwise. Hydraulic oil from inside the extend/retract cylinder will escape through the fault in the line.
4. If the line failure is in the boom retract line the boom must be retracted by following the next 3 steps:
 - (a) At the base of the extend/retract cylinder, locate the counterbalance valve cartridge Fig. 3.20. Loosen the retainer nut and turn the adjusting screw in (clockwise) until it bottoms out. Doing this will render the counterbalance valve inoperative.
 - (b) Clear the area around the machine of all personnel and return to the operators cab.
 - (c) Move the boom control lever to the left to retract the boom.
5. If the line failure was isolated to the extend/retract circuit only, the boom can now be lowered by operating the boom control lever in the normal fashion after the blocking is removed.

After the boom has been retracted fully, proceed as follows:

1. Remove the blocking that is supporting the boom.
2. If the line failure is in the boom hoist line the boom must be lowered by following the next step.
 - (a) Using two people to perform this procedure will make boom lowering much easier. At the base end of each hoist cylinder, locate the counterbalance valve cartridges, Fig. 3-20. Loosen the retainer nut and control the rate of boom lowering by turning the adjusting screw on each cartridge simultaneously into the cartridge **very slowly** clockwise. Hydraulic oil from inside the hoist cylinders will escape through the fault in the line.
3. If the line failure is in the boom lowering line the boom must be lowered by following the next 3 steps:
 - (a) At the base of each hoist cylinder, locate the counterbalance valve cartridges, Fig. 3-20. Loosen the retainer nut on each cartridge and turn the adjusting screws in (clockwise) until they bottom out. Doing this will render each counterbalance valve inoperative.
 - (b) Clear the area around the machine of all personnel and return to the operators cab.
 - (c) Move the boom control lever forward to lower the boom.

IMPORTANT: *This procedure is to be used in emergency situations only. By turning the counterbalance cartridge adjusting screws to lower the boom, the pressure settings of the cartridge have been altered. **DO NOT** attempt to reset these cartridges. Remove and replace all three cartridges with new parts. Failure to replace these cartridges with new parts will result in erratic (extreme bouncing) lowering action, which may cause damage to other components.*

3.3 QUICK ATTACH ASSEMBLY

The quick attach assembly, Fig. 3.21, provides a structure on which an attachment may be installed or removed from the forklift.

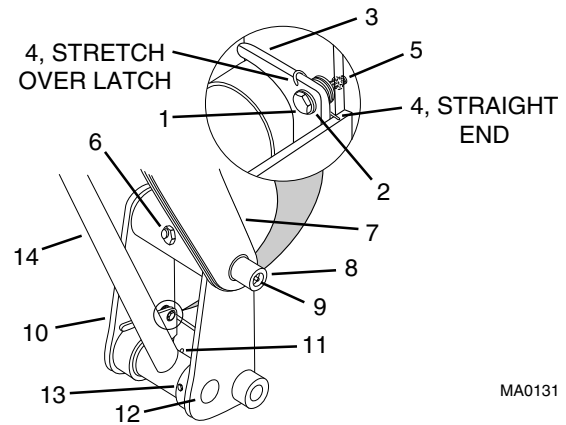
a. Removal

1. Fully lower boom and ground the attachment.
2. Remove the attachment from the quick attach.
3. Remove capscrew and locknut (13, Fig. 3.21) locking grille tilt cylinder rod end pin (12) in the quick attach.
4. Tap the grille tilt cylinder rod end pin from the quick attach.
5. Remove capscrew and locknut (6) locking quick attach pin (8) in the quick attach.
6. Tap the quick attach pin from the quick attach.
7. Remove quick attach assembly (10) from gooseneck (7).
8. Remove the latch assembly capscrew (1), flat washer (2), locknut (5), spring (4), spacer, and latch (3) if any replacement is necessary.

b. Installation

1. If the latch assembly was removed, install it as follows:
 - (a) Assemble flat washer (2, Fig. 3.21), latch (3), spacer, and spring (4) on the cap-screw.
 - (b) Install capscrew (1) on the quick attach making sure the straight end of the spring rides on the top edge of the weldment plate.
 - (c) Install, snug and then back off locknut (5) as required to permit free rotation of latch (3).
 - (d) Stretch the spring hook over the latch.

2. Install quick attach assembly (10) on goose-neck (7) with quick attach pin (8). Lock the pin in place with capscrew and locknut (6).
3. Lubricate the pin through grease fittings using a good grade of multi-purpose lithium based grease.
4. Install grille tilt cylinder rod (14) on the quick attach assembly with cylinder rod end pin (12). Lock the pin in place with capscrew and locknut (13).
5. Lubricate the pin through grease fitting using a good grade of multi-purpose lithium based grease.
6. Install the attachment on the quick attach assembly.



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- | | |
|--------------------------|--------------------------------|
| 1. Capscrew | 8. Pin, quick attach |
| 2. Washer, Flat | 9. Fitting, grease (both ends) |
| 3. Latch | 10. Quick Attach Assembly |
| 4. Spring | 11. Fitting, grease |
| 5. Lock nut | 12. Pin, grille cylinder |
| 6. Capscrew and Lock Nut | 13. Capscrew and Locknut |
| 7. Gooseneck | 14. Rod, grille tilt cylinder |

Fig. 3.21 Quick Attach Assembly

3.4 TROUBLESHOOTING

<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
Fails to Extend or Retract	Broken hydraulic line and/or connection leaks. Faulty Extend/Retract Cylinder. Faulty components in Extend/Retract hydraulic circuitry. Broken chains or chain connections.	Locate break and/or stop leaks. Repair Cylinder. Troubleshoot components and repair or replace components. Repair or replace chains.	Section 9 Section 9 See para. 3.1.4
Fails to Raise or Lower	Broken Hydraulic line and/or connection leaks. Faulty Hoist Cylinder(s). Faulty components in Raise/Lower hydraulic circuitry.	Locate break and/or stop leaks. Repair Cylinder(s). Troubleshoot components and repair or replace.	Section 9 Section 9
Excessive Boom Pivot Pin or Cylinder Pivot Pin Wear	Improper grease intervals. Worn bearings.	Replace worn pins and lubricate at regular intervals. Replace bearings and lubricate at regular intervals.	See para. 3.1.11 Section 9
Excessive Wear Pad Wear	Improper wear pad shimming. Contaminated, corroded or rusted wear pad sliding surfaces (due to improper preparation for long term storage).	Check shim adjustment and shim properly. Prep boom properly for long term storage.	See para. 3.1.8 See para. 3.1.10
Drooping Chain or Jerky Boom Extend or Retract Functions	Chains out of adjustment.	Readjust chains.	See para. 3.1.7
Grille Tilt or Auxiliary hydraulic Circuit Line Failures	Improper hose tension or hose sheave misaligned. Cracked and/or broken hose.	Reset hose sheave tension. Replace hose.	See para. 3.1.9
Excessive Chain Wear	Chain out of adjustment. Improper chain lubrication.	Replace and readjust chains properly. Replace chain(s) and lubricate at regular intervals.	See para. 3.1.4 & 3.1.6 See para. 3.1.4 & 3.1.5

3.5 SPECIFICATIONS

	For 13.00-24 10 ply Tires	For 15.00-19.5 12 ply Tires
Maximum lift height-boom extended	35 ft. 1 in. (11 m)	35 ft. 5 in. (10,8)
Maximum lift height - boom retracted	20 ft. 1 in. (6,1)	19 ft. 3 in. (5,79)
Maximum below grade depth – boom extended	39.5 in. (100,3 cm)	40.5 in. (102,9 cm)
Maximum reach from front of tire	22 ft. 5 in. (6,8 m)	22 ft. 10 in. (7,0 m)
Maximum reach at maximum lift angle – boom extended	45.0 in. (114,3 cm)	50.5 in. (128,3 cm)
Reach at maximum lift angle – boom retracted	–26.0 in. (–66,0 cm)	–19.6 in. (49,8 cm)
Maximum reach at minimum boom angle – boom extended	21 ft. 2.5 in. (6,5 m)	21 ft. 8.25 in. (6,5 m)
Maximum boom lift angle	71 degrees –9 degrees	71 degrees –9 degrees
Fork tilt angle at:		
Minimum boom angle up	11 degrees	11 degrees
Minimum boom angle down	101 degrees	101 degrees
Maximum boom angle up	87 degrees	87 degrees
Maximum boom angle down	25 degrees	25 degrees

SECTION 4 OPERATOR'S CAB

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4.1 SEAT

The seat, Fig. 4.1, is mounted on an adjustable suspension unit. The seat assembly consists of a seat cushion and two slides. One of the slides has a forward/backward adjustment lever. A seat belt is attached to the seat.

a. Adjustment

You can adjust the seat for your weight and height and position it horizontally and vertically.

Position the seat for your height by simply pulling up on the seat until the desired level (low, middle, or high) is attained. To return the seat to the low level, raise the seat past the high level and allow it to return to the low level.

Adjust the seat to your weight by turning a suspension adjust knob on the front of the suspension unit until you see your weight in kilograms (2.2 pounds per kilogram) on an indicator next to the knob.

Adjust the horizontal or forward/backward position of the seat by using the forward/backward lever on the slide to the left of the seat.

b. Seat Removal

The seat and seat slides may be removed from the suspension unit and mounting plate by removing four locknuts and flat washers that attach the seat slides to the suspension unit.

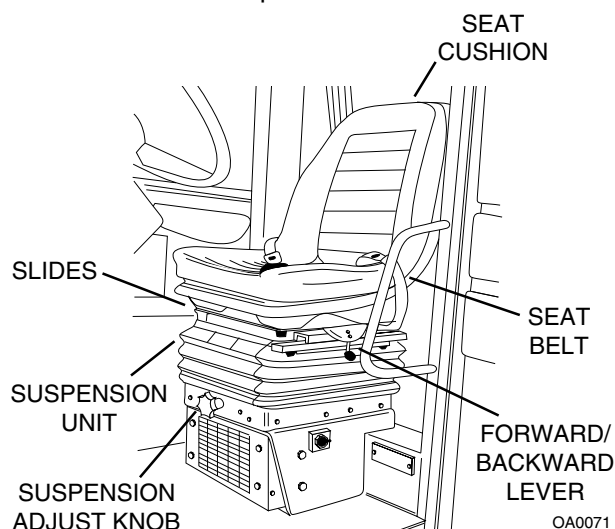


Fig. 4.1 Seat

4.2 MECHANICAL HAND CONTROLS

Mechanical hand controls in the operators cab are shown in Fig. 4.2.

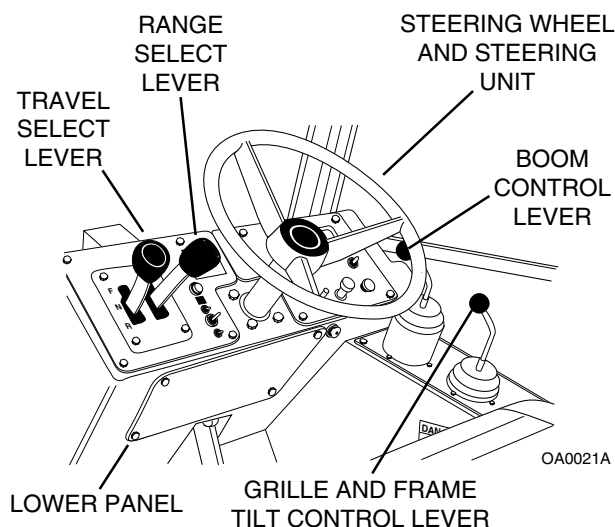
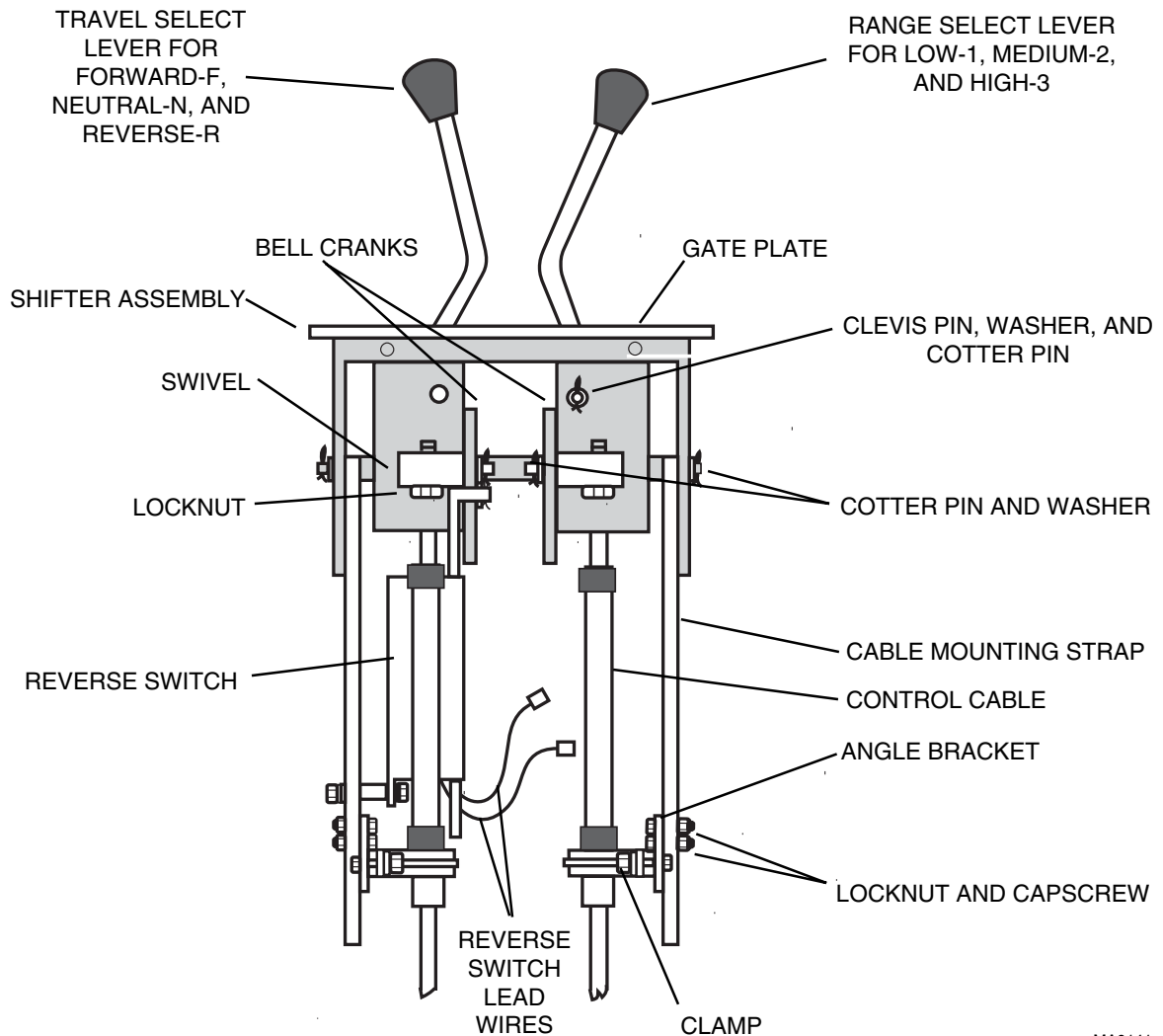


Fig. 4.2 Mechanical Hand Controls



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Fig. 4.3 Shifter Assembly

4.2.1 Steering Wheel and Steering Unit

The steering wheel changes the direction of forklift travel in two-wheel, four-wheel, or crab steering modes as designated by the steering select switch. Refer to your Owners/Operators Manual for a description of these steering modes.

The wheel is attached to the steering unit with a nut that must be torqued to 50 lb-ft (68 Nm). The steering unit is attached to the control console with four flange-head screws and lock washers.

4.2.2 Travel Select and Range Select Levers

Use the travel select lever to place transmission in Forward-F, Neutral-N, and Reverse-R and the range select lever to select Low-1, Medium-2, and High-3 gears.

The levers are mounted in a transmission shifter assembly, Fig. 4.3. A cable attached to each lever

terminates at a linkage which moves a spool in the transmission control valve.

a. Transmission Shifter

Removal

1. Remove lower panel, Fig. 4.2, below the control console.
2. Remove the clamps that secure the control cables to the angle brackets.
3. Remove the cotter pins and washers that attach the swivels to the bellcranks. Label and remove the cables from the shifter assembly, Fig. 4.3. Remove the swivel from the end of each cable by turning it counterclockwise.
4. Disconnect the reverse switch red and black lead wires from the wiring harness.
5. Remove the shifter assembly from the control console.

Maintenance

1. Prepare to clean and lubricate the spring, disk and ball in each travel and range select lever mechanism by removing the cotter pins, washers and clevis pins that secure each lever to the shifter assembly. Remove the levers from the shifter assembly.
2. Clean each lever spring, disk, and ball with an approved solvent. Replace defective or damaged parts as required. Apply a multi-purpose grease to each disk, spring, and ball.
3. Install the spring, disk and ball in the shifter assembly.

Installation

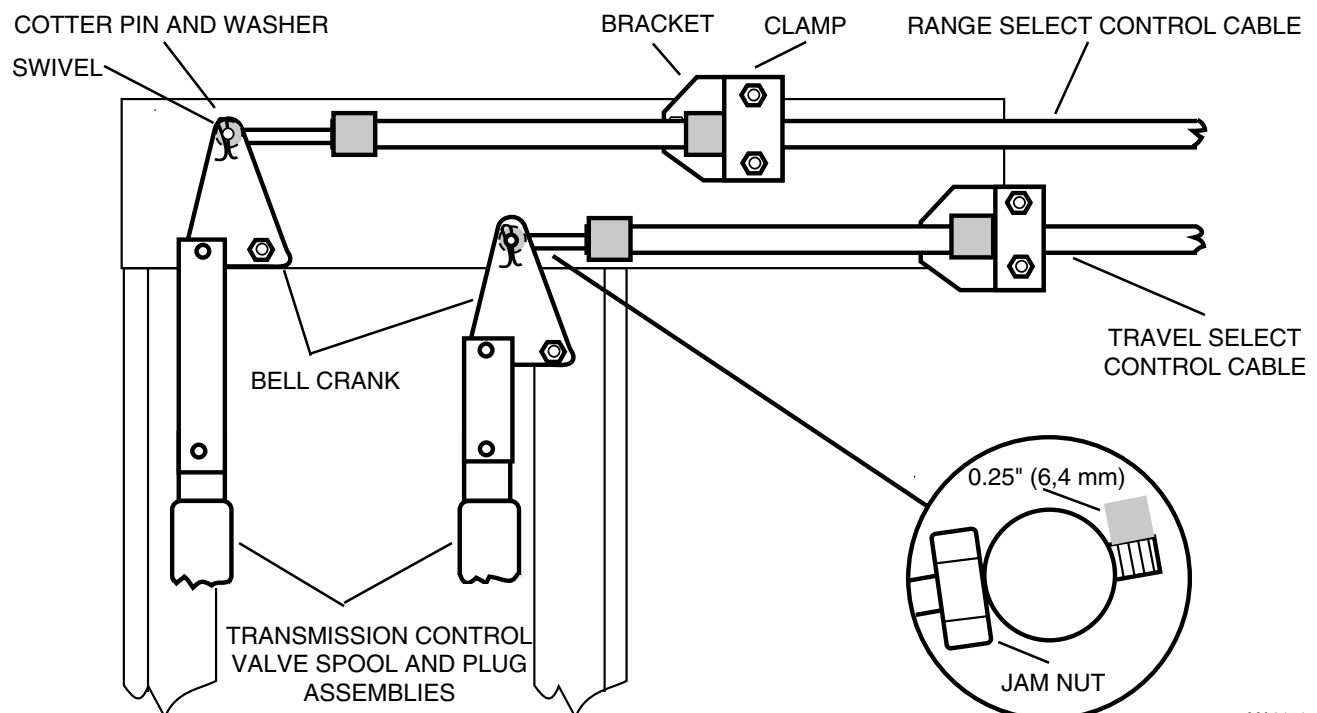
1. Install the shifter assembly on the control console.
2. Connect the reverse switch wires to the wire harness by connecting the red switch wire to red harness wire 24 and the black switch wire to yellow harness wire 31.
3. Use washers and cotter pins to connect the specific cable with swivels to the appropriate bellcranks.
4. Secure the control cables to their respective angle brackets with clamps.
5. Install the lower panel on the control console.

b. Transmission Cable**Removal**

1. Remove lower panel below control console.
2. Remove the clamp that secures control cable to angle bracket, Fig. 4.3.
3. Remove cotter pin and washer that attach the swivel to the shifter assembly bellcrank and remove the swivel with cable from the lever.
4. Remove the swivel from end of each cable.
5. Remove the transmission cover.
6. Remove the cotter pin and washer, Fig. 4.4, that attach the cable connecting the swivel to the bellcrank and remove the swivel with cable from the bellcrank.
7. Remove the swivel from the cable by turning it counterclockwise.

Installation

1. Thread jam nut and swivel on rod end as shown and connect swivel to bellcrank using a washer and a cotter pin, Fig. 4.4.
2. Tighten jam nut.
3. Place travel and range select levers in their middle positions—N and 2.
4. With transmission spools in center position, install clamp into groove on cable and secure clamp to bracket.

**Fig. 4.4 Transmission Control Valve Cable**

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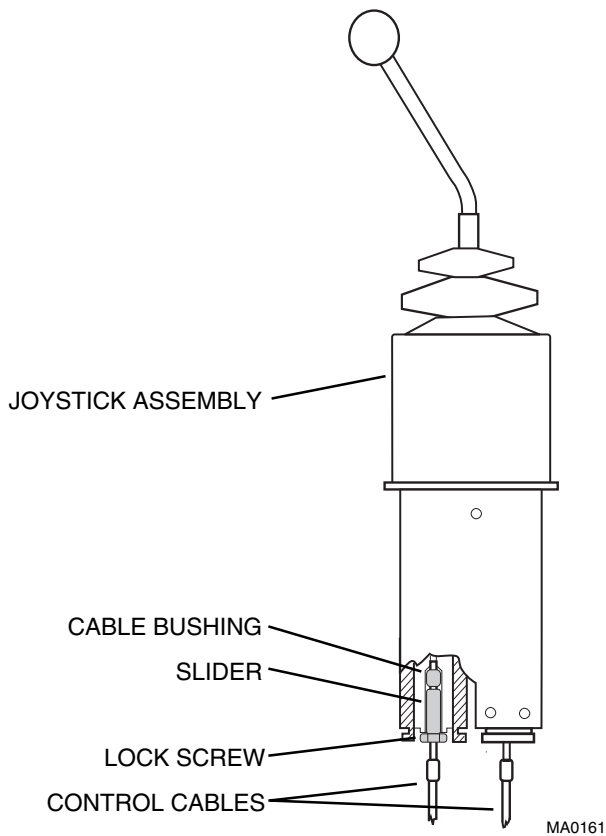


Fig. 4.5 Joystick Assembly With Covers Removed

5. Assemble the other end of each cable, Fig. 4.3, by installing the swivel on the cable by turning it clockwise. Position each swivel so it lines up with the hole in each bellcrank.
6. Install the swivel by using a washer and a cotter pin.
7. Clamp the cable to the angle bracket.
8. Install the transmission cover and lower panel.

4.2.3 Boom Control and Grille and Frame Tilt Joysticks

The Boom Control Joystick raises, lowers, retracts, and extends the boom. The Grille / Frame Tilt Joystick tips the carriage up or down and tilts the frame left or right. See the Owners/Operators Manual for operational descriptions.

A control cable attached to each joystick assembly, Fig. 4.5, terminates at a valve section on the main control valve, Fig. 4.6.

a. Joystick Assembly

Removal

1. Remove the lower panel which is located below the side console.
2. Remove the covers from the joystick assembly, Fig. 4.5.
3. Loosen the lock screws until the control cables, with lock screws and cable bushings, can be removed from the sliders.
4. Remove the joystick assembly from the side console panel.

Installation

1. Install joystick assembly in side console panel.
2. Install the control cables in the sliders.
3. Tighten the slider lock screws holding the sliders in position with a 5/8 inch open-end wrench.

IMPORTANT: Do not exceed 55 lb-ft (75 Nm); DO NOT let slider rotate during this step. It could damage other internal parts of the joystick.

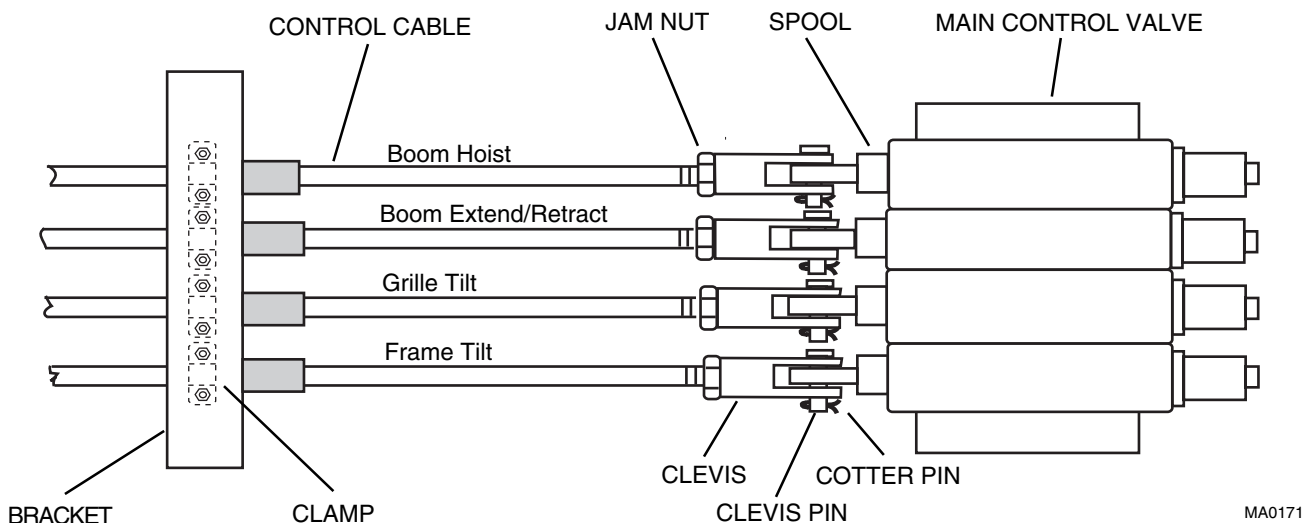


Fig. 4.6 Boom Control and Grille and Frame Tilt Control Lever Connections

4. Install the covers on the joystick assembly.
5. Install the lower panel.

b. Joystick Control Cables

Removal

1. Remove the lower panel which is below the side console.
2. Remove the covers from the joystick assembly, Fig. 4.5.
3. Loosen the lock screw until the control cable, with lock screw and cable bushing, can be removed from the slider.
4. Unthread cable bushing from cable and remove lock screw from cable.
5. Remove the transmission cover.
6. Remove the clamp, Fig. 4.6, that secures the control cable to the bracket on the forklift frame.
7. Remove the cotter and clevis pin that attaches the control cable to the spool on the main control valve.
8. Remove the clevis and jam nut from cable end.
9. Remove the cable from the forklift.

Installation

1. Route the control cable between the joystick and the main control valve.
2. Secure the cable to the main control valve spool, Fig. 4.6, with clevis and cotter pins.
3. At the other end of the cable, slip the lock screw over the cable rod end.
4. Thread the cable bushing onto the cable rod end and position it as shown in Fig. 4.5.
5. Insert the cable into the control slider. Then thread the lock screw into the slider.
6. Use a 5/8 inch open end wrench to hold the slider in position and tighten the slider lock screw; work carefully so you don't rotate the slider.

IMPORTANT: Do not exceed 55 lb-ft (75 Nm).

7. Adjust the cable at both ends so that it operates properly.
8. Replace the covers on the joystick assembly.
9. Install the lower panel below the side console.
10. Install the transmission cover.

4.3 ELECTRONIC JOYSTICK

4.3.1 Troubleshooting (without TLC)

All 6036 Sky Traks equipped with an electronic joystick (except Total Load Control, "TLC", equipped machines) that exhibit any of the following symptoms must be checked for proper calibration. Refer to SKY TRAK TLC System Maintenance Manual for forklifts equipped with TLC.

1. Boom Speeds do not meet specified times.
 - Boom Raise – less than 14 seconds
 - Boom Lower – less than 10 seconds
 - Boom Extend – less than 15 seconds
 - Boom Retract – less than 15 seconds
2. Poor boom "feathering or inching" capabilities. Appears most often in the Boom Lower mode.
3. Co-ordinated boom functions (operating two functions at once) slow down when RPM is increased or there is an extremely narrow band of co-ordinated boom operation in one mode only. Appears most often in the Boom Raise/Extend mode.

Check the calibration of the electronic joystick if a machine exhibits any of the above symptoms. The following procedures will guide you through the proper calibration procedures. Read through these procedures completely before making any adjustments.

4.3.2 Visual Inspection

1. Shut OFF the forklift engine. Make certain the parking brake is engaged.
2. Remove capscrews securing access cover to side of console.
3. Remove four capscrews securing the cover to the side console.
4. Carefully lift the cover, with joystick still attached, up and over the Fork/Frame Tilt joystick and place in a stable position which exposes the bottom of the joystick.
5. Check electrical connections at connector strips on the underside of joystick (Fig. 4.7) for looseness. Tighten loose connections.
6. If no further checks or repair are necessary, position joystick and cover in console and install capscrews (to secure). Install access cover and secure with capscrews.

4.3.3 Electronic Joystick Calibration (without TLC)

Locate the forklift in an area where the boom can be safely operated in all positions, out-of-doors and clear of power lines. A small screwdriver with a 3 inch long shank and a 1/8 inch wide blade will be required.

Carefully remove the four plastic caps located on the left side of the right console below the electronic joystick, Fig. 4.8. These holes provide access to the driver modules calibration adjustments.

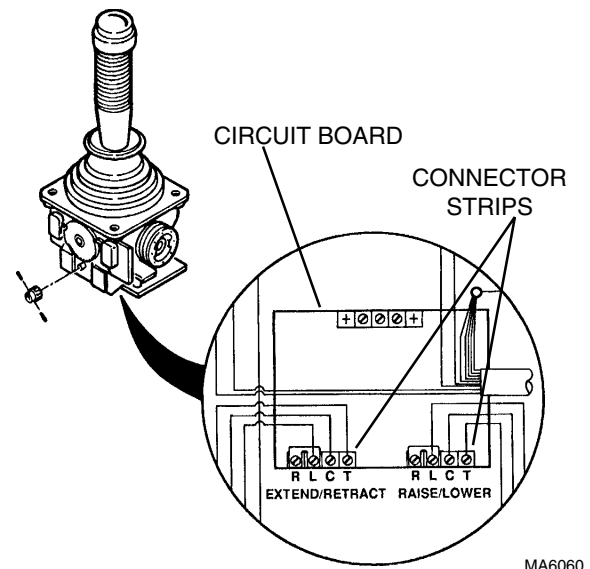
IMPORTANT: The driver module adjustment screws turn very easily and less than one full turn. **DO NOT** use excessive force when turning these screws, as they can be damaged very easily!

With the forklift engine shut off, try locating the four adjustment screws; a flashlight aimed through the holes will help in locating the screw slots. Very carefully turn each adjustment screw clockwise and then counterclockwise, observing the left and right stop positions of each adjustment screw. **DO NOT** force the screws past their left and right stop positions. If any of the stops are non existent the driver module will not function properly and must be replaced.

While the machine is shut off, observe the following functions of the joystick. When you move the joystick forward (boom lower) or to the right (boom extend) listen very carefully and you will hear two switch "clicks". You are now familiar with the components used to calibrate the electronic joystick. A second person will make the job easier.

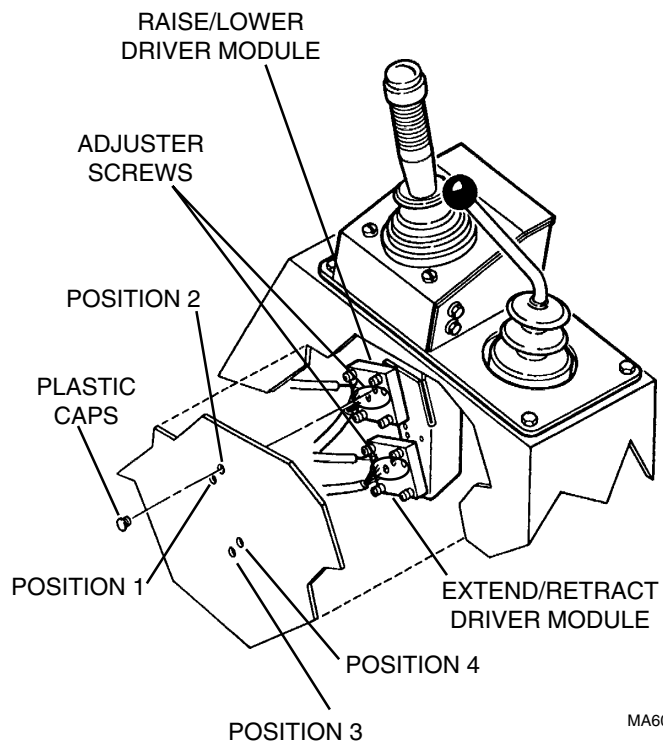
NOTE: You will hear only one switch "click" when the joystick is moved into the boom raise and boom retract positions. These joystick positions are not used during calibration.

To calibrate the Raise/Lower functions, proceed as follows:



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Fig. 4.7 Electrical Connections



MA6070

Fig. 4.8 Adjuster Screws

1. Through the top two adjusting screw holes you will calibrate the Raise/Lower functions, Fig. 4.8.
 - Adjustment screw through hole Position 1 will adjust the maximum amount of oil available (speed) to move the hoist cylinders (on later joysticks this adjuster has been sealed in the maximum speed position and cannot be adjusted, skip step 2).
 - Adjustment screw through hole position 2 calibrates the dead band (feathering) for the Raise/ Lower function.
2. With the engine OFF, through adjustment screw hole Position 1, use the small screw-driver and turn the screw fully clockwise. DO NOT use excessive force when turning the adjustment screw!
3. Start the engine and raise the boom to 50 degrees and SHUT OFF the engine. Move the joystick just past the second "click" of the forward (boom lower) position and hold the joystick in this position for the remainder of this procedure. Have your helper prepare to make the adjustment at the adjustment screw hole position 2. Start the engine and start turning the adjustment screw very slowly. Stop turning the adjustment screw when the boom just starts to move down. DO NOT use excessive force when turning the adjustment screw!
4. The Raise/Lower function is now calibrated. Lower the boom to a horizontal position and shut off the engine.

To calibrate the Extend/Retract functions, proceed as follows:

1. Through the bottom two adjusting screw holes you will calibrate the Extend/Retract functions, Fig. 4.8.
 - Adjustment screw through hole position 3 will adjust the maximum amount of oil available (speed) to move the Extend/ Retract cylinder (on later joysticks this adjustment has been sealed in the maximum speed position and cannot be adjusted, skip step 2).
 - Adjustment screw through hole Position 4 calibrates the dead band (feathering) for the Extend/Retract function.
2. With the engine OFF, through adjustment screw hole position 3, use the small screw-driver and turn the screw fully clockwise. DO NOT use excessive force when turning the adjustment screw!
3. Move the joystick to the right (boom extend) just past the second "click" and hold the joystick in this position for the remainder of this procedure. Have your helper prepare to make the adjustment at the adjustment screw hole Position 4. Start the engine and start turning the adjustment screw very slowly. Stop turning the adjustment screw when the boom just starts to move forward. DO NOT use excessive force when turning the adjustment screw!
4. The Extend/Retract function is now calibrated. Recheck joystick operation for the same symptoms as listed in paragraph 4.3.1. "Trouble Shooting".
5. Replace all four plastic caps if calibration was successful and resume operation.

Following the procedures very carefully should result in proper calibration of the joystick. If joystick still does not perform properly, repeat the above procedures one more time.

The symptom of slow boom speed may not have been corrected by the above calibration. If not, perform the "Joystick Resistance Check" and "Adjustment" procedures that follow.

4.3.4 Joystick Resistance Check (without TLC)

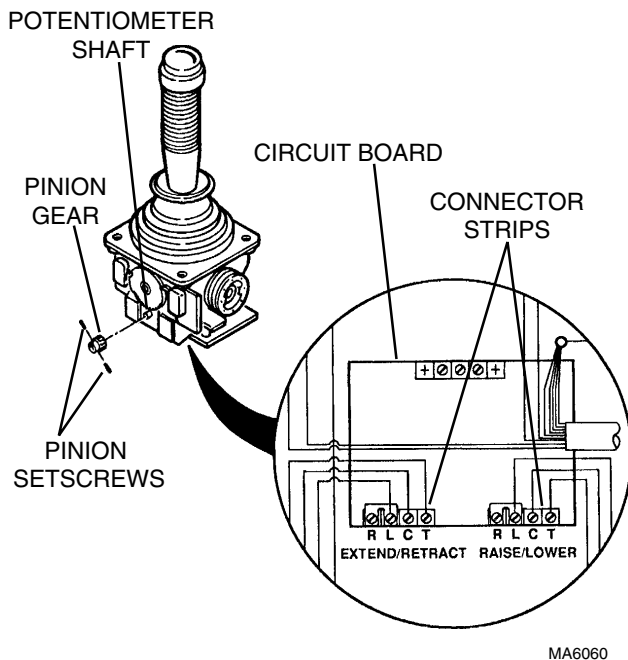


Fig. 4.9 Joystick Resistance and Adjustment

1. Shut off engine.
2. Remove the four screws that secure the joystick mounting cover to the right side console.
3. Carefully lift the cover, with joystick still attached, up and over the Fork/Frame tilt joystick and place in a stable position which exposes the bottom of the joystick.
4. On both connector strips attached to the bottom of the joystick circuit board, disconnect the grey wires from terminal connections "T" and the yellow wires from terminal connections "C".
5. Connect an ohmmeter between the "T" and "C" terminals on the Raise/Lower connector strip, Fig. 4.9. Move the joystick handle fully into the boom raise position until a resistance reading is measured on the ohmmeter. Record this reading. Move the joystick fully into the boom lower position. Record this reading.

6. Connect the ohmmeter between the "T" and "C" terminals on the extend/retract connector strip, Fig. 4.9. Move the joystick handle fully into the boom extend position until a resistance reading is measured on the ohmmeter. Record this reading. Move the joystick fully into the boom retract position. Record this reading.
7. If any of the resistance readings are below 1950 ohms minimum or the relationship between the two readings that were taken in step 5 (raise/lower) or in step 6 (extend/retract) is more than 100 ohms apart; the joystick potentiometer(s) zero point must be reset. Follow procedures below to make this adjustment.

If all resistance readings are at or above the 1950 ohms minimum and the raise/lower and extend/retract readings are within 100 ohms of each other, no adjustment is necessary. Follow procedures 8 thru 10 in the next set of steps to remount the joystick.

4.3.5 Joystick Resistance Adjustment (without TLC)

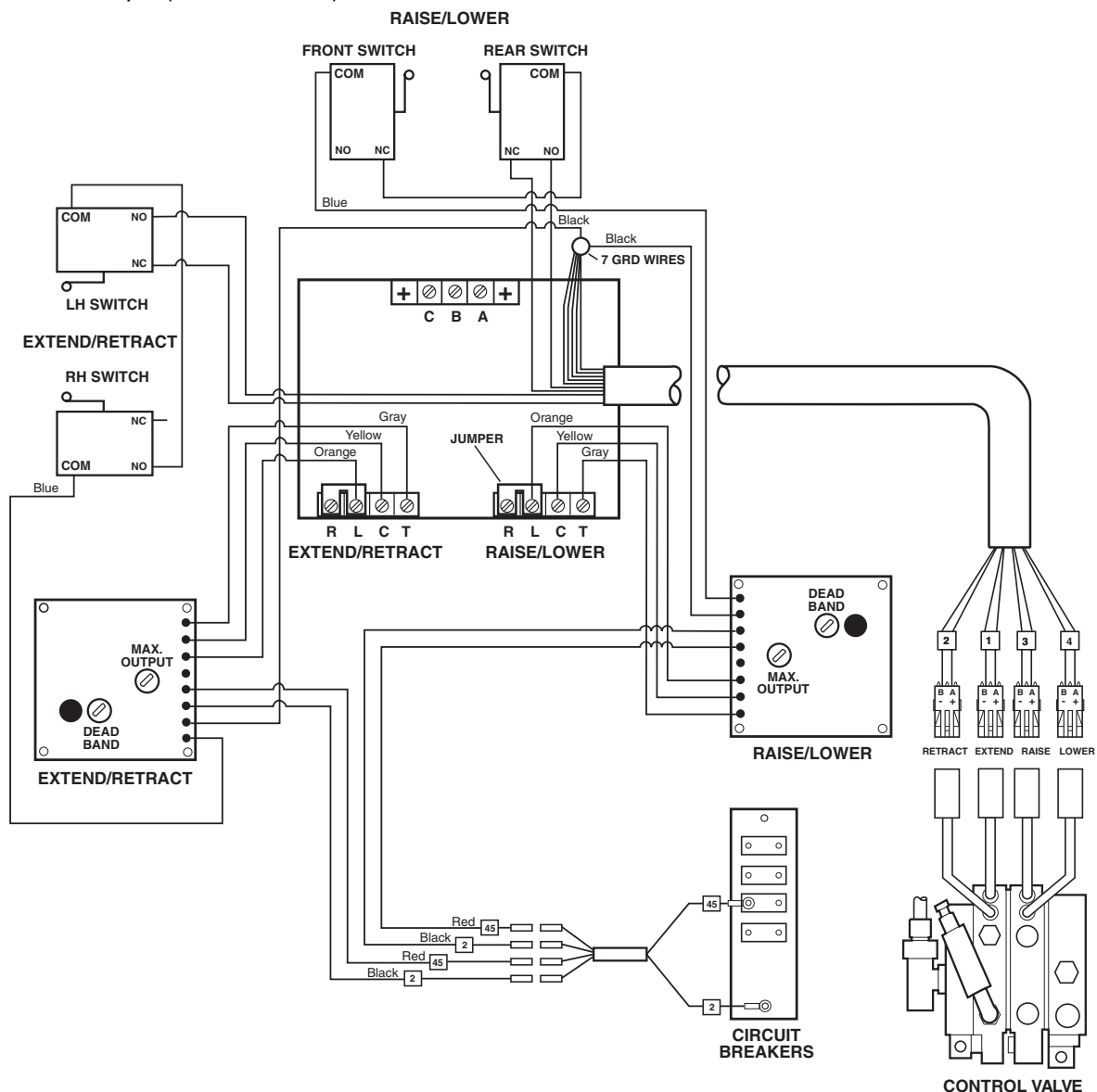
1. Loosen the two setscrews on the small pinion gear and remove the pinion gear from the potentiometer shaft, Fig. 4.9, (the setscrews will require a 1,5 mm allen wrench).
2. Connect the ohmmeter to terminals "T" and "C" of the respective function being adjusted.
3. Turn the potentiometer shaft, by hand, until the resistance reading is as close to (0) zero as possible.
4. Without turning the potentiometer shaft, replace the pinion gear and tighten only one setscrew in place.
5. Move the joystick handle in the respective direction of the functions being tested. Check the resistance readings in both directions. Both readings must be above 1950 ohms and must be within 100 ohms of each other. Repeat these procedures until the proper readings are reached.
6. Repeat procedures 1 thru 5 above if the zero point on the other potentiometer requires adjustment.
7. After the potentiometer(s) have been adjusted properly, tighten both pinion gear setscrews.

8. Reconnect the wires from the upper drive module (raise/lower) and lower drive module (extend/retract) to the appropriate connector strips as follows, Fig. 4.10.
 - Gray wire to terminal "T".
 - Yellow wire to terminal "C".
9. Remount the joystick mounting cover to the right side console.
10. Recheck boom speeds. If boom speeds are still not within the specified times, pressure settings in the hydraulic system must be checked. Verify that boom raise, boom lower and boom retract relieve at 2850 ± 50 psi ($196,4 \pm 3,4$ bar). Boom extend should relieve at 2850 ± 50 psi ($196,4 \pm 3,4$ bar).

4.3.6 Electronic Joystick Removal and Replacement without TLC

The following instructions describe how to remove and replace an electronic joystick without TLC (Total Load Control). For a forklift with TLC refer to the SKY TRAK TLC System Maintenance Manual.

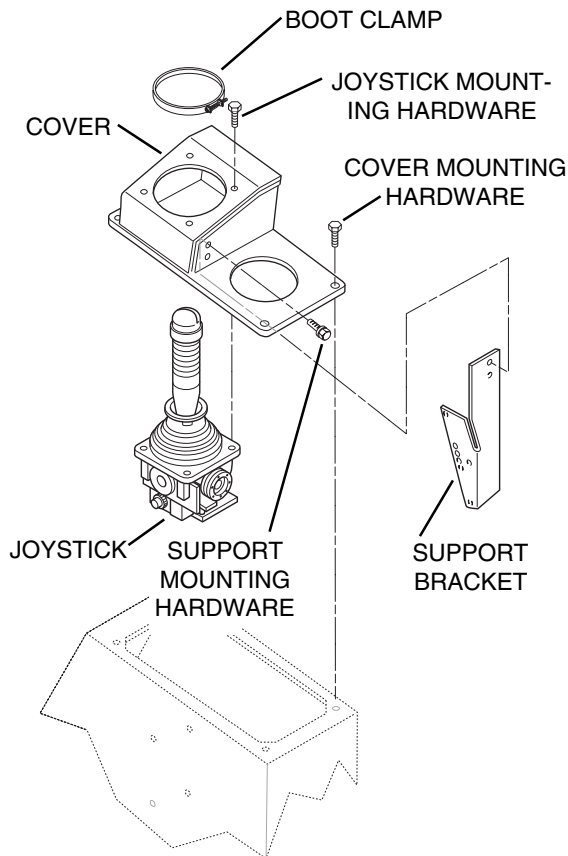
1. Disconnect negative (–) cable from batteries.
2. Remove capscrews from joystick console cover, Fig. 4.11.
3. Lift cover with joystick attached and secure in raised position to assist in removal. Be careful to avoid pulling harness connections apart when lifting joystick and cover.



PA1123b

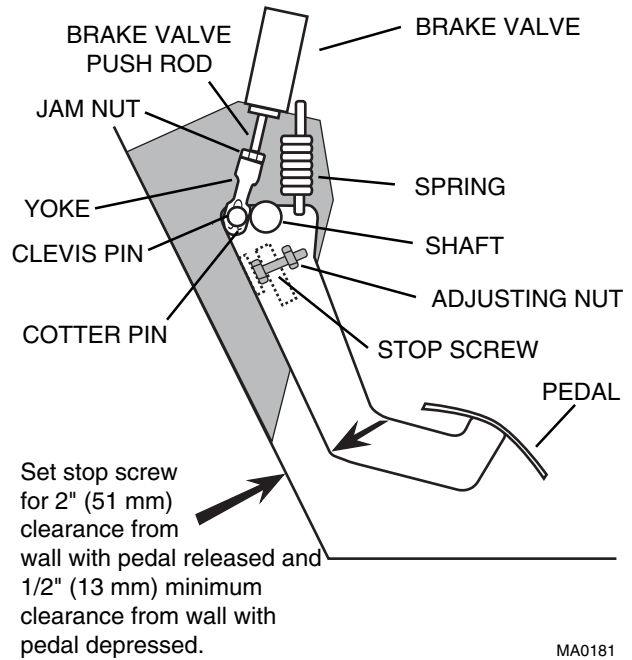
Fig. 4.10 Joystick Wiring Connections for Forklift Without TLC as Viewed from the Bottom of the Joystick

4. Remove driver module support bracket from console cover, Fig. 4.11.
5. Remove joystick weather boot clamp, Fig. 4.11.
6. Remove joystick mounting screws and separate joystick from console cover.
7. Tag and disconnect electrical leads from joystick, Fig. 4.10.
8. Reconnect the wires as shown in Fig. 4.10.
9. Remove joystick weather boot clamp from new joystick and assemble new joystick to console cover.
10. Reinstall weather boot clamp, Fig. 4.11.
11. Reconnect driver module support bracket to console cover.
12. Remount the joystick mounting cover to the right side console.
13. Connect negative (–) cable to batteries.
14. Check "Electronic Joystick Calibration" as described in paragraph 4.3.2.



MA6030

Fig. 4.11 Joystick Removal and Replacement



MA0181

Fig. 4.12 Service Brake Pedal

4.4 MECHANICAL FOOT CONTROLS

4.4.1 Service Brake Pedal

When you press the service brake pedal you activate a brake valve that applies the hydraulic service brakes. The service brake pedal pivots on a shaft and is held in the raised position by a spring.

a. Removal

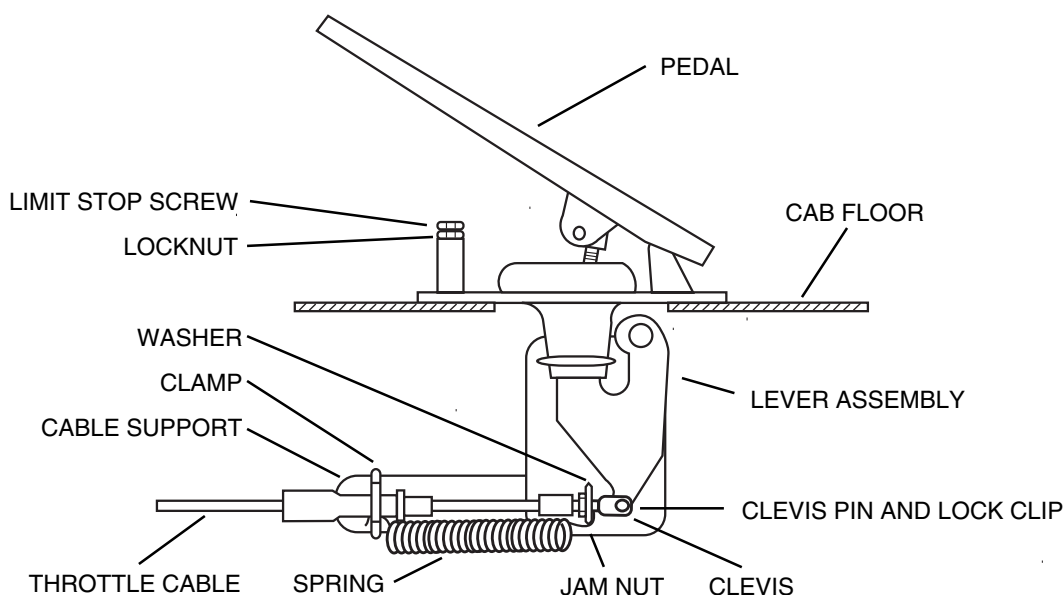
1. Remove the lower panel below the control console.
2. Remove the cotter pins and clevis, Fig. 4.12, that secures the brake valve yoke to the brake pedal.

NOTE: Brake valve push rod will slip out of brake valve at this point. Remove push rod with yoke attached.

3. Remove the spring from the pedal.
4. Remove one capscrew, washer and nut that attaches pedal shaft to mounting frame. Slide shaft out of pedal and remove pedal and flat washers.

b. Installation

1. Lubricate the shaft, Fig. 4.12, with multi-purpose lithium based grease. Install shaft through mounting frame, flat washer, pedal, flat washer and mounting frame. Secure in place with capscrew and nut.



MA0191

Fig. 4.13 Throttle Pedal

2. Install the spring on the pedal and hook the other end over the support inside the console.
3. Slide push rod into brake valve and secure the yoke to the pedal with clevis and cotter pins.
4. Check the brake valve capscrews to be sure they are torqued to 30 lb-ft (40,8 Nm).
5. Adjust the pedal as described in paragraph c.
6. Install the lower panel below the control console.

c. Adjustment

1. Remove the lower panel below the control console.
2. Fully depress the brake pedal and set push rod for 1/2" (13 mm) minimum clearance under pedal arm as shown in Fig. 4.12.
3. Release brake pedal and adjust the adjusting nut, Fig. 4.12, so the pedal is 2" (51 mm) from the front cab wall. Depress the pedal. It must not contact the cab wall.
4. Adjust push rod so it does not depress brake valve piston completely. There must be 1/2" (13 mm) clearance between the end of the rod and the piston. Tighten the rod jam nut to 30 lb-ft (40,8 Nm) when adjustments are complete.

4.4.2 Throttle Pedal and Cable

The throttle or accelerator pedal increases engine rpm. A throttle cable connects it to a throttle and stop lever on the engine fuel pump, Fig. 4.14. A spring returns it to the raised position.

a. Throttle Pedal Assembly**Removal**

1. Working beneath the operator's cab, remove the spring, Fig. 4.13, from between the pedal clamp and the clevis.
2. Remove the clevis pin and lock clip attaching the clevis to the throttle lever assembly.
3. Remove the clamp attaching the throttle cable to the cable support.
4. Working from inside the cab, remove the three bolts, lock washers, and nuts attaching the pedal to the cab floor.
5. Remove the pedal from the floor.

Installation

1. Secure the pedal, Fig. 4.13, to the floor with three bolts, lock washers, and nuts.
2. Attach the cable to the support with a clamp.
3. Fasten the clevis to the lever assembly with the clevis pin and lock clip.
4. Hook one end of the spring around the pedal clamp and the other end around the neck of the clevis, Fig. 4.13.
5. Check that all connections are secure.
6. If necessary, adjust the pedal limit stop as follows:

Adjustment

1. Lightly depress the throttle pedal to full position.

2. Adjust the limit stop screw until it touches the pedal.
3. Tighten the locknut to 120 to 125 lb-inch (13,6 to 14,1 Nm).
4. Check engine rpm at full throttle. If not 2600 to 2860 rpm, readjust the limit stop screw.

IMPORTANT: During the full throttle check

- operate no hydraulic function,
- do not steer, and
- be sure the transmission is in neutral.

b. Throttle Cable

Removal

1. Working beneath the operator's cab, remove the spring, Fig. 4.13, from between the pedal clamp and washer on the clevis.
2. Remove lock clip and clevis pin that attaches the clevis to the throttle lever assembly.
3. Remove the clamp attaching the throttle cable to the cable support. Remove short clevis, washer, and jam nut from the cable end.
4. Open the right side engine access door.
5. Remove the round head screws attaching the clamp, Fig. 4.14, to the throttle cable bracket. Remove the clamp from the bracket.
6. Remove the cotter pin, clevis pin and two washers attaching the throttle cable clevis to the engine stop and throttle lever, Fig. 4.14.

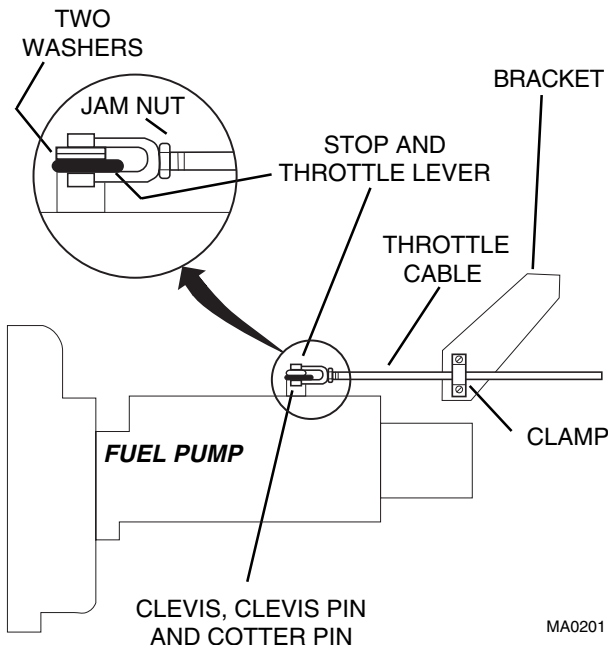


Fig. 4.14 Throttle Cable Engine Connection

7. Remove the long clevis and jam nut from the cable end.
8. Remove the throttle cable from the forklift.

Installation

1. Thread jam nut and long clevis completely onto one end of the cable. Thread a jam nut, washer and short clevis completely on the other end of the cable. Further adjustment on the rod end will be required after the cable is installed.
2. Secure long clevis end of throttle cable to the engine stop and throttle lever, Fig. 4.14, with clevis pin, washers and cotter pin. Be sure both washers are positioned between clevis and above engine stop and throttle lever.
3. Install the cable in the clamp and secure the clamp on the throttle cable bracket with round-head screws.
4. Route cable on forklift to throttle panel under floor of operator cab.
5. Attach the short clevis end of the cable to the support with a clamp, Fig. 4.13.
6. Fasten the short clevis to the lever assembly with a clevis pin and lock clip.
7. Clamp cable to cable support.
8. Hook one end of the spring around the pedal clamp and the other end around the neck of the clevis, Fig. 4.13.
7. Check that all connections are secure.
8. If necessary, adjust the pedal limit stop as described in the following paragraph.
9. Close and lock right side engine access door.

Adjustment

1. Lightly depress the throttle pedal to full position.
2. Adjust the limit stop screw until it touches the pedal.
3. Tighten the locknut to 120 to 125 lb-inch (13,6 to 14,1 Nm).
4. Check engine rpm at full throttle. If it is not between 2600 and 2860 rpm, readjust the limit stop screw.

IMPORTANT: During the full throttle check

- operate no hydraulic function,
- do not steer, and
- be sure the transmission is in neutral.

4.5 REAR VIEW MIRRORS

The forklift has two rear view mirrors.

- A 6-1/2 by 10" flat glass mirror on the cab frame to the left of the operator.
- A 6-1/2 by 6" convex glass mirror on the forklift frame to the right of the operator.

The mirrors have an outer gasket for edge shock protection. If a mirror shatters, a replacement mirror can be installed in the mirror head.

4.5.1 Mirror Head Adjustment

A "preset" locates the "home" position for each mirror. When you swing a mirror outward a detent locks the mirror in your preset viewing position. This reduces the need for frequent mirror adjustment.

You can swing the mirror assembly inboard to reduce overall vehicle width for parking in tight areas; the mirror will also pivot inboard upon impact.

Adjust mirror "preset" as follows:

IMPORTANT: Before attempting to reposition a mirror on a forklift which has just been received from the factory, loosen the bottom nuts to permit loop and mirror adjustment.

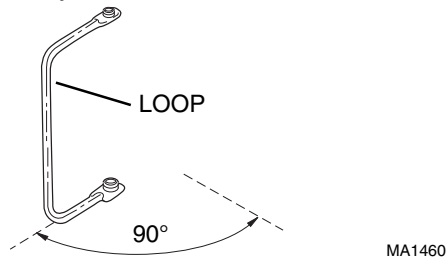


Fig. 4.15 Position Loop 90° from Side of Forklift

1. Position the loops so they extend from the side of the forklift, Fig. 4.15.
2. Adjust mirror heads for proper view. Evaluate view from operator's seat; change loop angle and readjust each mirror if necessary.

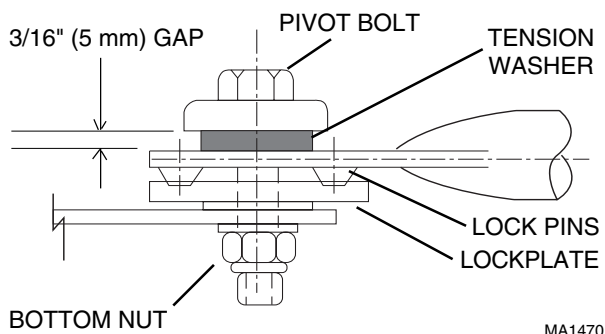


Fig. 4.16 Tighten Pivot Bolt to Provide a 3/16" (5 mm) Gap

3. Tighten "preset" pivot bolt to a 3/16" (5 mm) gap as shown in Fig. 4.16.

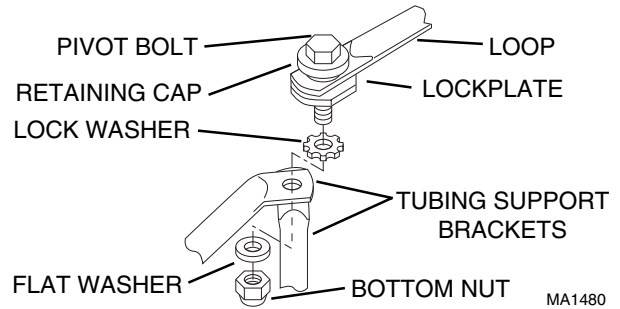


Fig. 4.17 Tighten Bottom Nut While Holding Pivot Bolt Stationary

4. Be sure lock pins are seated in lock plate as shown in Fig. 4.17. Tighten bottom nut while holding pivot bolt stationary. Then torque bottom nut 250 to 300 lb-inch (28 to 34 Nm). This will lock the "preset" to its "home" position. The effective torque value for your mirror could vary slightly. The nut must be tight enough to prevent the lock plate from rotating; it must hold the mirror assembly in position under forklift operating conditions and allow the mirror to pivot freely when moved by hand.
5. Check "preset" function by rotating loop back and forth. A definite click will be heard and felt as the loop is rotated past the "home" position.
6. Return loop to "home" position. The loop should snap firmly into place and the lock pins should be firmly located in the holes of the lock plate.

NOTE: Use all weather grease periodically on the lock pins to maintain smooth operation.

4.5.2 Mirror Cleaning and Inspection

1. The mirrors must be properly adjusted. They must be kept free from condensation, frost, ice, snow, dust and dirt. Rinse heavy grit from mirror before you clean it with glass cleaner and dry it with a soft cloth.
2. Be especially careful when removing ice from mirror to avoid breaking or scratching mirror. You can use a nonmetallic scraper, heat or an approved chemical to lower the freezing point of the ice to aid in ice removal.
3. Return each mirror to "home" position after cleaning.
4. Replace mirror glass if broken, damaged or missing (the concave surface of the convex mirror has a 21" radius).
5. Replace mounting hardware if damaged or missing.

Notes

SECTION 5

WHEEL ASSEMBLY, TIRES, AND AXLE

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5.1 WHEEL ASSEMBLY AND TIRE



Warning

Whenever you remove tire(s) and wheel(s) from forklift:

- Position forklift on a flat, hard surface and support forklift with approved jack stands.
- Use appropriate safety glasses, safety shoes and appropriate clothing and equipment.
- Do not wear rings or jewelry or use clothing or hair styles that could become caught in machinery or pinch points such as those created between tire and hub.
- Allow no one to be under forklift or near drive line when engine is operating or drive line is in motion because clothing and limbs could be caught by and drawn into drive line resulting in serious personal injury or death.
- Deflate tire completely before servicing as specified in paragraph 5.1.1.
- Use specialized tools for mounting and demounting tires. These include 18 and 36 inch bead unseating tools, tire irons, a mallet for unseating beads, a wire brush, a remote control inflation line with clip-on chuck so operator may stand aside during inflation, and an air/water pressure gauge that operator can observe during inflation.
- Use safety cage or enclose tire in safety chains when inflating a newly mounted tire or deflating a tire.
- Inflate tire to manufacturer's recommended cold operating pressure.
- Use only approved tire mounting lubricant; never use antifreeze, silicones or petroleum base lubricants.
- Be sure rim diameter exactly matches rim diameter molded on tire. Clean and inspect rim.
- Inspect inside of tire for dirt, foreign material, loose cords, cuts, penetrating objects, and other carcass damage; discard tires with unreparable damage.

The forklift may have standard or optional wheels and tires.

- 13.00 - 24, 10 ply tires and three piece 8.00 - 24 TGF wheels (S/N OF1191 & Before)
- Standard 13.00 - 24, 10 ply tires and one piece 9.00 - 24 wheels (S/N OF1192 & After)
- Optional 15.00 x 19.5, 12 ply tires and one piece 12.5 x 19.5 wheels.

The tires are filled with air and hydrofill which is a calcium chloride and water solution. Super large bore TR618A valve stems expedite inflation and deflation or evacuation. A special core housing ejector tool is used for inflating and evacuating. A hose connects the ejector tool to a pump and a barrel or reservoir of the calcium chloride solution, and an air/water pressure gauge.

IMPORTANT: Mount tire so it will rotate in the direction of arrow on side wall of tire, Fig. 5.1. Position tire on wheel so tire will rotate in direction of arrow. This mounting requirement produces Left Side and Right Side Tire and Wheel Assemblies.

When filling or evacuating a tire:

- position valve stem at its highest or top position when filling tire;
- position tire with valve stem at its lowest or bottom position when evacuating a tire.

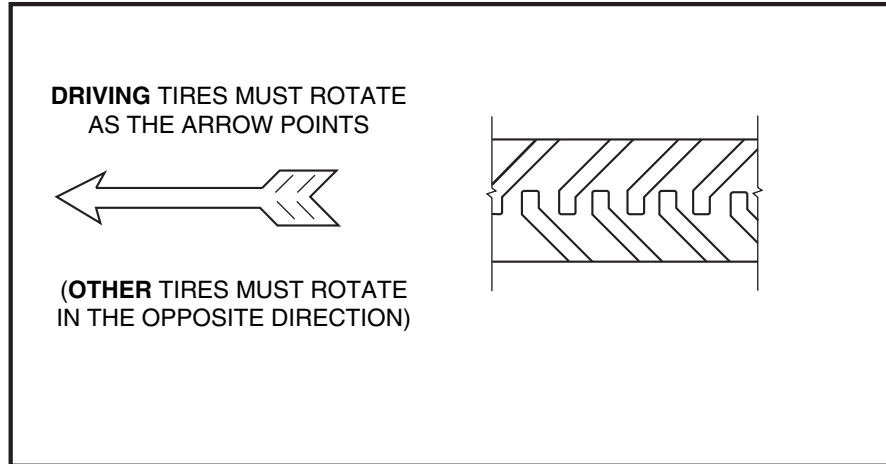
Check tire inflation with valve at the top of a hydrofill or liquid filled tire when tire is cold and before forklift is operated. A tire that has sufficient pressure when hot may be underinflated when it cools.



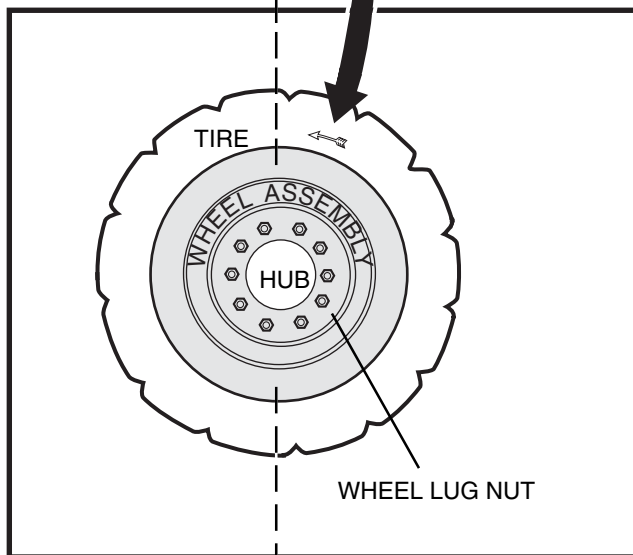
Warning

- NEVER operate forklift without hydrofill in tires.
- NEVER attempt to unseat the beads of an inflated tire.
- NEVER reinflate a tire that has been run flat or seriously underinflated without removing tire from wheel and checking for tire and rim damage.
- NEVER hit a tire or rim with a hammer or sharp object.
- NEVER rework, weld, heat, or braze a rim.

SOME TIRES HAVE THIS INSTRUCTION EMBOSSED IN SIDE WALL:



VALVE POSITION FOR FILLING
TIRE WITH HYDROFILL AND
AIR AND CHECKING TIRE
PRESSURE

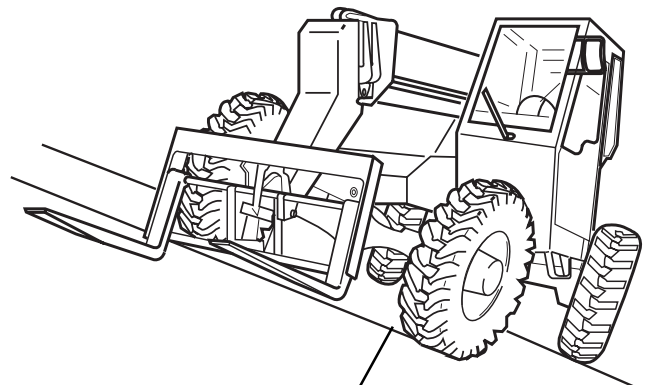


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VALVE POSITION FOR DRAINING
HYDROFILL FROM TIRE

ARROW POINTS TO RIGHT
ON BOOM SIDE OF FORKLIFT

MA0212



MA0214

NOTE DIRECTION OF
TREAD PATTERN

ARROW POINTS TO LEFT
ON CAB SIDE OF FORKLIFT

MA0213

Fig. 5.1 Tire Direction of Rotation and Valve Stem Positions for Tire Pressure Check, Fill and Evacuate

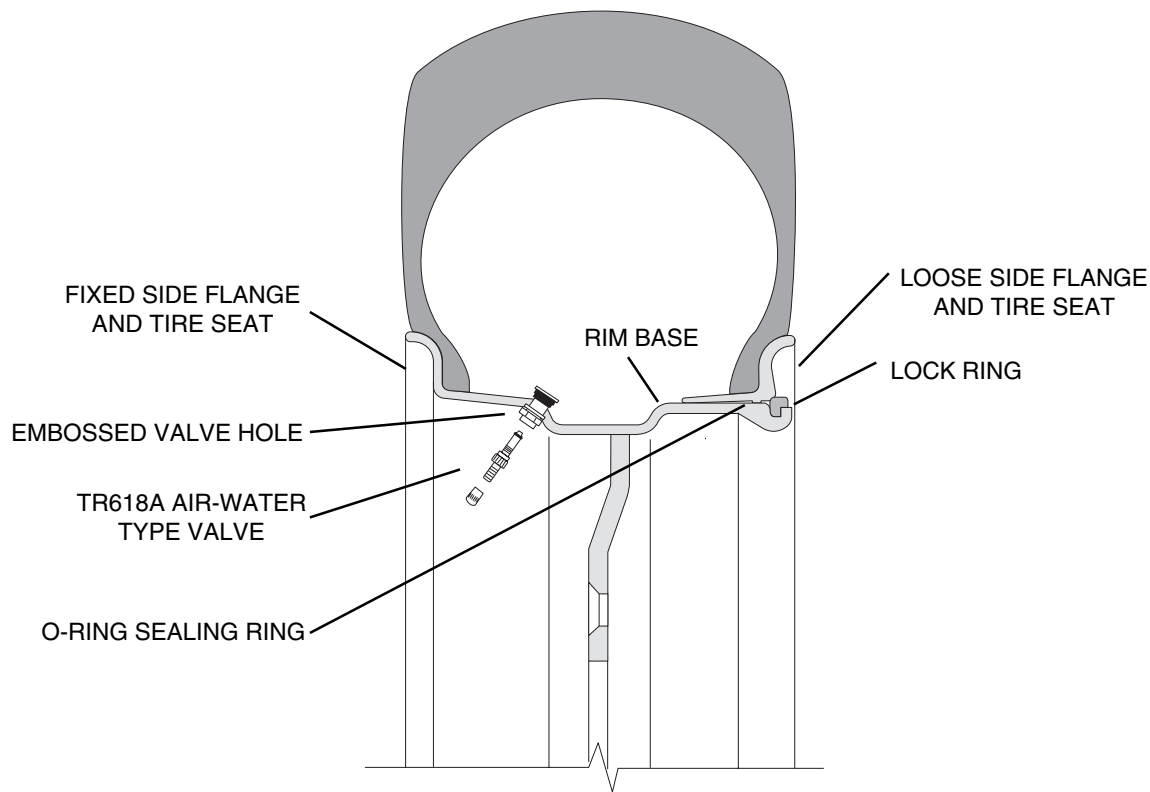
NOTE: The calcium chloride hydrofill solution will corrode a standard tire pressure gauge. Use a corrosion resistant tire pressure gauge. Be sure to flush the gauge with clear water after checking a tire inflated with hydrofill and air.

Before you remove a tire from a wheel, use an ejector tool to remove the valve core and use ejector tool and pump to remove calcium chloride

solution from the tire.

These instructions cover tire removal and installation for the standard three piece wheel and for the optional one piece wheel.

Instructions in *italics* refer to a tire with an optional *tube*. You may use a tube if the tire doesn't provide an air tight seal.



MA0221

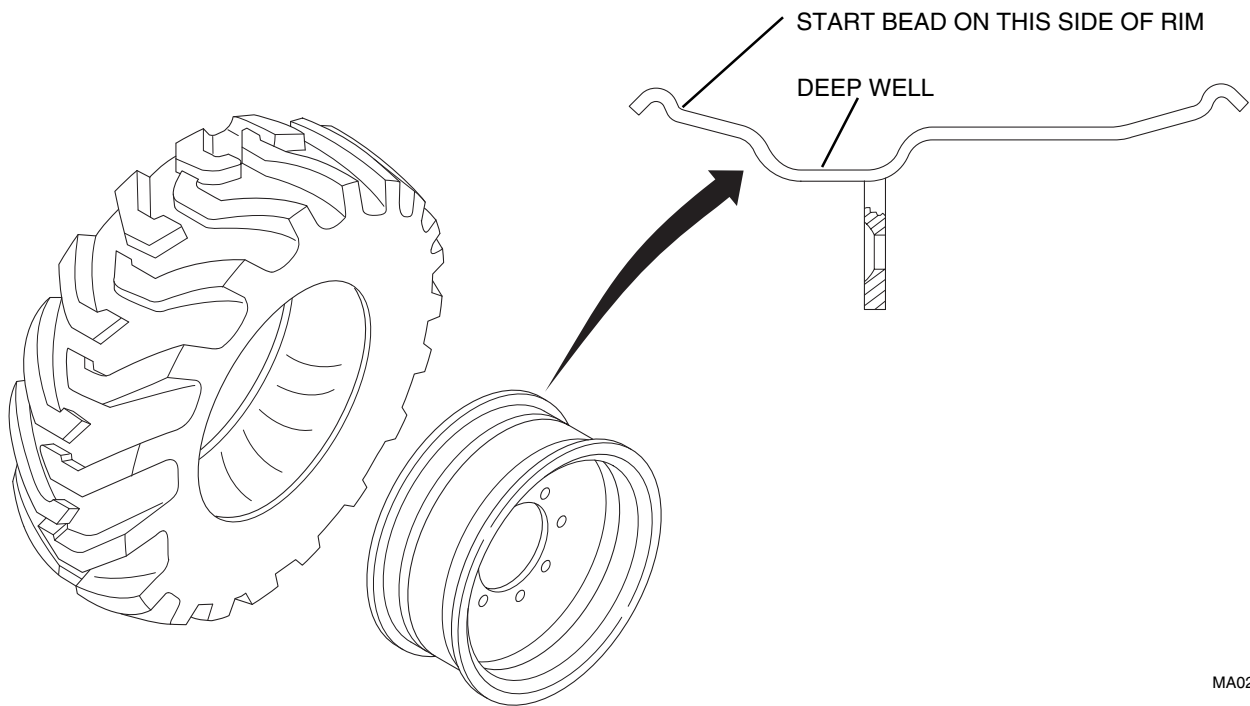
Fig. 5.2 Wheel Assembly with T-Type Rim and Fixed Back Flange (S/N OF1191 & Before)

Tire and wheel maintenance is covered in the following paragraphs:

- 5.1.1 Removing Hydrofill from Tire or Tube within Tire
- 5.1.2 Demounting Tire
- 5.1.3 Removing Wheel from Forklift
- 5.1.4 Demounting Tire from Three Piece Wheel
- 5.1.5 Demounting Tire from Single Piece Wheel
- 5.1.6 Wheel Cleaning
- 5.1.7 Wheel and Tire Inspection and Replacement
- 5.1.8 Tire and Wheel Lubrication
- 5.1.9 Mixing Hydrofill Solution
- 5.1.10 Filling Tire or a Tube within Tire with Hydrofill (a Calcium Chloride Solution)
- 5.1.11 Mounting Tire on Three Piece Wheel
- 5.1.12 Mounting Tire on Single Piece Wheel
- 5.1.13 Connecting Core Ejector Tool to Tire Valve Stem
- 5.1.14 Filling a Tire with Hydrofill (a Calcium Chloride Solution)
- 5.1.15 Installing a Wheel on the Forklift
- 5.1.16 Care of Core Ejector
- 5.1.17 Care of Pump
- 5.1.18 Tire Speed and Road Surface Limitations
- 5.1.19 Care and Storage of Tires

5.1.1 Removing Hydrofill from Tire or Tube within Tire

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. If tire or tube within tire is on the forklift, use a jack to raise the forklift until the tire is slightly deflected and the valve is at the bottom in the valve drain position, Fig. 5.1. Use jack stands to support the forklift in the raised position.
3. Connect core ejector tool (Fig. 5.4) to valve stem as described in paragraph 5.1.10.
4. With the pump control in the CHECK position, unscrew and retract core housing into ejector body.
5. Start pump and turn pump control to EVACUATE position and run until tire is completely evacuated.
6. Check to determine if the valve stem is plugged by removing the core ejector tool. Run a piece of wire through the stem to make sure it is not plugged.
7. Turn pump control to CHECK position, stop pump, replace core housing in valve stem, stop pump and disconnect core ejector.
8. If there is no tube within the tire, unseat beads and demount front bead from rim and pump remaining hydrofill solution from tire.



MA0231

Fig. 5.3 Wheel Assembly with Single Piece Rim (S/N OF1192 & After)

5.1.2 Demounting Tire

IMPORTANT: Always completely deflate tire as described in paragraph 5.1.1 before you attempt to demount tire.

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. To remove a wheel from the forklift refer to paragraph 5.1.3.

5.1.3 Removing Wheel from Forklift

The tires are filled with air and hydrofill which is a calcium chloride and water solution. Usually this solution is removed from the tire (as described in paragraph 5.1.1) before the wheel is removed from the forklift.

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Use a jack to raise the forklift. Rotate wheel to position tire valve at bottom and then lower wheel until tire is slightly deflected.
3. Remove hydrofill from tire or tube as described in paragraph 5.1.1.

IMPORTANT: Always completely deflate tire as described in paragraph 5.1.1 before you attempt to demount tire.

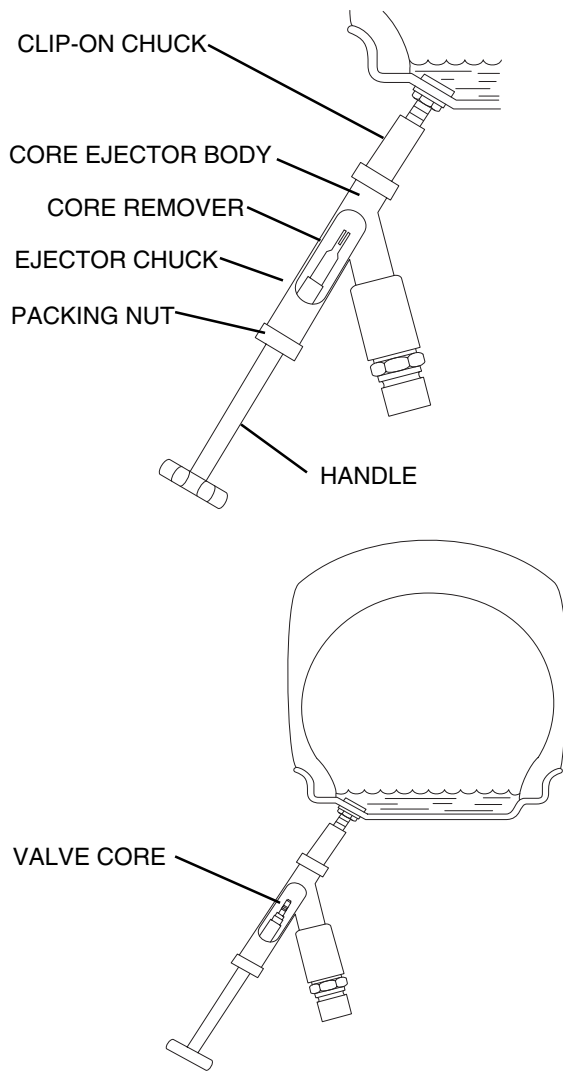
4. Loosen the wheel lug nuts.

5. Use a suitable hoist or jack to raise the axle until the tire clears the ground. Use approved jack stands to support the forklift; never rely solely on a jack or hoist.
6. Remove the wheel lug nuts, Fig. 5.1, and wheel and tire assembly from the axle hub.

5.1.4 Demounting Tire from Three Piece Wheel (S/N OF1191 & Before)

IMPORTANT: Always completely deflate tire as described in paragraph 5.1.1 before you attempt to demount a tire.

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Place the wheel and tire assembly on the floor on blocks with the loose side flange side up, Fig. 5.2.
3. After deflating the tire as described in paragraph 5.1.1, drive the hooked ends of two bead unseating tools between the tire bead and rim flange about 5 inches apart; be careful that you don't damage the tire bead area. Pry both tools down and out. Leave one tool in position and place the second about 5 inches beyond. Repeat the operation slowly, in successive steps, until tire bead is completely unseated.



MA0241

Figure 5.4 Core Ejector Tool

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 3.

4. After the tire bead is unseated, stand on the flange and tire side wall to depress the flange down along the rim base; then, pry loose the lock ring. Keep fingers out of the way.
5. Hold the side flange down with the hooked end of a bead unseating tool and remove the O-ring from the O-ring groove.
6. Remove the side flange. Turn tire and rim over and unseat second bead by inserting both bead unseating tools between the bead and rim flange as in step 3. Repeat step 3 until the tire bead is completely broken loose from the rim on the fixed flange side. Lift rim base out of tire.
7. Refer to paragraph 5.1.11 for tire mounting instructions

5.1.5 Demounting Tire from Single Piece Wheel (S/N OF1192 & After)

IMPORTANT: Always completely deflate tire as described in paragraph 5.1.1, before you attempt to demount a tire.

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Place the wheel and tire assembly on the floor on blocks with the narrow ledge on the bottom, Fig. 5.3.

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 3.

3. After deflating tire as described in paragraph 5.1.1, drive the hooked ends of two bead unseating tools between tire bead and rim flange about 5" (127 mm) apart; be careful that you don't damage the tire bead area. Pry both tools down and out. Leave one tool in position and place the second about 5" (127 mm) beyond. Repeat the operation slowly, in successive steps, until tire bead is completely unseated.
4. Turn the tire and wheel over and unseat the second bead as described in step 3.
5. Thoroughly lubricate rim flange and tire bead with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this requirement (never use petroleum-base lubricants or silicones).
6. Force part of bead across rim from valve into well. Starting at valve, pry bead over rim flange using two 18" (457,2 mm) tire irons. Continue by taking short bites to avoid damage to bead until top bead is completely over the rim flange.
7. Bring assembly to upright position and pull tube out of tire casing. When only tube requires repair or replacement, thoroughly inspect inside of tire casing for foreign material or damage and make sure both tube and inside of casing are dry before reinserting tube.
8. To completely remove tire from rim, turn assembly over and lubricate second tire bead and rim flange. Be sure one side of bead still on the rim is in the rim well and insert tire irons under opposite side of bead. Work rim slowly out of tire by taking small bites alternatively using both tire irons.

9. Remove the valve stem from the rim base.
10. Refer to paragraph 5.1.12 for tire mounting instructions.

5.1.6 Wheel Cleaning

Remove all rust, corrosion, dirt, and other foreign material from all metal surfaces. This is especially important in the rim gutter and bead areas, and mating surface of the lock ring.



Warning

Assembling dirty or rusty rim components is dangerous. Dirt and rust prevent components from seating properly which could result in an explosive separation. Such explosions could result in severe injury or death to the operator and to those in the area.

5.1.7 Wheel and Tire Inspection and Replacement

1. Inspect the air-liquid valve core and stem, Fig. 5.2. Replace the entire valve if either component is damaged. Replace the core O-ring and stem seal regardless of condition.
2. Replace any tire that is worn or cut through the cords. When replacing tires, follow the tire manufacturers recommendations.
3. Check all metal surfaces for rust, corrosion, cracks, bent flanges, sprung lock ring, and deep tool marks on rings or gutter areas. Replace all damaged, worn out, or cracked parts.
4. (Three Piece Rim S/N OF1191 & Before) Replace the rim base and/or lock ring if there is any wearing away of the metal mating surfaces and/or if they are deformed, broken or cracked, or pitted from corrosion.
5. (Three Piece Rim S/N OF1191 & Before) Replace the sealing ring regardless of condition.

5.1.8 Tire and Wheel Lubrication

1. Apply lubricant to the bead seat area, tire bead, and rim mating surfaces prior to mounting the tire.
2. Use only those lubricants recommended by rim and tire manufacturers.
3. (Three Piece Rim S/N OF1191 & Before) Lubricate the new sealing ring with an approved vegetable-based lubricant.

5.1.9 Mixing Hydrofill Solution

Prepare the hydrofill mixture by pouring calcium chloride into water; never add water to calcium chloride as considerable heat is generated in this mixing process. Let the solution cool to atmospheric temperature before pumping it into the tire. To mix and cool the solution, place the pump control in the FILL position and use the pump to circulate the solution through the core ejector body and back into the reservoir.

5.1.10 Filling a Tire or a Tube within a Tire with Hydrofill

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Place the wheel assembly with the valve stem straight up in a safety cage, Fig. 5.1. Attach clip on chuck, insert the valve core in the stem, Fig. 5.2, then withdraw handle of core ejector tool. Stand to the side during inflation.
3. Pressurize the tire to approximately 3 psi (20,7 kPa). Check for proper alignment of all components.
 - If assembly is incorrect, STOP, DEFLATE, correct the assembly and repeat the procedure.
 - If assembly is okay, continue to inflate to 35 psi (241,1 kPa).



Warning

Never inflate beyond 35 psi (241,1 kPa) pressure. If beads have not seated by the time pressure reaches 35 psi (241,1 kPa), deflate the assembly, reposition the tire on the rim, relubricate and reinflate. After seating beads, adjust inflation to recommended pressure. Allowing air pressure to build within the assembly in an attempt to seat the beads is a DANGEROUS PRACTICE. In seating beads, inflation beyond 35 psi (241,1 kPa) may break the bead (or even the rim) with explosive force sufficient to cause serious physical injury or death.

4. To fill a tire 75 percent with water solution, first inflate tire to 35 psi (241,1 kPa) after the beads have been fully seated in the mounting procedure. Jack up the wheel, if done on a forklift, and turn the wheel to bring valve to top position.

5. Inspect both sides of the tire to be sure beads are evenly seated. If not, completely deflate tire, unseat beads and repeat entire mounting procedure.
6. Lower jack until tire is slightly deflected. With pump not running and the pump control handle at CHECK position, connect ejector and remove core housing as described in paragraph 5.1.1.
7. After connection is made, bleed pressure down to about 5 psi (34,4 kPa) by moving pump control to EVACUATE. This is sufficient pressure to keep the beads seated on the rim.
8. When this point is reached, start pump and move pump control to the FILL position and start hydroinflating the tire.
9. Check pressure in tire periodically with pump gauge by placing pump in NEUTRAL or CHECK position.
10. If pressure exceeds 20 psi (137,8 kPa), move pump control to EVACUATE until pressure is bled back to not less than 5 psi (34,4 kPa).
11. After pressure is lowered, continue pumping. Repeat above steps as often as may be necessary until water or solution weight added to the assembly is equal to that shown in the table.
12. Replace core housing in valve stem by pushing handle in until contact is made; turn handle clockwise until core housing is screwed tight in valve stem.
13. Withdraw handle, set pump to EVACUATE, and pump all liquid from hose.
14. Shut off pump.
15. Unscrew ejector body from valve.
16. To assure fully-seated beads inflate tire to 35 psi (241,1 kPa) using a standard air line, and then with valve stem at top, bleed pressure—and excess water or solution—down to 1 to 2 psi (6,9 to 13,8 kPa) above recommended inflation.
17. Set final working pressure after tire has been mounted on forklift and with weight of forklift on tire. Position the wheel so valve stem is at the top position. Use an air-water gauge to check inflation pressure of each tire at least once a week.

18. Insert the valve core in the stem and pressurize the tire as follows:

AIR PRESSURES:

13.00 x 24 Size, 10 ply (Standard)
55 psi (378,9 kPa)

15.00 x 19.5 Size, 12 ply (Optional)
60 psi (413,4 kPa)

HYDROFILL MIXTURE:

13.00 x 24, 10 ply (Standard)
164 lb (74 kg) Calcium Chloride
to 33 gal. (125 liter) of water (each tire)

15.00 x 19.5, 12 ply (Optional)
120 lb (54 kg) Calcium Chloride
to 24 gal. (91 liter) of water (each tire)

5.1.11 Mounting Tire

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Refer to paragraph 5.1.12 or 5.1.13 when mounting tire on wheel which is not attached to forklift.

5.1.12 Mounting Tire on Three Piece Wheel (S/N OF1191 & Before)

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Install the valve stem, Fig. 5.2, into the hole in the rim and tighten to 45 to 55 lb-inch (5 to 6,2 Nm). Make sure parts are clean, repainted if necessary, and have been inspected for damage and cracks before proceeding with mounting.
3. Make sure correct parts are being assembled. Lay rim base on block with the flange side down. Place tire over rim base.

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 4.

4. Place side flange over rim base and push straight down with hands as far as possible. Make sure flange does not bind on rim base.
5. Stand on side flange to position it below both grooves in rim base and snap lock ring into lock ring (Upper) groove. Be certain the embossed "safety bulge" on the lock ring is up toward the operator.

6. Lubricate a new rubber O-ring. Place O-ring in groove on one side and stretch O-ring snapping it into place rather than rolling it into place. Then lubricate the entire O-ring groove areas with an approved vegetable-based lubricant.

NOTE: It may be necessary to hold the side flange down with the flat end of the tire iron to expose the O-ring groove.

7. Check the components to make certain they are correctly assembled. The lock ring must be fully seated in its gutter.
8. Partially inflate tube and insert in tire casing with valve located near valve hole in rim. Attach valve retrieval tool to valve and thread tool through valve hole (inserting the tube and attaching the tool may be facilitated by placing a block under the tire).
9. Inflate tire using hydrofill as described in paragraph 5.1.10.

5.1.13 Mounting Tire on Single Piece Wheel (S/N OF1192 & After)

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Install the valve stem, Fig. 5.3, into the hole in the rim and tighten to 45 to 55 lb-inch (5 to 6,2 Nm). Make sure parts are clean, repainted if necessary, and have been inspected for damage and cracks before proceeding with mounting.
3. Place rim on floor with narrow ledge on top.
4. Lubricate bottom tire bead and top rim flange with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this requirement (never use petroleum-base or silicone lubricants).

NOTE: A mechanical bead unseating and seating tool may be purchased from the Iowa Mold Tooling Company to facilitate step 5.

5. Push bottom bead over rim as far as possible. Use 36" tire irons to work the first bead completely over rim flange, taking **small** bites and being careful not to damage bead.

NOTE: On deep well rims, start bead on rim nearest deep well, Fig. 5.3.

6. Partially inflate tube with air and insert in tire casing with valve located near valve hole in rim. Attach valve retrieval tool to valve and thread tool through valve hole (inserting the

tube and attaching the tool may be facilitated by placing a block under the tire).

7. Starting opposite the valve, use tire irons to lever top bead over the rim flange and down into rim well. Be careful to avoid pinching tube with tire irons. Locking pliers may be used to "keep your place". When bead is well started lubricate remaining unmounted portion of tire bead and rim flange. Taking small bites, spoon tire bead over rim flange until final section drops over at valve.
8. Thoroughly lubricate tire beads and rim bead seats on both sides of tire.
9. Center tire on rim and inflate to fully seat bead [do not exceed 35 psi (241,1 kPa)] using an extension hose with clip-on chuck and gauge to permit operator to stand clear of tire. Then remove valve core and completely deflate. Reinsert valve core and reinflate to recommended pressure as described in paragraph 5.1.10.

NOTE: If either bead should fail to seat at 35 psi (241,1 kPa) inflation, the tire may be pinched between tire bead and rim or something else is interfering with proper mounting. Do not increase pressure to seat beads, but remove valve core and completely deflate. Break both beads loose from rim, relubricate both tire beads and rim bead seat areas. Reinstall core and repeat inflation procedures.

5.1.14 Connecting Core Ejector Tool to Tire Valve Stem

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. With the pump not running and pump valve in CHECK position, screw core ejector body onto stem with handle of core ejector pulled out.
3. Push handle of core ejector in until it makes contact with the core housing of the valve.
4. Hold the core ejector in you left hand and strike the handle with your right hand to force the core housing in ejector chuck.
5. Turn handle counterclockwise to unscrew the core housing, pushing inward lightly so you can feel the threads disengage when completely unscrewed.
6. Pull handle out as far as it will go to retract core housing into ejector body. The handle will pull out easier if rotated while pulling, as packing nut should be tight enough to prevent air or liquid leaks.

5.1.15 Installing a Wheel on the Forklift

1. Be sure you've read and understood the warning notices and general instructions in paragraph 5.1.
2. Remove the wheel assembly from the safety cage and place it on the axle hub.
3. Secure the wheel assembly to the axle hub with ten wheel lug nuts. Torque the nuts to 450 to 500 lb-ft (610 to 678 Nm). Use the torquing sequence shown in Fig. 5.5.

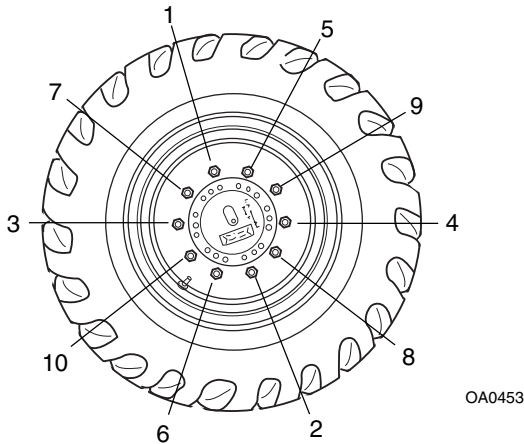


Fig. 5.5 Wheel Torque Sequence

4. Remove the jack stands and lower the tire to the ground.

5.1.16 Care of Core Ejector

Keep packing nut on plunger fairly tight to avoid leaks. However, do not set it so tight that plunger cannot easily be pushed into position. When not in use for long periods of time, keep core ejector submerged in a container of clear water.

5.1.17 Care of Pump

Do not pump all of the solution out of the reservoir. A small amount of solution is required to keep air out of the pump and thus prevent corrosion and sticking. If water is used, be sure to place pump and reservoir where the water will not freeze.

5.1.18 Tire Speed and Road Surface Limitations

Forklift tires are designed for low speed operations not exceeding 25 mph (40 km/hr). If the forklift is towed at high speeds on the highway, high temperatures may develop under the tread bars and weaken the rubber material and cord fabric. There may be no visible evidence of damage at the time. Later a premature failure occurs which experience

shows was started by the overheated condition that developed when the unit was towed at high speed.

If tires are to operate for any length of time on roads or other hard surfaces, it is advisable to increase pressure in the tire to the maximum recommendation to reduce the movement of the tread bars that causes excessive wiping action.

5.1.19 Care and Storage of Tires

Store unmounted tires vertically on tread. If stored for an extended period, rotate tires periodically to reduce stress concentrations in the area of ground contact. Tires should not be stored flat and "stove piped" as they will become squashed and distorted, making mounting on the rim difficult—particularly for tubeless tires.

Inflated tires should be stored under the conditions noted above, with inflation pressure reduced to 10 psi (68,9 kPa).

Tires should not be stored out-of-doors. However, if there is no alternative, tires so stored must be protected from the elements. An unbroken opaque covering is required as protection from sun and rain.

Exposure to weather will cause crazing and cracking of the rubber surfaces as well as deterioration of the tire carcass—particularly where rain water is permitted to accumulate in the tires.

When extended storage is anticipated, the forklift should be blocked up so the tires are out of ground contact. Inflation pressure in the tires should then be reduced to 10 psi (68,9 kPa). Other precautions as noted above should be observed.

If it is not possible to block up the forklift, inflation pressure in the tires should be increased 25 percent. The forklift should be moved from time to time to change the location of stress concentrations in the tire ground contact area.

Store tires indoors in a cool, dark, dry area free from drafts. Both heat and light are sources of oxidation on the tire surfaces—a result of which is crazing and weather checking. Never store tires on oily floors or otherwise in contact with solvents, oil or grease. Further, tires should not be stored in the same area with volatile solvents. Such solvents are readily absorbed by rubber and will damage and weaken it.

Store tires away from electric motors, generators, arc welders, etc., since these are active sources of ozone. Ozone attacks rubber and causes crazing and weather checking.

5.2 AXLE ASSEMBLY

The axle assembly rotates and turns the wheels. Both front and rear axles consist of a differential carrier assembly, a left and right axle steering joint, and a left and right wheel end, Fig. 5.6. The

front axle wheel ends contain service brakes. If the forklift has a turbocharged engine both the front and rear axle wheel ends contain service brakes.



Warning

Do not attempt carrier and differential removal and installation and differential and pinion disassembly and assembly without thoroughly understanding instructions in Spicer® Dana publications and correspondence which applies to your forklift. Refer to paragraph 5.3.

- Wear safety glasses at all times when working on forklift and forklift components.
- If it becomes necessary to disassemble any parts inside the carrier, it is suggested that the entire axle be removed from the forklift and held tight in a stand or rack with carrier pinion positioned up.
- When removing axle assembly, make sure forklift is properly supported; an improperly supported vehicle can cause serious injury or death.
- If axle assembly is still in the forklift, be sure carrier, differential and pinion assemblies are securely supported before they are separated from the axle housing.
- A serious or fatal injury can occur if you lack proper training, if you fail to follow recommended procedures, if you do not

use proper tools and safety equipment, if you assemble components improperly, if you use incompatible components, if you use worn-out or damaged components, or if you use components in a nonapproved application.

- Some manufacturers may require the assembly of brake components on Dana axles that use materials containing asbestos fibers. Breathing asbestos dust may be hazardous to your health and may cause serious respiratory or other bodily harm. Follow O.S.H.A. standards for proper protective devices when you work with asbestos materials.
- Before you use silicone rubber sealant (RTV) and lubricating grease and oils, become familiar with and follow all safety recommendations provided product manufacturer and supplier. When working with these products follow industrial hygiene practices (before eating, thoroughly wash hands and face). Do not eat, drink or smoke in areas where there is potential for significant exposure to these materials.
- When discarding materials observe all local, state, and federal laws and regulations for approved disposal procedures.



Caution

The use of non-original equipment replacement parts is not recommended as their use may cause unit failure and affect vehicle safety. An identification tag on the axle housing contains the axle assembly number, the serial number and the build date. Supply all of the information on this tag when referring to components of the axle assembly. Refer to Spicer® Dana Maintenance Manual for Models PS/PR-7036 for gear set identification instructions.

- Be extremely careful when working on components using snap rings or spring-loaded retention devices.

- Wear industrial strength safety goggles or glasses whenever you work on the forklift or forklift components.
- It is impossible to know, evaluate and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. Accordingly, whenever you use a service procedure or tool which is not recommended you must first satisfy yourself thoroughly that neither personal or vehicle safety will be jeopardized by the service method you select.

IMPORTANT:

- When replacing a fastener, replace it with one of equal or higher grade and quality. Torque fasteners are recommended for the application.
- Some service operations require the use of tools specifically designed for the purpose. Use the special tools when and as recommended.
- Hammering on end yokes or flanges to remove or install them is not only destructive to the yoke or flange itself, but can also cause serious internal damage. Hammering on end yokes can close the bearing bores or misalign yoke lugs and result in early failures of journal needle bearings or other driveline components. Serious damage can also be done internally to the ring and pinion set or pinion bearings by hammering on external parts. Remove and install end yokes by following recommended procedures.
- Do not reuse oil or grease seals.

CLEANING: Clean parts with machined or ground surfaces such as gears, bearings, and shafts with emulsion cleaners or petroleum based cleaners. Steam cleaning of internal components and the interior of the planetary hub and axle housing is not recommended. Water can cause corrosion of critical parts. Rust contamination in the lubricant can cause gear and bearing failure. Clean all surfaces of old gasket material.

DRYING: Use clean lintless towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication. After drying, lightly coat components with oil or rust preventive to protect them from corrosion. If components are to be stored for a prolonged period they should be wrapped in wax paper.

PERIODIC OPERATION REQUIREMENT: EVERY TWO WEEKS drive the forklift far enough to cause the drivetrain components to make several complete revolutions. This procedure will help assure that all internal components receive adequate lubrication to minimize component deterioration caused by an undesirable environment such as high humidity.

SUBMERSION OR DEEP WATER FORDING: If the vehicle is exposed to water deep enough to cover the hubs, disassemble the wheel ends and inspect for water damage and contamination. If you submerge the carrier housing in water,

particularly over the breather, drain the hypoid gear lubricant and inspect internal parts for water damage and contamination. Before you assemble and refill the unit with the specified lubricants, clean, examine, and replace damaged parts. Clean, examine, and replace damaged parts if necessary.

NOTE: If the hubs are exposed to deep water, it is possible that water could enter the carrier at the point the inner axle shaft enters the axle housing. This could also necessitate the draining of the hypoid lubricant as described above. Whenever you remove bearings, replace them with new bearings, regardless of mileage. Use suitable pullers for bearing removal. Clean, inspect, and lubricate all bearings just prior to reassembly. If replacement of a damaged bearing cup or cone is necessary, replace the cup and cone as a set.

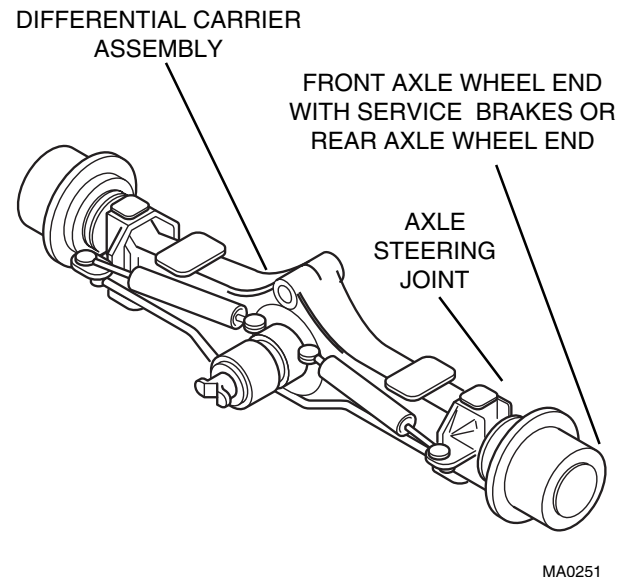


Fig. 5.6 Axle

5.2.1 Axle

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Place adequate support under the frame so that it will remain in place when the axle assembly is removed.
4. Remove the wheels from the axle as described in paragraph 5.1.3.
5. Use floor jacks or install a suitable hoist at the ends of the axle. Take up the slack.
6. Disconnect hydraulic hoses as required from steering cylinders, service brakes and park lock.
7. Remove the drive shaft from the axle input shaft end yoke, Fig. 5.7.
8. Remove the capscrew and locknut securing the axle pivot pin to the frame. Remove the pivot pin and shims.

NOTE: To remove the pivot pin from the front axle:

- thread a 1/2" bolt into front end of pin and pull or pry on bolt.

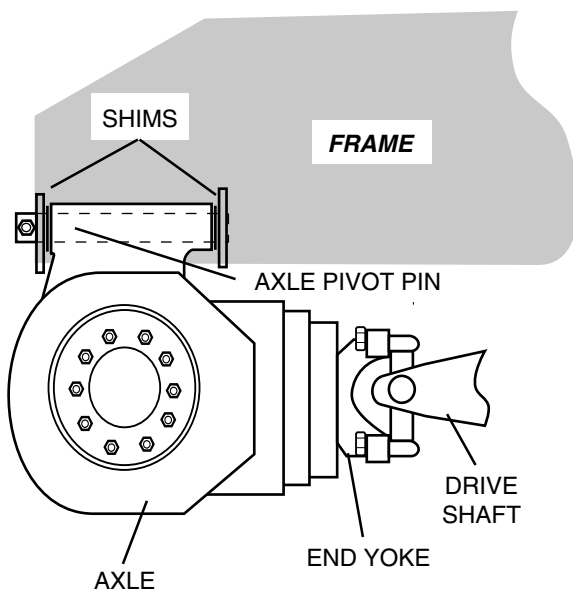
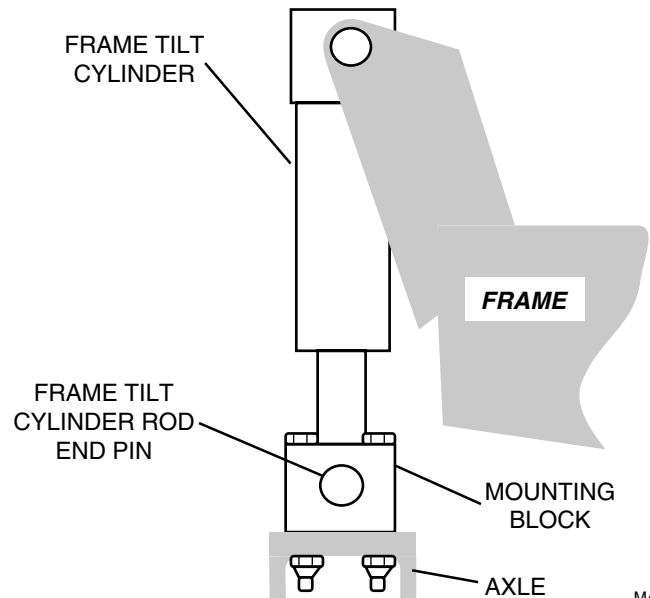
or

- drain fuel from fuel tank, remove tank and drive pin out from the back side.

9. At the front axle, remove two retaining rings from the frame tilt cylinder rod end pin, Fig. 5.7. Tap the pin from the mounting blocks.
10. Using the hoist, remove the axle from the frame and place it on a support at three points of the housing. A suitable holding stand is desirable, but not necessary. Refer to Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for internal servicing instructions.

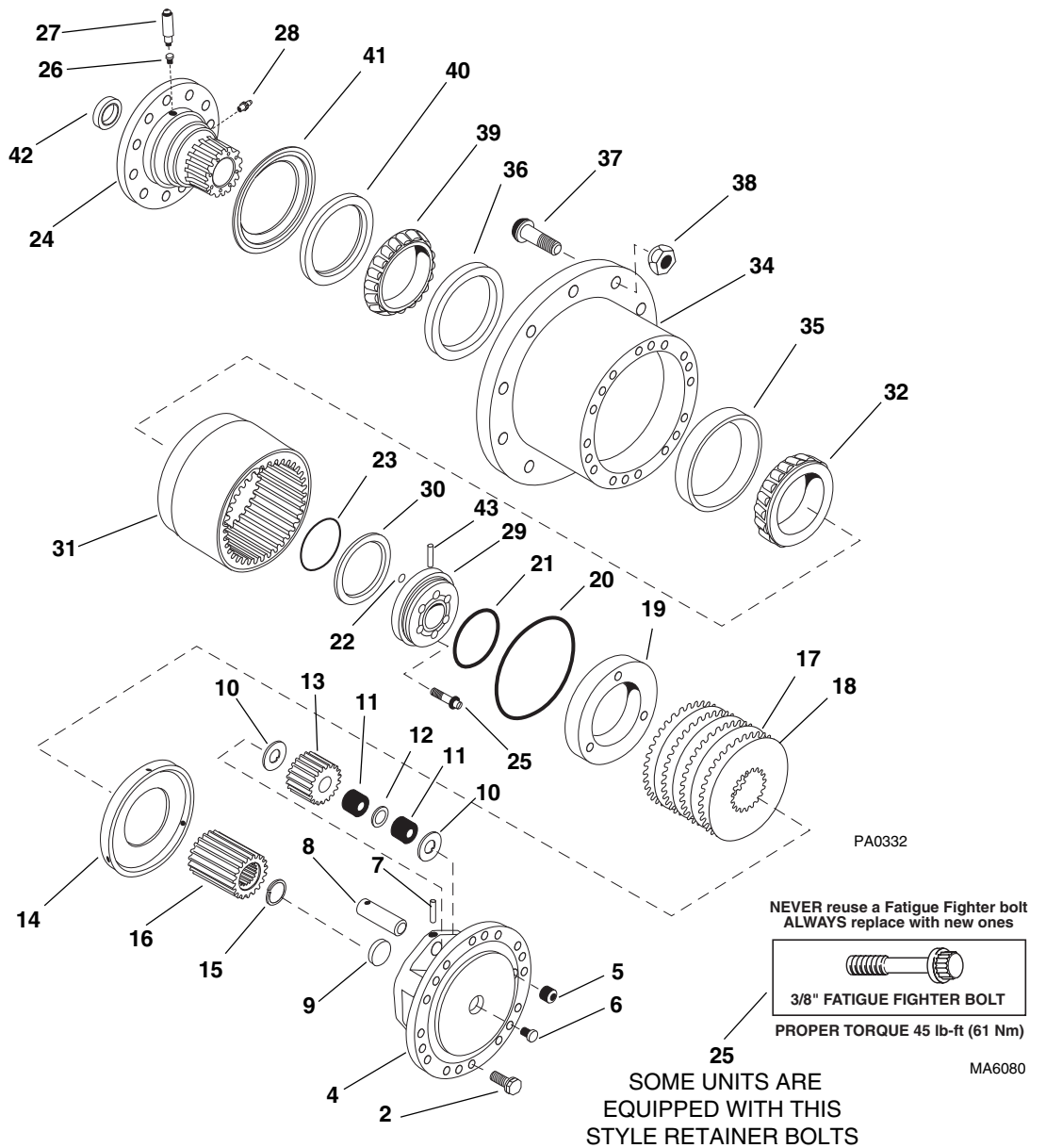
b. Installation

1. Using a suitable hoist, remove the axle from its support or stand and position it under the frame so that pivot pin holes are aligned with hole in axle.
2. Install the axle pivot pin and shims. There must be no more than a 0.10" (2,5 mm) gap between the frame and axle. Secure the pin in place with a cap screw and locknut. Tighten locknut until snug against collar, then an additional 1/4 turn.
3. Secure the frame tilt cylinder rod end to the frame mounting blocks, Fig. 5.7, with a pin and two retaining rings. The pin must pass easily through both mounting blocks. If not, shim the blocks as required. Lubricate the pin using the grease fitting on the cylinder rod.
4. Install the drive shaft on the axle input shaft end yoke. Be sure retaining rings are securely seated.



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Fig. 5.7 Axle Connections



- | | | |
|-----------------------------------|-------------------------|---------------------------|
| 1. Drive Flange (items 2 thru 16) | 16. Gear, sun spur | 31. Gear, planetary ring |
| Wheel End (items 17 thru 43) | 17. Plate, lining stop | 32. Cone, bearing (outer) |
| 2. Screw, self-locking | 18. Disc Assembly | 33. Hub Assembly |
| 3. Planetary Gear Assembly | 19. Piston | 34. Hub, planetary |
| 4. Flange, planetary drive | 20. O-ring, piston OD | 35. Cup, bearing (outer) |
| 5. Plug, drain/fill | 21. O-ring, piston ID | 36. Cup, bearing (inner) |
| 6. Plug | 22. O-ring, oil passage | 37. Bolt, wheel |
| 7. Pin, roll | 23. O-ring, retainer | 38. Nut, wheel |
| 8. Shaft, planet gear | 24. Spindle Assembly | 39. Cone, bearing (inner) |
| 9. Washer, drive flange | 25. Screw | 40. Seal, oil |
| 10. Washer, keyed | 26. Seat, bleeder | 41. Deflector, seal |
| 11. Bearing, single roller | 27. Bleeder | 42. Seal, oil |
| 12. Ring, spacer | 28. Fitting, brake | 43. Tubing, brake |
| 13. Gear, planet | 29. Retainer | |
| 14. Plate, lining stop | 30. Shim | |
| 15. Ring, retaining | | |

Fig. 5.8 Wheel End and Drive Flange—Front Axle and Service Brakes

5. Connect hydraulic hoses as required to steering cylinders, service brakes and park lock. Bleed the lines to the service brakes and park lock.
6. Remove the hoist from the ends of the axle.
7. Install the wheels on the axle as described in paragraph 5.1.15.
8. Remove the support from under the frame.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

9. Start the engine. Turn the steering wheel several times to purge any air in the steering cylinder hydraulic lines.

5.2.2 Wheel End With Service Brakes

If removing the entire axle assembly from the forklift refer to paragraph 5.2.1. A suitable holding stand is desirable, but not necessary. If the axle is to remain on the forklift, use support stands under machine and axle.

Steam clean the axle assembly prior to disassembly. Seal all openings before steam cleaning.

Refer to wheel and tire removal instructions in paragraph 5.1.3 and 5.1.2.

Except when servicing the planetary gear assembly, raise axle until pressure is relieved from wheel end and lower axle onto support stands.



Warning

Wear safety glasses at all times when assembling and disassembling the axle. The smallest eye injury may cause loss of vision.

Planetary Gear Assembly

a. Removal

Refer to page 13 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

b. Disassembly

Refer to page 14 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

c. Cleaning and Drying

1. Clean the groove under drive flange washer (9, Fig. 5.8). It is an access to the air vent.
2. Clean all parts with an approved petroleum based cleaner.
3. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
4. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

d. Inspection and Replacement

1. Replace drive flange washer (9, Fig. 5.8) if worn.
2. Replace planet gears (13) if worn, scored or chipped.
3. Replace single roller bearings (11) if worn, pitted or damaged.
4. Replace keyed washers (10) if worn, pitted or scored.
5. Replace planet gear shaft (8) if worn or scored.

e. Assembly and Installation

1. Refer to page 31 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly and installation instructions.
2. Install the planetary gear assembly as described in paragraph 5.2.2.
3. After the drive flange is installed, rotate the hub so drain/fill plug (5, Fig. 5.8) is up and fill hub. Refer to Section 5.4 page 5-28 for oil recommendations and capacities.

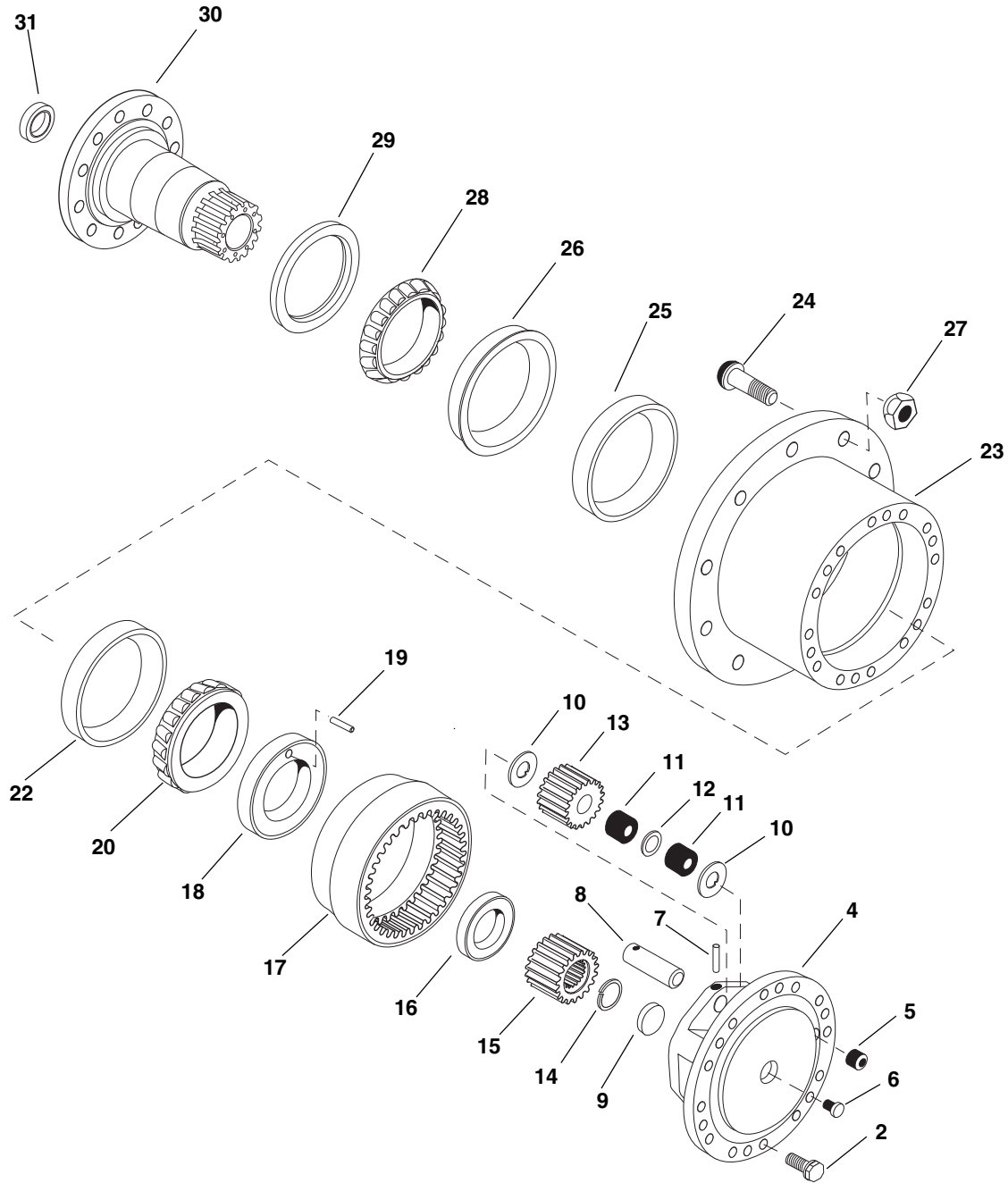
Wheel End Service Brakes

a. Disassembly

Refer to pages 15 and 16 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

b. Cleaning and Drying

1. Clean all parts with an approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.



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- | | | | |
|----------------------------|----------------------------|---------------------------|---------------------------|
| 1. Wheel End Assembly | 10. Washer, keyed | 18. Locknut | 26. Slinger, hub oil |
| 2. Screw, self-locking | 11. Bearing, single roller | 19. Pin, roll | 27. Nut, wheel |
| 3. Planetary Gear Assembly | 12. Washer, planet gear | 20. Cone, bearing (outer) | 28. Cone, bearing (inner) |
| 4. Flange, planetary drive | 13. Gear, planet | 21. Hub Assembly | 29. Seal, oil |
| 5. Plug, drain/fill | 14. Ring, retaining | 22. Cup, bearing (outer) | 30. Spindle Assembly |
| 6. Plug | 15. Gear, sun spur | 23. Hub, planetary | 31. Seal, oil |
| 7. Pin, roll | 16. Spacer, flat | 24. Bolt, wheel | |
| 8. Shaft, planet gear | 17. Gear, planetary ring | 25. Cup, bearing (inner) | |
| 9. Washer, drive flange | | | |

Fig. 5.9 Rear Axle Drive Flange and Wheel End Without Service Brakes

3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Replace all discs and plates as a set if any of the following conditions exist:
 - friction material groove depth on any disc is less than 0.005" (0,127 mm),
 - plates are warped as determined by a straight edge, or
 - any plate or disc is heat damaged.
2. Replace all O-rings regardless of condition.
3. Replace all bearings, cups, and cones if they are worn, pitted, or damaged.
4. Replace all gears that are worn, pitted, scored, or chipped.

d. Assembly

Refer to page 28 through 30 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly instructions.

5.2.3 Wheel End Without Service Brakes

If removing the entire axle assembly from the forklift refer to paragraph 5.2.1. A suitable holding stand is desirable, but not necessary. If the axle is to remain on the forklift, use support stands under machine and axle.

Steam clean the axle assembly prior to disassembly. Seal all openings before steam cleaning.

Refer to wheel and tire removal instructions in paragraph 5.2.1.

Except when servicing the planetary gear assembly, raise axle until pressure is relieved from wheel end and rest axle on support stands.



Warning

Wear safety glasses at all times when assembling and disassembling the axle. The smallest eye injury may cause loss of vision.

a. Disassembly

1. Remove the planetary gear assembly. Refer to page 13 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

2. Support the hub assembly with a lifting device.
3. Refer to page 15 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

b. Cleaning and Drying

1. Clean all parts with an approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Replace all bearings, cups, and cones if they are worn, pitted, or damaged.
2. Replace all gears that are worn, pitted, scored, or chipped.

d. Assembly

1. Secure the spindle assembly to the steering knuckle with locknuts and washers.
2. Refer to page 31 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly instructions.

5.2.4 Axle Steering Joints

If removing the entire axle assembly from the forklift refer to paragraph 5.2.1. A suitable holding stand is desirable, but not necessary. If the axle is to remain on the forklift, use support stands under machine and axle.

Steam clean the axle assembly prior to disassembly. Seal all openings before steam cleaning.

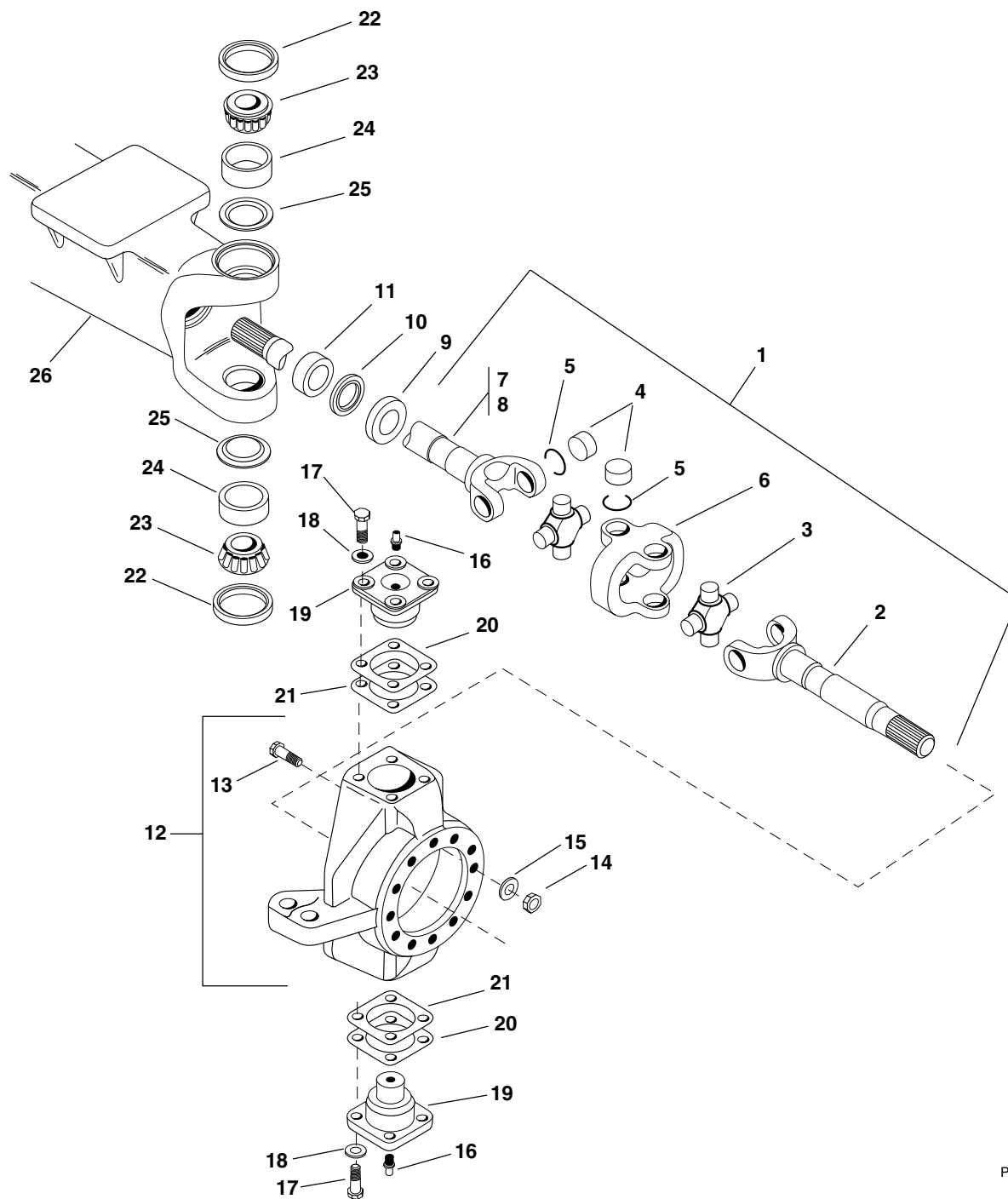
Refer to wheel and tire removal instructions in paragraph 5.2.1.

Except when servicing the planetary gear assembly, raise axle until pressure is relieved from wheel end and rest axle on support stands.



Warning

Wear safety glasses at all times when assembling and disassembling the axle. The smallest eye injury may cause loss of vision.



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- | | | | |
|-----------------------------|-----------------------------|---------------------|--------------------------|
| 1. Shaft and Joint Assembly | 8. Shaft, inner yoke, right | 14. Locknut | 20. Shim, formed |
| 2. Shaft, outer | 9. Deflector, seal | 15. Washer, flat | 21. Shim, formed |
| 3. Cross Assembly | 10. Seal, oil | 16. Fitting, grease | 22. Seal, oil |
| 4. Bearing Race Assembly | 11. Bushing, spindle | 17. Capscrew | 23. Cone, roller bearing |
| 5. Ring, retaining | 12. Knuckle Assembly | 18. Washer, flat | 24. Cup, roller bearing |
| 6. Yoke, center | 13. Stud, dowel | 19. Cap, king pin | 25. Retainer, grease |
| 7. Shaft, inner yoke, left | | | 26. Housing, axle |

Fig. 5.10 Axle Steering Joints

a. Disassembly

1. Refer to page 13 through 16 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removing and disassembling the drive flange and wheel end hub.
 2. On an axle with service brakes:
 - (a) Remove lining stop plates (14 and 17, Fig. 5.8) and disc assemblies (18).
 - (b) Remove retainer screws (25) and planetary ring gear (31), piston (19), and retainer (29) as a unit.
 - (c) Remove hub assembly (33).
 3. On an axle without service brakes:
 - (a) Support the hub assembly with a lifting device.
 - (b) Insert a small screwdriver under retaining ring (14, Fig. 5.9) on the axle shaft and remove it by rotating around the shaft.
 - (c) Remove the sun spur gear (15) and spacer (16) from the axle shaft.
 - (d) Remove planetary ring gear (17). Use a suitable puller if necessary.
- IMPORTANT:** Do not use a pilot puller on the axle shaft because it may damage the inboard axle seal.
- (e) Remove roll pin (19, Fig 5.9) from locknut (18) or ring gear (17).
 - (f) Remove the locknut using a three-pin spanner wrench.
 - (g) Remove bearing cone (20).
 - (h) Using a suitable lifting device, remove hub assembly (21) from spindle assembly (30)
4. Remove the spindle assembly mounting nuts and flat washers.

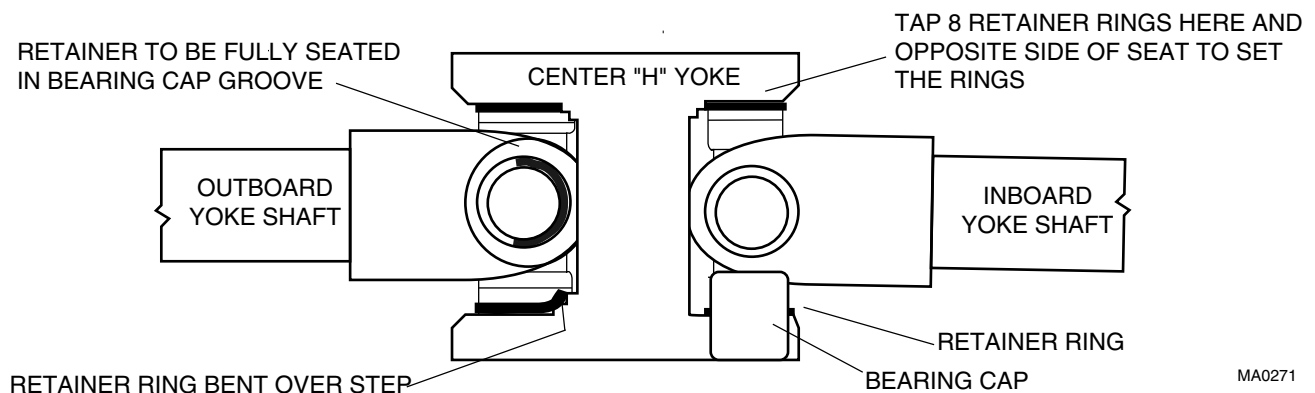
5. Tap the spindle with a soft-faced hammer to loosen the knuckle assembly (12, Fig. 5.10). Remove the spindle assembly.
6. Replace oil seal or bronze bushing (42, Fig. 5.8) or (31, Fig. 5.9) in the spindle bore.
7. Holding shaft and joint assembly (1, Fig. 5.10) level, pull the assembly straight out to avoid damaging inner shaft oil seal (10).
8. Remove oil seal (10) and spindle bushing (11) from the housing yoke bore.
9. Remove retaining rings (5).
10. Press out bearing race assemblies (4) and remove two crosses (3) and center yoke (6).
11. Refer to pages 20 through 22 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembling the axle steering knuckle.

b. Cleaning and Drying

1. Clean all parts with an approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Replace any bearing race assembly (4, Fig. 5.10) if it is worn, pitted, or damaged.
2. Replace cross assemblies (3) that are worn or damaged.
3. Replace axle shafts (2, 7, or 8) if there is evidence of torsional fractures or other indications of impending failure.

**Fig. 5.11 Retaining Ring Inspection**

MA0271

4. Replace roller bearing cups (24) or cones (23) if any are worn, pitted, or damaged.
5. Replace oil seals (10 and 22) regardless of condition.

d. Retaining Ring Inspection

1. Place the forklift in "Crab Steer" mode and turn the steering wheel full left to access shaft assemblies on the right side of the vehicle
2. Using a flashlight, visually inspect the right front shaft assembly retaining rings through the opening between the axle housing and steering knuckle.
3. Turn the wheel end clockwise or counterclockwise to expose both sides of all eight retaining rings
4. Inspect for the following (Fig. 5.11):
 - full seating of the retaining rings into the cap grooves,
 - no back and forth movement of the ring,
 - and overlap on the machined steps on the inboard side of the yoke ear
5. To set the rings, tap suspected rings with a hammer and punch where shown on Fig. 5.11.
6. Inspect the right rear shaft assembly as instructed in steps 2 thru 5.
7. Turn the forklift steering wheel full right to access the shaft assemblies on the left side of the vehicle.
8. Inspect the left side shaft assemblies as instructed in steps 2 thru 5.

e. Assembly

1. Refer to page 23 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for steering knuckle assembly instructions.
2. Refer to page 25 through 31 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for axle shaft and spindle assembly and installation instructions.
3. Connect the tie rod and steering cylinder to the knuckle assembly. Torque the socket assembly nuts to 140 lb-ft (190 Nm) minimum. Check to make sure the position of the offset in the tie rod clears the carrier assembly in full turn position (both directions). If full turn clearance is not found, switch the tie rod assembly around end for end and then retorque the slotted nuts.
4. Install cotter pins and bend each pin over to lock it in place.

NOTE: If the cotter pin cannot be installed after minimum torque is attained, the nut must be advanced until the cotter pin can be installed.

IMPORTANT: If the tie rod adjustment (toe-in) has been changed it will be necessary to readjust it. Position the steering knuckles in a straight ahead (0° turn angle) position. Position measuring bars on the spindle mounting face of the steering knuckles. Measure across them on the carrier side and cover side of the axle housing and compare readings. If necessary, remove tie rod, adjust the overall socket to socket length (in or out), reinstall the tie rod assembly and remeasure. Repeat this procedure until equal measurements are attained for zero toe-in. A zero to 1/2° toe-in is acceptable. Retorque slotted nuts to 140 lb-ft (190 Nm) minimum. Torque the tie rod clamp assembly bolts and nuts to 60 to 70 lb-ft (81 to 95 Nm).

5. If repairs were made to or the retracted length of the steering cylinder was inadvertently changed the retracted length of the assembly will require resetting as follows:
 - (a) Remove slotted nuts from and remove rod end socket assemblies from steer knuckles. Push in or use air pressure to retract the rod into the barrel assembly of both cylinders.
 - (b) Turn steering knuckle to full inside turn position on either right or left hand side.
 - (c) Adjust the socket assembly position in or out on the rod end and also barrel end, if required, such that its retracted length matches the length required for assembly to its steer knuckle. Reconnect the cylinder assembly as described in step 3. Torque the cylinder socket clamp bolts and nuts to 60 to 70 lb-ft (81 to 95 Nm).

IMPORTANT: Protect the rod from damage while adjusting socket position.

- (d) Turn the other steer knuckle to its full inside turn position. Adjust its steer cylinder retracted as noted in step c.
6. Connect the hydraulic hoses to the steering cylinders and "bleed" the system.
7. On an axle without service brakes:
 - (a) Using lifting device, install hub assembly (21, Fig. 5.9) on spindle assembly (30).
 - (b) Install bearing cone (20).
 - (c) Install locknut (18); tighten to 200 to 250 ft. lbs. (272 to 340 Nm). Back the nut off 1/8

turn and align any hole in the nut with a major spline on the spindle. Mark the end of the aligned spline on the edge of the spindle. Make sure the hub rotates freely.

- (d) Install roll pin (19) on the back face of planetary ring gear (17) and mark its location on the front face of the gear.
 - (e) Install planetary ring gear, making sure roll pin is locked into locknut hole. Align mark on the edge of the spindle with the mark on the front face of the planetary ring gear.
 - (f) Install spacer (16), sun spur gear (15), and retaining ring (14) on the axle shaft.
8. On an axle with service brakes:
- (a) Using a suitable lifting device, install the hub assembly onto the spindle.
 - (b) Install the planetary ring gear/piston/retainer unit on the spindle assembly, being sure oil passage hole in ring gear is to the bottom of the axle at 6 o'clock.
 - (c) Gradually increase torque on retainer screws (25, Fig. 5.8) using a crossing pattern until 45 lb-ft (61 Nm) is achieved on each screw.
 - (d) Install lining stop plates (14 and 17, Fig. 5.8 and Fig. 5.12) and discs (18).
9. Install the planetary gear assembly as described in paragraph 5.2.2.

5.2.5 Steering Cylinder and Tie Rod

a. Removal

Refer to page 20 through 22 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

b. Cleaning and Drying

1. Clean all parts with approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

c. Inspection and Replacement

1. Be sure rod is straight and undamaged. If rod is bent or damaged, install new rod.
2. Check condition of tube, attaching hardware and hydraulic hoses. Repair or replace as required.

d. Installation

Refer to page 24 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for installation instructions.

5.2.6 Park Lock Unit

The park lock unit consists of the park lock and a yoke shaft.

a. Removal

Refer to page 54 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for removal instructions.

b. Disassembly

Refer to page 55 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for disassembly instructions.

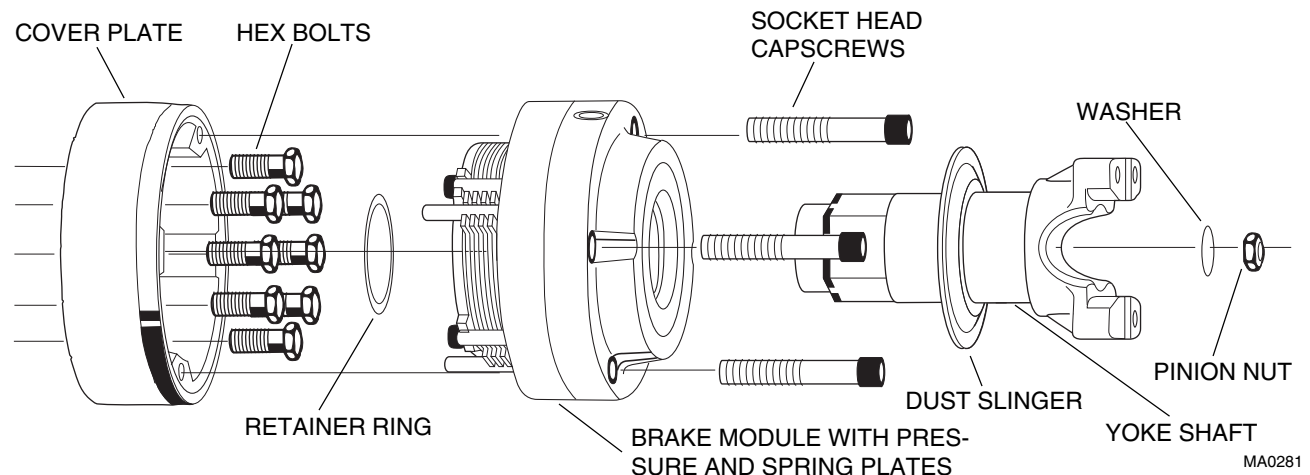
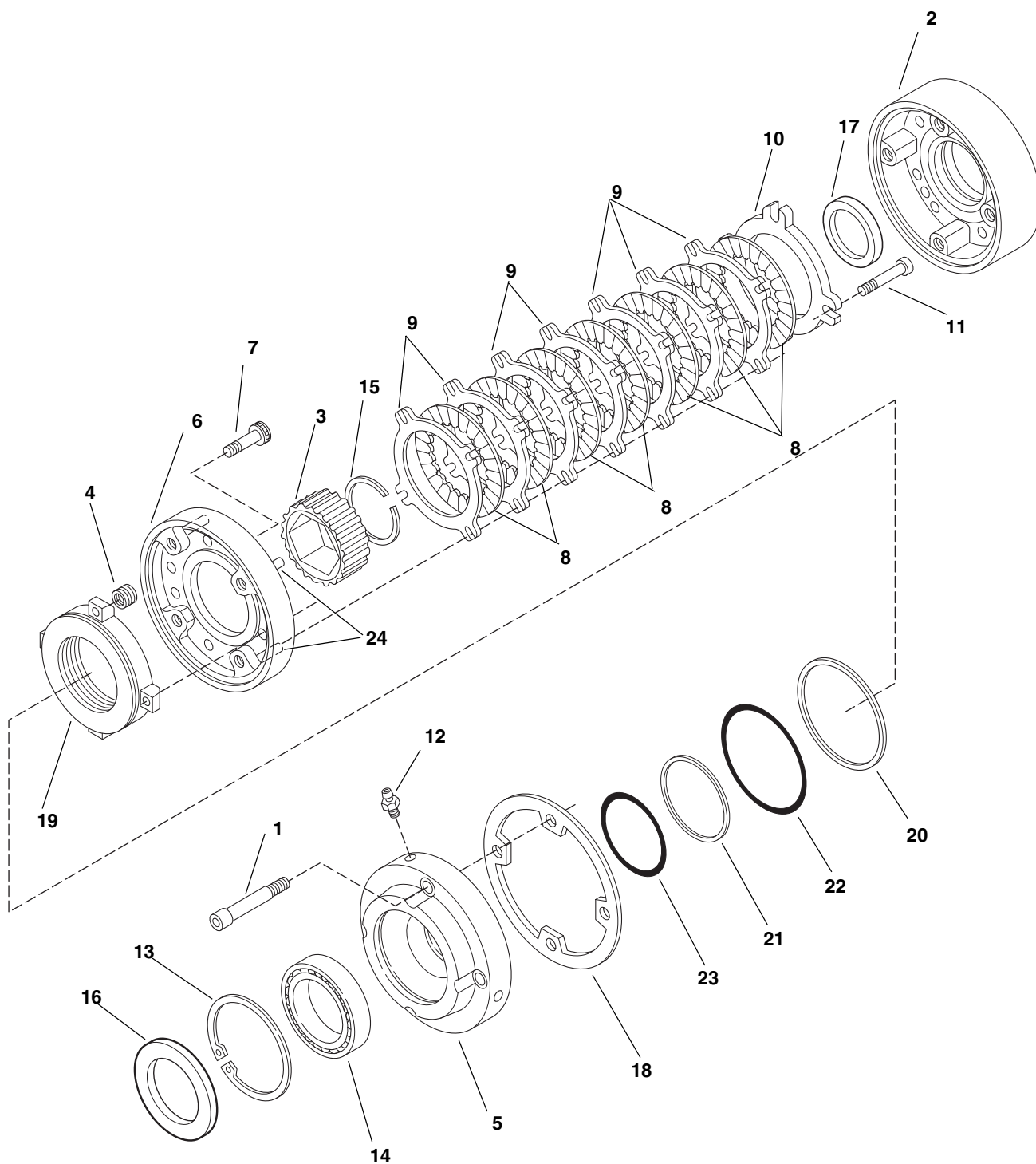


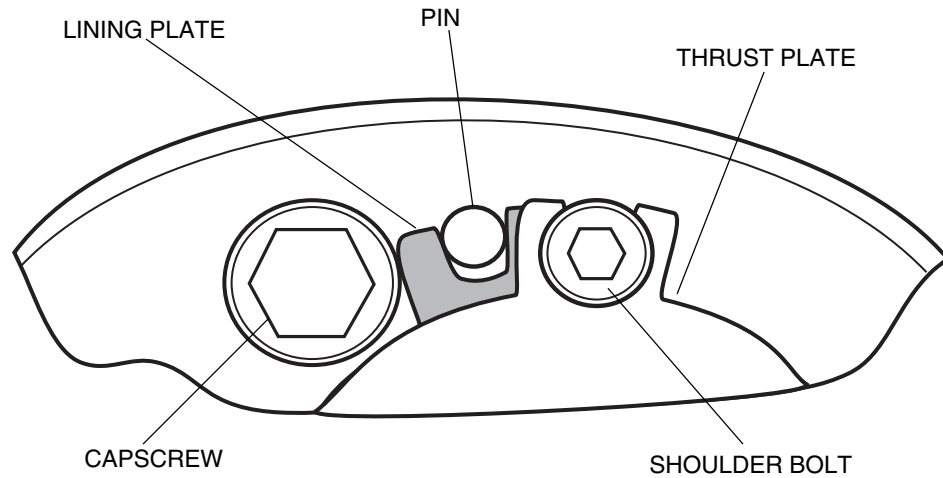
Fig. 5.12 Park Lock Removal



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- | | | | |
|-------------------------------|------------------------------------|--------------------|--------------------|
| 1. Screw, socket head cap (4) | 7. Screw, socket head cap (4) | 13. Ring, retainer | 19. Piston |
| 2. Plate, cover | 8. Disc, rotor (7) | 14. Bearing | 20. Ring, backup |
| 3. Spline, outer | 9. Plate, lining (7) | 15. Ring, retainer | 21. Ring, backup |
| 4. Spring, red (12) | 10. Plate, thrust | 16. Seal, oil | 22. O-ring |
| 5. Plate, pressure | 11. Bolt, socket head shoulder (4) | 17. Seal, oil | 23. O-ring |
| 6. Plate, spring | 12. Screw, bleeder | 18. Seal, case (2) | 24. Pin, dowel (4) |

Fig. 5.13 Exploded View of Park Lock



MA0291

Fig. 5.14 Plate and Disc Alignment

c. Cleaning and Drying

1. Clean all parts with approved petroleum based cleaner.
2. Use clean lint free towels to dry components after cleaning. DO NOT dry bearings by spinning with compressed air. This can damage mating surfaces due to lack of lubrication.
3. After drying, components should be lightly coated with oil or rust preventive to protect them from corrosion.

d. Inspection and Replacement

1. If yoke shaft (Fig. 5.12) shows wear in the area of oil seal (14 and 17, Fig. 5.13) contact, replace it.
2. Replace all oil seals (16 and 17), O-rings (22 and 23), and back up rings (20 and 21) regardless of condition.
3. Replace bearing (14) if it is worn, pitted, or damaged.
4. Replace outer spline (3) if it is worn, pitted, scored, or chipped.
5. Replace all weak, broken, or damaged springs (4).
6. If any one of lining plates (9) or rotor discs (8) show wear or scoring, replace the complete stack.

NOTE: If a new stack wasn't installed, keep the stack of plates and discs in exactly the same order in which they were removed.

e. Assembly

Refer to page 55 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for assembly instructions.

f. Installation

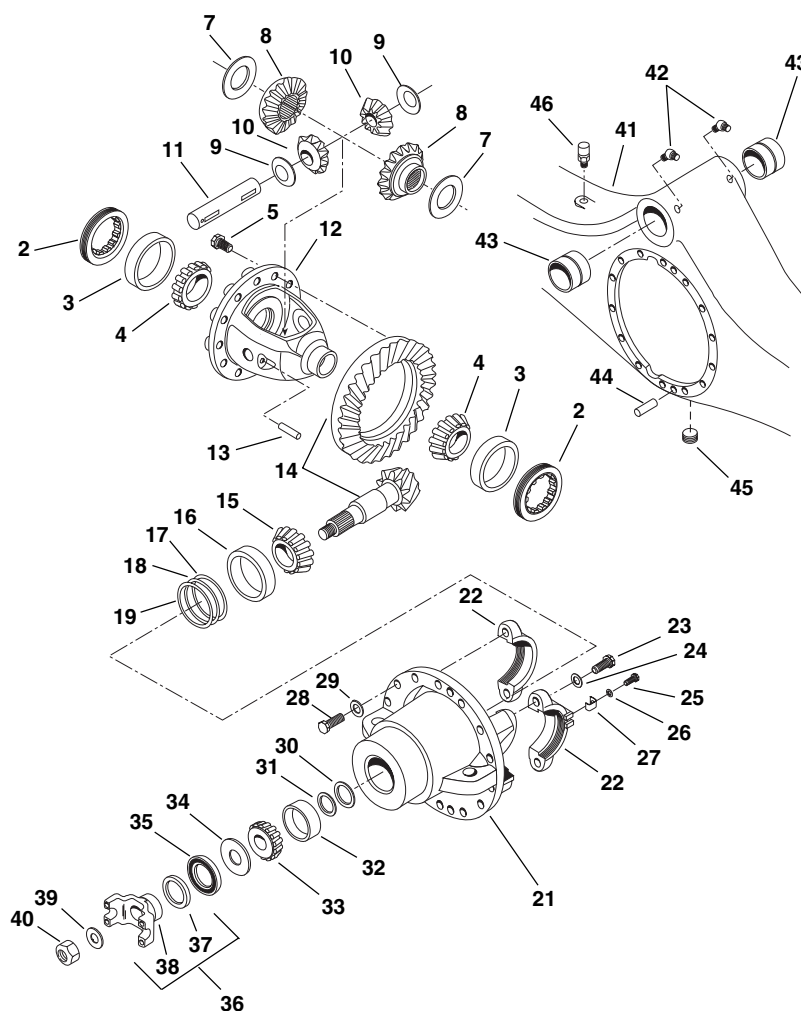
1. Install dust slinger (37, Fig. 5.16) on end yoke assembly (38).
2. Refer to page 54 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for installation instructions.

g. Bleeding

1. Be sure all pressure lines are secure and don't leak.
2. Bleed the pressure release section of the park lock by pressurizing the side inlet port and allowing air to escape from the top port.
3. Pressure should not exceed 100 psi (690 kPa) during bleeding.
4. Apply sufficient pressure to release the park lock and allow for the checking of system operation.

5.2.7 Carrier Assembly

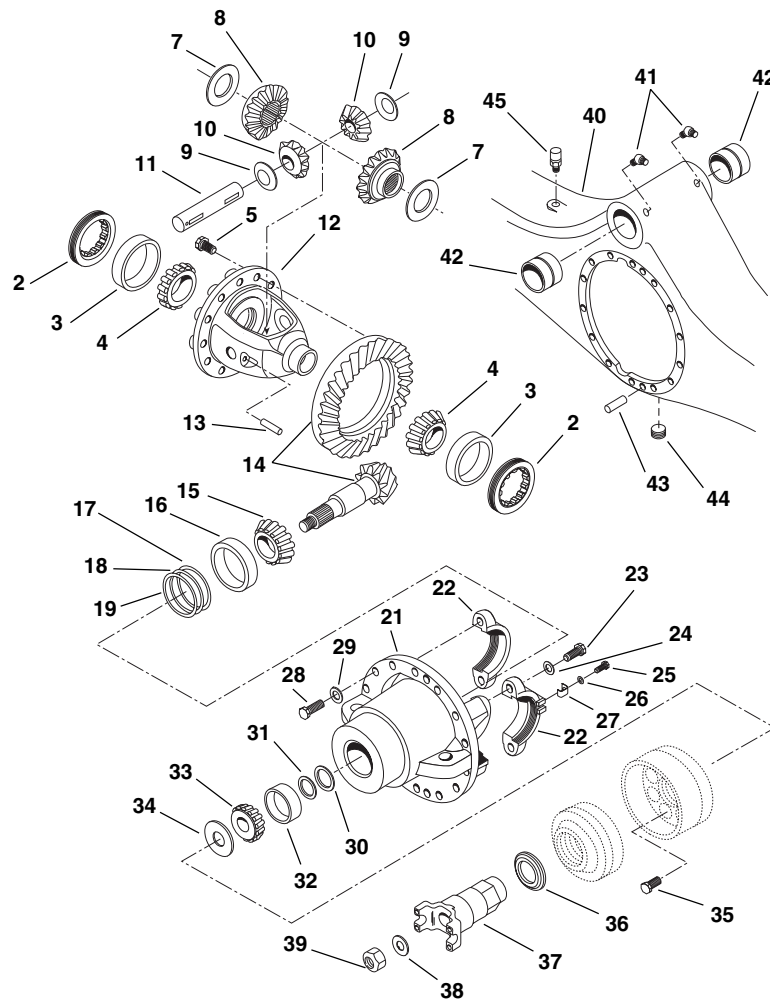
Refer to paragraph 5.2.1 for axle assembly removal and installation instructions. Refer to pages 38 through 53 of Spicer® Dana Models PS/PR-7036 Maintenance Manual for removal and installation of carrier from axle housing; removal and installation of differential from carrier, and differential and pinion disassembly and assembly.



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|---|--|
| 1. Differential Carrier Assembly (includes items 2 thru 40) | 23. Screw, differential bearing cap (4) |
| 2. Ring, adjusting (2) | 24. Washer, differential bearing cap (4) |
| 3. Cup, roller bearing (2) | 25. Bolt, hex (2) |
| 4. Cone, roller bearing (2) | 26. Washer, flat (2) |
| 5. Screw, differential (12) | 27. Clip, adjusting ring (2) |
| 6. Differential Case Assembly (includes items 7 thru 13) | 28. Screw, hex hd cap (14) |
| 7. Washer, thrust (2) | 29. Washer, flat (14) |
| 8. Gear, differential side (2) | 30. Spacer, flat |
| 9. Washer, pinion thrust (4) | 31. Shim, adjusting (AR) |
| 10. Gear, pinion (4) | 32. Cup, roller bearing |
| 11. Shaft, differential | 33. Cone, roller bearing |
| 12. Case, differential | 34. Washer, bearing thrust |
| 13. Pin, pinion bearing cage | 35. Seal, oil |
| 14. Gear and Pinion Assembly | 36. End yoke assembly (includes items 37 and 38) |
| 15. Cone, roller bearing | 37. Deflector |
| 16. Cup, roller bearing | 38. End Yoke |
| 17. Shim, bevel pinion bearing, 0.003" (AR) | 39. Washer, pinion nut |
| 18. Shim, bevel pinion bearing, 0.005" (AR) | 40. Nut, pinion |
| 19. Shim, bevel pinion bearing, 0.010" (AR) | 41. Housing, axle |
| 20. Carrier Assembly (includes items 21 thru 24) | 42. Fitting, grease (2) |
| 21. Carrier | 43. Bushing, axle pivot (2) |
| 22. Cap, differential carrier (2) | 44. Pin, dowel (2) |
| | 45. Plug, pipe (2) |
| | 46. Vent |

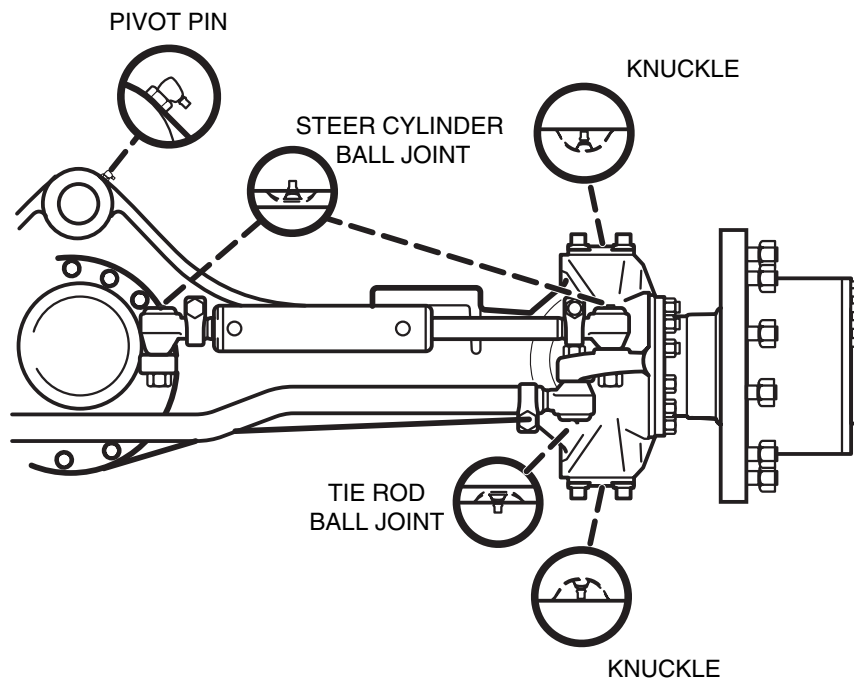
Fig. 5.15 Front Axle Differential Carrier Assembly



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- | | |
|---|--|
| 1. Differential Carrier Assembly (includes items 2 thru 39) | 23. Screw, differential bearing cap (4) |
| 2. Ring, adjusting (2) | 24. Washer, differential bearing cap (4) |
| 3. Cup, roller bearing (2) | 25. Bolt, hex (2) |
| 4. Cone, roller bearing (2) | 26. Washer, flat (2) |
| 5. Screw, differential (12) | 27. Clip, adjusting ring (2) |
| 6. Differential Case Assembly (includes items 7 thru 13) | 28. Screw, hex hd cap (14) |
| 7. Washer, thrust (2) | 29. Washer, flat (14) |
| 8. Gear, differential side (2) | 30. Spacer, flat |
| 9. Washer, pinion thrust (4) | 31. Shim, adjusting (AR) |
| 10. Gear, pinion (4) | 32. Cup, roller bearing |
| 11. Spider, differential | 33. Cone, roller bearing |
| 12. Case, differential | 34. Washer, bearing thrust |
| 13. Pin, pinion bearing cage | 35. Bolt, hex (8) |
| 14. Gear and Pinion Assembly | 36. Slinger, dust |
| 15. Cone, roller bearing | 37. End yoke assembly |
| 16. Cup, roller bearing | 38. Washer, pinion nut |
| 17. Shim, bevel pinion bearing, 0.003" (AR) | 39. Nut, pinion |
| 18. Shim, bevel pinion bearing, 0.005" (AR) | 40. Housing, axle |
| 19. Shim, bevel pinion bearing, 0.010" (AR) | 41. Fitting, grease (2) |
| 20. Carrier Assembly (includes items 21 thru 24) | 42. Bushing, axle pivot (2) |
| 21. Carrier | 43. Pin, dowel (2) |
| 22. Cap, differential carrier (2) | 44. Plug, pipe (2) |
| | 45. Vent |

Fig. 5.16 Rear Axle Differential Carrier Assembly



OA0192

Fig. 5.17 Axle Grease Points



Warning

- Do not attempt carrier and differential removal and installation and differential and pinion disassembly and assembly without thoroughly understanding instructions in Spicer® Dana publications and correspondence which applies to your forklift.
- If it becomes necessary to disassemble any parts inside the carrier, it is suggested that the entire axle be removed from the forklift and held tight in a stand or rack with carrier pinion positioned up.
- When removing axle assembly, make sure forklift is properly supported; an improperly supported vehicle can cause serious injury or death.
- If axle assembly is still in the forklift, be sure carrier, differential and pinion assemblies are securely supported before they are separated from the axle housing.

5.3 AXLE LUBRICATION

5.3.1 Grease

Lubricate the following axle points (Fig. 5.17) after overhaul or at 50 hour intervals using multi-purpose lithium-based grease:

- pivot pins (4 points)

Lubricate the following axle points (Fig. 5.17) after overhaul or at 250 hour intervals using multi-purpose lithium-based grease:

- steering knuckles (8 points)
- tie rod ball joints (4 points)
- steer cylinder ball joints (8 points)

5.3.2 Differential Housing Oil

Level Check (250 hour intervals)

1. Clean the area around the axle and remove the fill and level plug (Fig. 5.18) from the axle housing.
2. Check the oil level.
3. Add 80W90 gear oil as required to bring the oil up to the level of the plug hole.

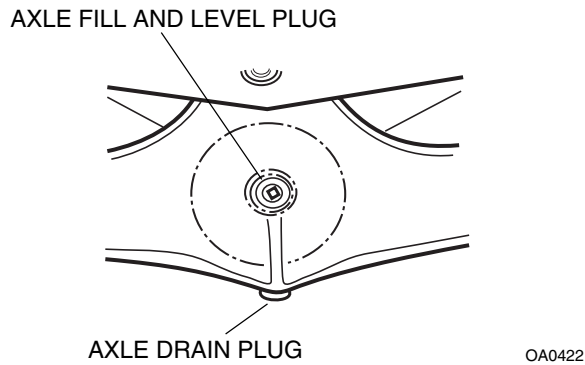


Fig. 5.18 Axle Fill and Drain Plugs

Change (1000 hour intervals)

1. Place a receptacle under the axle housing drain plug (Fig. 5.18).
2. Clean area around the axle fill and level plug and drain plug and remove both plugs.
3. Allow the oil to drain completely.
4. Install the drain plug.
5. Add 80W90 gear oil as required to bring the oil up to the level of the plug hole. Axle capacity is 18 quarts (17 liters).
6. Install the fill and level plug.

5.3.3 Wheel End Brake Oil

Magnetic Plug Check (First 50 hours)

1. Level the forklift, ground the carriage, shut off the engine, and engage the park lock. Be sure that the arrow on the wheel end housing is pointing down (Fig. 5.19).
2. Clean the area around the magnetic drain plug and remove the plug.
3. Remove any metallic debris that may have collected on the end of the plug.
4. Reinstall the plug.

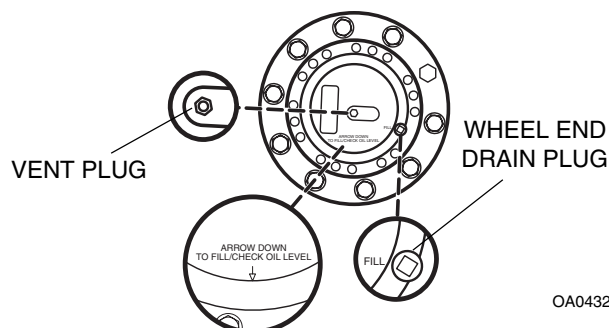


Fig. 5.19 Wheel End Drain and Vent Plugs

Level Check (250 hour intervals)

1. Level the forklift, ground the carriage, shut off the engine, and engage the park lock. Be sure that the arrow on the wheel end housing is pointing down (Fig. 5.19).
2. Clean the area around the magnetic drain plug and remove the plug.
3. Check the oil level, if necessary, add oil, use Amoco 1000 oil TRAK P/N 8522045 and Friction Modifier TRAK P/N 8522043. The use of TRAK Wet Disc Brake Oil P/N 8522042 is still recommended for use on very early axles that are equipped with paper-based friction discs

IMPORTANT: Other brake oils must not be used. If they are, loss of braking force and squealing will occur.

4. Clean and install the magnetic drain plug.

Oil Change (1000 hour intervals)

1. Level the forklift, ground the carriage, shut off the engine, and engage the park lock. Be sure that the drain plug on the wheel end housing is pointing down (Fig. 5.15).
2. Remove the vent plug
3. Clean the area around the magnetic drain plug and remove the plug.
4. Allow the oil to drain.
5. Move the forklift so that the arrow on the wheel end housing is pointing up.
6. Fill the wheel end using Amoco 1000 oil TRAK P/N 8522045 and Friction Modifier TRAK P/N 8522043. The use of TRAK Wet Disc Brake Oil P/N 8522042 is still recommended for use on very early axles that are equipped with paper-based friction discs as required to bring the level up to the drain plug hole. Capacity for the front wheel end is 54.0 ounces (1,6 liter) and for the rear wheel is 56.0 ounces (1,7 liter).
7. Clean and install the drain and vent plug.

5.4 SPECIFICATIONS

Oil Capacity of Differential Housing

18 qts (17 liters)

80W-90 with EP properties:

Amoco MP Gear Lube 80W90

Benz Multi-Purpose 80W90

Mobil Mobilube HD 80W90

Shell Spirax 80W90

Texaco Multi Gear Lube 80W90

Oil Capacity of Wheel End

Front-54 oz. (1,6 liter)

Amoco 1000 oil TRAK P/N 8522045 and Friction Modifier TRAK P/N 8522043. The use of TRAK Wet Disc Brake Oil P/N 8522042 is still recommended for use on very early axles that are equipped with paper-based friction discs

Rear-56 oz. (1,7 liter)

Amoco 1000 oil TRAK P/N 8522045 and Friction Modifier TRAK P/N 8522043. The use of TRAK Wet Disc Brake Oil P/N 8522042 is still recommended for use on very early axles that are equipped with paper-based friction discs

Park Lock Unit

Type:

Multiple Disc Park Lock, spring apply hydraulic release (dry disc design)

Maximum Speed:

1700 rpm

Release Pressure:

364 psi (2 512,0 kPa) min.

3000 psi (20 700,0 kPa) max.

Torque Rating:

17,000 in. lbs (19 210,0 N m) static (breakaway)

Volume displacement to release park lock:

1.2 cu. in. (19,6 cm)

Approximate Weight:

44 lbs (20 kg)

For use with mineral base hydraulic oil only.

NOTE: Refer to pages 59 and 60 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036 for additional specifications.

5.5 TROUBLESHOOTING

Troubleshooting instructions are provided on pages 56 through 59 of Spicer® Dana Maintenance Manual for Axle Models PS/PR-7036.

SECTION 6

DRIVE SHAFTS AND DROP BOX

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6.1 DRIVE SHAFTS

6.1.1 Drive Shaft Servicing

a. Removal

Drive Shaft–Transmission to Drop Gear Box

1. Remove the transmission cover from the forklift.
2. Remove the U-bolt assembly or bearing straps, Fig. 6.1, attaching the drive shaft cross assembly to the drop box input shaft yoke. Slide slip joint towards transmission so cross slips out of drop box input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

3. Remove the cap and bolt assembly or bearing straps securing the drive shaft cross assembly to the transmission output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

4. Remove the drive shaft assembly from the forklift.

Drive Shafts–Drop Gear Box to Axle

1. Provide a suitable support under the shaft.
2. Remove the U-bolt assemblies, Fig. 6.1, attaching the drive shaft cross assembly to the drop box output shaft yoke. Slide slip joint towards axles so bearing cross slips out of the drop box output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

3. Remove the U-bolt assemblies securing the drive shaft cross assembly to the axle input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings do not drop off cross.

4. Remove the axle drive shaft assembly from the forklift.

b. Disassembly

1. Using an approved nonflammable cleaning fluid, clean the drive shaft assembly, Fig. 6.1, with a brush. Wipe dry before disassembling.
2. Place the drive shaft assembly in a bench vise.
3. Pinch the ends of two retaining rings, Fig. 6.2, that secure the bearing cross assembly in the yoke with a pair of pliers and remove them from their grooves in the yoke.

NOTE: If the retaining ring does not readily snap out of the groove in the yoke, tap the end of the bearing cap lightly to relieve the pressure against the ring.

4. Using a soft round pin with a flat face about 1/32" (0,8 mm) smaller than the hole diameter in the yoke, drive on one end of the bearing assembly unit until the opposite bearing assembly comes out of yoke.
5. Turn the yoke over and tap the exposed end of cross until the opposite bearing assembly falls free.
6. Remove the cross from the yoke.
7. Repeat steps 2 thru 6 to remove cross and bearings on other end of drive shaft.
8. Mark the shaft and sleeve assembly so that it can be aligned properly when reassembled. Yokes at both ends of the drive shaft must be in the same plane to prevent excessive vibration.

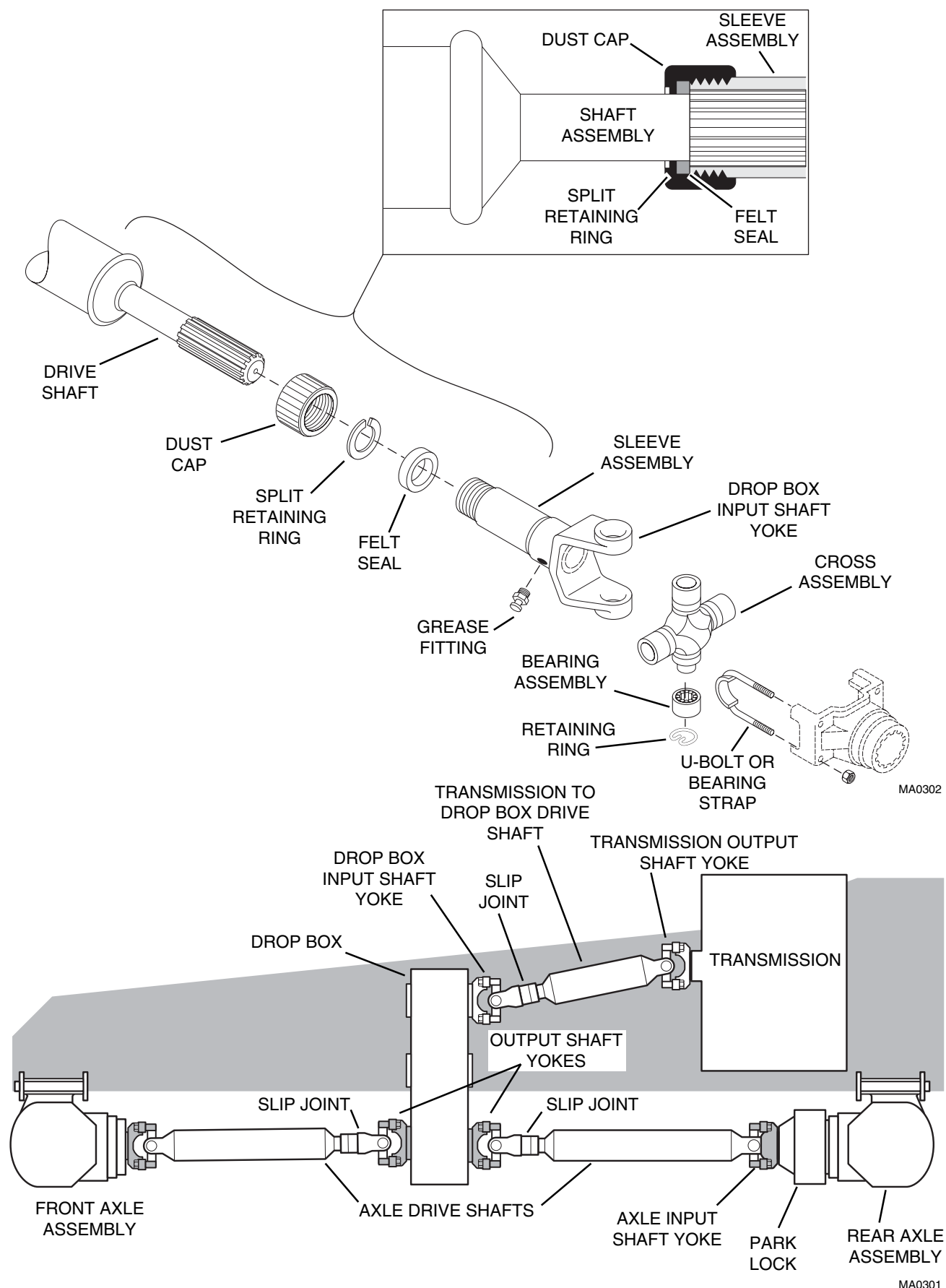


Fig. 6.1 Drive Shafts and Drop Box

9. Unscrew the dust cap and slide the sleeve assembly off the spline of the drive shaft.
10. Remove the dust cap, split retaining ring, and felt seal from the shaft assembly.

c. Cleaning and Drying

1. Disassemble and clean all parts using an approved cleaning fluid.
2. Remove any burrs or rough spots from any machined surfaces.

d. Inspection and Replacement

1. Individually inspect each cross, bearing caps and needle bearings for signs of wear or missing parts.

NOTE: *If all parts of the cross assemblies check to be in good condition, pack the bearing caps with a good grade of MP grease. Reassemble equal numbers of needle bearings into each cap and reassemble the cross assembly into the drive shaft yokes.*

2. Replace the cross assembly as a complete assembly if any parts are worn or missing.
3. Replace the felt seal if worn or damaged.
4. Replace the sleeve or shaft assemblies if they are severely dented or damaged.
5. Cross assemblies should flex and be free from excessive binding. A slight drag is desirable on a new cross assembly. Excessive looseness causes unbalance.

e. Assembly

1. Install dust cap, Fig. 6.1, split retaining ring, and felt seal on the shaft assembly.
2. Slide the sleeve assembly onto the splines of the drive shaft and tighten the dust cap.

IMPORTANT: *Be sure that the arrows or marks on the shaft and sleeve assemblies are aligned, since the yokes on both ends of the drive shaft must be in the same plane to prevent excessive vibration.*

3. Install the cross and both bearings in the yoke.
4. Install the two retaining rings in their grooves in the yoke.
5. Repeat steps 3 and 4 for the other cross assembly.
6. Using the grease fitting on the sleeve assembly, lubricate the shaft assembly spline with a multi-purpose lithium-based grease.

7. Temporarily tape the two loose bearing caps to the cross so they do not fall off during assembly of drive shaft onto the forklift.

f. Installation

Drive Shaft–Transmission to Drop Gear Box

1. Position the drive shaft assembly on the forklift so slip joint mounts to the drop box, Fig. 6.1.
2. Remove tape and secure this end of the drive shaft cross assembly to the transmission output shaft yoke with a cap and bolt assembly or bearing straps. Torque the cap and bolt assembly to 30 to 35 lb-ft (41 to 48 Nm) or the bearing strap to 55 to 60 lb-ft (75 to 82 Nm).
3. Slide slip joints as far as possible onto drive shaft, remove taps and secure the drive shaft cross assembly to the drop box input shaft yoke with a U-bolt assembly or bearing strap. Torque the U-bolt assembly to 20 to 24 lb-ft (27 to 37 Nm) or the bearing strap to 55 to 60 lb-ft (75 to 82 Nm).

4. Install the transmission cover on the forklift.

Drive Shafts–Drop Gear Box to Axle

1. Position the drive shaft on supports under the forklift so slip joint mounts to the drop box, Fig. 6.1.
2. Secure this end of the drive shaft cross assembly to the axle input shaft yoke with a U-bolt assembly. Torque the U-bolt assembly to 20 to 24 lb-ft (27 to 37 Nm).
3. Slide slip joint as far as possible into drive shaft, remove tape and secure the drive shaft cross assembly to the drop box output shaft yoke with a U-bolt assembly. Torque the U-bolt assembly to 20 to 24 lb-ft (27 to 37 Nm).
4. Remove supports from under the forklift.

6.2 DROP GEAR BOX FOR S/N 9N0941 AND BEFORE

6.2.1 End Yokes

a. Inspection

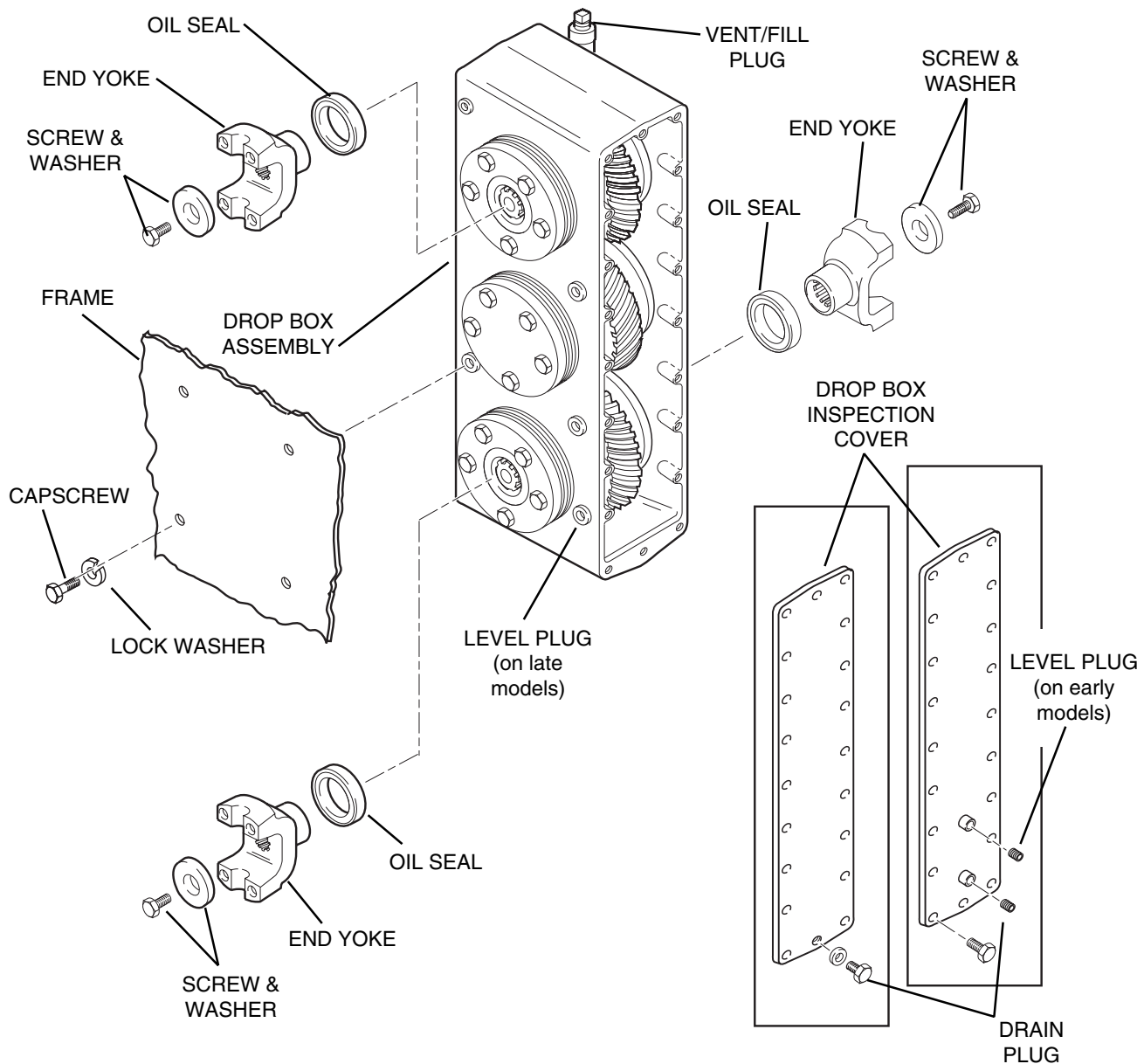
Replace end yoke, Fig. 6.4, if worn or damaged.

b. Removal

To remove end yoke, remove screw, washer and end yoke, Fig. 6.4.

c. Installation

To install end yoke, press yoke, Fig. 6.4, on shaft and secure with washer and screw.



PA0261

Fig. 6.2 Exploded View of Drop Gear Box for S/N 9N0941 and Before

6.2.2 Oil Seals

a. Inspection

Replace oil seal, Fig. 6.2, if worn or damaged.

b. Removal

To remove oil seal, remove screw, Fig. 6.2, washer, end yoke and oil seal.

c. Installation

1. To install oil seal, press oil seal and yoke on shaft.
2. Press yoke, Fig. 6.2, on shaft and secure with washer and screw.

6.2.3 Internal Inspection and Servicing

NOTE: JLG does not recommend servicing of gears, shafts or bearings inside this drop box. Attempts at internal disassembly of these items may cause damage to other parts and possibly the drop box case. The only serviceable items of this drop box are the yokes and oil seals. If internal servicing of drop box is required while still under warranty, return it to JLG for replacement with a new drop box.

6.2.4 Removal and Installation

Refer to paragraph 6.3.3 for removal instructions and paragraph 6.3.8 for installation instructions.

6.3 DROP GEAR BOX FOR S/N 9N0942 AND AFTER

6.3.1 End Yokes

a. Inspection

Replace end yokes (23 and 24, Fig. 6.3) if worn or damaged.

b. Removal

To remove an end yoke, remove nut (12), washer (14), and end yoke (23 or 24, Fig. 6.3).

c. Installation

To install an end yoke, press yoke (23 or 24, Fig. 6.3) on shaft and secure with washer (14) and nut (12).

6.3.2 Oil Seals

a. Inspection

Replace oil seal (21, Fig. 6.3, if worn or damaged.

b. Removal

To remove oil seal, remove nut (12, Fig. 6.3), washer (14), end yoke (24) and oil seal (21).

c. Installation

1. To install oil seal, press oil seal (21) and end yoke (24) on shaft.
2. Secure with washer (14) and nut (12).

6.3.3 Removal of Drop Gear Box

1. Remove the transmission and hydraulic tank covers from the frame.
2. Remove the U-bolt assembly or bearing straps attaching the transmission drop box drive shaft cross assembly to the drop box input shaft yoke, Fig. 6.1.
3. Remove the U-bolt assemblies attaching the axle drive shaft cross assemblies to the drop box output shaft yokes, Fig. 6.1. Slide slip joint back as far as possible on drive shaft. Tape bearing caps to cross to prevent loss of bearings.
4. Secure drop gear box in a sling, connect sling to a hoist and remove slack from hoist line.
5. Drain hydraulic tank. Detach hose that runs in between tank and drop box. Remove bolt and washer attaching input yoke to drop box.
6. From under the forklift, remove two capscrews and lock washers securing the drop box to the frame, Fig. 6.2.

7. From above, remove the remaining two capscrews and lock washers attaching the drop box to the frame.
8. Use hoist to lift drop box from forklift.
9. Clean the exterior of the drop box and move it to a clean work area.

6.3.4 Disassembly of Drop Gear Box for S/N 9N0942 and After Only

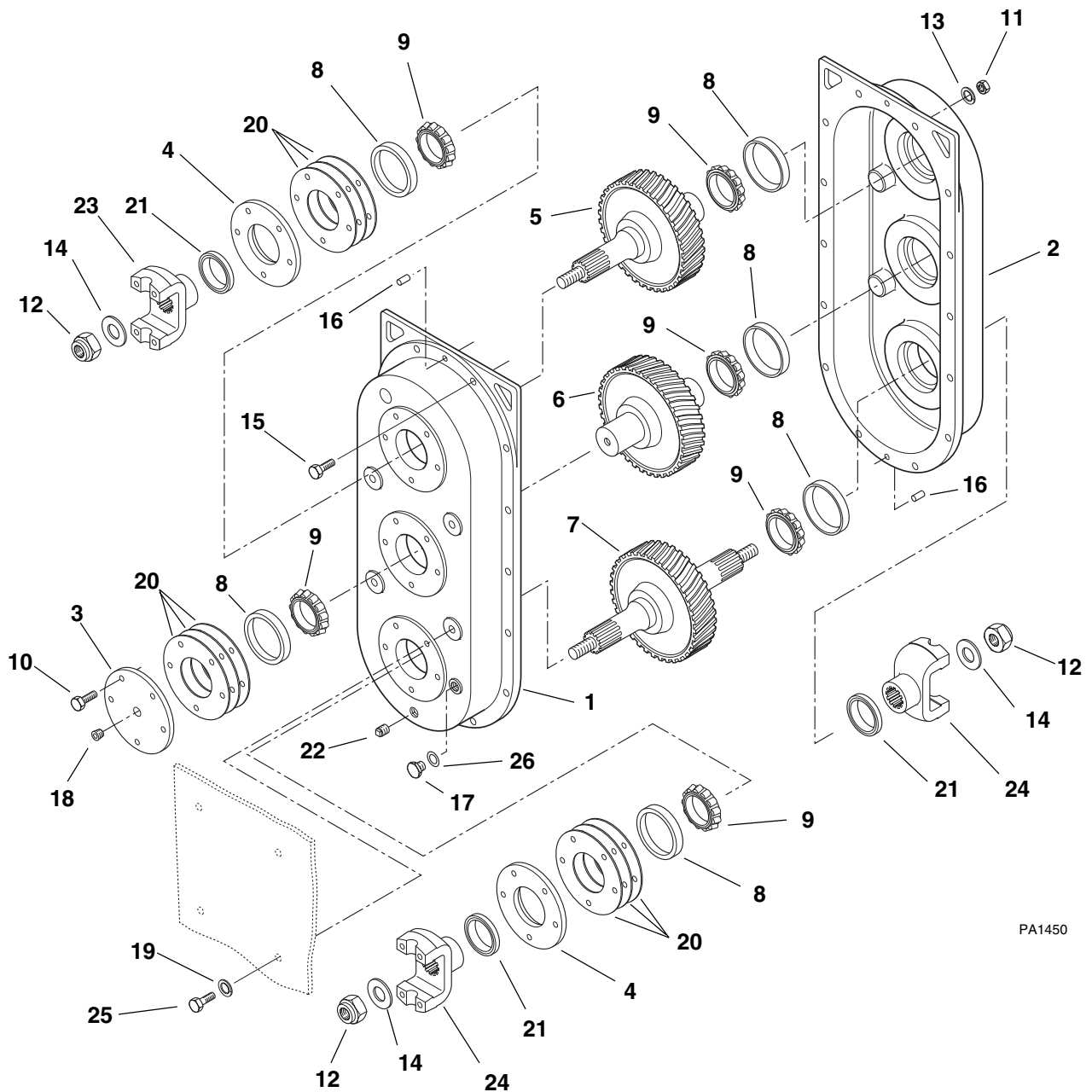
1. Prepare to drain oil from the drop box by positioning box with drain plug 22 at the bottom of the box.
2. Place a container suitable for collecting the oil under the drop box and remove the level plug (17), copper washer (26) and drain plug (22).
3. To remove each of the three end yokes (23 or 24, Fig. 6.3) remove nut (12) and washer (14).
4. Pull the three yokes from the shafts.
5. Remove capscrew (10), open cover (4), shims (20), bearing cup (8), and seal (21) from upper and lower shafts. Keep bearing cones and cups together as matched sets.
6. Remove plug (18), capscrew (10), closed cover (3), shims (20), bearing cup (8), and bearing cone (9) from center shaft.
7. Prepare to separate the housings (1 and 2) by removing nuts (11), capscrews (15) and lock washers (13).
8. Carefully separate the housings.
9. Remove gears (5, 6, and 7), bearing cone (9), and bearing cup (8).
10. If necessary, remove dowels (16).

6.3.5 Cleaning and Drying of Drop Gear Box for S/N 9N0942 and After Only

Clean drop box using an approved solvent and dry with a clean, lint-free cloth.

6.3.6 Inspection and Replacement of Drop Gear Box for S/N 9N0942 and After Only

1. Inspect and lubricate bearings.
2. Repair components as required.
3. Replace gears as a set if one or more gears is significantly worn or damaged.



PA1450

- | | | |
|---|---|--|
| 1. Housing | 10. Hex Head Capscrew
3/8-16 x 1" (15) | 18. Plug 1/2-14 NPT |
| 2. Housing | 11. Hex Nut 3/8-16 (14) | 19. Lock Washer 1/2" (4) |
| 3. Closed Cover | 12. Lock Nut (3) | 20. Shims as Required |
| 4. Open Cover (2) | 13. Lock Washer 3/8" (14) | 21. Seal (3) |
| 5. Input Pinion with 69 Teeth | 14. Flat Washer 1" (3) | 22. Drain Plug 3/8-18 NPT |
| 6. Intermediate Pinion with
67 Teeth | 15. Hex Head Capscrew
3/8-16 x 1-1/2" (14) | 23. Input End Yoke |
| 7. Output Pinion with 69 Teeth | 16. Dowel 3/8 by 3/4" (2) | 24. Output End Yoke (2) |
| 8. Bearing Cup (6) | 17. Fill Level Plug 3/8-18 NPT | 25. Hex Head Capscrew
1/2 NC x 2-3/4" Grade 5 (4) |
| 9. Bearing Cone (6) | | 26. Copper Washer (1) |

Fig. 6.3 Exploded View of Drop Gear Box for S/N 9N0942 and After

6.3.7 Assembly of Drop Gear Box for S/N 9N0942 and After Only

1. If necessary, install dowels (16).
2. Press in matching bearing cups (8) and press on cones (9).
3. Place gears (5, 6, and 7) in housing and align the holes in the housing with the dowel pins.
4. Install and loosely tighten capscrews (15), lock washers (13) and nuts (11).

6.3.8 Installation of Drop Gear Box

1. From above and below the frame, secure the drop gear box to the frame with four capscrews and lock washers. Torque capscrews 67.5 to 82.5 lb-ft (91,8 to 112,2 Nm).
2. Remove the level plug, Fig. 6.2.
3. Using level plug opening, fill housing with tractor hydraulic fluid meeting specifications in paragraph 6.3 until it flows from the level plug, Fig. 6.2.
4. Install the level plug securely.
5. Secure drive shaft cross assembly to drop box input shaft yoke with a U-bolt assembly or bearing strap, Fig. 6.1. Torque U-bolt assembly to 20 to 24 lb-ft (27 to 37 Nm) or the bearing strap to 55 to 60 lb-ft (75 to 82 Nm).
6. Secure the drive shaft cross assemblies to the drop box output shaft yokes with a U-bolt assembly, Fig. 6.1. Torque U-bolt assembly to 20 to 24 lb-ft (27 to 37 Nm).
7. Install transmission and hydraulic tank covers on frame.

6.4 SPECIFICATIONS

Transmission and Drop Box—Use a Tractor Hydraulic Fluid which meets the requirements of any of the following specifications:

John Deere J20 A

Detroit Diesel C-3; C-2

Ford Tractor M2C134B

White Farm UTHF Q1766, Q1722

Products known to meet these requirements include:

Texaco THD Oil

ARCO Tractor Fluid or equivalent

CAPACITIES:

Drop Box: 2.0 quarts (1,9 liter)

Transmission System (including filter and oil cooler): 3 gallons (13,7 liter)

Transmission Filter: 1 quart (0,95 liter)

Notes

SECTION 7

TRANSMISSION, CLARK SERIES 18000

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7.1 TRANSMISSION PREVENTIVE MAINTENANCE



Warning

- To avoid severe burns, **DO NOT** attempt this procedure when the engine, cooling, and hydraulic systems are hot. Wait until they have cooled before proceeding.
- Care must be exercised to avoid skin rashes, fire hazards and inhalation of vapors when using solvent and alkali cleaners.
- Be careful when using steam cleaner to avoid burns.

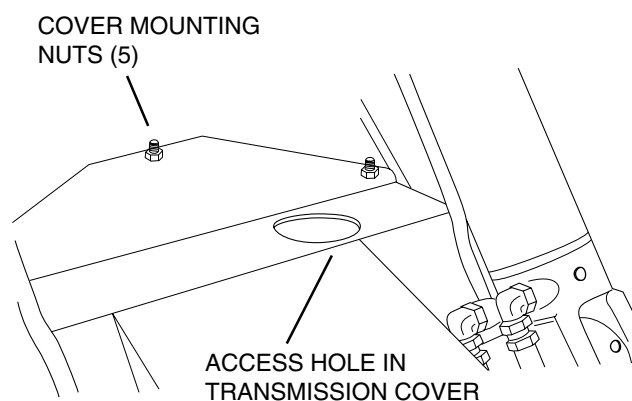
IMPORTANT: These instructions cover only the routine maintenance of the transmission. Refer to your 18000 Powershift Transmission Maintenance and Service Manual for transmission diagnosis, repair and component replacement. Cleanliness is of extreme importance. Before attempting any repairs, the exterior of the unit must be cleaned to prevent the possibility of dirt from entering the mechanism.

Model 6036/6036T S/N 9B0500 thru 14833

7.1.1 Daily or 10 Hour Intervals

Level Check

1. Check the oil level with the engine running at idle, and oil at normal operating temperature.
2. Level the forklift, engage the parking lock, ground the carriage, and place the travel select lever in neutral.



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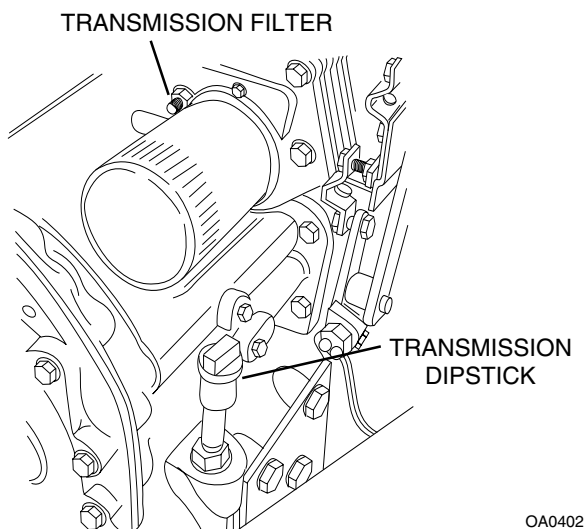
Fig. 7.1 Transmission Cover Access Hole

3. Remove the transmission dipstick through the access hole in the transmission cover, Fig. 7.1, and check the reading.
4. Add oil (see table on page 7-2) to the transmission as required to bring it up to the full mark. Transmission capacity is 4.3 gallons (16,3 liter).

7.1.2 First 50 Hours and 500 Hour Intervals Thereafter

Filter Change

1. Level the forklift, ground the carriage, shut off the engine, and engage the parking lock.
2. Remove the transmission cover from the top of the frame.
3. Place a receptacle under the transmission filter, Fig. 7.2, to catch fluid when the filter is removed.
4. Remove the old filter element and discard the element.
5. Apply a thin film of clean oil to the new element gasket.



OA0402

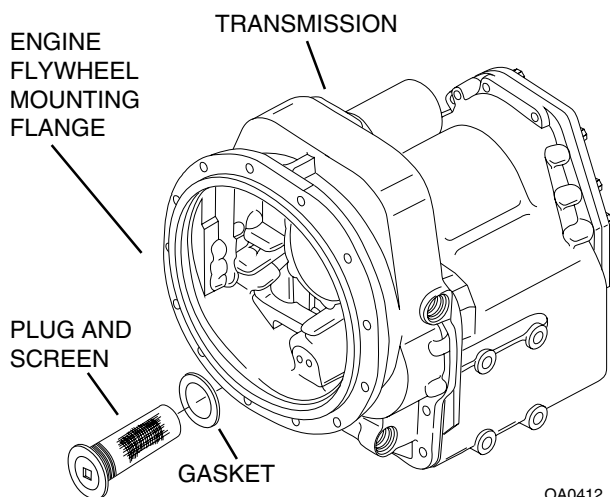
Fig. 7.2 Transmission Filter and Dipstick

6. Turn the element on the transmission fitting. Tighten the element to 20 to 25 lb-ft (27 to 34 Nm).
7. Remove the receptacle.
8. Check the transmission level as instructed in the previous paragraph and add tractor hydraulic fluid as required.
9. Install the transmission cover on the frame.

7.1.3 1000 Hour Intervals

Fluid Change

1. Level the forklift, ground the carriage, shut off the engine, and engage the parking lock.
2. Place a funnel with a flexible drain and a receptacle under the transmission sump housing.



OA0412

Fig. 7.3 Transmission Sump Plug and Screen

3. Remove sump plug and screen with gasket from housing, Fig. 7.3. Allow the transmission to drain completely.
4. Clean the plug and screen thoroughly with an approved solvent.
5. Install a new filter element as described in paragraph 7.1.2. **DO NOT START ENGINE.**
6. Install the cleaned drain plug and screen and gasket into the transmission sump housing.
7. Add oil (see table on this page) as required to bring level up to full mark. Transmission capacity is 4.3 gallons (16,3 liter).

MIL-L-2104C
10W Motor Oil*

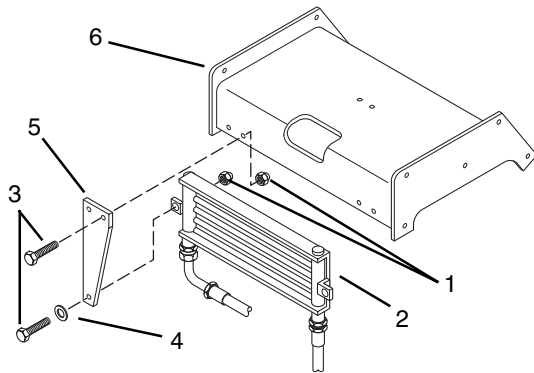
Castrol Deusol CRD
Esso Essolube D-3HP
Esso Essolube XD-3
Castrol Agricastrol HDD
Shell Rimula CT
Shell Rimula X
Shell Rimula TX
* 5W20 Motor Oil may be substituted for -30° F to 70° F (-34 to 21° C) only.

7.2 HOW TO TOW THE FORKLIFT

Before you tow the forklift for long distances be sure to disconnect and remove both front and rear drive lines to avoid damage to the transmission. Because of the design of the hydraulic system, the engine **cannot** be started by pushing or towing. For short distance towing consult your Owners/Operators Manual.

7.3 HOW TO DRAIN TRANSMISSION

The procedure for draining the transmission is described in paragraph 7.1.3.



MA0321

- | | |
|----------------------------|-----------------------|
| 1. Lock Nut | 4. Flat Washer |
| 2. Transmission Oil Cooler | 5. Oil Cooler Support |
| 3. Capscrew, hex hd | 6. Rear Support |

Fig. 7.4 Transmission Oil Cooler

7.4 HOW TO BACK FLUSH OIL COOLER

The transmission oil cooler, Fig. 7.4, is mounted behind the radiator. Periodically disconnect and back flush the oil cooler with oil and compressed air until all foreign material has been removed. If necessary, remove oil cooler from forklift and clean it using oil, compressed air and steam.

IMPORTANT: DO NOT use flushing compounds for cleaning purposes.

7.5 TRANSMISSION REMOVAL

Please refer to paragraph 8.6 for engine and transmission removal instructions (they are removed as a single unit).

7.6 TRANSMISSION REPLACEMENT

If the transmission is to be replaced as a complete assembly, detach and transfer the following:

- Tandem Pump
- Transmission Temperature Switch
- Transmission Connector Kit (from valve)
- Two Side Mount Brackets
(*Neutral Start Switch comes with new transmission*)

7.7 INTERNAL SERVICING

If servicing the transmission internally, the tandem pump may require removal for disassembly.

Refer to the enclosed "Clark 18000 Powershift Transmission Maintenance and Service Manual" when servicing the transmission internally.

7.8 INSTALLATION

Please refer to paragraph 8.8 for engine and transmission installation instructions (they are installed as a single unit).

7.9 TROUBLESHOOTING

Trouble	Probable Cause	Remedy
Low Clutch Pressure	Low oil level Clutch pressure regulating valve stuck open Faulty charge pump Broken or worn clutch shaft or piston sealing rings Clutch piston bleed valve stuck open	Fill to proper level Clean valve spool and housing Replace pump Replace sealing rings Clean bleed valve thoroughly
Low Converter Charging Pump Output	Low oil level Suction screen plugged Defective oil pump	Fill to proper level Clean suction screen Replace pump
Overheating	Worn oil sealing rings Worn oil pump Low oil level	Remove, disassemble, and re-build converter assembly Replace pump Fill to proper level
Noisy Converter	Worn oil pump Worn or damaged bearings	Replace pump Disassemble converter to determine what bearing is faulty
Lack of Power	Converter stalls because of low engine rpm Worn oil sealing rings Worn oil pump Low oil level	Tune engine and check governor Remove, disassemble, and re-build converter assembly Replace pump Fill to proper level

7.10 SPECIFICATIONS

System Capacity (inc. filter and oil cooler)	4.3 gallons (16,3 liter)
Filter Capacity	1 quart (0,95 liter)
Transmission Oil (MIL-L-2104C)	Castrol Deusol CRD Esso Essolube D-3HP Esso Essolube XD-3 Castrol Agricastrol HDD Shell Rimula CT Shell Rimula X Shell Rimula TX
Converter: Outlet oil temperature Outlet pressure	180 to 200 °F (82 to 93 °C) Transmission in Neutral. 25 psi (172,3 bar) minimum pressure at 2000 rpm engine speed 70 psi (482,3 bar) outlet pressure with engine operating at no-load governed speed.
Controls	Forward and Reverse is Manual Speed Selection is Manual
Clutch Type	Multiple discs, hydraulically actuated, spring released, automatic wear compensated, and non adjustable. Oil cooled and lubricated. Inner Disc—Friction Outer Disc—Steel
Oil Filtration	Full flow oil filter safety by pass. Strainer screen in sump at bottom of transmission case.
Clutch Pressure	180 to 220 psi (1240 to 1516 bar) with: <ul style="list-style-type: none"> • park lock set (<u>Never use service brakes</u>) • oil temperature at 80 to 200 °F (82 - 93 °C) • engine at idle (400 to 600 rpm) Shift thru direction and speed clutches. All clutch pressure must be equal within 5 psi (34,5 bar). If clutch pressure varies in any one clutch by more than 5 psi (34,5 bar), <u>repair the clutch</u> .

Notes

SECTION 8A

ENGINE, PERKINS SERIES 4.236 AND T4.236

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Warning

To protect yourself and others:

- DO NOT smoke or operate engine during refueling.
- DO NOT operate engine in the presence of a fuel spill or gas leak. Such combustible vapors when drawn into the engine can cause engine over-speeding, an explosion, fire and extensive personal injury and property damage. Before you operate in any hazardous environment consult a recognized authority in this field such as your engine distributor.
- DO NOT remove radiator cap while engine and coolant are hot; coolant under pressure is dangerous and can injure the eyes and cause severe burns.
- DO NOT use salt water or other corrosive liquid in the cooling system.
- DO NOT pull or pry on the fan blades. This practice will damage the fan blades and cause fan failure. Use only approved methods and tools for manually rotating the engine.
- DO NOT operate, clean, lubricate or adjust engine without correct training.
- DO NOT permit loose clothing, long hair, etc., near moving parts.
- Keep away from parts which rotate; fan blades can appear invisible when fan is rotating.
- At any time only one person must be in control of engine and forklift; forklift brakes must work.
- Install guards before operating engine and forklift.
- Clear all persons from the immediate area during engine and forklift operation.
- Be sure engine operation will not produce a concentration of toxic emissions.
- Operate well within the stability limits of the equipment.
- Work area must support the weight of the equipment plus the torque produced by the suspended load.
- Wear protective glasses and protective shoes.
- Make only adjustments and repairs you understand.
- DO NOT work on engine or equipment that is supported ONLY by lift jacks or a hoist; use blocks or special stands.
- To avoid burns, be alert for components which remain hot after power is turned off or disconnected.
- Corrosion inhibitor contains alkali. Do not get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Get medical assistance immediately. Keep out of the reach of children.
- Before beginning any adjustments or repairs, place a "Do Not Operate" tag in the operator's compartment and on the controls, disconnect negative cable from batteries.
- Relieve pressure in fuel, oil, cooling and hydraulic lines before servicing; get medical assistance immediately if a *high pressure jet* of fuel, oil, antifreeze or hydraulic fluid strikes your skin.
- Keep sparks and fire away from batteries; batteries produce hydrogen gas which can explode and cause severe personal injury and property damage.
- Battery fluid can burn the skin and injure the eyes. If you come in contact with battery acid, flush skin with large amounts of water and get medical assistance immediately.
- Some of the gaskets on the engine contain asbestos. Breathing asbestos dust is dangerous to health and may cause severe bodily harm. Avoid creating dust and follow local directives for handling and disposing of materials which contain asbestos.
- Always use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of lesser quality if replacement is necessary.
- Never use gasoline or other flammable materials when cleaning parts; use an approved cleaning solvent.
- Diesel fuel can irritate the skin; use gloves or a protective hand lotion.
- Avoid prolonged and repeated skin contact with new and used engine oil. This contact may cause skin disorders and bodily injury. Wash thoroughly after contact and keep out of the reach of children.

8A.1 DISCLAIMER AND SCOPE OF THE INSTRUCTIONS

These instructions are written for world wide use. In territories where legal requirements govern engine smoke emission, noise, safety factors etc., then all instructions, data and dimensions given must be applied in such a way that, after servicing (preventive maintenance) or repairing the engine, it does not contravene the local regulations when in use.

IMPORTANT: *These instructions cover only the routine maintenance of the engine. Refer to your Perkins Engine Distributor for engine diagnosis, repair and component replacement.*

A gradual running in of a new engine is not necessary. Full load can be applied to a new engine as soon as the engine is put into service and the coolant temperature is at least 140 °F (60 °C). Extended light load operation during the early life of the engine is not recommended. Do not run engine at high no load speeds. Do not apply an overload to the engine.

8A.2 STANDARD PRACTICES

Cleanliness is very important during the repair of a diesel engine. Contamination of the engine during repair will reduce the life of an engine.

Gaskets will be replaced and gasket faces will be cleaned, where applicable.

In reassembly and inspection, all parts are to be thoroughly cleaned, and where present, burrs and scale are to be removed.

Any open ports of high precision components such as fuel system equipment, exposed by removal or disassembly, will be covered until reassembled to prevent the entry of foreign material.

Use a suitable sealant such as Loctite® when installing screws into "through" holes into the interior of the engine.

NOTE: *Screw threads which have been sealant coated can be identified by their red, blue, etc. color.*

8A.3 UNIFIED THREADS

All threads used on the engine are Unified Series and American Pipe Series.

Unified threads are not interchangeable with BSF and although BSW have the same number of threads per inch as Unified Coarse Series, interchanging is not recommended, due to a difference in thread form.

Model 6036/6036T S/N 9B0500 thru 14833

8A.4 ENGINE MAINTENANCE

8A.4.1 Left and Right Sides of Engine

Throughout this section, the left or right side of the engine is the side of the engine when viewed from the flywheel end.

8A.4.2 Maintenance Intervals

Your engine will require maintenance:

- daily before operation
- every 250 hours or three months
- every 500 hours or six months
- every 1000 hours or annually
- every 2500 hours or two years

Use shorter intervals if ambient temperature is consistently below 0 °F (–18 °C), above 100 °F (38 °C), if frequent stops are made or if you are operating in a dusty environment. Consult your engine distributor for recommended intervals.

8A.5 ENGINE MAINTENANCE Daily Before Operating Engine

8A.5.1 Inspect the Engine

1. Level the forklift, lower carriage to ground, shut off engine and engage park lock.
2. Unlock and open the access doors and look for any change in engine appearance such as leaks, loose or damaged parts, and worn or damaged belts.

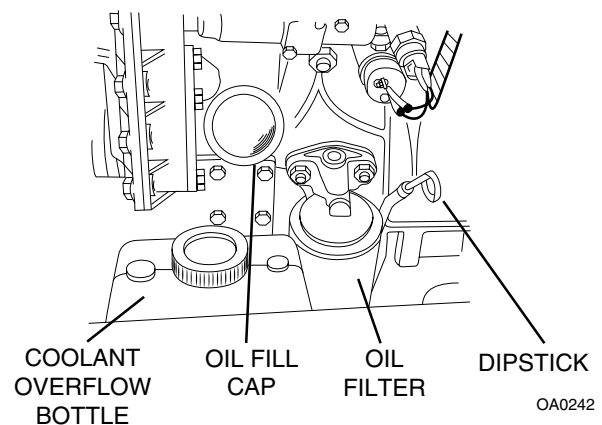


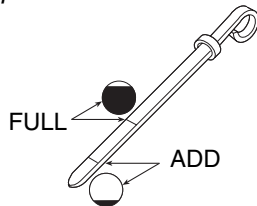
Fig. 8A.1 Check Engine Coolant and Oil Levels

3. Check the fan for cracks, loose rivets and bent or loose blades. Make sure it is securely mounted and capscrews are tightened. Replace fan if damaged.
4. Continue with next step.

8A.5.2 Check Engine Coolant Level

1. Check coolant level in overflow bottle, Fig. 8A.1, only when the engine is stopped.
2. When the coolant is hot, the bottle should be 3/4 full to full. When the coolant is cool, the bottle should be 1/4 to 1/2 full.
3. Remove cap on overflow bottle and add coolant as required. Use a 50/50 mixture of ethylene glycol and water. Protect the engine to -34 °F (-37 °C) year round.
4. Several weeks before you anticipate freezing temperatures, check antifreeze concentration using a hydrometer as described in paragraph 8A.11.1.
5. Continue with next step.

NOTE: Use of a sealing additive to stop leaks in the coolant system can plug coolant passages and cause inadequate coolant flow.



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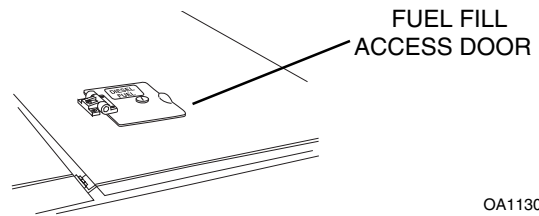
Fig. 8A.2 Engine Oil Level Dipstick

8A.5.3 Check Engine Oil Level

1. Wait at least 5 minutes after shutting off the engine to check the oil. This allows time for the oil to drain to the oil pan.
2. Remove and check the engine oil level dipstick, Fig. 8A.2.
3. Oil should be between the full and add mark.
4. Replace dipstick.
5. If required, add 10W30 or 15W40 motor oil that is equal to API, CD or CE (severe duty diesel engine) specifications. Refer to paragraph 8A.12.
6. Continue with next step.

8A.5.4 Fill Fuel Tank

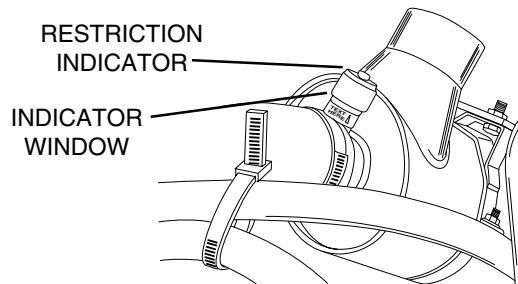
1. Open fuel fill access door with key, Fig. 8A.3.
2. Remove fill cap and fill tank with Diesel Fuel which meets or exceeds specifications in paragraph 8A.16.1. Tank capacity is 24 gallons (90 liters).
3. Install fill cap and lock fuel fill access door.
4. Continue with next step when necessary.



OA1130

Fig. 8A.3 Fuel Fill Access Door

8A.5.5 Check Air Cleaner Restriction Indicator



OA0202

Fig. 8A.4 Air Cleaner Restriction Indicator

1. Check air cleaner restriction indicator, Fig. 8A.4. If red band has appeared, clean or replace the primary element as described in paragraph 8A.5.7.
2. Momentarily press reset button on top of indicator after you service the primary element.

IMPORTANT: Never operate the engine without air cleaner. Intake air must be filtered to prevent dirt and debris from entering the engine and causing premature wear.

NOTE: Maximum intake air restriction for a turbocharged engine is 25" (635 mm) of water and for a naturally aspirated engine is 20" (508 mm) of water. You must operate a turbocharged engine at rated rpm and full load when checking maximum intake air restriction. Clean or replace air cleaner element before restriction reaches the maximum allowable limit.

3. Continue with next step.

8A.5.6 Check Air Cleaner Vacuator Valve

1. With the carriage lowered to the ground, the engine shut-off and the park lock engaged, unlock and open the right rear engine access door.
2. Remove dust and dirt from the vacuator valve, Fig. 8A.5. The lips of the automatic dust ejector must close but not adhere or stick together.
3. Continue with next step.

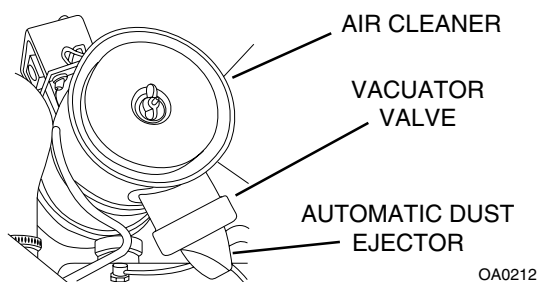


Fig. 8A.5 Vacuator Valve

8A.5.7 Clean or Replace Primary Element as Required by Restriction Indicator

All air cleaner manufacturers agree that attempting to clean or wash an element increases the chance for element damage. It is highly recommended that you consider the value of cleaning an element against the risks which could lead to engine damage. Adopt the policy that all elements should be replaced with new and not cleaned.

Careful cleaning or washing, if done correctly, can extend the life of an element. But you must realize that each time an element is cleaned the dirt holding capacity is reduced and the risk of dirt reaching the clean side of the filter is increased. Filters should never be washed more than six times or retained for more than one year's service, whichever comes first.

If you wash an element, it is recommended that you use a non-sudsing detergent that dissolves combustion residues without damaging the filter media. One such detergent that is specifically formulated for this purpose is FM 1400. This cleaner contains biodegradable synthetic detergents and is environmentally safe. It is marketed by Filter Service Corp., 2105 W. Apache, Farmington, New Mexico, 87401, Telephone (505) 326-1127.

1. Remove the air cleaner cover wing nut, cover, and primary element, Fig. 8A.6.
2. Remove loose particles from the filter with compressed air (maximum 30 psi [207,0 kPa]) or water hose (maximum 40 psi [2,76 bar] without nozzle). Rotate and apply air pressure from the inside of the element.



Warning

Wear safety glasses when using compressed air to clean element.

3. Soak filter in a non-sudsing detergent (such as FM 1400) for at least 15 minutes. Never soak more than 24 hours.
4. Swish filter around in the solution to remove loosened dirt particles.

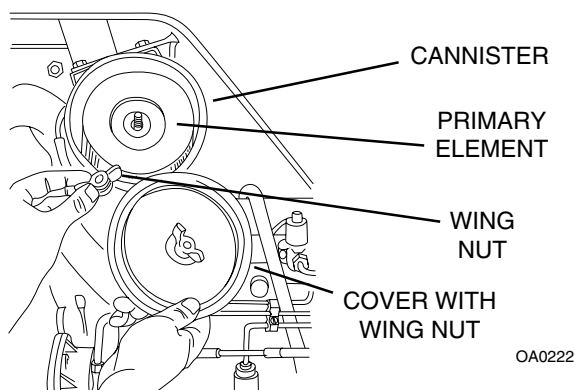


Fig. 8A.6 Air Cleaner Primary Element

5. Rinse the filter from the inside out with a gentle stream of water to remove all dirt and suds (less than 40 psi [2,76 bar], no nozzle). If the inside of the element has been contaminated with dirty water from the soaking, rinse from both sides.
6. Dry the filter before reusing. Circulate warm air at less than 160 °F (71 °C). DO NOT use a light bulb or compressed air to dry the filter.
7. Inspect for holes or tears by looking through the filter toward a bright light. Check for damaged gaskets or metal parts. DO NOT reuse damaged filters.
8. Replace the primary element after six cleanings or annually.
9. Continue with next step when necessary.

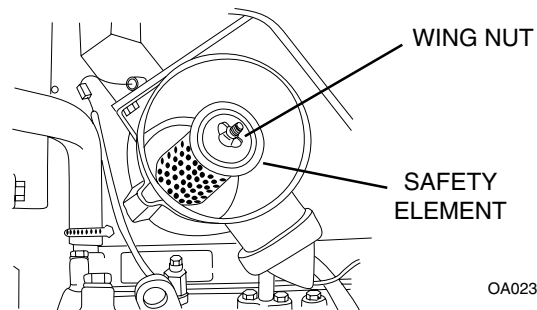


Fig. 8A.7 Air Cleaner Safety Element

8A.5.8 Install a New Safety Element With Every Third Primary Element

1. An inner safety element should never be washed or reused. Always install a new element. Replace safety elements after every third primary element change. DO NOT remove a safety element until you have thoroughly cleaned the inside of the air cleaner canister. This will prevent dirt, which could damage the engine, from entering the induction manifold.

IMPORTANT: Make sure the primary element cannister is thoroughly cleaned before you remove the safety element. Dirt could enter the intake manifold and cause internal engine damage.

2. Install the primary element, air cleaner cover and tighten the wing nut.
3. Check all hose connections at this time.
4. Close and lock access doors.

8A.6 ENGINE MAINTENANCE Every 250 Hours or 3 Months

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.

8A.6.1 Inspect Air Intake System

Inspect intake piping for cracked hoses, loose clamps, and punctures. Tighten or replace parts as necessary to make sure the air intake system does not leak.

8A.6.2 Change Engine Oil and Filter

Change the oil and filters to remove the contaminants suspended in the oil.

IMPORTANT: If the engine is being operated, under no circumstances can the oil drain interval extend beyond 250 hours or 3 months.

1. Operate the engine for approximately 5 minutes to bring water temperature to 140 °F (60 °C). Drain the oil only when it is hot and the contaminants are in suspension.
2. Level forklift, lower the carriage to ground, shut off engine, and engage park lock.



Warning

- Hot oil can cause personal injury.
- Avoid prolonged and repeated skin contact with used engine oils. Such prolonged and repeated contact may cause serious skin disorders or other serious bodily injury. Avoid excessive contact, wash thoroughly after contact, and keep engine oil out of the reach of children.

3. Place a receptacle under the engine oil pan drain plug. Use a container that can hold at least 15 U.S. quarts (14,2 liters) of oil.

4. Remove drain plug on rear face of the engine oil pan and allow oil to drain completely into receptacle.

IMPORTANT: Protect the environment. Handling and disposal of used engine oil may be subject to federal, state and local laws and regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for used oil. If in doubt, contact your state and local environmental authorities or the Environmental Protection Agency for guidance as to proper handling and disposal of used engine oil.

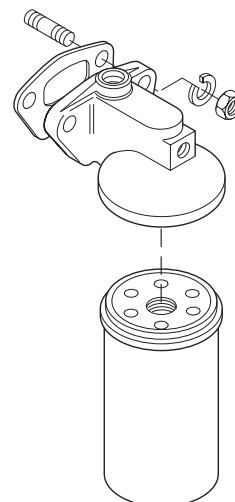
5. Unlock and open the right rear access door.
6. Clean the area around the lubricating oil filter head. Remove the oil filter element, Fig. 8A.8 or 8A.9 and discard the old filter element. A strap or chain filter wrench may be required.
7. Clean the filter sealing surface.

IMPORTANT: The O-ring can stick on the filter head. Make sure it is removed.

NOTE: The Turbo Engine has an oil cooler which is mounted between the filter head and oil filter element. Before fitting a replacement filter element, the retaining adaptor screw should be checked for tightness, Fig. 8A.9.

8. Using clean engine oil, liberally oil top seal of the new filter element.
9. Fill the filter element with clean lubricating oil allowing time for the oil to filter through the element. Screw replacement filter element onto filter head until seal just touches head and then tighten as per instructions on the filter element.

IMPORTANT: Mechanical overtightening may distort the threads and/or damage the filter element seal.



MA0333

Fig. 8A.8 Oil Filter for Naturally Aspirated Engine

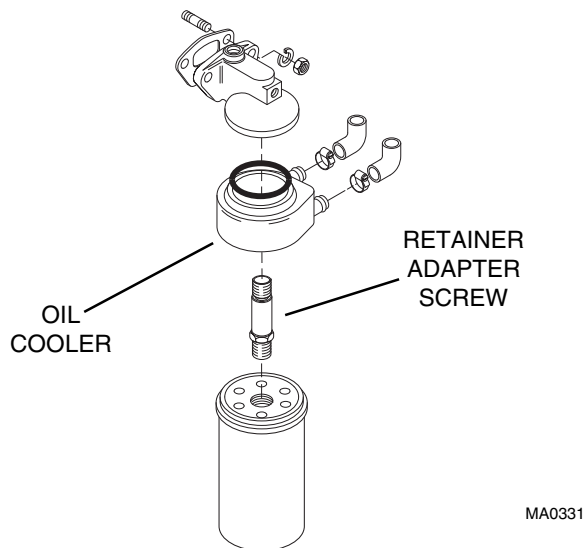


Fig. 8A.9 Oil Filter for Turbo Engine with Oil Cooler

10. Check and clean the oil drain plug threads and sealing surface. Install the oil pan drain plug and torque plug to 60 lb-ft (80 Nm).
11. Remove oil fill cap, Fig. 8A.1, and add 10W30 motor oil equal to API, CD or CE (severe duty diesel engine) specifications, refer to paragraph 8A.10. DO NOT overfill. Crankcase capacity with filter is 9.4 quarts (8,9 liters) for Perkins Natural and 9.9 quarts (9,4 liters) for Perkins Turbo.
12. Start the engine and run for several minutes.
13. Stop the engine and allow oil to drain back for a few minutes.
14. Check dipstick and add oil if required.
15. Idle the engine to inspect for leaks at the filters and drain plug. Retighten if necessary.
16. Stop the engine. Wait approximately 5 minutes to let the oil drain from the upper parts of the engine. Check the oil level again. If required, add oil to bring level to full (F) or high (H) mark on the dipstick.
17. Close and lock engine access door.

8A.6.3 Drain Fuel Pre-Filter

1. Unlock and open right rear access door.
2. Open top bleed screw of fuel pre-filter, Fig. 8A.10.
3. Loosen drain cock on bottom of fuel pre-filter and allow all water to drain into a glass until clear fuel is visible.

4. Tighten the drain cock and top bleed screw after draining.
5. Close and lock the right rear engine access door.

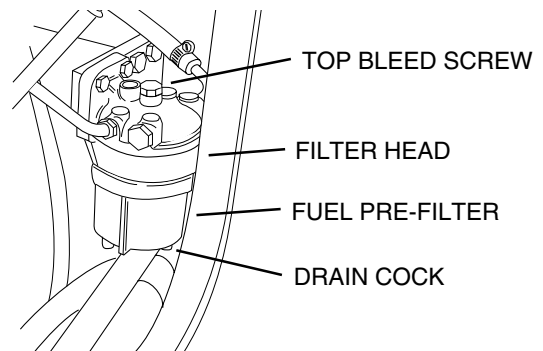


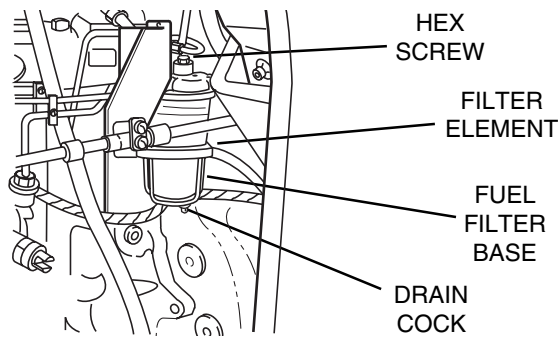
Fig. 8A.10 Drain Fuel Pre-Filter

8A.6.4 Inspect Fan Belt and Check Fan Belt Tension

1. Lower carriage to ground, shut off engine, and engage park lock.
2. Unlock and open the left rear engine access door.
3. Inspect the fan belt. Replace a cracked or frayed belt.
4. Check fan belt tension midway between the crankshaft and alternator pulleys, Fig. 8A.21. Deflection should be 1/4 to 3/8" (6,3 to 9,5 mm) with an applied force of 13 to 15 lb (6 to 7 kg).
5. If belt deflection exceeds this tolerance, loosen both alternator mounting screws. Carefully pry the alternator to tighten the belt and, at the same time, tighten the alternator screws. Recheck belt deflection.

8A.7 ENGINE MAINTENANCE Every 500 Hours or 6 Months

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.



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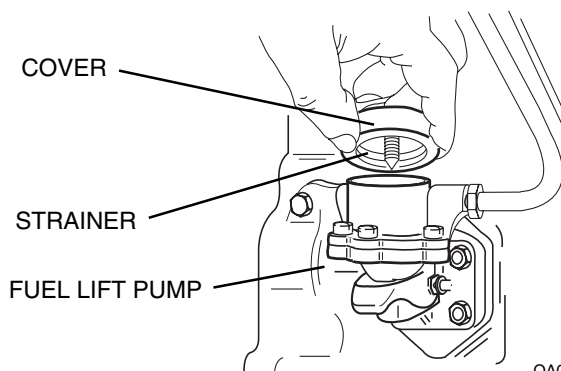
Fig. 8A.11 Fuel Filter

8A.7.1 Replace Fuel Filter Elements

1. Unlock and open the right rear engine access door.
2. Remove screw in top of the filter assembly, Fig. 8A.11.
3. Remove filter base and discard element and gasket. Clean base and head.
4. Refer to SKY TRAK Parts Manual and select filter elements.
5. Position a new gasket and filter element between the base and head and install and tighten screw on top of filter assembly until snug.
6. Remove air from the fuel system (see paragraph 8A.7.3, How to Bleed Fuel System).
7. Close and lock the right rear engine access door.

8A.7.2 Clean Sediment Chamber of Fuel Lift Pump

1. Unlock and open the left rear engine access door.
2. Remove fuel lift pump cover and strainer, Fig. 8A.12.
3. Wash any sediment from the lift pump and clean the cover and strainer.



OA0312

Fig. 8A.12 Fuel Lift Pump

4. Install the cover making sure that it seats on the pump with NO leakage.
5. Remove air from the fuel system (see paragraph 8A.7.3, How to Bleed to Fuel System).
6. Close and lock the left rear engine access door.

NOTE: Marginal fuel cleanliness conditions will require fuel system service more frequently. Loss of engine power is often caused by dirty fuel filters.

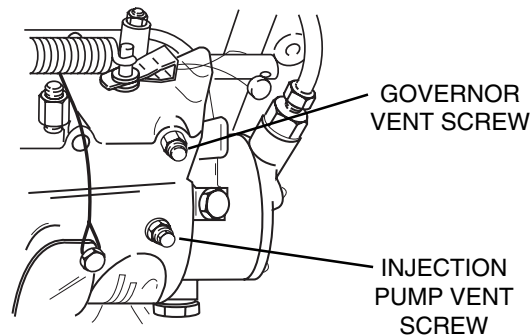
8A.7.3 How to Bleed the Fuel System

Air must be vented from the fuel system whenever any part of the system between the fuel tank and injection pump has been disconnected for any reason, or when the system has been emptied of fuel.

IMPORTANT: DO NOT start the engine until the injection pump has been filled and primed as the pump can be severely damaged due to lack of lubrication.

Remove air from the fuel system as follows:

NOTE: More than one person may be required to perform this procedure.

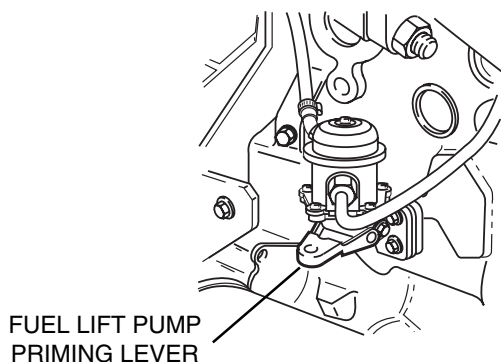


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Fig. 8A.13 Vent Screws in Injection Pump

1. Unlock and open the right rear engine access door. Loosen the governor vent screw in the fuel injection pump governor control cover, Fig. 8A.13.
2. Loosen the injection pump vent screw on the side of the fuel injection pump, Fig. 8A.13.
3. Unlock and open the left rear engine access door. Operate the priming lever on the fuel lift pump, Fig. 8A.14, until fuel, free of air, comes from both vents.

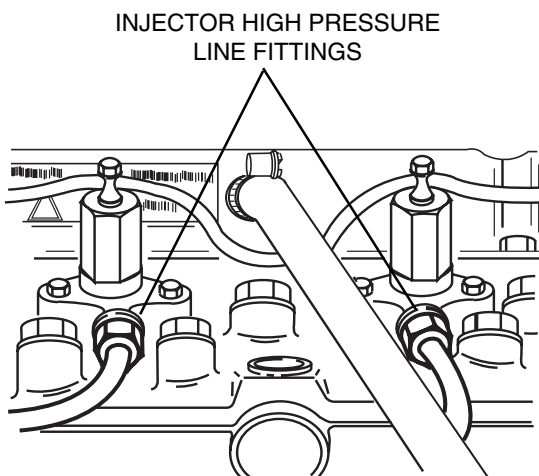
NOTE: If the fuel lift pump cam is on maximum lift, you will not be able to operate the priming lever. Turn over the engine momentarily to reposition the lift pump cam.



OA0332

Fig. 8A.14 Priming Lever

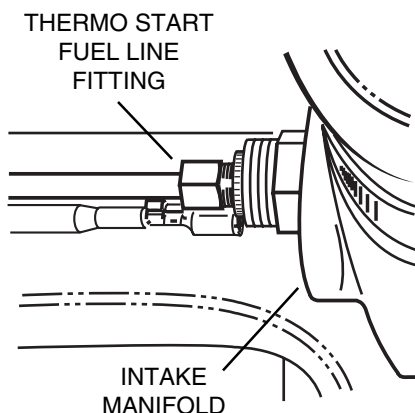
4. Continue to pump fuel and close the vents in the following order:
 - Injection pump vent screw
 - Governor vent screw



OA0342

Fig. 8A.15 Injector High Pressure Line Fittings

5. Loosen any two high pressure fittings (in the lines from the fuel injection pump) at the base of the injectors, Fig. 8A.15. Also loosen the fitting of the Thermo Start fuel line in the intake manifold, Fig. 8A.16.



OA0352

Fig. 8A.16 Thermo Start Fuel Line Fitting

6. Turn the ignition key to the START position and operate the starter until fuel, free from air, comes from the injector and Thermo Start fuel line fittings. Turn ignition switch OFF. Tighten all fittings.
7. Close and lock both access doors. The engine is now ready to start.

If the engine runs correctly for a short time and then stops or runs roughly, check for air in the fuel system. If there is air in the fuel system, there is probably a leak in the low pressure system.

8A.8 ENGINE MAINTENANCE

Every 1,000 Hours or Annually

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.

8A.8.1 Drain System, Flush with Sodium Carbonate Mixture and Refill with Coolant

1. With forklift on level ground, unlock and open the left rear engine access door.



Warning

- To prevent personal injury, never remove the radiator cap when coolant is above 120 °F (49 °C). Always turn the cap slowly to the first stop and allow pressure to escape before you remove cap completely. Hot coolant spray can burn you and injure your eyes. Wear safety glasses.
- To avoid severe burns, DO NOT attempt this procedure when engine is hot. Wait for engine, muffler, and tail pipe to cool before proceeding.

2. Slowly turn the radiator cap to the first stop, allow pressure to escape, then continue to turn and remove the cap.
3. Attach a hose to petcock at bottom left corner of radiator, Fig. 8A.17. Place the other end of the hose into a 5 gallon (18,9 liters) or larger container. Open petcock and drain coolant from the system.

NOTE: If engine is turbocharged, disconnect hose lines to oil cooler in lube oil filter, drain coolant into the container, and flush cooler and reconnect the hose lines (see paragraph 8A.11.4).

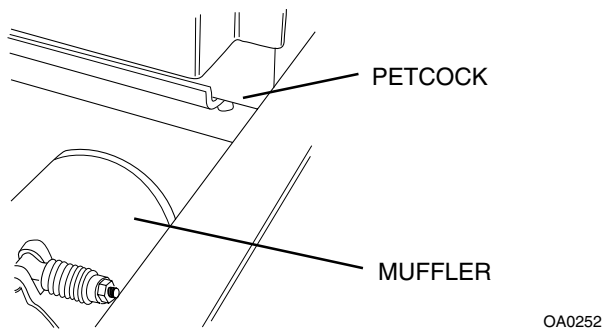


Fig. 8A.17 Radiator Petcock

4. Detach the line from the bottom of the coolant overflow bottle at the radiator and position line so coolant drains into the container.
5. Flush the system with clean water.

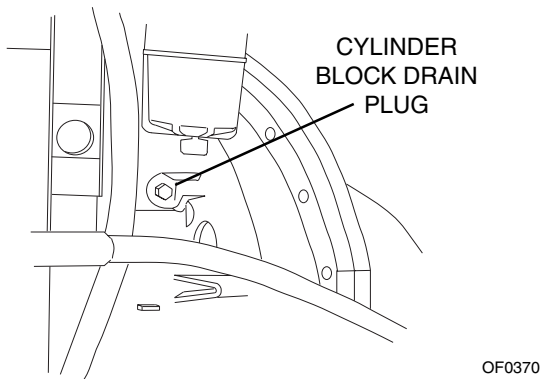


Fig. 8A.18 Cylinder Block Drain Plug

6. Remove cylinder block drain plug, Fig. 8A.18, and drain the engine block. Replace the drain plug.

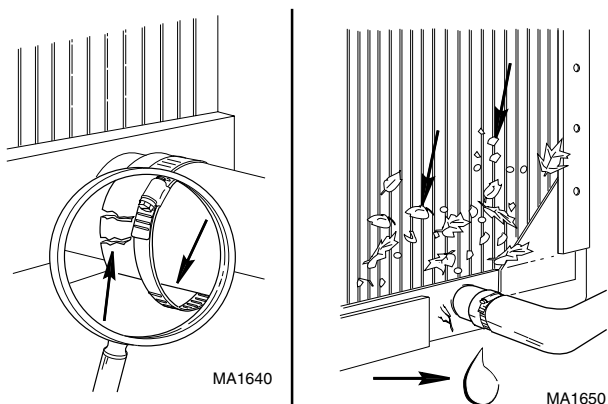


Fig. 8A.19 Inspect for Worn Hoses, Loose Clamps, Leaks and for the Accumulation of Dirt

7. Check for damaged hoses and loose or damaged hose clamps, Fig. 8A.19. Replace as required. Check the radiator for leaks, damage and buildup of dirt. Clean and repair as required.
8. Connect line to overflow bottle, install plug in bottom of coolant inlet to engine, and close the petcock on the radiator.
9. Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent) through the radiator fill opening. Use 1 lb of sodium carbonate to 6 U.S. gallons of water (0,5 kg of sodium carbonate to 22,7 liters of water).
10. Operate the engine for 5 minutes with the coolant temperature above 180 °F (82 °C).
11. Shut off the engine, allow system to cool and drain the entire cooling system.
12. Fill the cooling system with clean water. Be sure to vent the engine for complete filling.
- IMPORTANT:** Do not install the radiator cap.
13. Operate the engine for 5 minutes with the coolant temperature above 180 °F (82 °C).
14. Shut off the engine and drain the cooling system; if the water being drained is still dirty, flush the system again until the water is clean.
15. Fill the cooling system (through the radiator fill opening) with a mixture of 50 percent water and 50 percent ethylene glycol antifreeze. System capacity is 5.8 gal. (21,9 liters).
16. Install the radiator pressure cap. Operate the engine until it reaches 180 °F (82 °C) and check for coolant leaks.
17. Refer to paragraph 8A.2.1 and fill radiator with 5.4 gallons (20,4 liters) of coolant.
18. Add coolant to overflow bottle until bottle is 1/4 to 1/2 full — approximately 3 qts. (2,8 liters).

8A.8.2 Replace Air Filter Primary Element

Replace air filter primary element, Fig. 8A.6, after six cleanings or annually (refer to paragraph 8A.5.7).

8A.8.3 Check Valve Stem to Rocker Arm Gap

Check and set valves with the engine cold—below 140 °F (60 °C). The correct gap between the top of the valve stem and the rocker lever is 0.012" (0,30 mm) with the engine cold.

NOTE: No. 1 cylinder is at the front of the engine.

To set these gaps:

1. Turn the crankshaft in the normal direction of rotation until the inlet valve of No. 4 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of the No. 1 cylinder valves and adjust if necessary, Fig. 8A.20.
2. Turn the crankshaft in the normal direction of rotation until the inlet valve of No. 2 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of the No. 3 cylinder valves and adjust if necessary.
3. Turn the crankshaft in the normal direction of rotation until the inlet valve of No. 1 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of the No. 4 cylinder valves and adjust if necessary.
4. Turn the crankshaft in the normal direction of rotation until the inlet valve of No. 3 cylinder has just opened and the exhaust valve of the same cylinder has not fully closed. Check the clearances of the No. 2 cylinder valves and adjust if necessary.

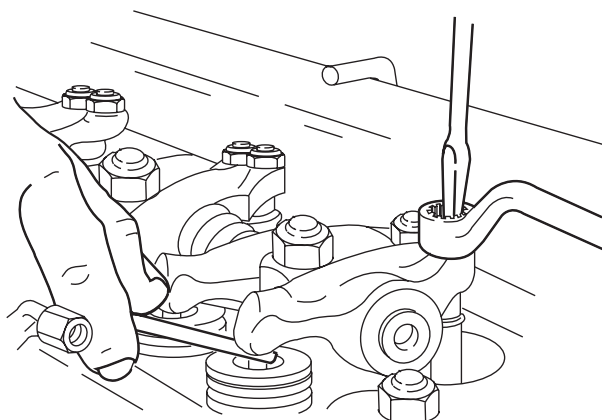


Fig. 8A.20 Checking Gap Between Valve Stem Tip and Rocker Arm Lever

8A.8.4 Check Fan Belt Tension

1. Maximum fan belt deflection at the longest span of the belt should be 1/4 to 3/8" (6 to 9 mm) with an applied force of 13 to 15 lbs. (6 to 7 kg) Fig. 8A.21.

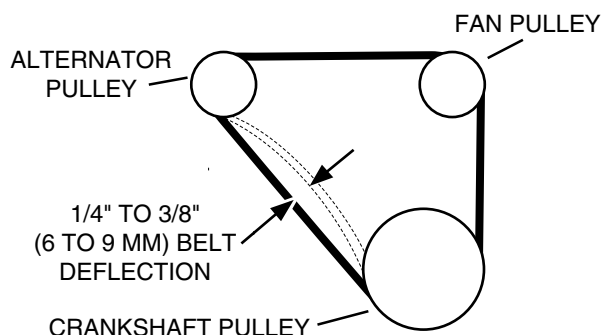


Fig. 8A.21 Fan Belt Tension

8A.8.5 Inspect Fan Hub

Inspect the hub as follows:

1. Remove fan belt.
2. Check the fan hub bearing; the hub should spin freely without any wobble or excessive end play. Maximum end play is 0.006" (0,15 mm).
3. Install the fan belt.

8A.9 ENGINE MAINTENANCE Every 2,500 Hours or 2 Years

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.

1. Inspect and service proprietary equipment such as starter motor, alternator, turbocharger (if applicable) etc.
2. Service fuel injectors, paragraph 8A.13.8.
3. Check and adjust valve stem tip to rocker arm gap clearances, paragraph 8A.8.3.
4. Visually inspect vibration dampers on motor mounts.

8A.10 ENGINE OIL SPECIFICATIONS

Use 10W30 or 15W40 motor oil that is equal to API, CD or CE (severe duty diesel engine) specifications.

Engine Oil Type	Ambient Temperature
10W30	Below 23 °F (-5 °C)
15W40	Above 23 °F (-5 °C)

8A.11 ENGINE COOLING SYSTEM

The engine cooling system consists of coolant passages in the engine, a thermostat, pump, hoses, a radiator and a radiator overflow bottle.

The engine is cooled by the circulation of coolant through passages in the cylinder block and head. Circulation is by thermo-syphon action assisted by an impeller type water pump driven by a V-belt from the crankshaft pulley.

The water pump bearings are prepacked with a special grease during assembly and do not require attention in service.

8A.11.1 Coolant Requirements

The quality of coolant will determine the efficiency and life of the cooling system.

- Check antifreeze concentration, Fig. 8A.22, several weeks before the beginning of the cold season. The antifreeze must have an ethylene glycol (ethanediol) base. Use a low silicate antifreeze that conforms to one of the standards given below or which contains no more than 0.1 percent anhydrous alkali metasilicate.
 - U.S.A.—Engineering Standard GM6038-M.
 - U.K.—BS 3151: 1959: Ethanediol Antifreeze Type B with Sodium Benzoate and Sodium Nitrite Inhibitors
 - Australia—AS 2108-1977: Antifreeze Compounds and Corrosion Inhibitors for Engine Cooling Systems
- There is an advantage to using antifreeze even when frost protection is not necessary. Antifreeze protects against corrosion and also raises the boiling point of the coolant. A 50 percent concentration of antifreeze is preferred, but if this much protection is not

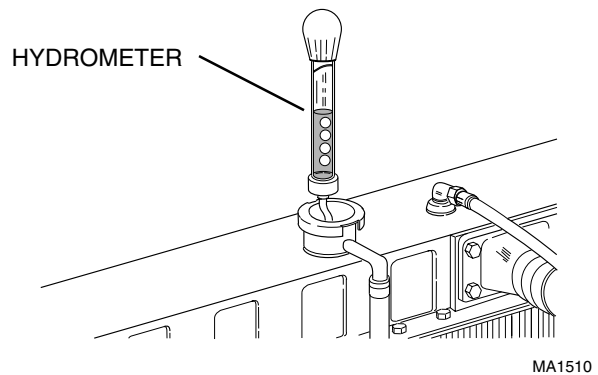


Fig. 8A.22 Testing Antifreeze Concentration

required, a 33 percent concentration can be used. Never use more than a 65 percent concentration under any condition. Where frost protection will never be required, add an approved corrosion inhibitor to clean soft water. Change the water/corrosion inhibitor every six months or according to the manufacturer's recommendations.

- DO NOT USE HARD WATER in the cooling system. Hard water, or water with high levels of calcium and magnesium ions, encourages the formation of silica gel formations, especially after a number of heating and cooling cycles. These gel formations can result in loss of cooling or heating in radiators and cab heater cores by coating and plugging the tubes. The formations usually deposit in the cooler section of the cooling system, such as the radiator bottom tank.
- USE SOFT, DISTILLED OR DEIONIZED WATER to reduce the potential and the severity of silicate dropouts.

IMPORTANT: If you use water without a corrosion inhibitor, rust will form and plug the small holes in the head gasket. These holes are orifices and their size is critical. Do not enlarge the size of the orifices. To do so will disturb the coolant flow and will not solve an overheating problem. If you use water without a corrosion inhibitor for even a relatively short period, the cup plugs will rust through, allowing coolant to leak. An incorrect or malfunctioning radiator cap can result in the loss of coolant and the engine running hot. Any sudden loss of coolant from a heavily loaded engine can result in severe damage to the pistons and cylinder bore.

NOTE: Some corrosion inhibitor mixtures contain soluble oil which can have an adverse effect on some types of water hose.

8A.11.2 Radiator Pressure Cap

The system is designed to use a radiator pressure cap to prevent the boiling of the lubricant. For a 210 °F (99 °C) system use a 7 psi (48 kPa) radiator cap. An incorrect or malfunctioning cap can result in the loss of coolant and the engine running hot.

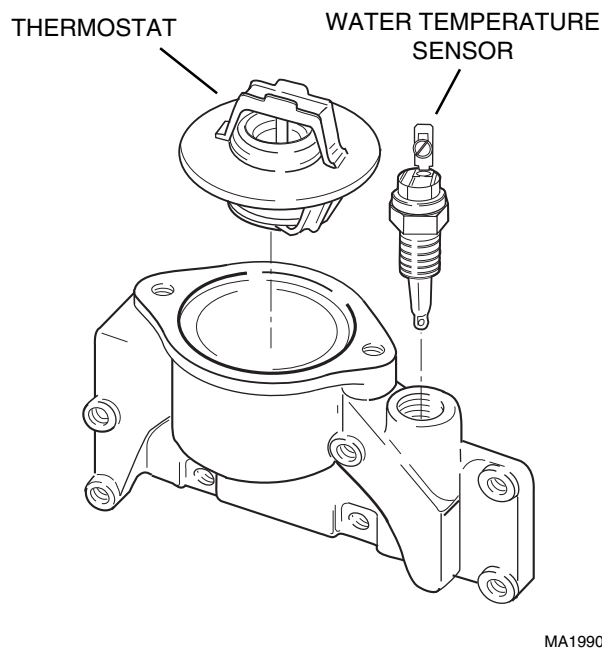


Fig. 8A.23 Thermostat Housing for a Naturally Aspirated Perkins Engine

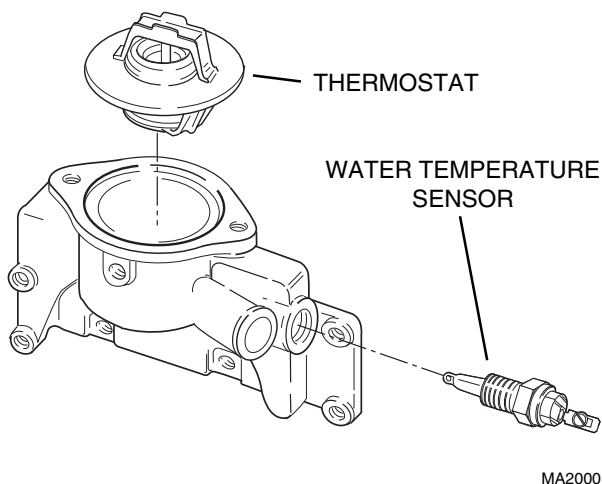


Fig. 8A.24 Thermostat Housing for a Turbo Engine

8A.11.3 How to Replace Thermostat and Water Temperature Sensor

If it becomes necessary to replace the thermostat and/or water temperature sensor, Figs. 8A.23 and 24, proceed as follows.

1. Drain Coolant.
2. Disconnect hose.
3. Remove outlet adaptor.
4. Remove thermostat or sensor.
5. Clean the gasket area of the housing.
6. Position thermostat or thread sensor in housing.
7. Place gasket and hose connection over thermostat.
8. Install lock washer and capscrew.
9. Torque the capscrews to 18 lb-ft (24 Nm).

8A.11.4 Integral Oil Cooler in Oil Filter

The oil filter for a turbocharged engine, Fig. 8A.25, has an integral oil cooler. Whenever you change engine coolant, drain the oil cooler by removing inlet and outlet connections, flush the cooler and reconnect hoses.

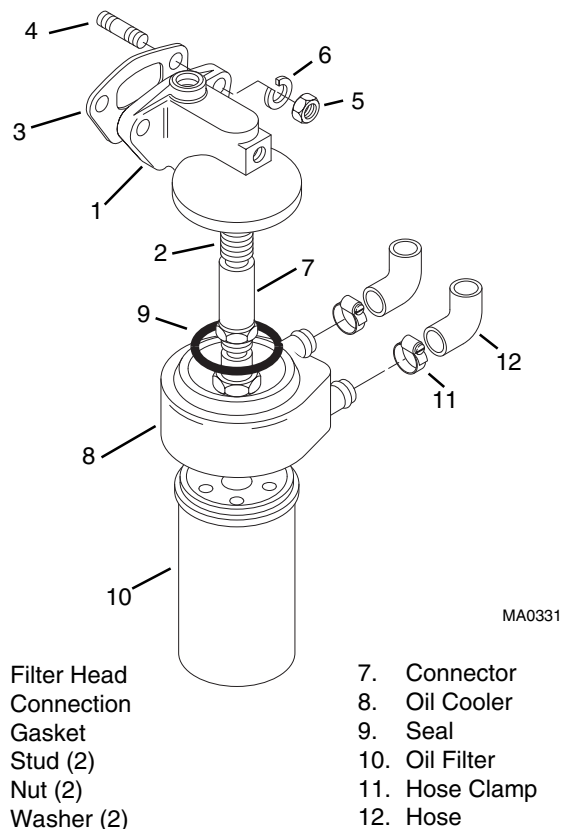
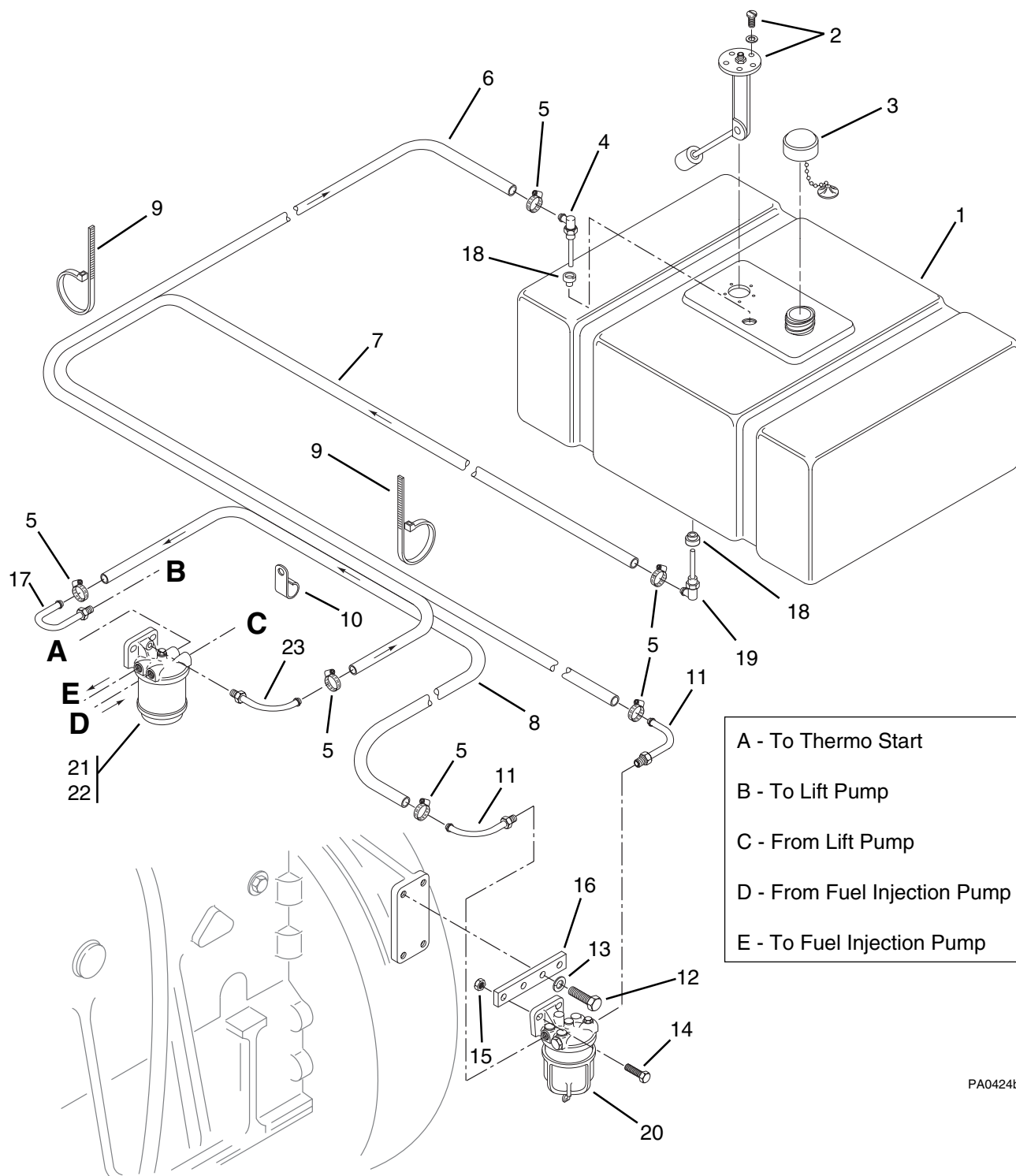


Fig. 8A.25 Oil Filter with Integral Oil Cooler



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- | | | |
|-------------------------------|------------------------|---|
| 1. Fuel Tank | 9. Tie Wrap | 17. Fuel Pump Tube |
| 2. Fuel Level Sender | 10. Hose Support | 18. Rubber Bushing |
| 3. Filler Cap with Tether | 11. Fuel Filter Tube | 19. Elbow, 90°, with standpipe |
| 4. Elbow, 90°, with standpipe | 12. Capscrew, hex head | 20. Fuel Pre-Filter Assembly |
| 5. Hose Clamp | 13. Lock Washer | 21. Fuel Filter Assembly |
| 6. Fuel Return Hose | 14. Capscrew, hex head | 22. Fuel Filter Element Kit for item 21 |
| 7. Fuel Supply Hose | 15. Lock Nut | 23. Fuel Filter Tube |
| 8. Fuel Supply Hose | 16. Mounting Bar | |

Fig. 8A.26 Engine Fuel System

8A.12 ENGINE ELECTRICAL SYSTEM

The engine electrical system is described in Section 10, Electrical System. These instructions describe warning devices, wiring harnesses, circuit breakers, the starting and charging circuits, switches and solenoids, gauges and indicator lights, and electrical troubleshooting.

8A.13 ENGINE FUEL SYSTEM

The engine fuel system includes a fuel tank (1, Fig. 8A.26), a fuel level sender (2) and gauge, a fuel pre-filter (3), a fuel lift pump, Fig. 8A.28, a fuel filter (21, Fig. 8A.26), and fuel lines to and from the fuel injection pump, and fuel lines from the fuel injection pump to and from the fuel injectors back to the fuel filter and fuel tank. A separate line runs from the fuel filter to the Thermo Start plug, Fig. 8A.16, in the intake manifold.

The threaded fuel fill opening in the top of the fuel tank has a filler cap with a tether (3, Fig. 8A.26). The fuel level sender (2) and gauge are described in Section 10, Electrical System.

A fuel supply hose carries fuel from the bottom of the tank to the fuel pre-filter (20). The fuel then flows through a fuel filter tube, a hose and a fuel pump tube to the fuel lift pump, Fig. 8A.28, which is located on the left side of the engine.

A tube carries fuel under pressure from the fuel lift pump to fuel filter (21, Fig. 8A.26). Fuel which has been filtered by the fuel filter is directed through tubes to the fuel injection pump and to the Thermo Start plug, Fig. 8A.17 in the intake manifold.

A tube from the fuel injectors returns surplus fuel from the injectors to the fuel filter (21, Fig. 8A.26) and into a line and hose which returns it to the fuel tank.

8A.13.1 Type of Diesel Fuel to Use

Fuel represents a major portion of your forklift operating costs; therefore, it is important to use it efficiently. Don't let cost tempt you to use inferior diesel fuel. The initial savings is a false economy when you consider the damage poor fuel can do to your forklift engine.

NOTE: Use only diesel fuel designed for diesel engines. Some heating fuels contain harmful chemicals which can seriously affect engine efficiency and performance.

Model 6036/6036T S/N 9B0500 thru 14833



Warning

Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.

IMPORTANT: Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

Use ASTM No. 2 D Fuel with a minimum Cetane number of 40. No. 2 diesel fuel gives the best economy and performance under most operating conditions. Cetane number indicates ignition performance. Fuel with a low cetane number can cause cold start problems and affect combustion.

At operating temperatures below 32 °F (0 °C), use a blend of No. 1 D and No. 2 D fuels, also known as "winterized" No. 2 D.

NOTE: No. 1 D fuel can be used, however, fuel economy will suffer.

Use low sulfur content fuel having a cloud point that is at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which wax crystals begin to form in diesel fuel.

The viscosity of the fuel must be kept above 1.3 centistrokes to provide adequate fuel system lubrication.

NOTE: When using diesel fuel with a sulfur content below 1.3 percent, the oil filter change interval must be reduced by 75 hours. The use of fuel with a sulfur content above 1.3 percent is not recommended.

8A.13.2 Fuel Tank

The fuel tank (1, Fig. 8A.26) is located directly behind the front axle.

a. Removal

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Disconnect the negative (–) battery cable.
3. Using a hand operated pump, when available, pump as much fuel as possible through the fill cap or fuel level sensor openings in the fuel tank. Pump the fuel oil into a marked and approved receptacle for fuel oil.



Warning

Never drain or store fuel in an open container due to the possibility of fire; discard the fuel in an approved manner.

4. Prepare to drain remaining fuel by centering a receptacle which can hold the remaining fuel beneath the elbow (19, Fig 8A.26) at the bottom of the tank. Loosen hose clamp (5) at the bottom of the tank, twist fuel supply hose (7) off elbow (19), and drain fuel into receptacle. Discard the fuel in an approved manner. Remove elbow (19) from bottom of the tank to drain remaining fuel from tank.
5. Loosen hose clamp (5) and twist the fuel return hose (6) off elbow (4).
6. Disconnect wires from fuel level sender.
7. Lift and tilt the rear of the tank to remove it from the forklift.

b. Disassembly

1. Remove five capscrews, fuel level sender (2, Fig. 8A.26) and gasket from fuel tank.
2. Remove fuel supply elbow (4) and rubber bushing (18) from fuel tank.

c. Cleaning and Drying

If contaminated fuel or foreign material is in the tank, the tank can usually be cleaned. Replace tank if it is damaged or if there are leaks in unreparable areas.

Clean the tank as follows:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Disconnect the negative (–) battery cable.
3. Remove and disassemble fuel tank as described in paragraphs a and b. Invert, rock and drain tank.
4. Clean tank with high pressure washer or flush with hot water for five minutes. Invert, rock and drain tank completely.
5. If necessary, add a diesel fuel emulsifying agent to the tank, refill with water, and agitate mixture for 10 minutes. Drain tank completely. Refer to manufacturer's instructions for correct emulsifying agent to water mixture.
6. When empty, refill to overflowing with water. Completely flush and empty tank.

d. Inspection and Replacement

1. Plug all outlets before removing a fuel tank for a suspected fuel leak; make sure that one of the fuel hoses isn't leaking onto the tank.
2. To test a fuel tank which is out of the forklift, plug all openings except a supply or return elbow. Apply a small amount of air pressure to tank through this elbow (approximately 1 to 1-1/2 psi (7,0 to 10,33 kPa). Test tank for leaks by applying soap solution to exterior of tank or by submerging tank in water and looking for bubbles.
3. For a short term repair you may be able to repair a small leak by installing a sheet metal screw with a neoprene gasket in the opening. Replace tank for long term repair.

e. Assembly

1. Install rubber bushings (18, Fig. 8A.26), fuel supply and return elbows (4 and 19) in tank. Reconnect both supply and return hoses (6 and 7) and clamp to elbows.
2. Position fuel level sender gasket and fuel level sender (2) in tank.
3. Loosely install the screw which secures the ground wire to the sender and fuel tank.
4. Install the other four screws and alternately torque the five screws which secure the sender to the fuel tank from 10 to 14 lb-in (1 to 2 Nm). Use No. 10-24 screws.
5. Install the wire and nut on the center terminal of the sender.

8A.13.3 Fuel Level Sender and Gauge

The fuel level sender and gauge assembly is described in Section 10, Electrical System.

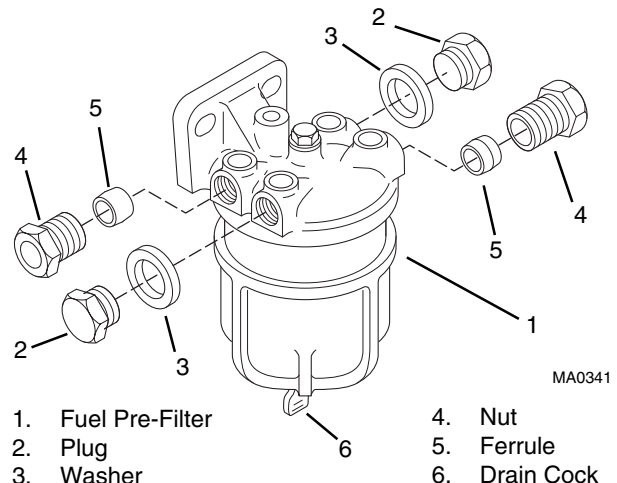


Fig. 8A.27 Fuel Pre-Filter

8A.13.4 Fuel Pre-Filter

Drain water from fuel pre-filter, Fig. 8A.26 and 8A.27, every 250 hours of operation.

1. Unlock and open the right rear engine access door.
2. Loosen drain cock (6, Fig. 8A.27) on underside of fuel pre-filter and drain water into a glass until clear fuel is visible.
3. Tighten drain cock after draining.
4. Close and lock access door.

a. Removal

1. Remove fuel pre-filter inlet and outlet tubes, Fig. 8A.26.
2. Support filter with one hand and remove lock nuts (15) and capscrews (14) and remove fuel pre-filter from mounting bar.

b. Disassembly

Loosen the hex head screw in the top of the filter and separate the filter base from the filter head.

c. Cleaning and Drying

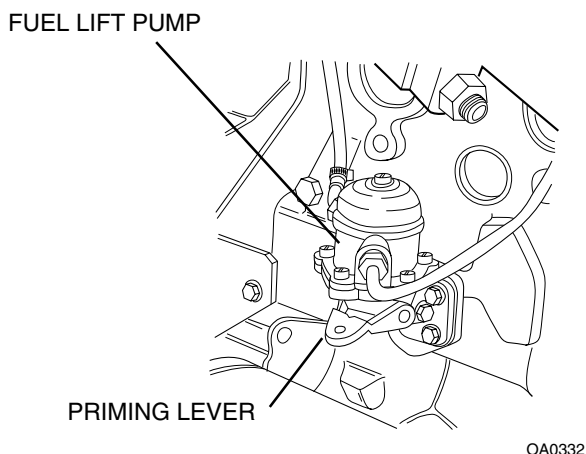
Clean the pre-filter using an approved solvent and dry with a clean, lint-free cloth.

d. Assembly

Assemble filter base to filter head using hex head screw.

e. Installation

1. Hold filter in position and install capscrews (14) and lock nuts (15) to secure filter to mounting bar.
2. Reconnect inlet and outlet tubes.



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Fig. 8A.28 Typical Fuel Lift Pump

8A.13.5 Fuel Lift Pump

Clean fuel lift pump sediment chamber, Fig. 8A.28, every 500 hours of operation.

1. Unlock and open the left rear engine access door.
2. Remove fuel lift pump cover screw, cover washer, cover, and strainer (Fig. 8A.12).
3. Wash any sediment from lift pump and clean cover and strainer.
4. Install strainer and cover making sure that cover seats on pump with NO leakage.
5. Remove air from the fuel system (see paragraph 8A.7.3, How to Bleed to Fuel System).
6. Close and lock access door.

a. How to Test Fuel Lift Pump in Position

To test the diaphragm, block the fuel inlet line with your finger and operate the priming lever. A good pump will have suction that will not bleed down until you remove your finger from the inlet.

To test pump performance:

1. Disconnect the outlet line from the fuel lift pump to the fuel filter.
2. Rotate the engine. There should be a spurt of fuel from the outlet port once every two revolutions.

b. Check Pressure with Pump in Position

1. Fit a 0 to 10 psi (0 to 0,69 bar) pressure gauge to the outlet of the pump. Ensure that there are no leaks at the connections between pump and gauge.
2. Crank the engine for 10 seconds and note the maximum pressure on gauge. If the pressure recorded is less than 75 percent of minimum production static pressure which is 4.5 psi (0,31 kgf/cm² or 31 kN/m²), then replace the pump.

NOTE: Minimum production static pressure is 6 psi (0,42 kgf/cm² or 41 kN/m²).

Also observe the rate at which the pressure drops to half the maximum figure obtained when cranking has ceased. If less than 30 seconds, replace the pump.

NOTE: These figures apply to a 4-bolt-type fuel lift pump. If your engine has a 2-bolt-type fuel lift pump, contact your Engine Distributor for pump pressure specifications.

c. Fuel Lift Pump Removal

1. Disconnect lines from the water separator and to the fuel filter.
2. Remove four capscrews and lock washers that secure the fuel lift pump to the engine.

d. Disassembly and Assembly

Replace fuel lift pump as a complete assembly.

e. Cleaning and Drying

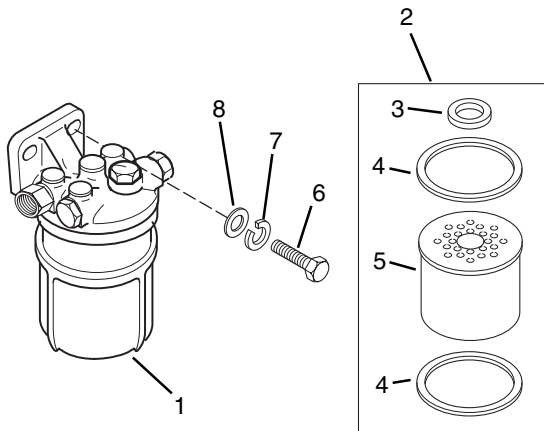
Clean the pump as described in paragraph 8A.7.2. Clean the exterior of the pump with mineral spirits and dry with a clean lint-free cloth.

f. Inspection and Replacement

1. Inspect the camshaft lever and return spring for excessive wear.
2. Replace the fuel lift pump as a complete assembly.

g. Fuel Lift Pump Installation

1. Position the fuel lift pump on the engine and install the four capscrews and lock washers that secure the fuel lift pump to the engine.
2. Reconnect inlet and outlet fuel lines to lift pump.



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| 1. Fuel Filter | 5. Filter Element |
| 2. Filter Element Kit | 6. Screw (2) |
| 3. Seal | 7. Washer (2) |
| 4. Gasket (2) | 8. Washer (2) |

Fig. 8A.29 Fuel Filter

8A.13.6 Fuel Filter

Change element (5, Fig. 8A.29) every 500 hours of operation.

1. Unlock and open the right rear engine access door.
2. Loosen hex screw in top of filter, Fig. 8A.29, and lower filter bowl cover.
3. Remove and discard element and gaskets.
4. Before you put new filter element into lower cover, clean top and bottom filter covers and install new gaskets.
5. Position new filter element between base and head and install hex screw to secure parts.
6. Remove air from the fuel system (see paragraph 8A.7.3, How to Bleed to Fuel System).

a. Fuel Filter Removal

1. Disconnect lines from fuel pump, to fuel injection pump, from fuel injection pump, to Thermo Start, from fuel pipe and to fuel tank.
2. Support fuel filter with one hand and remove capscrews and lock washers that secure fuel filter and bracket to engine.
3. Remove filter from engine. Hold filter upright until you pour fuel oil from filter into an approved container. Dispose of the fuel in an approved manner.

b. Disassembly

Remove hex screw in top of filter, Fig. 8A.29, remove filter base and discard element.

c. Cleaning and Drying

Clean the filter using an approved solvent and dry with a clean, lint-free cloth.

d. Assembly

Position new filter element between base and head and install hex screw to secure parts.

e. Installation

1. Support fuel filter with one hand and install capscrews and lock washers that secure fuel filter and bracket to engine.
2. Connect lines from fuel pump, to fuel injection pump, from fuel injection pump, to Thermo Start, from fuel pipe and to fuel tank.

8A.13.7 Fuel Injection Pump

The fuel injection pump is a distributor type pump with a mechanical flyweight type governor. The pump is flange mounted and is driven from the engine timing case.

IMPORTANT: Instructions and specifications in the Perkins Engine Manuals are required for fuel injection pump maintenance and servicing. Do not remove pump from engine unless you have this information which is essential to correct fuel injection pump installation.

8A.13.8 Fuel Injectors

Fuel injectors should be taken out for examination at regular intervals.

When replacing fuel injectors in the cylinder head it is essential that a new, correct type copper washer is installed between the nozzle cap and cylinder head.

Earlier engines have a one piece collar-type dust seal; later engines have an improved two-piece arrangement which consists of a soft rubber sealing ring or sleeve and a rigid plastic spacer which presses down onto the rubber sealing ring. The rubber sealing ring is always installed below the rigid spacer.

Tighten securing nuts evenly to 14 lb-ft (19 Nm).

a. How to Locate Faulty Fuel injector(s)

A faulty fuel injector can cause:

- Misfiring
- Knocking in one (or more) cylinders
- Engine overheating
- Loss of power
- Smoky exhaust (black)
- Increased fuel consumption

The particular faulty fuel injector or fuel injectors may be determined by releasing the pipe union nut on each fuel injector in turn, with the engine running at a fast "tick-over". If after slackening a pipe union nut the engine revolutions remain constant, this denotes a faulty fuel injector.

To test the fuel injector:

1. Remove the fuel injector from the cylinder head.
2. Invert the fuel injector with the nozzle facing outwards and then retighten the unions.
3. Slacken the unions of the other fuel injector pipes (to avoid the possibility of engine starting).

4. Use the starter to turn the engine over until fuel sprays from the nozzle. Examine the shape of the spray. If the spray is unduly "wet" or "streaky" or obviously to one side, or if the nozzle "dribbles" it may only be necessary to probe the nozzle holes to remove carbon.

IMPORTANT: Do not attempt to adjust injection pressure without a testing pump and pressure gauge. It is impossible to adjust the setting of fuel injectors with any degree of accuracy without the proper equipment.

A perfect fuel injector, when tested by pumping fuel through it in the open air gives a short "pinging" sound as the fuel emerges from the holes. After the fuel injector has been in service for some time, the "pinging" changes to a crackling sound. It is not until the fuel injector sounds "dead" that its condition is likely to affect the running of the engine.

b. Fuel Injector Identification

Currently, the fuel injector code is stamped on the fuel injector body.

c. How to Replace a Fuel Injector

1. Remove the fuel leak off pipe.
2. Remove the high pressure pipe union nuts from the fuel injector and fuel injection pump and release the pipe.
3. Remove the fuel injector flange nuts and remove the fuel injector and seat washer.
4. Put new fuel injector with new seat washer, in position. Be sure fuel injector is not tilted and tighten the flange nuts evenly by small amounts to 14 lb-ft (19 Nm).



Caution

Be careful to keep hands and face from coming in contact with spray as it will cause fuel oil to penetrate the skin.

5. Connect high pressure fuel pipe and tighten nut to 15 lb-ft (20 Nm).
6. Connect the leak off pipe.
7. Run the engine and check for fuel and air leakage.
8. Bleed the fuel system by following the procedures in paragraph 8A.7.3.

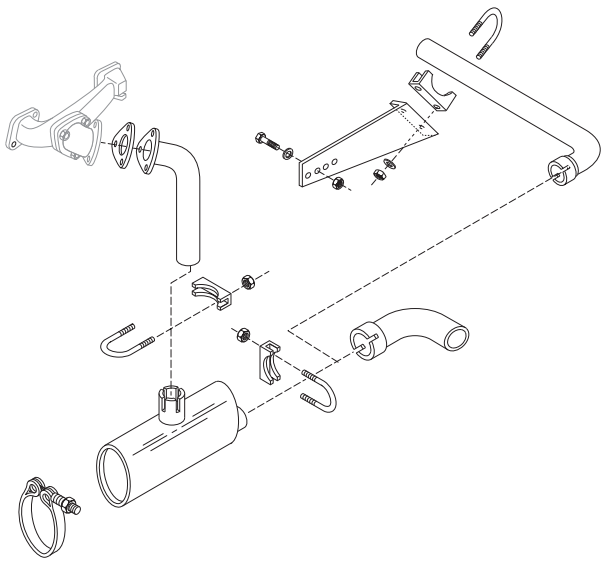


Fig. 8A.30 Exhaust System for a Naturally Aspirated Engine

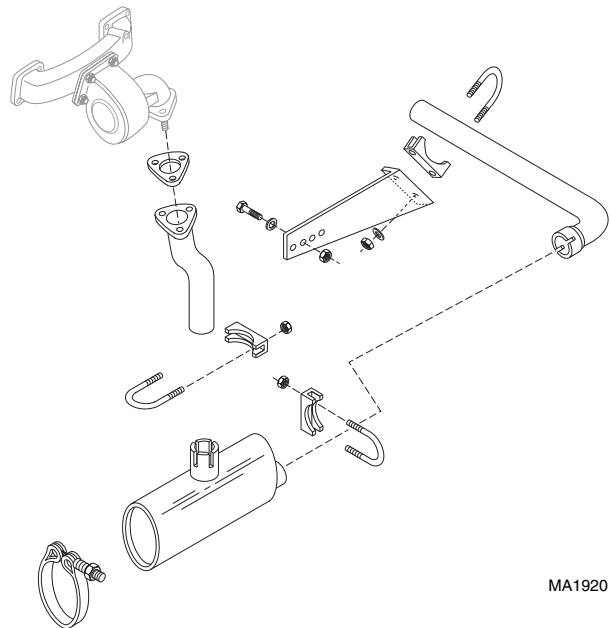


Fig. 8A.31 Exhaust System for a Turbocharged Engine

8A.14 ENGINE EXHAUST SYSTEM



Warning

- Exhaust fumes contain carbon monoxide, a colorless, odorless gas which is fatal when inhaled in a confined area. Avoid breathing exhaust fumes and be sure engine operation will not cause a concentration of toxic emissions.
- Exhaust system components get very hot and can cause severe burns.

The exhaust system, Fig. 30 and 31, is supported by the engine to minimize the transfer of noise and vibration into the operators cab. The tail pipe on current forklifts is directed to the right side of the forklift, which is more remote from the operators cab.

Annoying rattles and noise vibrations in the exhaust system are usually caused by misalignment of parts. When aligning the system, leave all bolts or nuts loose until all parts are properly aligned, then tighten, working from front to rear.

Whenever you replace a muffler you should also replace the tail pipe.

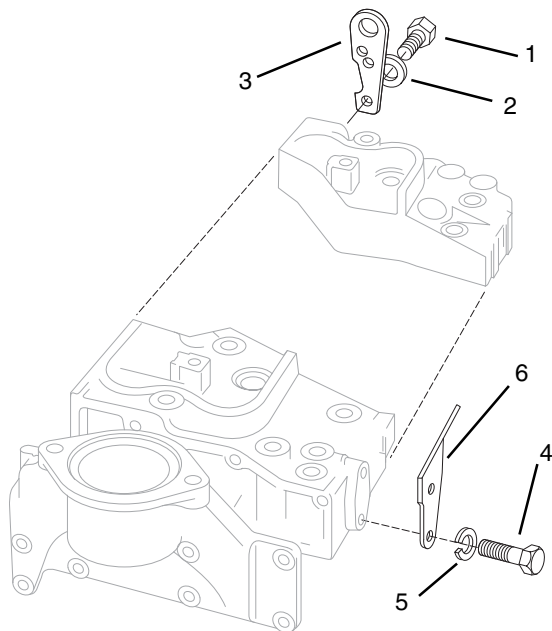
Use Exhaust System Sealer at all slip joint connections before assembly.

When installing exhaust parts, make sure there is sufficient clearance between the hot exhaust parts, pipes, hoses, and wiring that would be adversely affected by excessive heat.

When installing an exhaust system be careful to provide for expansion when the system is hot.

Check complete exhaust system for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, and other deterioration which could permit exhaust fumes to seep into the operators cab. Any damaged areas must be corrected immediately.

Periodic maintenance of the exhaust system is not required; however, it is advisable to check the condition of the system when performing other maintenance on the forklift.



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|---------------|--------------|---------------|
| 1. Screw (2) | 3. Plate | 5. Washer (2) |
| 2. Washer (2) | 4. Screw (2) | 6. Plate |

Fig. 8A.32 Engine Lifting Plates

NOTE: Normally the engine and transmission are removed as a unit by suspending both units from these plates. The combined weight is 1,400 lb (635 kg).

8A.15 HOW TO REMOVE ENGINE FROM FORKLIFT



Warning

To avoid severe burns, **DO NOT** attempt this procedure when the engine, cooling, and hydraulic systems are hot. Wait until they have cooled before proceeding.

1. Remove the transmission cover and open both engine access doors.
2. Lower the boom to the ground.
3. Remove the counterweight from the rear of the frame.
4. Remove the radiator cover.
5. Remove oil cooler from the rear support and detach the lines. Catch any excess oil that drains from cooler and lines. Cap the lines.

- 6A. Detach and remove the air cleaner system from a naturally aspirated engine as follows:
 - (a) Loosen clamp that secures the elbow to the engine inlet manifold.
 - (b) Loosen clamp that secures the elbow to the air cleaner assembly.
 - (c) Remove the nuts, lock washers, washers and capscrews that secure the air cleaner.
- 6B. Detach and remove the air cleaner system from a turbocharged engine as follows:
 - (a) Loosen clamp that secures hose to hose reducer at the air inlet to the turbocharger.
 - (b) Loosen clamp that secures hose to hump hose at the air cleaner assembly.
 - (c) Remove the nuts, lock washers, washers and capscrews that secure the air cleaner mounting band to the forklift frame.
7. Detach the exhaust system from the engine at exhaust manifold as follows:
 - (a) Remove the parts attaching tail pipe to engine and muffler, Fig. 8A.30 and 8A.31.
 - (b) Loosen and remove the T-Bolt that secures the muffler to the engine.
 - (c) Remove the parts attaching the exhaust pipe to the exhaust manifold or turbo-charger, as applicable.
8. Drain the radiator as follows:
 - (a) Remove the radiator cap.
 - (b) Place a container under the radiator petcock at the bottom left corner or the bottom center of the radiator.
 - (c) Open the petcock and allow the coolant to drain from the radiator.
9. Disconnect radiator overflow bottle and radiator hose connections at engine.
10. Remove the radiator, hoses, and shroud.
11. Disconnect the wiring to the backup alarm, Fig. 8A.33.
12. Remove the rear support (which is above the engine between the side frame members) along with the backup alarm.

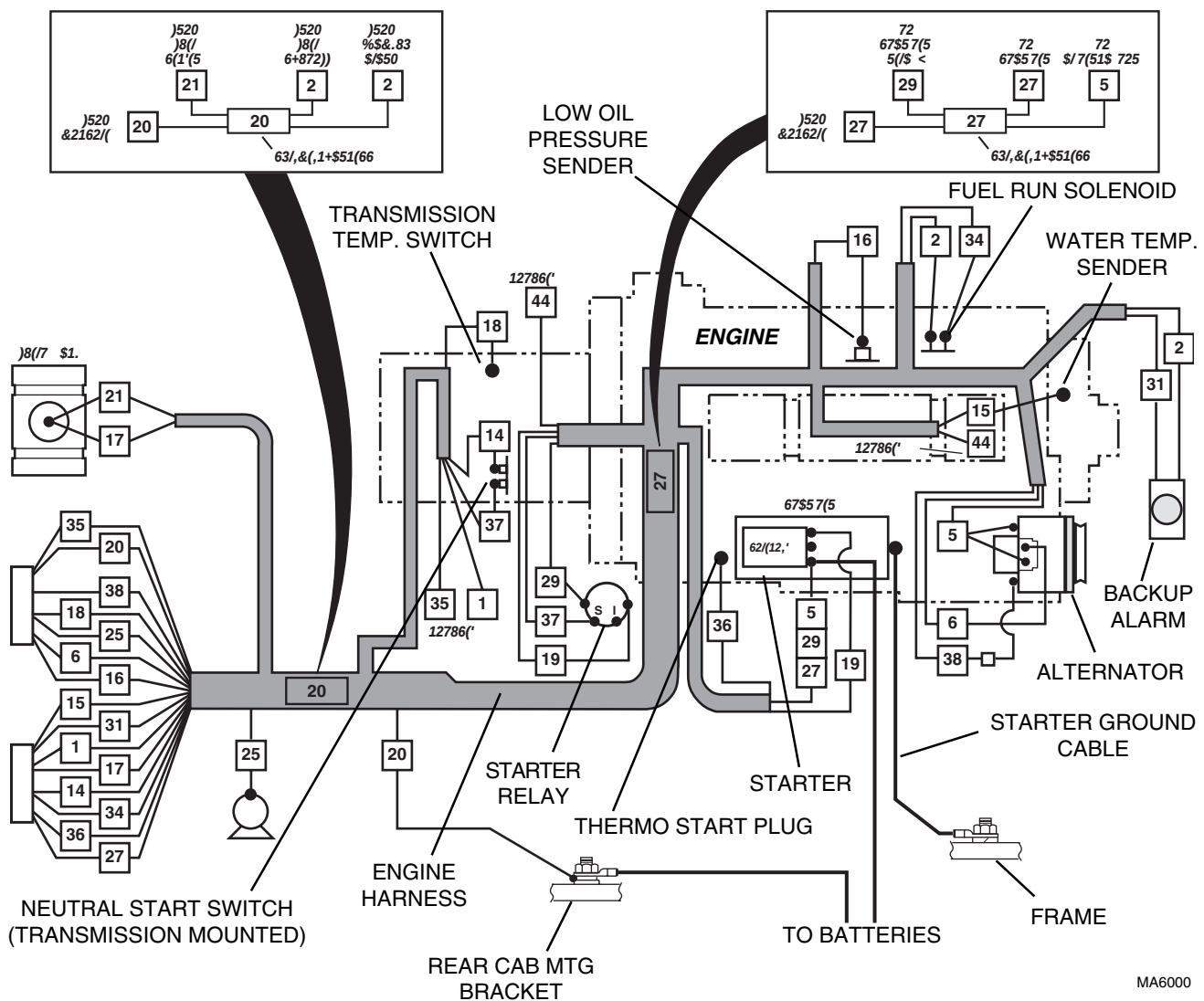


Fig. 8A.33 Engine Harness Connections

13. Disconnect the engine wire harness at the following components, Fig. 8.33:

- Starter
- Starter Ground Cable
- Starter Relay
- Neutral Start Switch (on transmission)
- Transmission Temperature Switch
- Low Oil Pressure Sender
- Water Temperature Sender
- Fuel Run Solenoid
- Alternator
- Thermo Start Plug

Pull harness off of engine and forward on forklift so it is out of the way.

14. Detach and plug fuel lines as required at fuel pre-filter and fuel filter.

15. Detach throttle cable from engine as follows:

- Remove cable clamp securing throttle cable to throttle cable bracket.
- Disconnect the throttle cable from the fuel injection pump.

16. Remove the transmission control cables from the connector kit on the transmission as follows:

- Remove the cable clamps securing the control cable to the connector kit, Fig. 4.4.
- Disconnect the control cables from the swivel linkage.

17. Disconnect transmission drive shaft from the transmission:

- (a) Remove the U-bolt assembly or bearing straps, Fig. 6.1, attaching the drive shaft cross assembly to the drop box input shaft yoke. Slide slip joint towards transmission so cross slips out of drop box input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings don't drop off cross.

- (b) Remove the cap and bolt assembly or bearing straps securing the drive shaft cross assembly to the transmission output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings don't drop off cross.

- (c) Remove drive shaft assembly from forklift.

18. Detach and remove the hydraulic lines from the main pump.

IMPORTANT: Be sure main suction line is raised above level in reservoir.

19. Detach and remove the transmission cooler lines at the transmission.
20. Remove the engine and transmission from the forklift frame as follows:
 - (a) Attach a suitable engine hoist to the lift plates, Fig. 8A.32, on the top of the engine.
 - (b) Remove both transmission mounts from the transmission and frame.
 - (c) Remove the capscrew, vibration mount, rebound washer, and locknut attaching the engine mount to the frame.
 - (d) Pull the engine and transmission out the rear of the forklift.
21. With the engine and transmission adequately supported, separate the engine from the transmission as follows:
 - (a) Remove one of the two access hole plastic plugs on the engine flywheel housing.
 - (b) Remove the eight torque converter drive plate screws and washers.
 - (c) Remove the eleven capscrews securing the converter housing to the flywheel housing.
 - (d) Using a suitable engine hoist, separate the transmission from the engine.

8A.16 HOW TO OVERHAUL THE ENGINE

Refer to the Perkins Engine Workshop Manual for the 4.236 Series engines (Publication No. 601TPD1229) for engine overhaul.

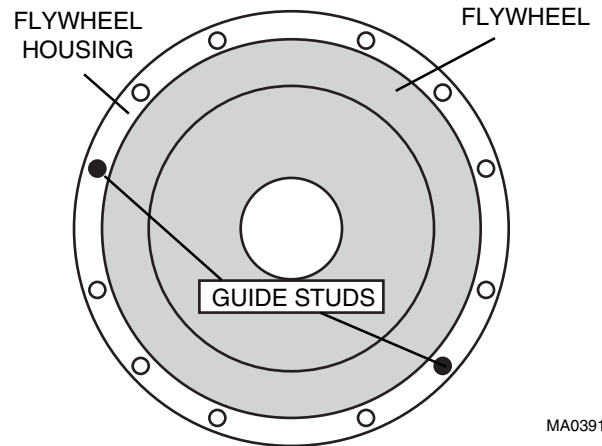
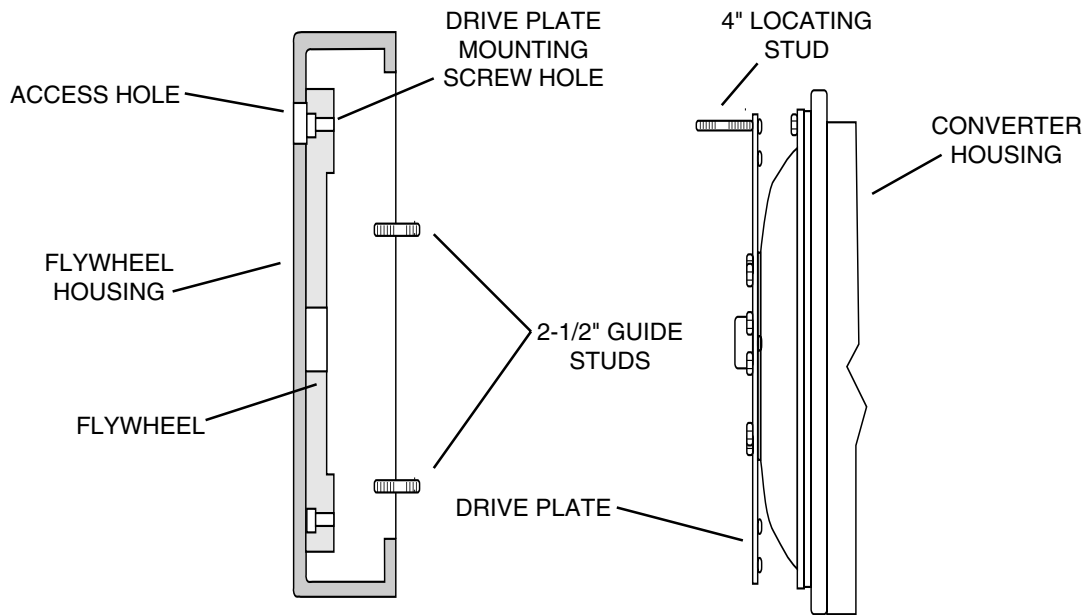


Fig. 8A.34 Guide Studs

8A.17 HOW TO INSTALL THE ENGINE IN FORKLIFT

1. Install two 2.5" (63,5 mm) guide studs in the engine housing as shown in Fig. 8A.34.
2. Rotate the engine flywheel to align a drive plate mounting screw hole with the flywheel housing access hole.
3. Install a 4.0" (101,6 mm) long locating stud (0.375-24 fine thread) in a drive plate nut as shown in Fig. 8A.35.
4. Rotate the drive plate to align the locating stud, Fig. 8A.35 with the flywheel drive plate mounting screw hole positioned in step 2.
5. Position the transmission on the flywheel housing with the guide and locating studs aligned.
6. Install the nine capscrews securing the converter housing to the flywheel housing.
7. Remove the two guide studs and install the remaining two capscrews securing the converter housing to the flywheel housing. Torque all eleven housing capscrews to 25 to 30 lb-ft (34 to 41 Nm).
8. Using the access hole on the flywheel housing, remove the drive plate locating stud and install a capscrew in its place. Snug the capscrew, but do not tighten it.
9. Rotate the engine flywheel and individually install the remaining seven flywheel to drive



MA0401

Fig. 8A.35 Locating Stud

- plate capscrews through the access hole. Snug the screws, but do not tighten them.
10. After all eight capscrews have been installed, rotate the engine flywheel again and individually torque all eight to 25 to 30 lb-ft (34 to 41 Nm).
11. Install the engine and transmission on the forklift frame as follows:
 - (a) Attach a suitable engine hoist to the lifting lugs on the top of the engine.
 - (b) Push the engine and transmission in through the rear of the forklift and rest it on the frame aligning the engine mount hole.
 - (c) Secure both transmission mounts to the transmission and frame with capscrews and locknuts.
 - (S/N 9H0793 and before) Torque the 1/2 inch capscrew attaching the mount to the frame to 68 to 72 lb-ft (93 to 98 Nm).
 - (S/N 9H0794 and after) Torque the 5/8 inch capscrews attaching the mount to the frame to 225 to 275 lb-ft (305 to 373 Nm).
 - Torque the 3/4 inch capscrews attaching the mount to the transmission to 225 to 275 lb-ft (305 to 373 Nm).
 - (d) Secure the engine mount to the frame with a capscrew, vibration mount, rebound washer, and locknut. Torque to 225 to 275 lb-ft (305 to 373 Nm).
 - (e) Remove the engine hoist.
12. Attach the main pump to the transmission.
13. Secure transmission drive shaft to transmission with U-bolt or bearing strap. Torque U-bolt to 20 to 24 lb-ft (27 to 32 Nm) or bearing strap to 55 to 60 lb-ft (75 to 81 Nm).
14. Install the transmission control cables as follows:
 - (a) Place the transmission control valve spools, Fig. 4.4, in the center position.
 - (b) Secure the control cables to the bracket being sure to have the clamp and cable grooves aligned.
 - (c) Position swivel and lock nut on rod end as shown in Fig. 4.4. Tighten the locknut.
 - (d) Be sure the shifter levers are in the center or middle position.
 - (e) Reposition the swivel and lock nut so it aligns with its hole in the swivel linkage control arm.
 - (f) Secure the swivel to the control arm with cotter pin.

15. Attach the throttle control cable to the engine fuel injection pump as follows:
 - (a) Fasten the throttle cable to the throttle cable bracket with a clamp being sure to align the grooves in the cable and clamp.
 - (b) Secure the throttle cable clevis to the fuel injection pump throttle and stop lever with cotter and clevis pins. Adjust the clevis so that the lever touches the stop screw.
16. Connect the fuel lines to the fuel pre-filter and fuel filter assemblies.
17. Connect engine wire harness to the engine and transmission components, Fig. 8A.33:
 - Starter
 - Starter Ground Cable
 - Starter Relay
 - Neutral Start Switch (on transmission)
 - Transmission Temperature Switch
 - Low Oil Pressure Sender
 - Water Temperature Sender
 - Fuel Run Solenoid
 - Alternator
 - Thermo Start Plug
18. Secure the rear support between the side frame members with ten capscrews, lock washers, and hex nuts. Torque to 225 to 275 lb-ft (305 to 373 Nm).
19. Connect the wiring to the backup alarm.
20. Attach the exhaust system to the engine.
21. Install the air cleaner system on the rear support and connect the hoses.
22. Install the radiator overflow bottle.
23. Install the radiator, hoses, and shroud.
24. Connect the radiator hoses to the engine.
25. Fill the radiator as follows:
 - (a) Be sure the radiator petcock is closed and the engine cylinder block drain plug is installed.
 - (b) Fill the radiator completely with 50/50 mixture of ethylene glycol and water. Capacity is 5.4 gallons (20,4 liters).
 - (c) Replace radiator cap.
 - (d) Add coolant to the overflow bottle until it is about 1/4 to 1/2 full — approximately 1 quart (0,95 liter).
 - (e) Clean dirt and debris from radiator fins and core. Remove rear radiator cover for access to radiator.
26. Install the transmission oil cooler on the rear support and connect it to the transmission.
27. Fill the transmission as follows:
 - (a) Install a cleaned drain plug, screen and gasket, Fig. 7.1, into the transmission sump housing.
 - (b) Fill transmission with MIL-L-2104C Oil to LOW mark on dipstick, Fig. 7.6.
28. Install the radiator cover.
29. Install counterweight on the rear of the frame.
30. Check the fluid levels as follows:
 - (a) Start the engine and allow it to heat to operating temperature. Do not operate engine for more than two minutes.
 - (b) **Shut the engine off**, wait for engine to cool, and check the coolant level. Top it off as required by adding coolant through the overflow bottle.
 - (c) Be sure the engine oil level is between the full and add marks. If it is below the add mark, add 10W30 motor oil equal to API, CD or CE (severe duty diesel engine) specifications. Engine crankcase capacity is 9.4 quarts (8,9 liters) for Perkins Natural with a filter change or 9.9 quarts (9,3 liters) for Perkins Turbo with a filter change.
 - (d) Check the transmission oil level. If it is below the add mark, add MIL-L-2104C Oil to bring it to the full mark on the dipstick. Transmission capacity is 4.3 gallons (16,3 liters).
31. Install the transmission cover, close and lock both engine access doors.

8A.18 HOW TO TORQUE CYLINDER HEAD SCREWS AND NUTS

Refer to Perkins Engine Workshop Manual for the 4.236 Series engines (Publication No. 601TPD1229).

8A.19 ENGINE STORAGE

Use the following procedures immediately when engine is removed from service for an extended period. The instructions for the use of Perkins POWERPART products are given on the outside of each container.

1. Clean outside of engine.
2. Where a preservative fuel is to be used, drain the fuel system and fill with the preservative fuel. POWERPART Lay-Up 1 can be added to the normal fuel to change it to a preservative fuel. If preservative fuel is not used, the system can be kept charged with normal fuel but this will have to be drained and discarded at the end of the storage periods together with the fuel filter.
3. Run the engine until it is warm. Correct any fuel, lubricating oil or air leakage. Stop the engine and drain the lubricating oil sump.
4. Replace the lubricating oil filter canister.
5. Fill the sump to the FULL mark on the dip stick with clean new lubricating oil or with an approved preservative fluid. POWERPART Lay-Up 2 can be added to the lubricating oil to protect against corrosion. If a preservative fluid is used, this must be drained and normal lubricating oil used when the engine is returned to service.
6. Drain the cooling system as described in paragraph 8A.10.1. To give protection against corrosion, it is better to fill the cooling system with a coolant that has a corrosion inhibitor (see paragraph 8A.10.1). If frost protection is needed, use an antifreeze mixture. If no frost protection is needed, use water with an approved corrosion inhibitor mixture.
7. Run the engine for a short period to send the lubricating oil and coolant around the engine.
8. Clean out the engine breather pipe (where fitted) and seal the end of the pipe.
9. Remove the fuel injectors and spray POWERPART Lay-Up 2 into each cylinder bore. If this is not available, clean engine lubricating oil will give a degree of protection. Spray into cylinder bores 1/4 pint (118,3 ml) of lubricating oil divided evenly between the four cylinders.
10. Slowly turn crankshaft one revolution and then install the fuel injectors complete with new seat washers.
11. Remove the air filter and any pipe installed between the air filter and induction manifold or turbocharger. It is recommended that the spray time for the turbo charger is 50 percent longer than the manifold spray time. Spray POWERPART Lay-Up 2 into the induction manifold or turbocharger. Seal the manifold or turbocharger with waterproof tape.
12. Remove the exhaust pipe. Spray POWERPART Lay-Up 2 into the exhaust manifold or turbocharger. It is recommended that the spray time for the turbo charger is 50 percent longer than the manifold spray time. Seal the manifold or turbocharger with waterproof tape.
13. Remove the lubricating oil filler cap. Spray POWERPART Lay-Up 2 around the rocker shaft assembly. Replace the filler cap.
14. Disconnect the batteries and put them into safe storage in a fully charged condition. Before the batteries are put into storage, give the battery terminals a protection against corrosion. POWERPART Lay-Up 3 can be used on the terminals.
15. Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.
16. Remove the fan belt and put it into storage.
17. To prevent corrosion, spray the engine with POWERPART Lay-Up 3. Do not spray the inside of the alternator cooling fan area.

NOTE: Before the engine is started after a period in storage, operate the starter motor with one of the fuel run solenoids wires disconnected until oil pressure shows on the oil pressure gauge or the warning light goes out.

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins Engines Ltd. and JLG are not responsible for any damage that occurs in relation to a service storage period.

8A.20 TROUBLESHOOTING

Trouble	Possible Causes (see Key)
Low Cranking Power	1, 2, 3, 4
Will Not Start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33
Difficult Starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33
Lack of Power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 61, 63
Misfiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32
Excessive Fuel Consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33, 63
Black Exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33, 61, 63
Blue/White Exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56, 62
Low Oil Pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59
Erratic Running	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49
High Oil Pressure	4, 38, 41
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57
Excessive Crankcase Pressure	25, 31, 33, 34, 45, 55, 60
Poor Compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59
Starts and Stops	10, 11, 12

Key to Troubles

- | | | |
|---|--|---|
| 1. Battery capacity low | 23. Sticking throttle or restricted movement | 44. Choked oil filter |
| 2. Bad electrical connection | 24. Exhaust pipe restriction | 45. Piston seizure / pick up |
| 3. Faulty starter motor | 25. Leaking cylinder head gasket | 46. Incorrect piston height |
| 4. Incorrect grade of lubricating oil | 26. Overheating | 47. Damaged fan |
| 5. Low cranking speed | 27. Cold running | 48. Faulty engine mounting |
| 6. Fuel tank empty | 28. Incorrect tappet adjustment | 49. Incorrectly aligned flywheel housing, or flywheel |
| 7. Faulty stop control operation | 29. Sticking valves | 50. Faulty thermostat |
| 8. Blocked fuel feed line | 30. Incorrect high pressure pipes | 51. Restriction in water jacket |
| 9. Faulty fuel lift pump | 31. Worn cylinder bores | 52. Loose fan belt |
| 10. Choked fuel filter | 32. Pitted valves and seats | 53. Choked radiator |
| 11. Restriction in air cleaner | 33. Broken, worn or sticking piston ring(s) | 54. Faulty water pump |
| 12. Air in fuel system | 34. Worn valve stems and guides | 55. Choked breather pipe |
| 13. Faulty fuel injection pump | 35. Overfull air cleaner | 56. Damaged valve stem oil deflectors (if fitted) |
| 14. Faulty fuel injectors or incorrect type | 36. Worn or damaged bearings | 57. Coolant level too low |
| 15. Incorrect use of cold start equipment | 37. Insufficient oil in sump | 58. Blocked sump strainer |
| 16. Faulty cold start equipment | 38. Inaccurate gauge | 59. Broken valve spring |
| 17. Broken fuel injection pump drive | 39. Oil pump worn | 60. Exhauster or vacuum pipe leak |
| 18. Incorrect fuel pump timing | 40. Pressure relief valve sticking open | 61. Turbo impeller damaged or dirty |
| 19. Incorrect valve timing | 41. Pressure relief valve sticking closed | 62. Turbo lubricating oil seal leak |
| 20. Poor compression | 42. Broken relief valve spring | 63. Induction system leaks (turbocharged engines) |
| 21. Blocked fuel tank vent | 43. Faulty suction pipe | |
| 22. Incorrect grade of fuel | | |

Notes

SECTION 8B

ENGINE, CUMMINS 4B3.9 AND 4BT3.9

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Warning

To protect yourself and others:

- DO NOT smoke or operate engine during refueling.
- DO NOT operate engine in the presence of a fuel spill or gas leak. Such combustible vapors when drawn into the engine can cause engine over-speeding, an explosion, fire and extensive personal injury and property damage. Before you operate in any hazardous environment consult a recognized authority in this field such as your engine distributor.
- DO NOT remove radiator cap while engine and coolant are hot; coolant under pressure is dangerous and can injure the eyes and cause severe burns.
- DO NOT use salt water or other corrosive liquid in the cooling system.
- DO NOT pull or pry on the fan blades. This practice will damage the fan blades and cause fan failure. Use only approved methods and tools for manually rotating the engine.
- DO NOT operate, clean, lubricate or adjust engine without correct training.
- DO NOT permit loose clothing, long hair, etc., near moving parts.
- Keep away from parts which rotate; fan blades can appear invisible when fan is rotating.
- At any time only one person must be in control of engine and forklift; forklift brakes must work.
- Install guards before operating engine and forklift.
- Clear all persons from the immediate area during engine and forklift operation.
- Be sure engine operation will not produce a concentration of toxic emissions.
- Operate well within the stability limits of the equipment.
- Work area must support the weight of the equipment plus the torque produced by the suspended load.
- Wear protective glasses and protective shoes.
- DO NOT work on engine or equipment that is supported ONLY by lift jacks or a hoist; use blocks or special stands.
- To avoid burns, be alert for components which remain hot after power is turned off or disconnected.
- Corrosion inhibitor contains alkali. Do not get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Get medical assistance immediately. Keep out of the reach of children.
- Make only adjustments and repairs you understand.
- Before beginning any adjustments or repairs, place a "Do Not Operate" tag in the operator's compartment and on the controls, disconnect negative cable from batteries.
- Relieve pressure in fuel, oil, cooling and hydraulic lines before servicing; get medical assistance immediately if a *high pressure jet* of fuel, oil, antifreeze or hydraulic fluid strikes your skin.
- Keep sparks and fire away from batteries; batteries produce hydrogen gas which can explode and cause severe personal injury and property damage.
- Battery fluid can burn the skin and injure the eyes. If you come in contact with battery acid, flush skin with large amounts of water and get medical assistance immediately.
- Some of the gaskets on the engine contain asbestos. Breathing asbestos dust is dangerous to health and may cause severe bodily harm. Avoid creating dust and follow local directives for handling and disposing of materials which contain asbestos.
- Always use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of lesser quality if replacement is necessary.
- Never use gasoline or other flammable materials when cleaning parts; use an approved cleaning solvent.
- Diesel fuel can irritate the skin; use gloves or a protective hand lotion.
- Avoid prolonged and repeated skin contact with new and used engine oil. This contact may cause skin disorders and bodily injury. Wash thoroughly after contact and keep out of the reach of children.

8B.1 DISCLAIMER AND SCOPE OF THESE INSTRUCTIONS

These instructions are written for world wide use. In territories where legal requirements govern engine smoke emission, noise, safety factors, etc., then all instructions, data and dimensions given must be applied in such a way that, after servicing (preventive maintenance) or repairing the engine, it does not contravene the local regulations when in use.

IMPORTANT: *These instructions cover only the routine maintenance of the engine. Refer to your Cummins Engine Distributor for engine diagnosis, repair and component replacement.*

A gradual running in of a new engine is not necessary. Full load can be applied to a new engine as soon as the engine is put into service and the coolant temperature is at least 140 °F (60 °C). Extended light load operation during the early life of the engine is not recommended. Do not run engine at high no load speeds. Do not apply an overload to the engine.

8B.2 STANDARD PRACTICES

Cleanliness is very important during the repair of a diesel engine. Contamination of the engine during repair will reduce the life of an engine.

Gaskets will be replaced and gasket faces will be cleaned, where applicable.

In reassembly and inspection, all parts are to be thoroughly cleaned, and where present, burrs and scales are to be removed.

Any open ports of high precision components such as fuel system equipment, exposed by removal or disassembly, will be covered until reassembled to prevent the entry of foreign material.

The B Series engine uses parts that are of metric dimensions.

Always use caution to be sure that capscrews from the engine are put back in their original locations.

When replacing capscrews, always use a capscrew of the same size and strength as the capscrew being replaced. Incorrect capscrews can result in engine damage.

Metric capscrew nomenclature:

M8 X 1.25 - 25

└─ Major thread diameter in millimeters

└─ Distance between threads in millimeters

└─ Length in millimeters

8B.3 ENGINE MAINTENANCE

8B.3.1 Left and Right Sides of Engine

Throughout this section, the left or right side of the engine is the side of the engine when viewed from the flywheel end.

8B.3.2 Maintenance Intervals

Your engine will require maintenance:

- daily before operation
- every 250 hours or three months
- every 500 hours or six months
- every 1000 hours or annually

Use shorter intervals if ambient temperature is consistently below 0 °F (–18 °C), above 100 °F (38 °C), if frequent stops are made or if you are operating in a dusty environment. Consult your engine distributor for recommended intervals.

8B.4 ENGINE MAINTENANCE DAILY BEFORE OPERATING ENGINE

8B.4.1 Inspect the Engine

1. Level the forklift, lower carriage to ground, shut off engine and engage park lock.
2. Unlock and open the access doors and look for any change in engine appearance such as leaks, loose or damaged parts, and a worn or damaged belt.
3. Check the fan for cracks, loose rivets and bent or loose blades. Make sure it is securely mounted and capscrews are tightened. Replace fan if damaged.
4. Continue with next step.

8B.4.2 Check Engine Coolant Level

1. Check coolant level in overflow bottle, Fig. 8B.1, only when the engine is stopped.

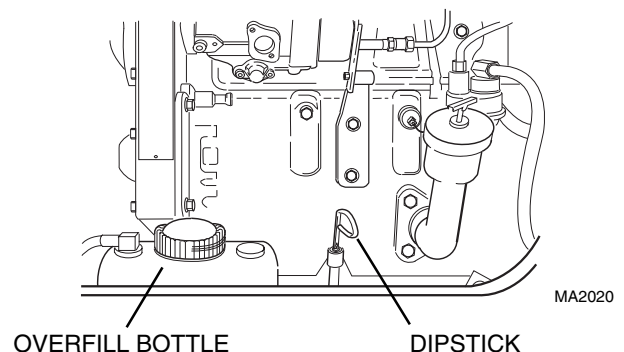
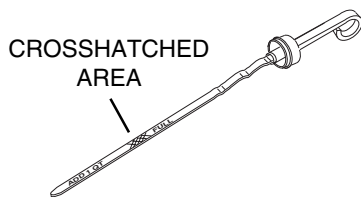


Fig. 8B.1 Check Engine Coolant and Oil Levels

- When the coolant is hot, the bottle should be 3/4 full to full. When the coolant is cool, the bottle should be 1/4 to 1/2 full.
- Remove cap on overflow bottle and add coolant as required. Use a 50/50 mixture of ethylene glycol and water. Protect the engine to -34°F (-37°C) year round.
- Several weeks before you anticipate freezing temperatures, check antifreeze concentration using a hydrometer as described in paragraph 8B.9.1.
- Continue with next step.

NOTE: Use of a sealing additive to stop leaks in the coolant system can plug coolant passages and cause inadequate coolant flow.

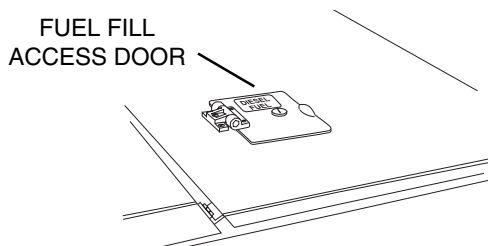


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Fig. 8B.2 Engine Oil Level Dipstick

8B.4.3 Check Engine Oil Level

- Wait at least 5 minutes after shutting off the engine to check the oil. This allows time for the oil to drain to the oil pan.
- Remove and check the engine oil level dipstick, Fig. 8B.2.
- Oil should be within the crosshatched area.
- Replace dipstick.
- If required, add 10W30 or 15W40 motor oil that is equal to API, CD or CE (severe duty diesel engine) specifications. From the low mark to the high mark, oil capacity is 1 quart (0,95 liters). Refer to paragraph 8B.8 for oil Specifications.
- Continue with next step.



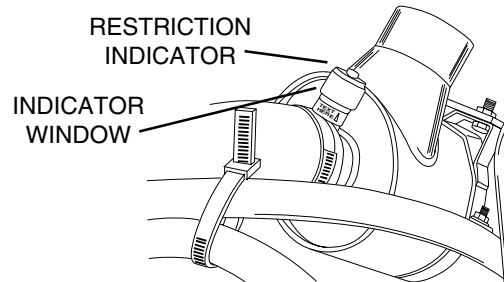
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Fig. 8B.3 Fuel Fill Access Door

8B.4.4 Fill Fuel Tank

- Open fuel fill access door with key, Fig. 8B.3.

- Remove fill cap and fill tank with Diesel Fuel which meets or exceeds specifications in paragraph 8B.11.1. Tank capacity is 24 gallons (90,8 liters).
- Install fill cap and lock fuel fill access door.
- Continue with next step.



OA0202

Fig. 8B.4 Air Cleaner Restriction Indicator

8B.4.5 Check Air Cleaner Restriction Indicator

- Check air cleaner restriction indicator, Fig. 8B.4. If red band has appeared, clean or replace the primary element as described in paragraph 8B.4.7.
- Momentarily press reset button on top of indicator after you service the primary element.

IMPORTANT: Never operate the engine without air cleaner. Intake air must be filtered to prevent dirt and debris from entering the engine and causing premature wear.

NOTE: Maximum intake air restriction for a turbocharged engine is 25" (635 mm) of water and for a naturally aspirated engine is 20" (508 mm) of water. You must operate a turbocharged engine at rated rpm and full load when checking maximum intake air restriction. Clean or replace air cleaner element before restriction reaches the maximum allowable limit.

- Continue with next step.

8B.4.6 Check Air Cleaner Vacuator Valve

- With the carriage lowered to the ground, the engine shut-off and the park lock engaged, unlock and open the right rear engine access door.
- Remove dust and dirt from the vacuator valve, Fig. 8B.5. The lips of the automatic dust ejector must close but not adhere or stick together.
- Continue with next step.

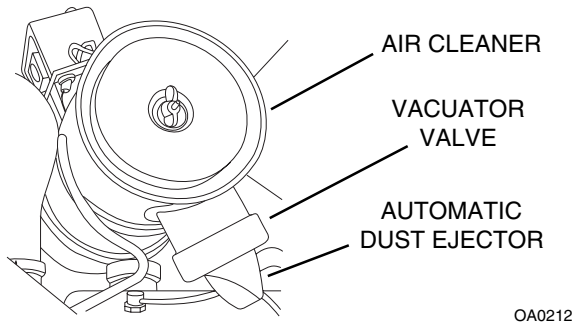


Fig. 8B.5 Vacuator Valve

8B.4.7 Clean or Replace Primary Element as Required by Restriction Indicator

All air cleaner manufacturers agree that attempting to clean or wash an element increases the chance for element damage. It is highly recommended that you consider the value of cleaning an element against the risks which could lead to engine damage. Adopt the policy that all elements should be replaced with new and not cleaned.

Careful cleaning or washing, if done correctly, can extend the life of an element. But you must realize that each time an element is cleaned the dirt holding capacity is reduced and the risk of dirt reaching the clean side of the filter is increased. Filters should never be washed more than six times or retained for more than one year's service, whichever comes first.

If you wash an element, it is recommended that you use a non-sudsing detergent that dissolves combustion residues without damaging the filter media. One such detergent that is specifically formulated for this purpose is FM 1400. This cleaner contains biodegradable synthetic detergents and is environmentally safe. It is marketed by Filter Service Corp., 2105 W. Apache, Farmington, New Mexico, 87401, Telephone (505) 326-1127.

1. Remove the air cleaner cover wing nut, cover, and primary element, Fig. 8A.6.
2. Remove loose particles from the filter with compressed air (maximum 30 psi [207,0 kPa]) or water hose (maximum 40 psi [2,76 bar] without nozzle). Rotate and apply air pressure from the inside of the element.



Warning

Wear safety glasses when using compressed air to clean element.

3. Soak filter in a non-sudsing detergent (such as FM 1400) for at least 15 minutes. Never soak more than 24 hours.
4. Swish filter around in the solution to remove loosened dirt particles.

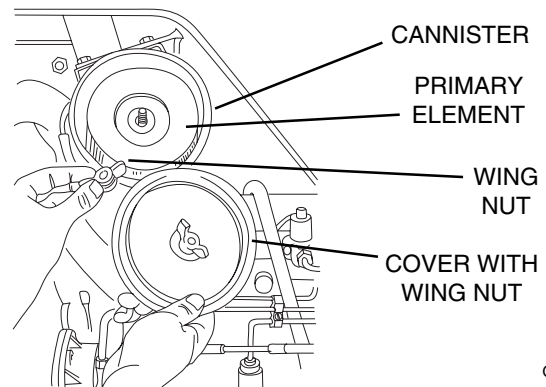


Fig. 8B.6 Air Cleaner Primary Element

5. Rinse the filter from the inside out with a gentle stream of water to remove all dirt and suds (less than 40 psi [2,76 bar], no nozzle). If the inside of the element has been contaminated with dirty water from the soaking, rinse from both sides.
6. Dry the filter before reusing. Circulate warm air at less than 160° F (71 °C). DO NOT use a light bulb or compressed air to dry the filter.
7. Inspect for holes or tears by looking through the filter toward a bright light. Check for damaged gaskets or metal parts. DO NOT reuse damaged filters.
8. Replace the primary element after six cleanings or annually.
9. Continue with next step when necessary.

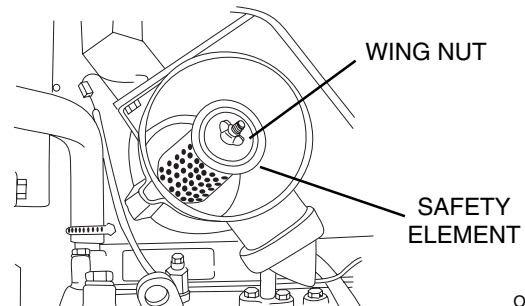


Fig. 8B.7 Air Cleaner Safety Element

8A.5.8 Install a New Safety Element With Every Third Primary Element

1. An inner safety element should never be washed or reused. Always install a new element. Replace safety elements after every third primary element change. DO NOT remove a safety element until you have thoroughly cleaned the inside of the air cleaner canister. This will prevent dirt, which could damage the engine, from entering the induction manifold.

IMPORTANT: Make sure the primary element cannister is thoroughly cleaned before you remove the safety element. Dirt could enter the intake manifold and cause internal engine damage.

2. Install the primary element, air cleaner cover and tighten the wing nut.
3. Check all hose connections at this time.
4. Continue with next step.

8B.5 ENGINE MAINTENANCE EVERY 250 HOURS OR 3 MONTHS

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.

8B.5.1 Inspect Air Intake System

Inspect intake piping for cracked hoses, loose clamps, and punctures. Tighten or replace parts as necessary to make sure the air intake system does not leak.

8B.5.2 Change Engine Oil and Filter

Change the oil and filters to remove the contaminants suspended in the oil.

IMPORTANT: If the engine is being operated, under no circumstances can the oil drain interval extend beyond 250 hours or 3 months.

1. Operate the engine for approximately 5 minutes to bring water temperature to 140 °F (60 °C). Drain the oil only when it is hot and the contaminants are in suspension.
2. Level forklift, lower the carriage to ground, shut off engine, and engage park lock.



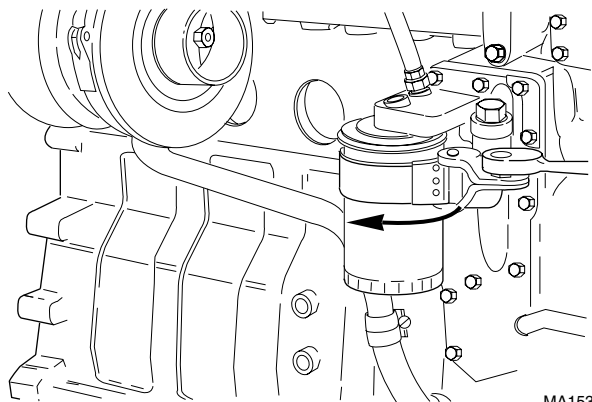
Warning

- Hot oil can cause personal injury.
- Avoid prolonged and repeated skin contact with used engine oils. Such prolonged and repeated contact may cause serious skin disorders or other serious bodily injury. Avoid excessive contact, wash thoroughly after contact, and keep engine oil out of the reach of children.

3. Unlock and open the rear access doors.

IMPORTANT: Protect the environment. Handling and disposal of used engine oil may be subject to federal, state and local laws and regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for used oil. If in doubt, contact your state and local environmental authorities or the Environmental Protection Agency for guidance as to proper handling and disposal of used engine oil.

5. Place a receptacle under the engine oil pan drain plug. Use a container that can hold at least 15 U.S. quarts (14,2 liters) of oil.
6. Clean the area around the lubricating oil filter head.
7. Remove the oil filter, Fig. 8B.8. A strap or chain filter wrench may be required.

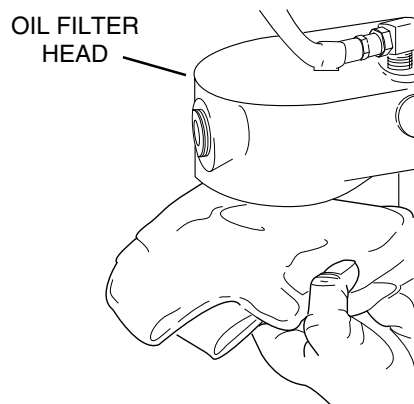


MA1530

Fig. 8B.8 Remove the Oil Filter Element

8. Clean the filter sealing surface of the filter head, Fig. 8B.9.

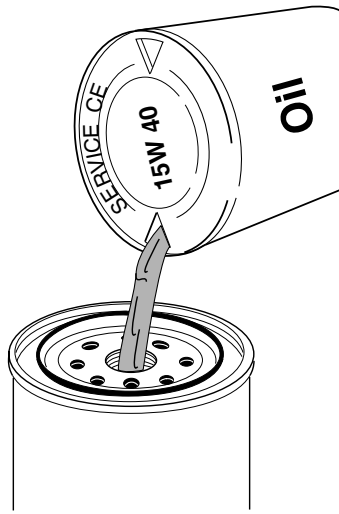
IMPORTANT: The O-ring can stick on the filter head. Make sure it is removed.



MA1540

Fig. 8B.9 Clean the Gasket Surface of the Oil Filter Head

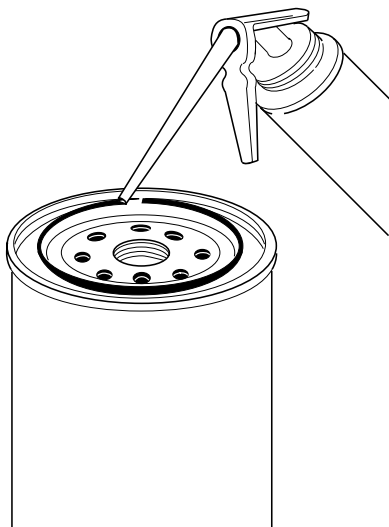
IMPORTANT: Fill filter with clean lubricating oil before installation.



MA1550

Fig. 8B.10 Filling the Filter with Clean Lubricating Oil

9. Refer to SKY TRAK Parts Manual and select filter elements.
10. Fill the filter element with clean lubricating oil before installation, Fig. 8B.10.
11. Apply a thin coat of clean engine oil to the seal of a new filter, Fig. 8B.11.



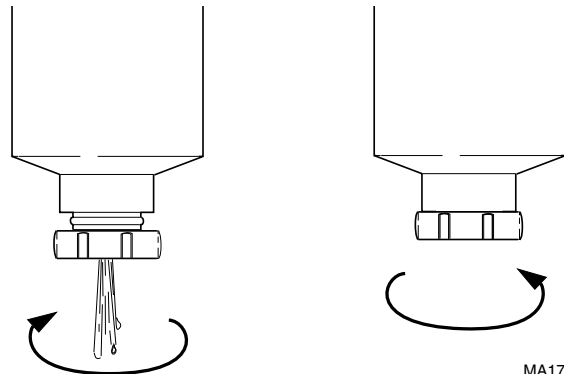
MA1560

Fig. 8B.11 Apply Film of Clean Lubricating Oil to Gasket Sealing Surface

12. Install the filter as specified by the filter manufacturer, hand tighten only.

IMPORTANT: Mechanical overtightening may distort the threads or damage the filter element seal.

13. Check and clean the oil drain plug threads and sealing surface. Install the oil pan drain plug and torque plug to 60 lb-ft (81 Nm).
14. Remove oil fill cap, Fig. 8B.1, and add a high quality multi-grade lubricating oil as outlined in paragraph 8B.8. Add 11.5 quarts (10,9 liters) to attain the proper level.
15. Start the engine and operate at idle for several minutes.
16. Stop the engine and allow oil to drain back for a few minutes.
17. Check dipstick and add oil if required.
18. Idle the engine to inspect for leaks at the filters and drain plug. Retighten if necessary.
19. Stop the engine. Wait approximately 5 minutes to let the oil drain from the upper parts of the engine. Check the oil level again. If required, add oil until the level is within the crosshatched area.
20. Close and lock engine access door.



MA1760

Fig. 8B.12 Drain Fuel-Water Separator

8B.5.3 Drain Fuel-Water Separator

Drain the water and sediment from the separator daily.

1. Use your hand to open the drain valve and turn the valve counter-clockwise approximately 1-1/2 to 2 turns. Allow all water to drain into a glass until clear fuel is visible, Fig. 8B.12.

IMPORTANT: Do not overtighten the valve. Overtightening can damage the threads.

2. Turn the valve clockwise to close the drain valve.
3. Close and lock rear engine access doors.

8B.6 ENGINE MAINTENANCE EVERY 500 HOURS OR 6 MONTHS

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.

8B.6.1 Replace Fuel Filter Elements

1. Unlock and open the right rear engine access door.
2. Clean the area around the fuel filter head.
3. Use filter wrench and remove and discard the elements and the sealing rings. Clean the sealing surfaces of the filter head, Fig. 8B.13.
4. Refer to SKY TRAK Parts Manual and select filter elements.

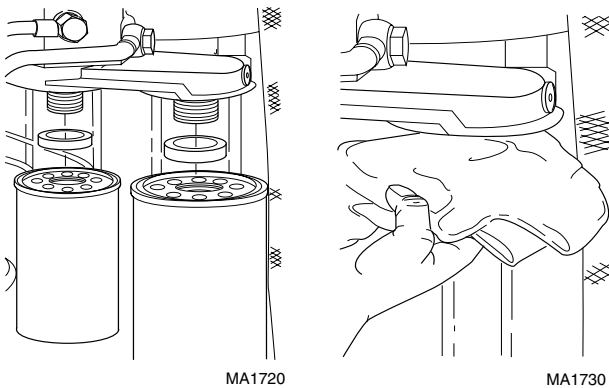


Fig. 8B.13 Remove Elements and Sealing Rings and Clean Sealing Surfaces of Filter Head

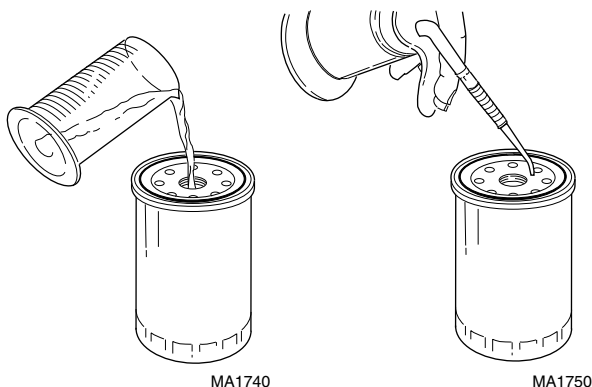


Fig. 8B.14 Fill and Lubricate the Elements

5. Fill the new elements with clean No. 2 Diesel Fuel and lubricate the sealing rings with clean lubricating oil, Fig. 8B.14.

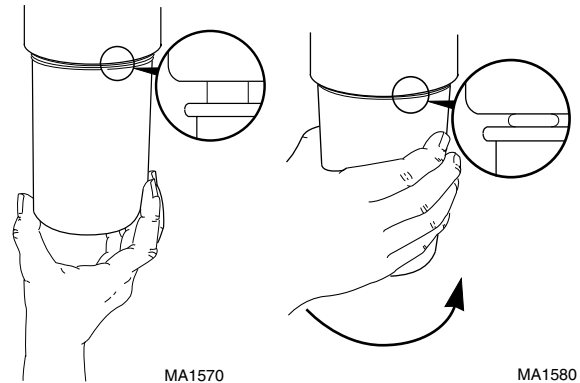


Fig. 8B.15 Hand Tighten Filter Elements

IMPORTANT: Mechanical over-tightening may distort the threads or damage the sealing rings.

6. Install the filters as specified by the manufacturer, hand tighten only, Fig. 8B.15.
7. Controlled venting is provided at the injection pump through the fuel drain manifold, Fig. 8B.16. Small amounts of air introduced by changing the filter elements will be vented automatically if the elements were filled with fuel prior to installation.
8. Close and lock the right rear engine access door.

8B.6.2 How to Bleed the Fuel System

NOTE: Manual bleeding is required if:

- The fuel filter is not filled prior to installation.
- Injection pump is replaced.
- High pressure fuel line connections are loosened or lines replaced.
- Initial engine start up or start up after an extended period of no engine operation.
- Vehicle tank has run empty.

IMPORTANT: DO NOT start the engine until the injection pump has been filled and primed as the pump can be severely damaged due to lack of lubrication.

Remove air from the fuel system as follows:

NOTE: More than one person may be required to perform this procedure.

Controlled venting is provided at the injection pump through the fuel drain manifold, Fig. 8B.16. Small amounts of air introduced by changing the filter elements or injection pump supply line are vented automatically, if the fuel filter is changed in accordance with the instructions.

Warning

Do not bleed air from a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

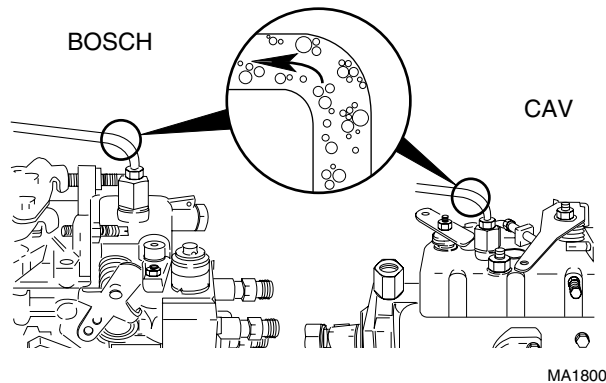


Fig. 8B.16 Fuel Drain Manifold

1. To vent the low pressure lines and fuel filter(s):
 - Open the vent screw, Fig. 8B.17.
 - Operate plunger on lift pump until the fuel flowing from the fitting is free of air, Fig. 8B.17.
 - Tighten the vent screw and torque it to 6 lb-ft (8 Nm), Fig. 8B.17.

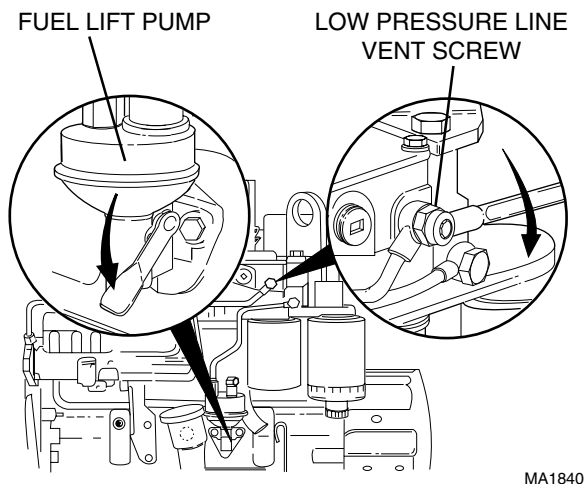
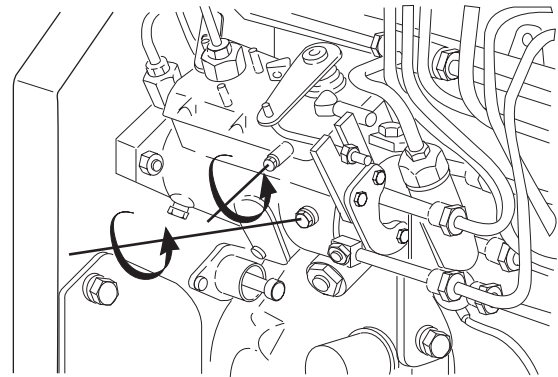


Fig. 8B.17 Operating the Plunger on the Lift Pump



MA2050

Fig. 8B.18 Venting Air from Lucas CAV Injection Pump

2. Bleed the Lucas CAV injection pump at the locations shown in Fig. 8B.18. Bosch pumps do not need bleeding at the pump.
3. Air/fuel can be pumped from this location, Fig. 8B.19, with the hand lever on the lift pump if the fuel solenoid valve is energized. This procedure will work for the Lucas CAV injection pump only.

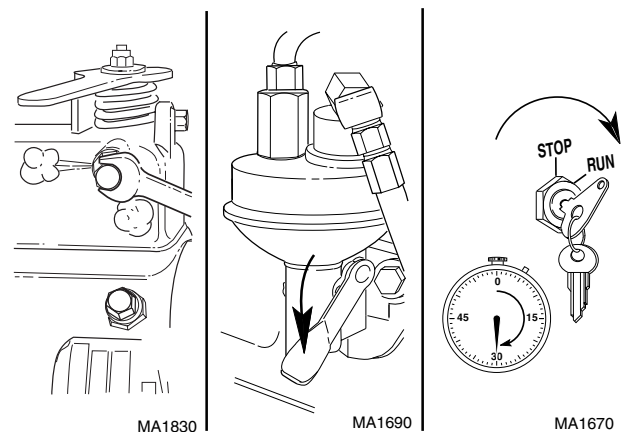


Fig. 8B.19 Pumping from Fuel Lift Pump

Warning

- It is necessary to put the engine in the "Run" position. Because the engine may start, be sure to follow all the safety precautions. Use the normal engine starting procedure.
- When using the starting motor to vent the system, do not engage it for more than 30 seconds at a time; wait two minutes between engagements.

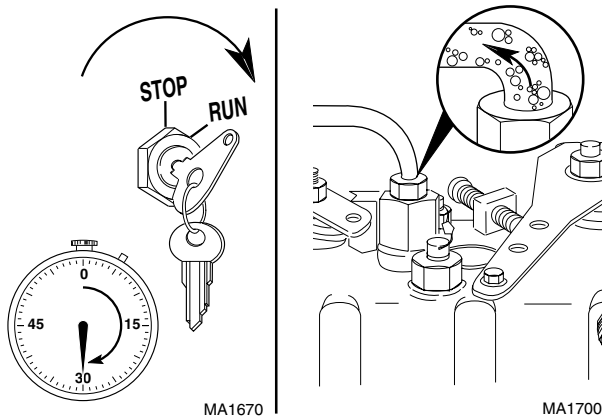


Fig. 8B.20 Venting Fuel Drain Manifold by Operating the Starting Motor

4. Air can be vented from both pumps through the fuel drain manifold line, Fig. 8B.20, by operating the starting motor.
5. High pressure lines are vented by loosening one or more fittings at the injectors and cranking the engine to allow entrapped air to bleed from the lines, Fig. 8B.21.

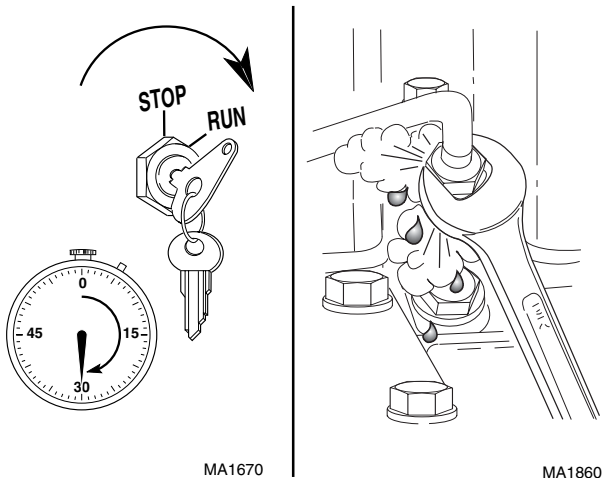


Fig. 8B.21 Venting Fittings at the Injectors



Warning

- The pressure of the fuel in the high pressure line is sufficient to penetrate the skin and cause serious bodily harm.
- Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

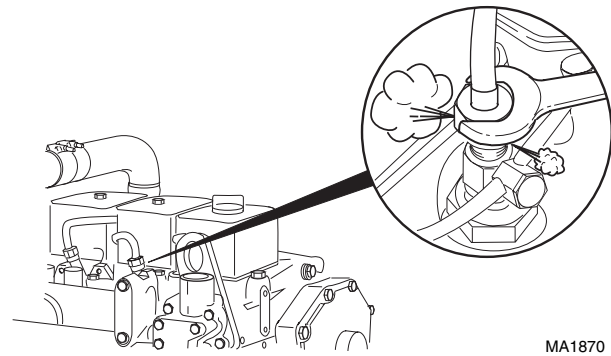


Fig. 8B.22 Venting One Injector at a Time

6. Start the engine and vent one line at a time until the engine runs smoothly, Fig. 8B.22.
7. Close and lock the engine access doors.

8B.7 ENGINE MAINTENANCE EVERY 1,000 HOURS OR ANNUALLY

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time in addition to those listed under this maintenance interval.

8B.7.1 Drive Belt Inspection

1. Remove drive belt by carefully lifting the tensioner with a 1/2 inch square drive installed in square hole in tensioner bracket, Fig. 8B.23.

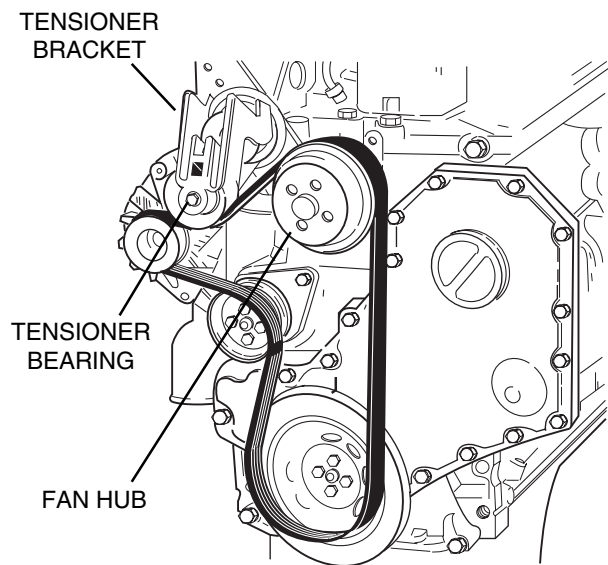


Fig. 8B.23 Removing and Installing Drive Belt

2. Inspect the belt for damage.
 - Transverse (across the belt width) cracks are acceptable.
 - Longitudinal (direction of belt length) cracks that intersect with transverse cracks are not acceptable.
 - Replace the belt if it has unacceptable cracks, is frayed or has pieces of material missing.
3. Continue with next step.

8B.7.2 Tensioner Bearing

1. Check the tensioner bearing, Fig. 8B.23.
2. Spin the pulley and check to see that there are no rough spots detected under hand pressure.
3. Continue with next step.

8B.7.3 Fan Hub

1. Check the fan hub bearing, Fig. 8B.23.
2. Spin the fan and check for wobble or excessive play (maximum end play should be no more than 0.006 in. (0,15 mm).
3. Install the drive belt.

NOTE: Installing the drive belt should be done by positioning the belt over the grooved pulleys first and then, while holding the tensioner up, slide the belt over the water pump pulley, Fig. 8B.23.

8B.7.4 Check Valve Stem to Rocker Arm Gap

The correct gap between the top of the valve stem and the rocker lever with the engine cold is 0.010" (0,25 mm) for the intake valves and 0.020" (0,51 mm) for the exhaust valves of the Cummins Engine. Adjust the valves as shown in Fig 8B.25, with a screw driver, a wrench and a feeler gauge.

Set the gaps between the valve stem tips and rocker arms, Fig. 8B.25, in the following sequence:

1. Remove the valve covers, Fig. 8B.24.

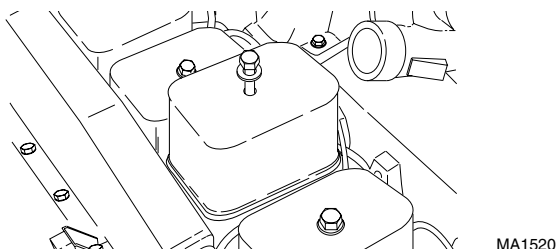
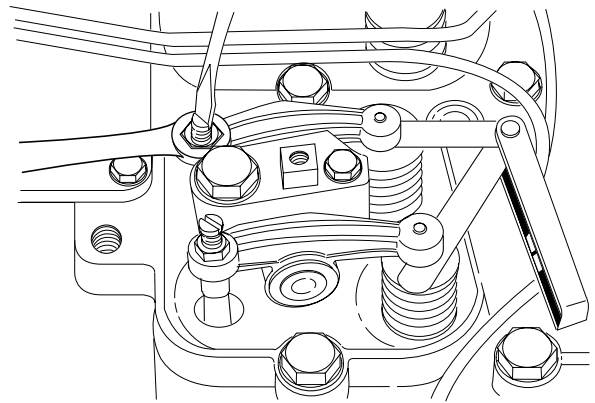


Fig. 8B.24 Valve Covers

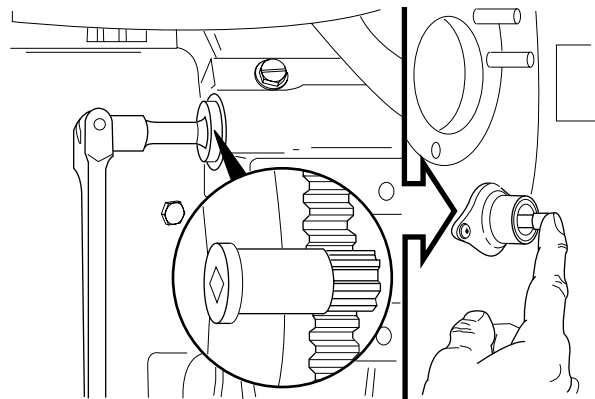


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Fig. 8B.25 Checking Valve Stem to Rocker Arm Gap

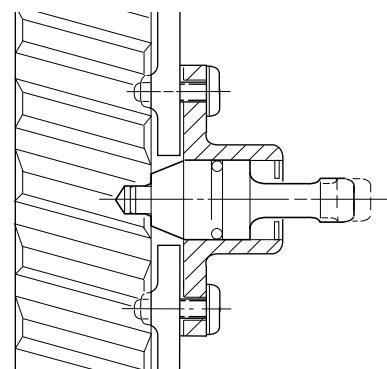
2. Locate Top Dead Center (TDC) for Cylinder Number 1 by barring the engine slowly using a 1/2" drive and the Cummins Engine Barring Gear (Cummins part number 3824591), while pressing on the engine timing pin, Fig. 8B.26. When the pin engages the hole in the camshaft gear, Cylinder Number 1 is at TDC on the compression stroke, Fig. 8B.27.

IMPORTANT: To prevent damage to the engine or pin, be sure to disengage the pin by pulling it out after locating TDC.



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Fig. 8B.26 Locating (TDC) for Cylinder Number 1



MA1610

Fig. 8B.27 Timing Pin Engaged

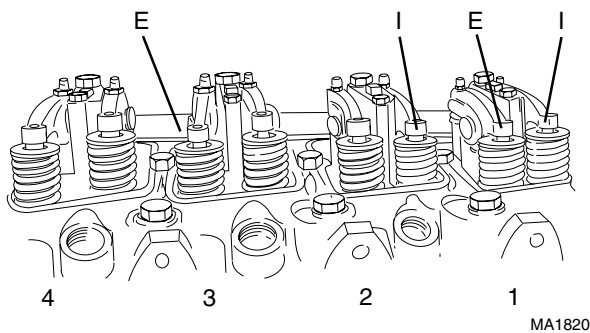


Fig. 8B.28 Set These Valves with Cylinder Number 1 at TDC

3. With cylinder Number 1 at TDC, set the two intake and two exhaust valves as indicated by letters in Fig. 8B.28. Set intake at 0.010" (0,25 mm) and exhaust at 0.020" (0,51 mm). Tighten the locknut and measure the valve gap again, Fig. 8B.25.
4. Torque the locknut to 18 lb-ft (24 Nm).

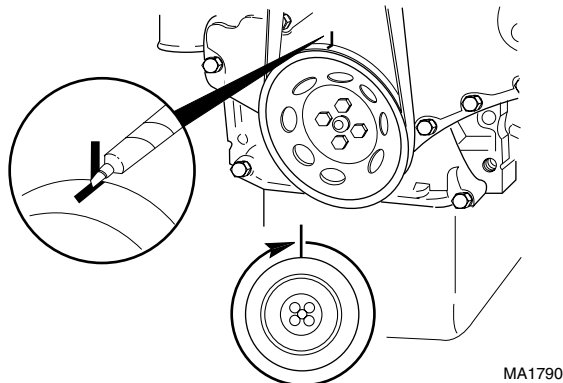


Fig. 8B.29 Rotate Crankshaft One Full Turn

5. Mark the vibration damper and the front cover. Be sure the timing pin is disengaged and rotate the crankshaft one full turn (360°), Fig. 8B.29.

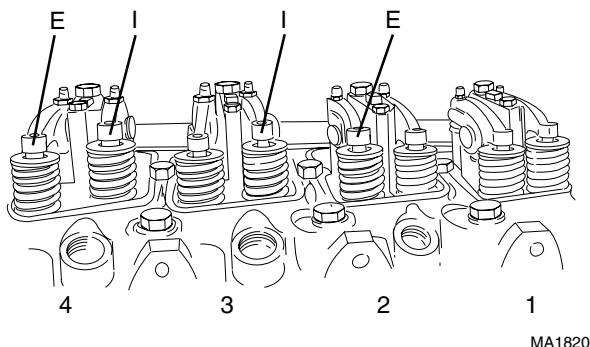


Fig. 8B.30 Set These Valves with Cylinder Number 1 at TDC Plus 360°

6. With Cylinder Number 1 at TDC plus 360° (the timing pin will not engage), set the two intake and two exhaust valves as indicated by the letters in Fig. 8B.30. Set intake at 0.010"

(0,25 mm) and exhaust at 0.020" (0,51 mm). Tighten the lock nut and measure the valve gap again, Fig. 8B.25.

7. Torque the locknut to 18 lb-ft (24 Nm).
8. Install the valve covers and tighten the cap-screws to 18 lb-ft (24 Nm).

8B.7.5 Drain Cooling System

1. With forklift on level ground, unlock and open the left rear engine access door.



Warning

- To prevent personal injury, never remove the radiator cap when coolant is above 120 °F (49 °C). Slowly turn radiator cap to first stop and allow pressure to escape before you remove cap completely. Hot coolant spray can burn you and injure your eyes. Wear safety glasses.
- To avoid severe burns, DO NOT attempt this procedure when engine is hot. Wait for engine, muffler, and tail pipe to cool before proceeding.

2. Slowly turn the radiator cap to the first stop and allow pressure to escape, then continue to turn and remove the cap.
3. Attach a hose to petcock at bottom left corner or the bottom center the of radiator. Place the other end of the hose into a 5 gallon (18,9 liters) or larger container. Open petcock and drain coolant from the system.
4. Detach the line from the bottom of the coolant overflow bottle at the radiator and drain contents into the container.
5. Remove the plug in bottom of the coolant inlet to engine, Fig. 8B.31, and drain the engine coolant into a container.

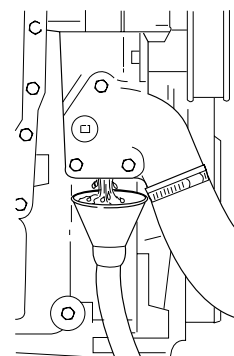


Fig. 8B.31 Remove the Plug in the Bottom of Coolant Inlet to Engine

MA1620

6. Check for damaged hoses and loose or damaged hose clamps. Replace as required. Check the radiator for leaks, damage and build up of dirt and debris, Fig. 8B.32. Clean and repair as required.

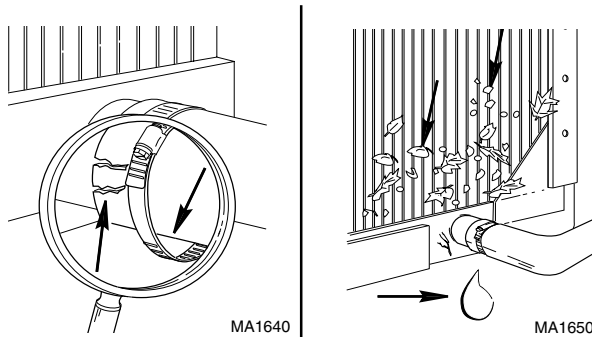


Fig. 8B.32 Inspect for Worn Hoses, Loose Clamps, Leaks and for the Accumulation of Dirt

8B.7.6 Cleaning the Cooling System

Back flush the radiator and engine to clean the cooling system.

1. Remove both radiator hoses from the engine. Attach the water supply to the lower radiator connection and back flush the radiator, Fig 8B.33. If the radiator shows mineral build-up, scale, rust or oil, use a heavy duty radiator cleaner and follow the manufacturer's directions.
2. Remove the top heater hose. Attach the water supply to the heater line and back flush the engine, Fig. 8B.34. If the radiator shows mineral build-up, scale, rust or oil, use a heavy duty radiator cleaner and follow the manufacturer's directions.

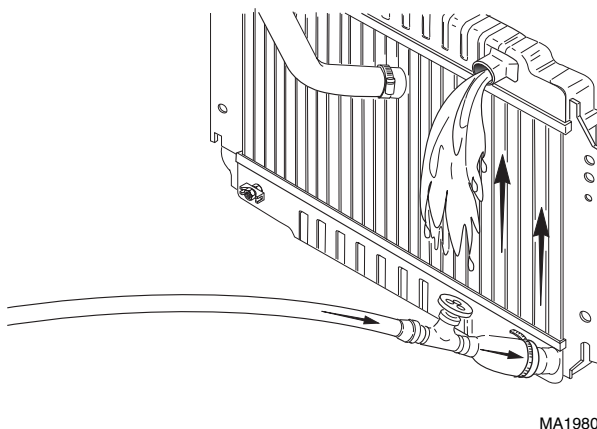


Fig. 8B.33 Back Flushing Radiator

Model 6036/6036T S/N 9B0500 thru 14833

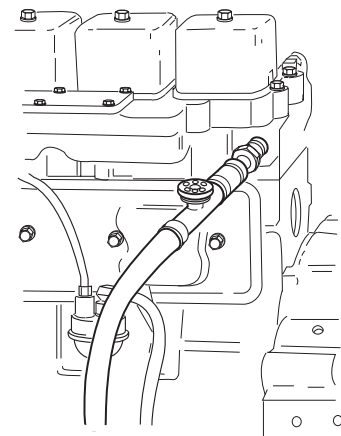


Fig. 8B.34 Back Flushing the Engine

8. Install the radiator hoses, heater hose, engine drain plug, tube to over flow bottle, and close the radiator petcock.

8B.7.7 Filling the Cooling System

The system has a maximum fill rate of 3.5 gallons per minute (14 liters per minute). DO NOT exceed this fill rate.

IMPORTANT: The system must be filled slowly to prevent air locks. During filling, air must be vented from the engine coolant passages, Fig. 8B.35. Be sure to open the petcock on the aftercooler for aftercooled engines. Wait 2 to 3 minutes to allow air to be vented, then add mixture to bring the level to the top.

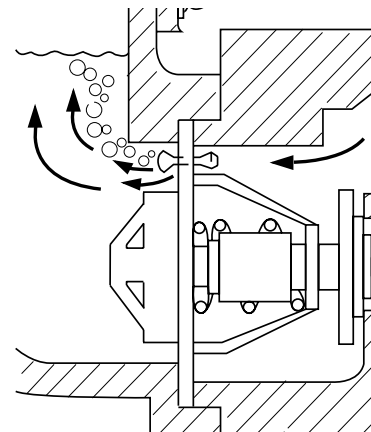


Fig. 8B.35 "Jiggle Pin" Air Vent in Thermostat

8B.7.8 Replace Air Filter Primary Element

Refer to paragraph 8B.4.7 and replace the air filter primary element.

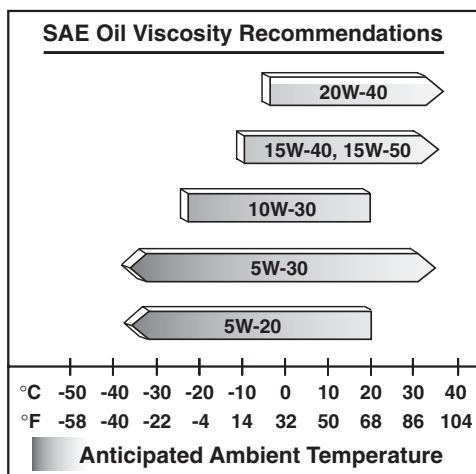
8B.8 ENGINE OIL SPECIFICATIONS

The use of quality engine lubricating oils combined with appropriate oil drain and filter change intervals are critical factors in maintaining engine performance and durability.

Use Cummins Premium Blue 15W40 multi-viscosity oil or equivalent meeting the American Petroleum Institute (API) Classification of CD or CE (severe duty diesel engine) specifications.

The use of multi-viscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

While 15W40 multi-viscosity oil is recommended for most climates, refer to Fig. 8B.36, for oil viscosity recommendations for extreme climates.



MA1950

Fig. 8B.36 SAE Oil Viscosity Recommendations

IMPORTANT: DO NOT use special “break-in” lubricating oils for new or rebuilt Cummins engines. Use the same type of oil during the “break-in” as used in normal operation.

NOTE: Limited use of low viscosity oils, such as 10W30 may be used for easier starting and providing sufficient oil flow at ambient temperatures below 23 °F (–5 °C). However, continuous use of low viscosity oils can decrease engine life due to wear. Refer to Fig. 8B.36.

If an engine is operated in ambient temperatures consistently below –10 °F (–23 °C) and there are no provisions to keep the engine warm when it is not in operation, use a synthetic CE or CD engine oil with adequate low temperature properties such as; 5W20 to 5W30.

The oil supplier must be responsible for meeting the performance service specifications.

IMPORTANT: The use of a synthetic base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as; corrosion, deposits and wear.

8B.9 ENGINE COOLING SYSTEM

The engine cooling system consists of coolant passages in the engine, oil cooler, thermostat, pump, hoses, a radiator and a radiator overflow bottle.

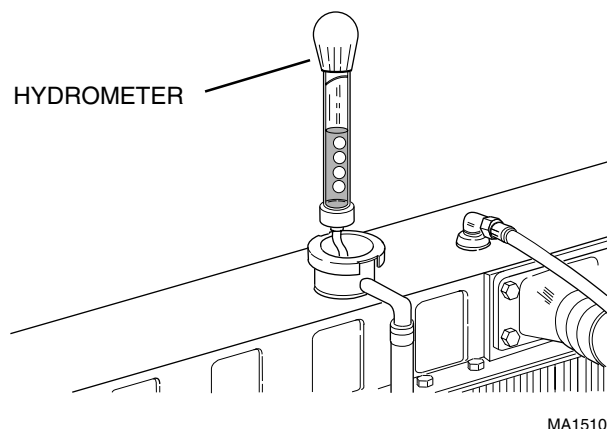
The engine is cooled by the circulation of coolant through passages in the cylinder block and head. Circulation is by thermo-syphon action assisted by an impeller type water pump driven by a drive belt from the crankshaft pulley.

The water pump bearings are prepacked with a special grease during assembly and do not require attention in service.

8B.9.1 Coolant Requirements

The quality of coolant will determine the efficiency and life of the cooling system.

1. Check antifreeze concentration, Fig. 8A.37, several weeks before the beginning of the cold season. The antifreeze must have an ethylene glycol (ethanediol) base. Use a low silicate antifreeze that conforms to one of the standards given on following page or which contains no more than 0.1 percent anhydrous alkali metasilicate.



MA1510

Fig. 8B.37 Testing Antifreeze Concentration

- U.S.A.—Engineering Standard GM6038-M.
 - U.K.—BS 3151: 1959: Ethanediol Antifreeze Type B with Sodium Benzoate and Sodium Nitrite Inhibitors
 - Australia—AS 2108-1977: Antifreeze Compounds and Corrosion Inhibitors for Engine Cooling Systems
2. There is an advantage to using antifreeze even when frost protection is not necessary. Antifreeze protects against corrosion and also raises the boiling point of the coolant. A 50 percent concentration of antifreeze is preferred, but if this much protection is not required, a 33 percent concentration can be used. **NEVER USE MORE THAN A 65 PERCENT CONCENTRATION UNDER ANY CONDITION.** Where frost protection will never be required, add an approved corrosion inhibitor to clean soft water. Change the water/corrosion inhibitor every six months or according to the inhibitor manufacturer's recommendations.
- **DO NOT USE HARD WATER** in the cooling system. Hard water, or water with high levels of calcium and magnesium ions, encourages the formation of silica gel formations, especially after a number of heating and cooling cycles. These gel formations can result in loss of cooling or heating in radiators and cab heater cores by coating and plugging the tubes. The formations usually deposit in the cooler section of the cooling system, such as the radiator bottom tank.
 - **USE SOFT, DISTILLED OR DEIONIZED WATER** to reduce the potential and the severity of silicate dropouts.

IMPORTANT: If you use water without a corrosion inhibitor, rust will form and plug the small holes in the head gasket. These holes are orifices and their size is critical. Do not enlarge the size of the orifices. To do so will disturb the coolant flow and will not solve an overheating problem. If you use water without a corrosion inhibitor for even a relatively short period, the cup plugs will rust through, allowing coolant to leak. An incorrect or malfunctioning radiator cap can result in the loss of coolant and the engine running hot. Any sudden loss of coolant from a heavily loaded engine can result in severe damage to the pistons and cylinder bore.

NOTE: Some corrosion inhibitor mixtures contain soluble oil which can have an adverse effect on some types of water hose.

8B.9.2 Radiator Pressure Cap

The system is designed to use a radiator pressure cap to prevent the boiling of the lubricant. For a 210 °F (99 °C) system use a 7 psi (48 kPa) radiator cap. An incorrect or malfunctioning cap can result in the loss of coolant and the engine running hot.

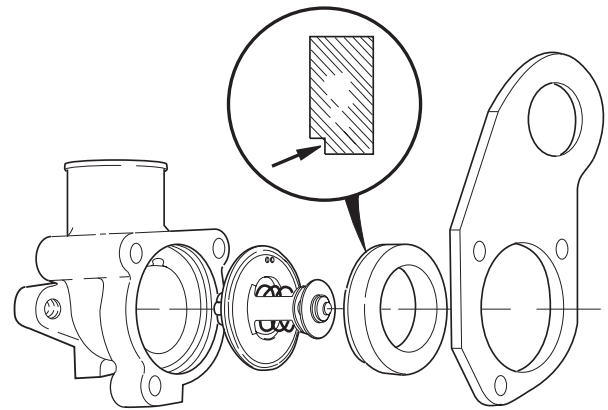


Fig. 8B.38 Thermostat Housing

8B.9.3 How to Replace Thermostat

If it becomes necessary to replace the thermostat, Fig. 8B.38, follow these steps.

1. Preparatory steps:
 - Drain 2.1 quarts (2 liters) of coolant.
 - Remove the radiator hose from the outlet connection.
 - Remove the drive belt.
 - Disconnect the negative battery cable.
2. Loosen the alternator link capscrew on the bottom of the alternator. Remove the alternator mounting capscrew and lower the alternator.
3. Remove the thermostat housing, gasket, lifting bracket and thermostat.
4. Remove the thermostat and clean the gasket surfaces. **DO NOT** let any debris fall into the thermostat cavity when cleaning gasket surfaces.

IMPORTANT: Always use the correct thermostat and never operate the engine without a thermostat.

5. Assemble the removed parts in the reverse order of removal. Make sure the gasket is aligned with the capscrew holes.
6. Install the capscrews and use your fingers to tighten.
6. Tighten all the capscrews and torque to 18 lb-ft (24 Nm).
7. Position the alternator and install the mounting capscrew, torque to 32 lb-ft (43 Nm).
8. Tighten the link capscrew and torque to 18 lb-ft (24 Nm).
9. Install the drive belt.
10. Fill the cooling system, refer to paragraph 8B.7.7. Operate the engine and check for leaks.
11. Vent the engine and the aftercooler.

8B.10 ENGINE ELECTRICAL SYSTEM

The engine electrical system is described in Section 10, Electrical System. These instructions describe warning devices, wiring harnesses, circuit breakers, the starting and charging circuits, switches and solenoids, gauges and indicator lights, and electrical troubleshooting.

8B.11 ENGINE FUEL SYSTEM

The engine fuel system includes a fuel tank (1, Fig. 8B.39), a fuel level sender (2) and gauge, a fuel pre-filter (10), a fuel injection pump, Fig. 8B.18, two fuel filters (17, 18 Fig. 8B.39), and fuel lines to and from the fuel injection pump, and fuel lines from the fuel injection pump to and from the fuel injectors back to the fuel filter and fuel tank.

The threaded fuel fill opening in the top of the fuel tank has a filler cap with a tether (3, Fig. 8B.39). A fuel level sender (2) and gauge are described in Section 10, Electrical System.

A fuel supply hose carries fuel from the bottom of the tank to the fuel pre-filter (10). The fuel then flows through a fuel filter tube, a hose and a fuel pump tube to the fuel lift pump, Fig. 8B.40, which is located on the left side of the engine.

A tube carries fuel under pressure from the fuel lift pump to fuel filter. Fuel which has been filtered by the fuel filter is directed through tubes to the fuel injection pump.

A tube from the fuel injection pump returns surplus fuel to the fuel filters for recirculation back to the fuel injection pump.

A tube from the fuel injectors returns surplus fuel from the injectors to the fuel filters and into a line and hose which returns it to the fuel tank.

8B.11.1 Type of Diesel Fuel to Use

Fuel represents a major portion of your forklift operating costs; therefore, it is important to use it efficiently. Don't let cost tempt you to use inferior diesel fuel. The initial savings is a false economy when you consider the damage poor fuel can do to your forklift engine.

NOTE: Use only diesel fuel designed for diesel engines. Some heating fuels contain harmful chemicals which can seriously affect engine efficiency and performance.

IMPORTANT: Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

Use ASTM No. 2 D Fuel with a minimum Cetane number of 40. No. 2 diesel fuel gives the best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to prevent misfires and excessive smoke.

When operating in temperatures above 32 °F (0 °C), use diesel fuel No. 2 D with a minimum cetane rating of 40. When operating in temperatures below 32 °F (0 °C) use a blend of No. 1 D and No. 2 D fuels, also known as "winterized" No. 2 D.

NOTE: No. 1 D fuel can be used, however, fuel economy will suffer.

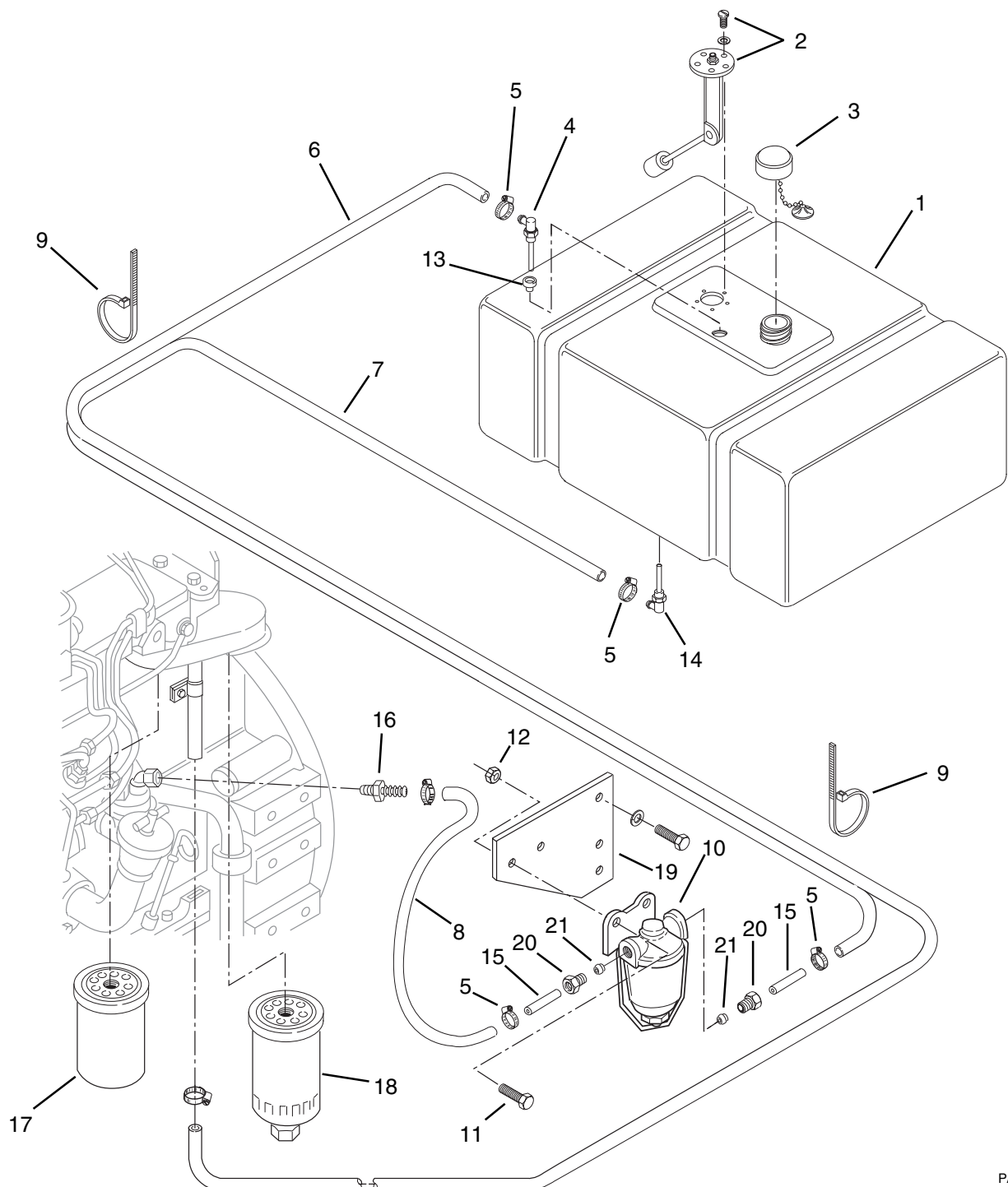


Warning

Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.

Use low sulfur content fuel having a cloud point that is at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which wax crystals begin to form in diesel fuel.

The viscosity of the fuel must be kept above 1.3 centistrokes to provide adequate fuel system lubrication.



PA1183

- | | |
|------------------------------|--------------------------------------|
| 1. Fuel Tank | 12. Lock Nut |
| 2. Fuel Level Sender | 13. Rubber Bushing |
| 3. Filler Cap with Tether | 14. Elbow, 90° with Standpipe |
| 4. Elbow, 90° with Standpipe | 15. Tube Nipple |
| 5. Hose Clamp | 16. Barbed Fitting |
| 6. Fuel Return Hose | 17. Secondary Fuel Filter Element |
| 7. Fuel Supply Hose | 18. Primary Fuel Filter Element |
| 8. Fuel Supply Hose | 19. Water Separator Mounting Bracket |
| 9. Tie Wrap | 20. Bushing |
| 10. Water Separator Assembly | 21. Sleeve |
| 11. Capscrew | |

Fig. 8B.39 Engine Fuel System

NOTE: When using diesel fuel with a sulfur content below 1.3 percent, the filter change interval must be reduced by 75 hours. The use of fuel with a sulfur content above 1.3 percent is not recommended.

8B.11.2 Fuel Tank

The fuel tank (1, Fig. 8B.39) is located directly behind the front axle.

a. Removal

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Disconnect the negative (–) battery cable.
3. Using a hand operated pump, when available, pump as much fuel as possible through the fill cap or fuel level sensor openings in the fuel tank. Pump the fuel oil into a marked and approved receptacle for fuel oil.
4. Prepare to drain remaining fuel by centering a receptacle which can hold the remaining fuel beneath the elbow (14, Fig 8B.39) at the bottom of the tank. Loosen hose clamp (5) at the bottom of the tank, twist fuel supply hose (7) off elbow (14), and drain fuel into receptacle. Discard the fuel in an approved manner. Remove elbow (14) from bottom of the tank to drain remaining fuel from tank.
5. Loosen hose clamp (5) and twist the fuel return hose (6) off elbow (4).
6. Disconnect wires from fuel level sender (2).
7. Lift and tilt the rear of the tank to remove it from the forklift.

b. Disassembly

1. Remove five capscrews, washers, fuel level sender (2, Fig. 8B.39) and gasket from fuel tank.
2. Remove fuel supply elbow (4) and rubber bushing (13) from fuel tank.



Warning

Never drain or store fuel in an open container due to the possibility of fire; discard the fuel in an approved manner.

c. Cleaning and Drying

If contaminated fuel or foreign material is in the tank, the tank can usually be cleaned. Replace tank if tank is damaged or if there are leaks in unreparable areas.

Clean the tank as follows:

1. Have a dry chemical (Class B) fire extinguisher near the work area.
2. Disconnect the negative (–) battery cable.
3. Remove and disassemble fuel tank as described in paragraphs a and b. Invert, rock and drain tank.
4. Clean tank with high pressure washer or flush with hot water for five minutes. Invert, rock and drain tank completely.
5. If necessary, add a diesel fuel emulsifying agent to the tank, refill with water, and agitate mixture for 10 minutes. Drain tank completely. Refer to manufacturer's instructions for correct emulsifying agent to water mixture.
6. When empty, refill to overflowing with water. Completely flush and empty tank.

d. Inspection and Replacement

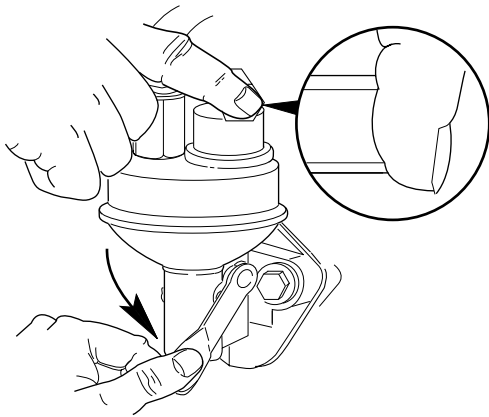
1. Plug all outlets before removing a fuel tank for a suspected fuel leak; make sure that one of the fuel hoses isn't leaking onto the tank.
2. To test a fuel tank which is out of the forklift, plug all openings except a supply or return elbow. Apply a small amount of air pressure to tank through this elbow (approximately 1 to 1-1/2 psi (7,0 to 10,3 kPa). Test tank for leaks by applying soap solution to exterior of tank or by submerging tank in water and looking for bubbles.
3. For a short term repair you may be able to repair a small leak by installing a sheet metal screw with a neoprene gasket in the opening. Replace tank for long term repair.

e. Assembly

1. Install rubber bushing (13, Fig. 8A.39), fuel supply and return elbows (4 and 14) in tank.
2. Position fuel level sender gasket and fuel level sender (2) tank.
3. Loosely install the screw and washer which secures the ground wire to the sender and fuel tank.
4. Install the other four screws and washers and alternately torque the five screws which secure the sender to the fuel tank from 10 to 14 lb-inch (1 to 2 Nm). Use No. 10-24 screws.
5. Install the wire and nut on the center terminal of the sender.

8B.11.3 Fuel Level Sender and Gauge

The fuel level sender and gauge assembly is described in Section 10, Electrical System.



MA1940

Fig. 8B.40 Typical Fuel Lift Pump

8B.11.4 Fuel Lift Pump Testing

Inspect the camshaft lever and return spring for excessive wear. To test the diaphragm, block the fuel inlet line with your finger and operate the priming lever. A good pump will have suction that will not bleed down until you remove your finger from the inlet, Fig. 8B.40.

a. Fuel Lift Pump Removal

1. Clean debris from around the lift pump.
2. Disconnect the fuel lines.
3. Remove the capscrews, gasket, and fuel lift pump.

b. Cleaning and Drying

Clean the exterior of pump with mineral spirits and blow dry with compressed air.

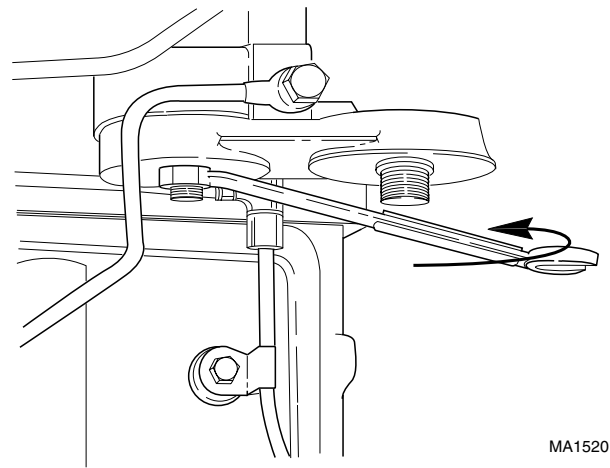
NOTE: Parts replacement is not practical; the pump is serviced as an assembly.

c. Replacement

1. Clean the mounting surface on the cylinder block.
2. Install the lift pump with new gasket, and torque the capscrews to 18 lb-ft (24 Nm).
3. Connect the fuel lines.

8B.11.5 Dual Head Fuel Filter

Replace fuel filter elements every 500 hours or six months. Refer to paragraph 8B.6.1.



MA1520

Fig. 8B.41 Fuel Filter Head Adapter

a. Fuel Filter Head Adapter Replacement

Preparatory Steps:

- Clean debris
- Remove fuel filters.

1. Remove the retaining nut, filter head adapter and sealing washers, Fig. 8B.41.
2. Install in reverse order of removal. Torque retaining nut to 24 lb-ft (32 Nm)

8B.11.6 How to Bleed the Fuel System

See paragraph 8B.6.2, How to Bleed the Fuel System, for procedures to remove air from the fuel system.

8B.11.7 Fuel Injectors

The Cummins engine uses Robert Bosch, 17 mm closed nozzles, hole type injectors. However, the injectors can have different part numbers for different engine ratings. The last four digits of the Cummins part number are used to identify the injectors. The part number is located on the bottom portion of the injector.

IMPORTANT: Use only the specified injector for the engine.

During the injection cycle, high pressure from the injection pump rises to the operating (pop) pressure which causes the needle valve in the injector to lift. Fuel is then injected into the cylinder. A shimmed spring is used to force the needle valve closed as the injection pressure drops below the pop pressure to seal off the nozzle after injection.

Failure of the needle valve to lift and close at the correct time or needle valve stuck open can cause the engine to misfire and produce low power. Fuel leaking from the open nozzle can cause a fuel knock, poor performance, smoke, poor fuel economy, and rough running.

a. How to Locate Faulty Fuel Injector(s)

A faulty fuel injector can cause:

- Misfiring
- Knocking in one (or more) cylinders
- Engine overheating
- Loss of power
- Smoky exhaust (black)
- Increased fuel consumption

The particular faulty fuel injector or fuel injectors may be determined by releasing the pipe union nut on each fuel injector in turn, with the engine running at a fast "tick-over". If after slackening a pipe union nut the engine revolutions remain constant, this denotes a faulty fuel injector.

To test the fuel injector:

1. Remove the fuel injector from the cylinder head.
2. Invert the fuel injector with the nozzle facing outwards and then retighten the unions.
3. Slacken the unions of the other fuel injector pipes (to avoid the possibility of engine starting).
4. Use the starter to turn the engine over until fuel sprays from the nozzle. Examine the shape of the spray. If the spray is unduly "wet" or "streaky" or obviously to one side, or if the nozzle "dribbles" it may only be necessary to probe the nozzle holes to remove carbon.



Warning

Be careful to keep hands and face from coming in contact with spray as it will cause fuel oil to penetrate the skin.

IMPORTANT: Do not attempt to adjust injection pressure without a testing pump and pressure gauge. It is impossible to adjust the setting of fuel injectors with any degree of accuracy without the proper equipment.

A perfect fuel injector, when tested by pumping fuel through it in the open air gives a short "pinging" sound as the fuel emerges from the holes. After the fuel injector has been in service for some time, the "pinging" changes to a crackling sound. It is not until the fuel injector sounds "dead" that its condition is likely to affect the running of the engine.

b. Injector Replacement (Fig. 8B.42)

Preparatory Steps:

- Thoroughly clean around the injectors.
- Disconnect the high pressure fuel lines.
- Disconnect the fuel drain manifold.

IMPORTANT: The injector must not rotate in the bore of the cylinder head. This will damage the cylinder head. If rust has formed on the hold down nut, soak the hold down nut with a rust penetrating solvent for a minimum of 3 minutes and hit the injector body with a drift pin to loosen any rust.

1. Hold the injector body with a 16 mm wrench while you loosen the hold-down nut with a 24 mm box end wrench.
2. Clean the injector nozzle bore.
3. Remove the injector hold-down nut from the injector body.
4. Apply a coat of anti-seize compound to the new injector surface, avoid getting the anti-seize compound in the fuel drain hole.
5. Install the hold-down nut on the injector body.
6. Install a new o-ring into the recessed groove in the top of the hold-down nut. Make sure the o-ring is not cut or twisted when installing.
7. Apply a coat of anti-seize compound to the threads of the injector hold-down nut.
8. Assemble the injector and new copper washer, use only one copper washer. Place a light coat of clean 15W40 engine oil between the washer and injector to help keep the washer from falling during installation.
9. Install the injector with the protrusion on the side of the nozzle fitting into the notch in the head.
10. Tighten the hold-down nut and torque to 44 lb-ft (60 Nm).
11. Install the fuel drain manifold and torque to

6 lb-ft (8 Nm).

12. Install the high pressure fuel lines and torque to 18 lb-ft (24 Nm).
13. Run the engine and check for fuel and air leakage.
14. Bleed the fuel system by following the procedures in paragraph 8B.7.2, How to Bleed the Fuel System.

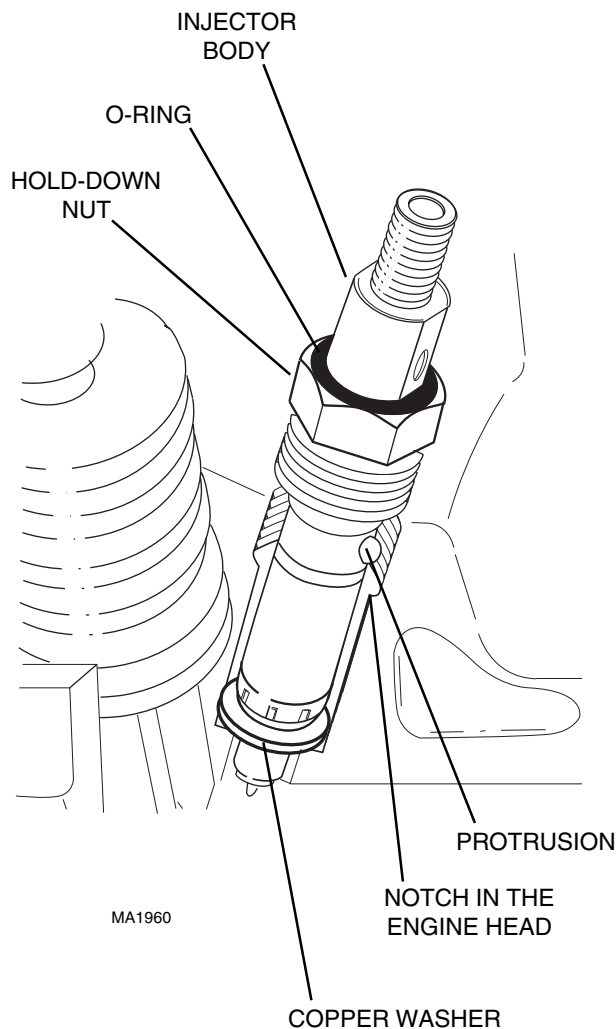


Fig. 8B.42 Fuel Injector

8B.12 ENGINE EXHAUST SYSTEM



Warning

- Exhaust fumes contain carbon monoxide, a colorless, odorless gas which is fatal when inhaled in a confined area. Avoid breathing exhaust fumes and be sure engine operation will not cause a concentration of toxic emissions.
- Exhaust system components get very hot and can cause severe burns.

The exhaust system, Fig. 8B.43 and 8B.44, is supported by the engine to minimize the transfer of noise and vibration into the operators cab. The tail pipe on current forklifts is directed to the right side of the forklift which is more remote from the operators cab.

Annoying rattles and noise vibrations in the exhaust system are usually caused by misalignment of parts. When aligning the system, leave all bolts or nuts loose until all parts are properly aligned, then tighten working from front to rear.

Whenever you replace a muffler you should also replace the tail pipe.

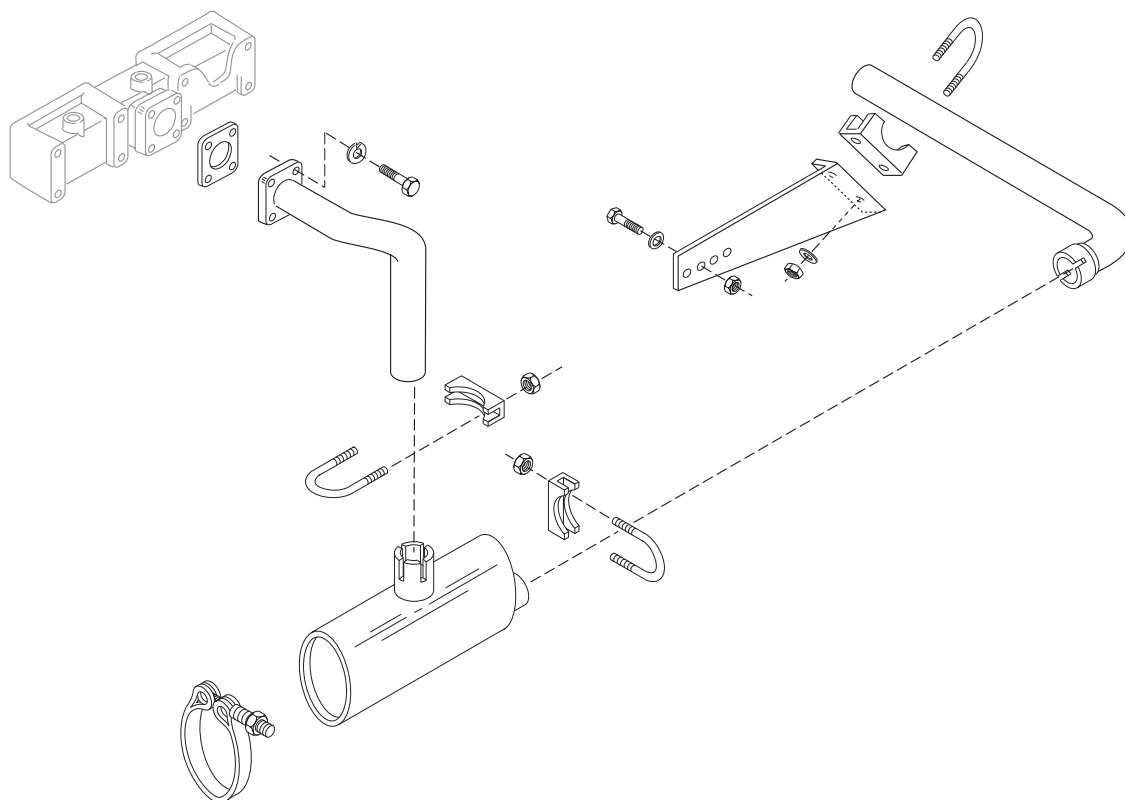
Use Exhaust System Sealer at all slip joint connections before assembly.

When installing exhaust parts, make sure there is sufficient clearance between the hot exhaust parts, pipes, hoses and wiring that would be adversely affected by excessive heat.

When installing an exhaust system be careful to provide for expansion when the system is hot.

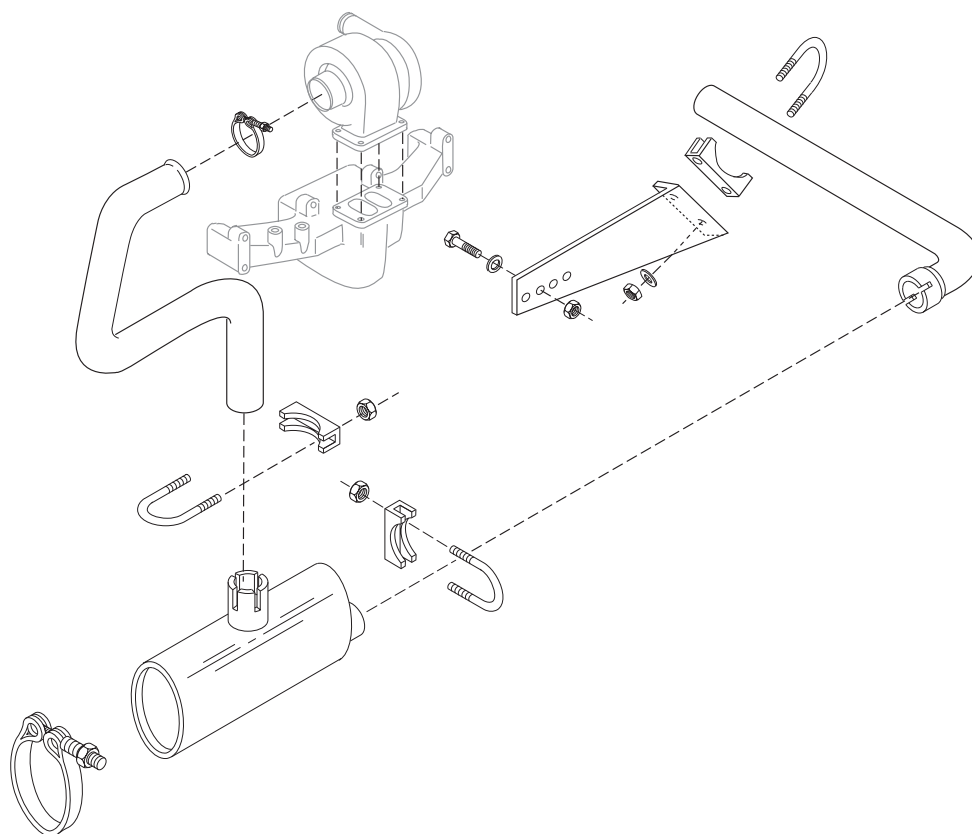
Check complete exhaust system for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, and other deterioration which could permit exhaust fumes to seep into the operators cab. Any damaged areas must be corrected immediately.

Periodic maintenance of the exhaust system is not required; however, it is advisable to check the condition of the system when performing other maintenance on the forklift.



MA1910

Fig. 8B.43 Exhaust System for a Naturally Aspirated Engine



MA1900

Fig. 8B.44 Exhaust System for a Turbocharged Engine

8B.13 HOW TO REMOVE ENGINE FROM FORKLIFT



Warning

To avoid severe burns, **DO NOT** attempt this procedure when the engine, cooling, and hydraulic systems are hot. Wait until they have cooled before proceeding.

1. Remove the transmission cover and open both engine access doors.
2. Lower the boom to the ground.
3. Remove the counterweight from the rear of the frame.
4. Remove the radiator cover.
5. Remove oil cooler from the rear support and detach the lines. Catch any excess oil that drains from cooler and lines. Cap the lines.
- 6A. Detach and remove the air cleaner system from a naturally aspirated engine as follows:
 - (a) Loosen clamp that secures the elbow to the engine inlet manifold.
 - (b) Loosen clamp that secures the elbow to the air cleaner assembly.
 - (c) Remove the nuts, lockwashers, washers and capscrews that secure the air cleaner mounting band to the forklift frame.
- 6B. Detach and remove the air cleaner system from a turbocharged engine as follows:
 - (a) Loosen clamp that secures hose to hose reducer at the air inlet to the turbocharger.
 - (b) Loosen clamp that secures hose to hump hose at the air cleaner assembly.
 - (c) Remove the nuts, lockwashers, washers and capscrews that secure the air cleaner mounting band to the forklift frame.
7. Detach the exhaust system from the engine at exhaust manifold as follows:
 - (a) Remove the parts attaching tail pipe to engine and muffler, Fig. 8B.43 and 8B.44.
 - (b) Loosen and remove the T-Bolt that secures the muffler to the engine.
 - (c) Remove the parts attaching the exhaust pipe to the exhaust manifold or turbo-charger, as applicable.
8. Drain the radiator as follows:
 - (a) Remove the radiator cap.
 - (b) Place a container under the radiator petcock at the bottom left corner or the bottom center of the radiator.
 - (c) Open the petcock and allow the coolant to drain from the radiator.
9. Disconnect radiator overflow bottle and radiator hose connections at engine.
10. Remove the radiator, hoses, and shroud.
11. Disconnect the wiring to the backup alarm, Fig. 8B.46.
12. Remove the rear support (which is above the engine between the side frame members) along with the backup alarm.
13. Disconnect the engine wire harness at the following components, Fig. 8B.46:
 - Starter
 - Starter Ground Cable
 - Starter Relay
 - Neutral Start Switch (on transmission)
 - Transmission Temperature Switch
 - Low Oil Pressure Sender
 - Water Temperature Sender
 - Fuel Run Solenoid
 - Alternator

Pull harness off of engine and forward on forklift so it is out of the way.
14. Detach and plug fuel lines as required at fuel pre-filter and fuel filter.
15. Detach throttle cable from engine as follows:
 - (a) Remove cable clamp securing throttle cable to throttle cable bracket.
 - (b) Disconnect the throttle cable from the fuel injection pump.
16. Remove the transmission control cables from the connector kit on the transmission as follows:
 - (a) Remove the cable clamps securing the control cable to the connector kit, Fig. 4.4.
 - (b) Disconnect the control cables from the swivel linkage.

17. Disconnect transmission drive shaft from the transmission:

- (a) Remove the U-bolt assembly or bearing straps, Fig. 6.1, attaching the drive shaft cross assembly to the drop box input shaft yoke. Slide slip joint towards transmission so cross slips out of drop box input shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings don't drop off cross.

- (b) Remove the cap and bolt assembly or bearing straps securing the drive shaft cross assembly to the transmission output shaft yoke.

NOTE: Wrap tape around bearings and cross so bearings don't drop off cross.

- (d) Remove drive shaft assembly from forklift.

18. Detach and remove the hydraulic lines from the main pump.

IMPORTANT: Be sure main suction line is raised above level in reservoir.

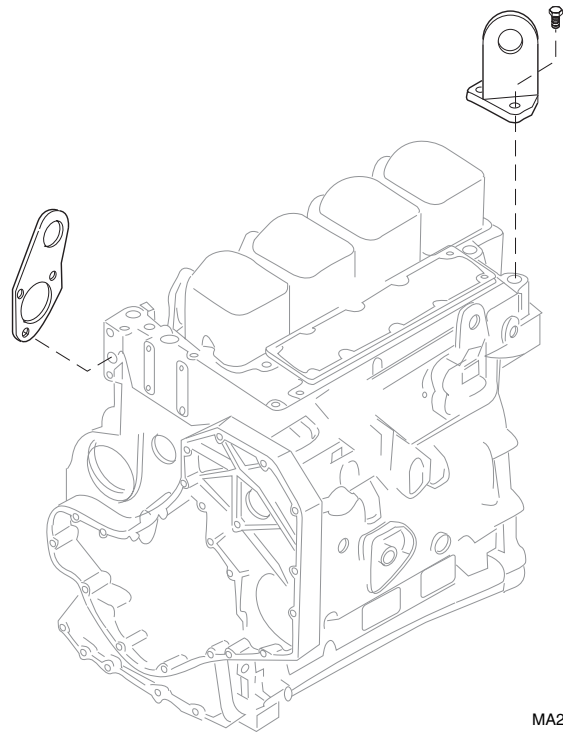
19. Detach and remove the transmission cooler lines at the transmission.

20. Remove the engine and transmission from the forklift frame as follows:

- (a) Attach a suitable engine hoist to the lift plates, Fig. 8B.45, on the top of the engine.
- (b) Remove both transmission mounts from the transmission and frame.
- (c) Remove the capscrew, vibration mount, rebound washer, and locknut attaching the engine mount to the frame.
- (d) Pull the engine and transmission out the rear of the forklift.

21. With the engine and transmission adequately supported, separate the engine from the transmission as follows:

- (a) Remove one of the two access hole plastic plugs on the engine flywheel housing.
- (b) Remove the eight torque converter drive plate screws and washers.
- (c) Remove the eleven capscrews securing the converter housing to the flywheel housing.
- (d) Using a suitable engine hoist, separate the transmission from the engine.



MA2030

Fig. 8B.45 Engine Lifting Plates

8B.14 HOW TO OVERHAUL THE ENGINE

Refer to the Cummins Shop Manual, B Series Engines.

8B.15 HOW TO INSTALL THE ENGINE IN FORKLIFT

1. Install two 2.5" (63,5 mm) guide studs in the engine housing as shown in Fig. 8B.47.
2. Rotate the engine flywheel to align a drive plate mounting screw hole with the flywheel housing access hole.
3. Install a 4.0" (101,6 mm) long locating stud (0.375-24 fine thread) in a drive plate nut as shown in Fig. 8B.48.
4. Rotate the drive plate to align the locating stud with the flywheel drive plate mounting screw hole positioned in step 2.
5. Position the transmission on the flywheel housing with the guide and locating studs aligned.
6. Install the nine capscrews securing the converter housing to the flywheel housing.

7. Remove the two guide studs and install the remaining two capscrews securing the converter housing to the flywheel housing. Torque all eleven housing capscrews to 25 to 30 lb-ft (34 to 41 Nm).
 8. Using the access hole on the flywheel housing, remove the drive plate locating stud and install a capscrew in its place. Snug the capscrew, but do not tighten it.
 9. Rotate the engine flywheel and individually install the remaining seven flywheel-to-drive-plate capscrews through the access hole. Snug the screws, but do not tighten them.
 10. After all eight capscrews have been installed, rotate the engine flywheel again and individually torque all eight to 25 to 30 lb-ft (34 to 41 Nm).
 11. Install the engine and transmission on the forklift frame as follows:
 - (a) Attach a suitable engine hoist to the lifting lugs on the top of the engine.
 - (b) Push the engine and transmission in through the rear of the forklift and rest it on the frame aligning the engine mount hole.
 - (c) Secure both transmission mounts to the transmission and frame with capscrews and locknuts.
- (S/N 9H0793 and before) Torque the 1/2 inch capscrew attaching the mount to the frame to 68 to 72 lb-ft (92 to 98 Nm).
 - (S/N 9H0794 and after) Torque the 5/8 inch capscrews attaching the mount to the frame to 225 to 275 lb-ft (305 to 373 Nm).
 - Torque the 3/4 inch capscrews attaching the mount to the transmission to 225 to 275 lb-ft (305 to 373 Nm).

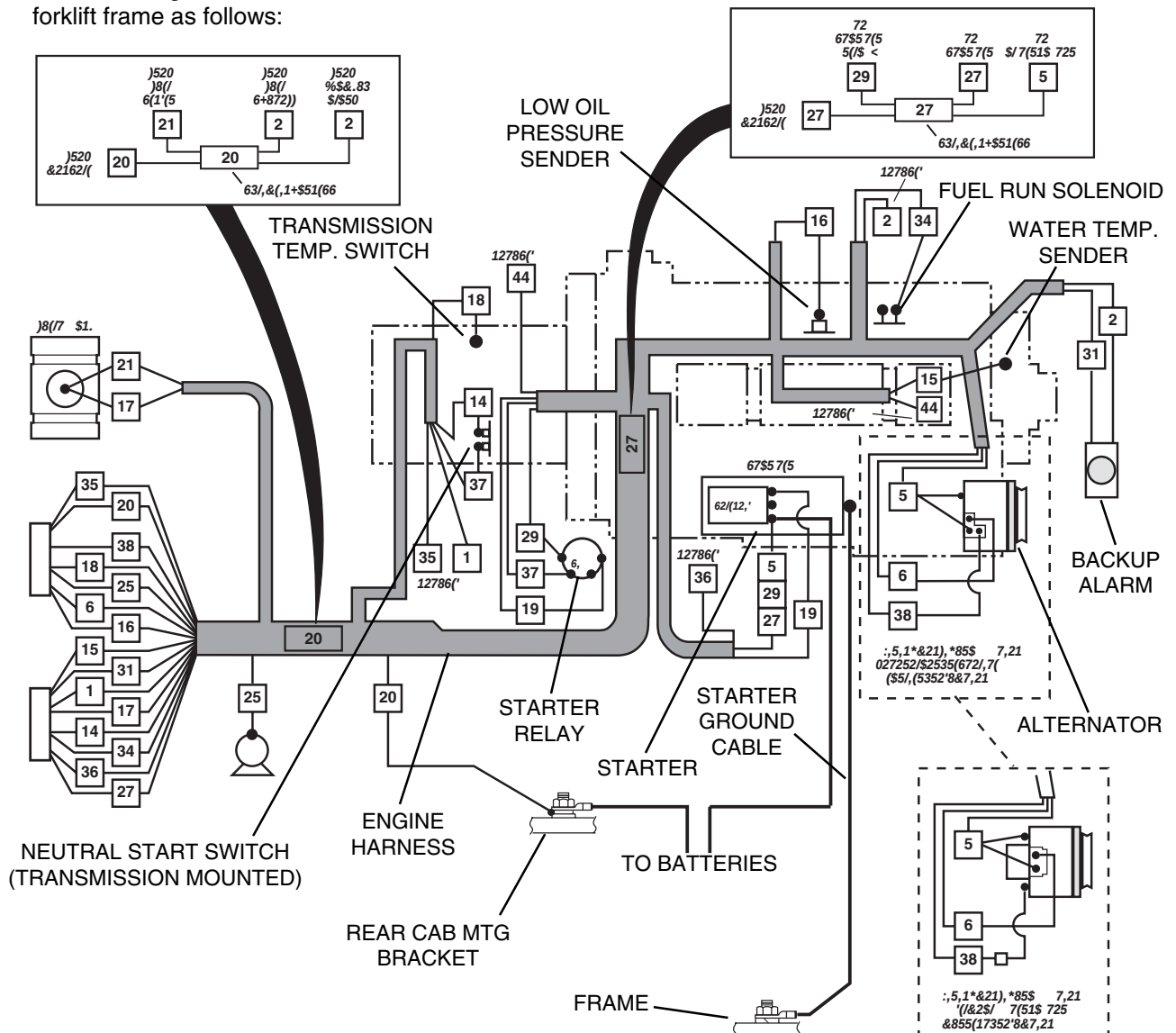


Fig. 8B.46 Engine Harness Connections

MA6010

- (d) Secure the engine mount to the frame with a capscrew, vibration mount, rebound washer, and locknut. Torque to 225 to 275 lb-ft (305 to 373 Nm).

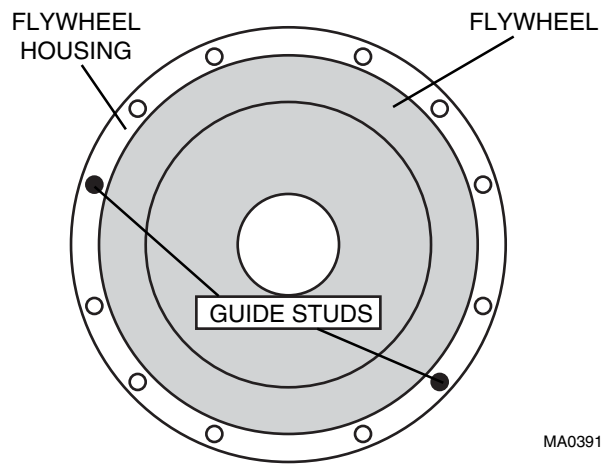
- (f) Remove the engine hoist.

12. Attach the main pump to the transmission.

13. Secure transmission drive shaft to transmission with U-bolt or bearing strap. Torque U-bolt to 20 to 24 lb-ft (27 to 32 Nm) or bearing strap to 55 to 60 lb-ft (75 to 81 Nm).

14. Install the transmission control cables as follows:

- (a) Place the transmission control valve spools in the center position.
- (b) Secure the control cables to the bracket being sure to have the clamp and cable grooves aligned.
- (c) Position swivel and lock nut on rod end as shown in Fig. 4.4. Tighten the locknut.
- (d) Be sure the shifter levers are in the center or middle position.
- (e) Reposition the swivel and lock nut so it aligns with its hole in the swivel linkage control arm.
- (f) Secure the swivel to the control arm with cotter pin.



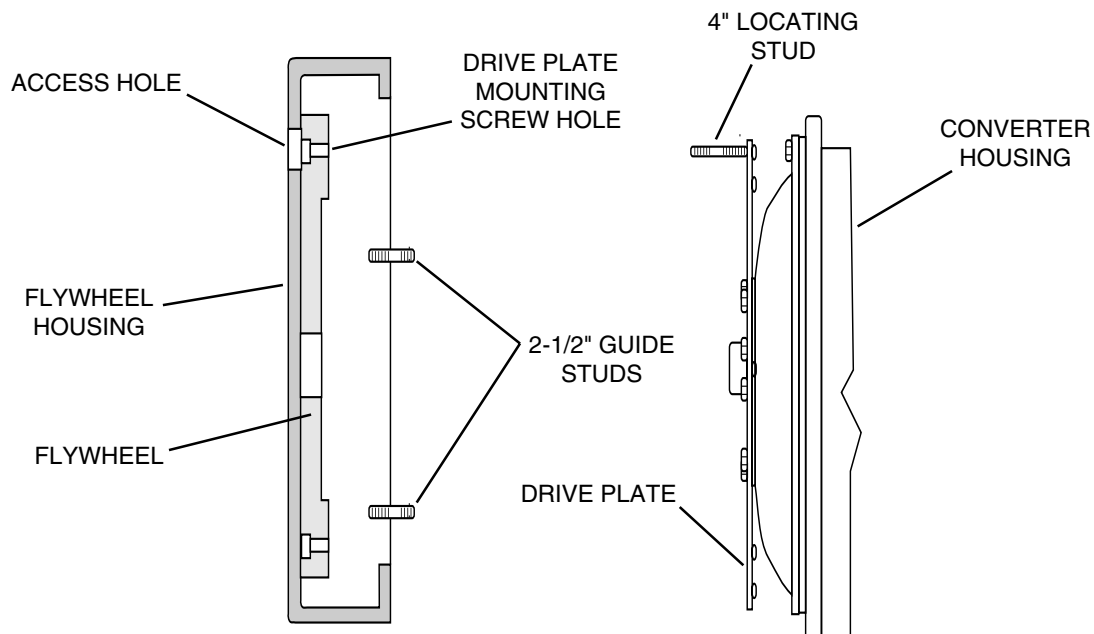
MA0391

Fig. 8B.47 Guide Studs

15. Attach the throttle control cable to the engine fuel injection pump as follows:

- (a) Fasten the throttle cable to the throttle cable bracket with a clamp being sure to align the grooves in the cable and clamp.
- (b) Secure the throttle cable clevis to the fuel injection pump throttle and stop lever with cotter and clevis pins. Adjust the clevis so that the lever touches the stop screw.

16. Connect the fuel lines to the fuel pre-filter and fuel filter assemblies.



MA0401

Fig. 8B.48 Locating Stud

17. Connect engine wire harness to the engine and transmission components, Fig. 8B.46:
 - Starter
 - Starter Ground Cable
 - Starter Relay
 - Neutral Start Switch (on transmission)
 - Transmission Temperature Switch
 - Low Oil Pressure Sender
 - Water Temperature Sender
 - Fuel Run Solenoid
 - Alternator
18. Secure the rear support between the side frame members with ten capscrews, lock-washers, and hex nuts. Torque to 225 to 275 lb-ft (305 to 373 Nm).
19. Connect the wiring to the backup alarm.
20. Attach the exhaust system to the engine.
21. Install the air cleaner system on the rear support and connect the hoses.
22. Install the radiator overflow bottle.
23. Install the radiator, hoses, and shroud.
24. Connect the radiator hoses to the engine.
25. Fill the radiator as follows:
 - (a) Be sure the radiator petcock is closed and the engine cylinder block drain plug is installed.
 - (b) Fill the radiator completely with 50/50 mixture of ethylene glycol and water. Capacity is 5.4 gallons (20,4 liters).
 - (c) Replace radiator cap.
 - (d) Add coolant to the overflow bottle until it is about 1/4 to 1/2 full — approximately 1 quart (0,95 liter).
 - (e) Clean dirt and debris from radiator fins and core. Remove rear radiator cover for access to radiator.
26. Install the transmission oil cooler on the rear support and connect it to the transmission.
27. Fill the transmission as follows:
 - (a) Install a cleaned drain plug, screen and gasket, Fig. 7.1, into the transmission sump housing.
 - (b) Fill transmission with MIL-L-2104C Oil to LOW mark on dipstick, Fig. 7.6.
28. Install the radiator cover.
29. Install counterweight on the rear of the frame.
30. Check the fluid levels as follows:
 - (a) Start the engine and allow it to heat to operating temperature. Do not operate engine for more than two minutes.
 - (b) **Shut the engine off**, wait for engine to cool, and check the coolant level. Top it off as required by adding coolant through the overflow bottle.
 - (c) Be sure the engine oil level is within the crosshatched area. If it is below the crosshatched area, add a high quality multi-grade motor oil equal to API, CD or CE (severe duty diesel engine) specifications as outlined in paragraph 8B.8. Engine crankcase capacity is 11.5 quarts (10,9 liters) with a filter change.
 - (d) Check the transmission oil level. If it is below the add mark, add MIL-L-2104C Oil to bring it to the full mark on the dipstick. Transmission capacity is 4.3 gallons (16,3 liters).
31. Install the transmission cover and close and lock both engine access doors.

8B.16 ENGINE STORAGE

Use the following procedures immediately when engine is removed from service for an extended period.

1. Clean outside of engine.
2. Where a preservative fuel is to be used, drain the fuel system and fill with the preservative fuel. If preservative fuel is not used, the system can be kept charged with normal fuel but this will have to be drained and discarded at the end of the storage periods together with the fuel filter.
3. Run the engine until it is warm. Correct any fuel, lubricating oil or air leakage. Stop the engine and drain the lubricating oil sump.
4. Replace the lubricating oil filter canister.
5. Fill the sump to the FULL mark on the dip stick with clean new lubricating oil or with an approved preservative fluid. If a preservative fluid is used, this must be drained and normal lubricating oil used when the engine is returned to service.

6. Drain the cooling system as described in paragraph 8B.7.5. To give protection against corrosion, it is better to fill the cooling system with a coolant that has a corrosion inhibitor (see paragraph 8B.9.1). If frost protection is needed, use an antifreeze mixture. If no frost protection is needed, use water with an approved corrosion inhibitor mixture.
7. Run the engine for a short period to send the lubricating oil and coolant around the engine.
8. Clean out the engine breather pipe (where fitted) and seal the end of the pipe.
9. Remove the fuel injectors and spray clean engine lubricating oil into cylinder bores, 1/4 pint (118,3 ml) of lubricating oil divided evenly between the four cylinders.
10. Remove the air filter and any pipe installed between the air filter and induction manifold. Seal the manifold with waterproof tape.
11. Remove the exhaust pipe. Seal the manifold with waterproof tape.
12. Disconnect the batteries and put them into safe storage in a fully charged condition. Before the batteries are put into storage, give the battery terminals a protection against corrosion.
13. Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.
14. Remove the fan belt and put it into storage.

NOTE: Before the engine is started after a period in storage, operate the starter motor with one of the fuel run solenoids wires disconnected until oil pressure shows on the oil pressure gauge or the warning light goes out.

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Cummins Engine Company, Inc. and JLG are not responsible for any damage that occurs in relation to a service storage period.

8B.17 TROUBLESHOOTING

Trouble	Possible Causes (see Key)
Low Cranking Power	1, 2, 3, 4
Will Not Start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33
Difficult Starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33
Lack of Power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 61, 63
Misfiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32
Excessive Fuel Consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33, 63
Black Exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33, 61, 63
Blue/White Exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56, 62
Low Oil Pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59
Erratic Running	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49
High Oil Pressure	4, 38, 41
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57
Excessive Crankcase Pressure	25, 31, 33, 34, 45, 55, 60
Poor Compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59
Starts and Stops	10, 11, 12

Key to Troubles

- | | | |
|---|--|---|
| 1. Battery capacity low | 23. Sticking throttle or restricted movement | 44. Choked oil filter |
| 2. Bad electrical connection | 24. Exhaust pipe restriction | 45. Piston seizure / pick up |
| 3. Faulty starter motor | 25. Leaking cylinder head gasket | 46. Incorrect piston height |
| 4. Incorrect grade of lubricating oil | 26. Overheating | 47. Damaged fan |
| 5. Low cranking speed | 27. Cold running | 48. Faulty engine mounting |
| 6. Fuel tank empty | 28. Incorrect tappet adjustment | 49. Incorrectly aligned flywheel housing, or flywheel |
| 7. Faulty stop control operation | 29. Sticking valves | 50. Faulty thermostat |
| 8. Blocked fuel feed line | 30. Incorrect high pressure pipes | 51. Restriction in water jacket |
| 9. Faulty fuel lift pump | 31. Worn cylinder bores | 52. Loose fan belt |
| 10. Choked fuel filter | 32. Pitted valves and seats | 53. Choked radiator |
| 11. Restriction in air cleaner | 33. Broken, worn or sticking piston ring(s) | 54. Faulty water pump |
| 12. Air in fuel system | 34. Worn valve stems and guides | 55. Choked breather pipe |
| 13. Faulty fuel injection pump | 35. Overfull air cleaner | 56. Damaged valve stem oil deflectors (if fitted) |
| 14. Faulty fuel injectors or incorrect type | 36. Worn or damaged bearings | 57. Coolant level too low |
| 15. Incorrect use of cold start equipment | 37. Insufficient oil in sump | 58. Blocked sump strainer |
| 16. Faulty cold start equipment | 38. Inaccurate gauge | 59. Broken valve spring |
| 17. Broken fuel injection pump drive | 39. Oil pump worn | 60. Exhauster or vacuum pipe leak |
| 18. Incorrect fuel pump timing | 40. Pressure relief valve sticking open | 61. Turbo impeller damaged or dirty |
| 19. Incorrect valve timing | 41. Pressure relief valve sticking closed | 62. Turbo lubricating oil seal leak |
| 20. Poor compression | 42. Broken relief valve spring | 63. Induction system leaks (turbocharged engines) |
| 21. Blocked fuel tank vent | 43. Faulty suction pipe | |
| 22. Incorrect grade of fuel | | |

Notes

SECTION 9 HYDRAULIC SYSTEM

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9.1 SYSTEM OPERATION

There are two different types of operator control systems available on this machine for actuating main boom functions. The systems are Cable Control and Electronic Control. Each use a different main control valve and joystick to actuate the raise/lower and extend/retract boom functions.

NOTE: Refer to the 6036B Hydraulic Schematics in Troubleshooting, paragraph 9.8, for overall diagrams.

9.2 MAIN CONTROL VALVE OPERATION CABLE CONTROL

9.2.1 Control Valve

The control valve has four sections – inlet, outlet and two parallel working sections, one for raise/lower and one for extend/retract, Fig. 9.3. The working sections are mounted between the inlet and outlet sections to form a valve stack. The supply pressure passages are common in the stack as are the return to reservoir and pilot pressure passages.

a. Inlet Section

The inlet section of the control valve contains:

- An inlet port for the hydraulic oil to enter the control valve from the 30 gpm section (rear half) of the tandem pump.

- A pilot-operated main relief valve, set at 2700 -100/+150 psi (186 -6,9/+10,3 bar).

b. Relief Valve Operation

Fluid at supply pressure is admitted to the relief area, Fig. 9.1, of the valve through a hole in the piston. Initially, the pilot poppet, relief valve poppet and check valve poppet are seated.

The relief valve setting is determined by the compression of the pilot spring as set by the adjustment screw. When the pressure exceeds the relief setting, the pilot poppet acts against the poppet spring to unseat. The fluid then flows around the pilot poppet through cross-drilled holes in the plug to the reservoir; some pressure is relieved.

Due to the reduced pressure, the piston seats against the pilot poppet. This shuts off fluid flow through the valve and causes a low pressure area internally. The differential pressure between the supply pressure and the internal pressure causes the relief valve poppet to unseat and fluid flows to the reservoir thus relieving the pressure.

If low supply pressure should occur due to pump cavitation, the check valve poppet will unseat and allow fluid to flow back to the supply from the reservoir.

Refer to each circuit for information on each relief valve function and testing.

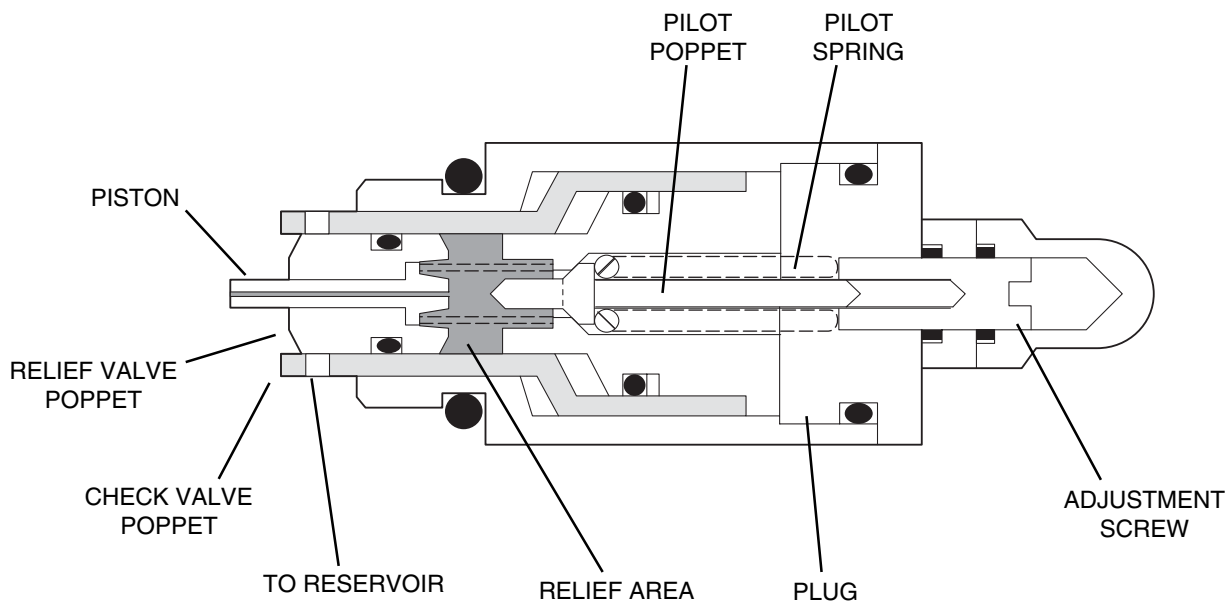
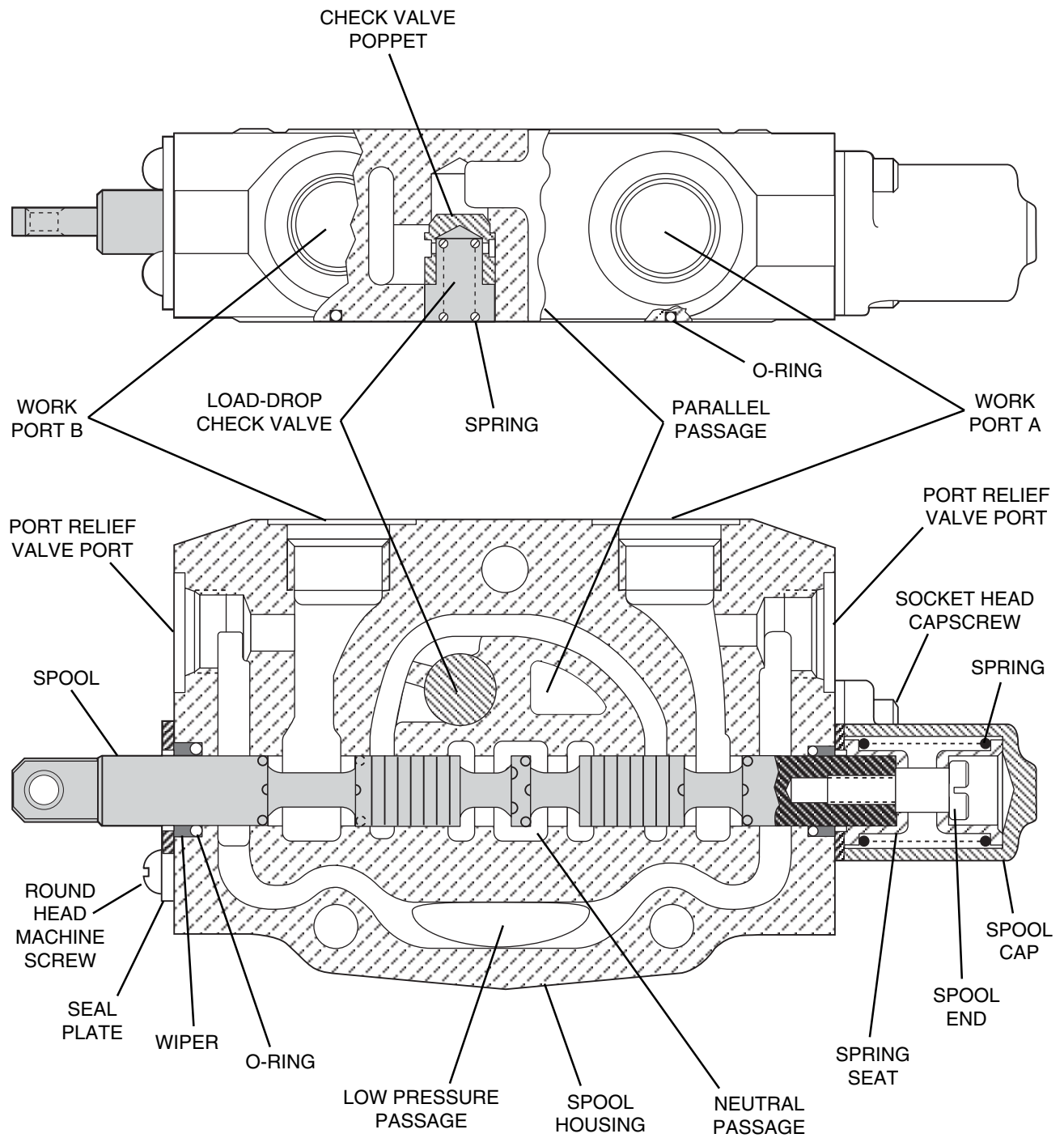


Fig. 9.1 Relief Valve (Sectional View)

MA0652



MA2080

Fig. 9.2 Parallel Working Section (Sectional View)

c. Working Sections

There are two parallel working sections of the control valve, Fig. 9.2, one for controlling the boom raise/lower function and one for controlling the boom extend/retract function, Fig. 9.3.

The boom raise/lower working section contains:

- A spring centered spool that is shifted by the operator joystick and its associated cable that directs the hydraulic oil. Function and operation of the spool is explained in the raise/lower circuit, paragraph 9.2.2.
- A load-drop check valve to prevent a load from dropping when the operating spool is shifted.
- Two work ports that allow the hydraulic oil to flow to and from the cylinders.
- One port relief valve, set at 2850 ± 50 psi ($196,4 \pm 3,4$ bar). Function of the relief valve is explained in the boom raise/lower circuit, paragraph 9.2.2. Operation of the valve is explained in paragraph 9.2.1.b.

The boom extend/retract working section contains:

- A spring centered spool that is shifted by the operator joystick and its associated cable that directs the hydraulic oil. Function and operation of the spool is explained in the extend/retract circuit, paragraph 9.2.3.
- A load-drop check valve to prevent a load from dropping when the operating spool is shifted.
- Two work ports that allow the hydraulic oil to flow to and from the cylinders.
- Two port relief valves, set at 2850 ± 50 psi ($196,4 \pm 3,4$ bar). Function of the relief valves is explained in the boom extend/retract circuit, paragraph 9.2.3. Operation of the valves is explained in paragraph 9.2.1.b.



Warning

- If anyone is injured by or if any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.
- Wear appropriate eye protection. Hydraulic fluid can cause permanent eye injury. Do not wear loose fitting clothing when servicing the forklift.

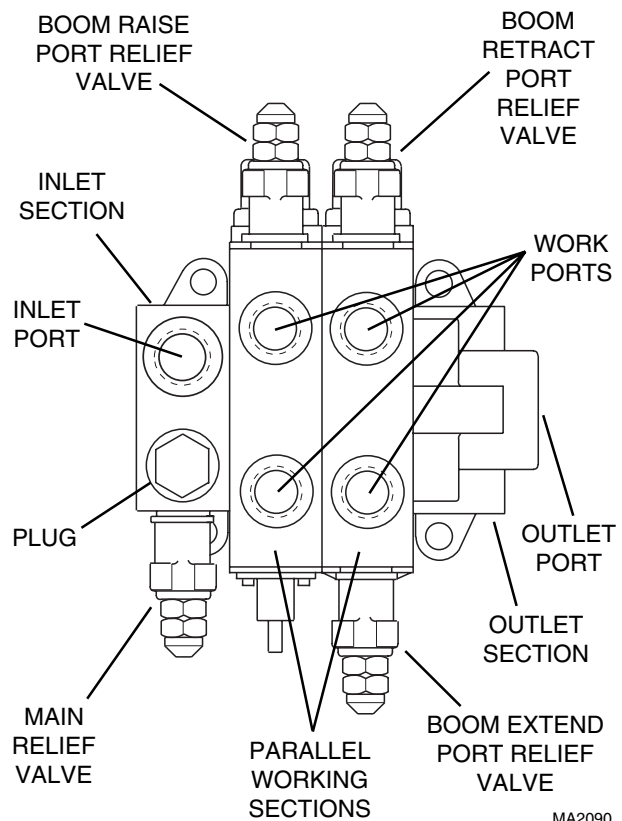


Fig. 9.3 Main Control Valve (Cable Control)

d. Outlet Section

The outlet section is an end cover where the outlet port is located on the side of the cover, Fig. 9.3.

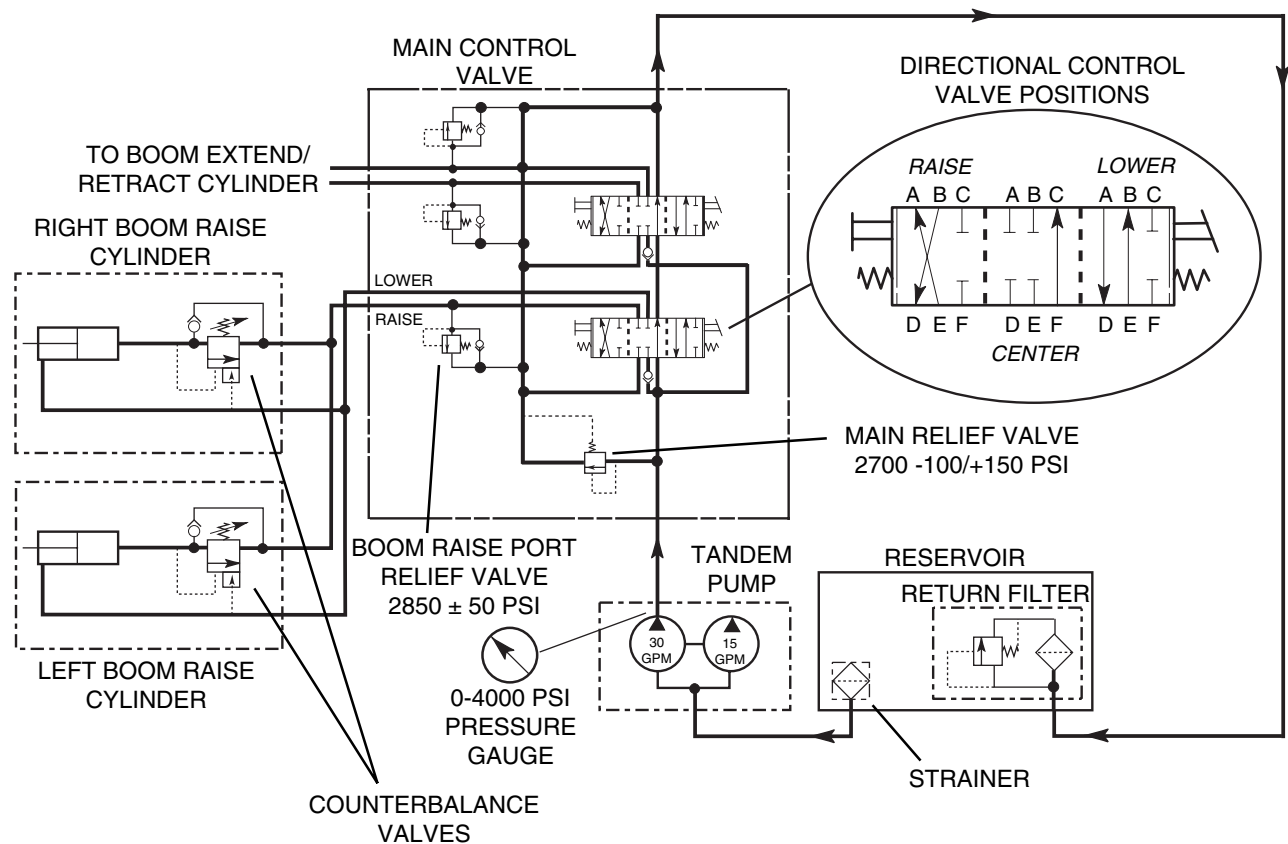
9.2.2 Boom Raise/Lower Circuit

a. Description

Hydraulic pressure is applied in the boom raise/lower circuit by the 30 gpm section (rear half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.4. Supply pressure is directed to either side of the right and left boom hoist cylinder pistons, by the shifting of a spool in a directional control valve found in the main control valve assembly. The spool is shifted by the **operator joystick** and its associated control cable. The joystick positions for raising and lowering the boom are as follows:

Center Position

When the joystick is placed in the center or neutral position, the directional control valve spool is positioned so that supply pressure is directed through ports F to C, Fig. 9.4, to the return filter and reservoir, Fig. 9.4. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).



MA3000

Fig. 9.4 Cable Control Boom Raise/Lower Circuit

Raise Position

When the joystick is placed in the raise position, the directional control valve spool is shifted so that supply pressure is directed through ports E to A, Fig. 9.4, to the base end of both left and right boom hoist cylinder pistons. If supply pressure reaches 2850 psi (196,4 bar), the **boom raise port relief valve**, Fig. 9.4, will open allowing hydraulic oil to return to the reservoir.

Return oil from the top end of the boom raise cylinder piston is directed back to the directional control valve through ports B to D, Fig. 9.4, to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar)

Lower Position

When the joystick is placed in the lower position, the directional control valve spool is shifted so that supply pressure is directed through ports E to B, Fig. 9.4, to the rod (top) end of both left and right boom hoist cylinder pistons. This supply pressure also pilots open the **counterbalance valve**, Fig. 9.4. The open counterbalance valve allows return oil from the base end of the cylinder to return through ports A to D, Fig. 9.4, of the directional control valve to the **return filter** and **reservoir**. If supply pressure reaches 2700 -100/+150 psi (186 -6,9/+10,3 bar), the **main relief valve**, Fig. 9.4, will open, allowing hydraulic oil to return to the reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

The counterbalance valve in each boom hoist cylinder serves another main function for safety purposes. This function can be described as follows:

- Should any of the hydraulic lines going to either hoist cylinder fail, there will be a loss of hydraulic system pressure to the cylinder(s). *Example:* If there was a hydraulic line failure in the pressurized lowering line during lowering, the counterbalance valve would lose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped, which would immediately stop boom lowering and prevent an elevated load from falling to the ground uncontrolled. The load can be lowered safely to the ground by following the "Emergency Boom Lowering" procedures in your Owners/Operators Manual.

IMPORTANT: *DO NOT attempt to reset the counterbalance valve cartridges. In the event that the counterbalance valve cartridges were disabled for emergency boom lowering or any unauthorized adjustments are ever made to these cartridges, remove and replace both cartridges with new parts. Failure to replace these cartridges with new parts may alter the holding characteristics of the counterbalance valves creating an unsafe condition for machine operation.*

b. Pressure Checks and Adjustments

Main Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Raise and lower the boom fully several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the "lower" position and hold until the hoist cylinders have fully retracted. Continue holding the joystick in the "lower" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2700 -100/+150 psi (186 -6,9/+10,3 bar). If not, adjust the main relief valve, Fig. 9.3, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Raise and lower the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

Boom Raise Port Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
3. Remove the transmission cover from the frame.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.4.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Raise and lower the boom fully several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the "raise" position and hold until the hoist cylinders have fully extended. Continue holding the joystick in the "raise" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2850 ± 50 psi ($196,4 \pm 3,4$ bar). If not, adjust the boom hoist port relief valve, Fig. 9.3, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Raise and lower the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

c. Testing

The boom raise/lower circuit should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.

2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Raise and lower the boom fully several times to purge the system of air if necessary.
4. Starting with the boom fully retracted and at its lowest position, raise the boom at full engine speed. The time required for full raise should be less than 15 seconds (no load).
5. Starting at the fully raised position, lower the boom at full engine speed. The time required to lower the boom to its lowest position should be less than 10 seconds (no load).
6. Repeat steps 4 and 5 to recheck performance.
7. If the boom raise/lower circuit test does not meet performance requirements, locate the cause of the problem (refer to Troubleshooting, paragraph 9.8) and correct before putting the vehicle into service.

9.2.3 Boom Extend/Retract Circuit

a. Description

Hydraulic pressure is applied in the boom extend/retract circuit by the 30 gpm section (rear half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.5. Supply pressure is directed to either side of the extend/retract cylinder piston by the shifting of a spool in a directional control valve found in the main control valve assembly. The spool is shifted by the **operator joystick** and its associated control cable. The joystick positions for extending or retracting the boom are as follows:

Center Position

When the joystick is placed in the center or neutral position, the directional control valve spool is positioned so that supply pressure is directed through ports F to C, Fig. 9.5, to the **return filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

Extend Position

When the joystick is placed in the extend position, the directional control valve spool is shifted so that supply pressure is directed through ports E to A, Fig. 9.5, to the base end of the boom extend cylinder piston. If supply pressure reaches 2850 ± 50 psi ($196,4 \pm 3,4$ bar), the **boom extend port**

relief valve, Fig. 9.5, will open allowing hydraulic oil to return to the reservoir.

Return oil from the rod side of the extend cylinder piston is directed back to the directional control valve through ports B to D, Fig. 9.5, to the **return filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Retract Position

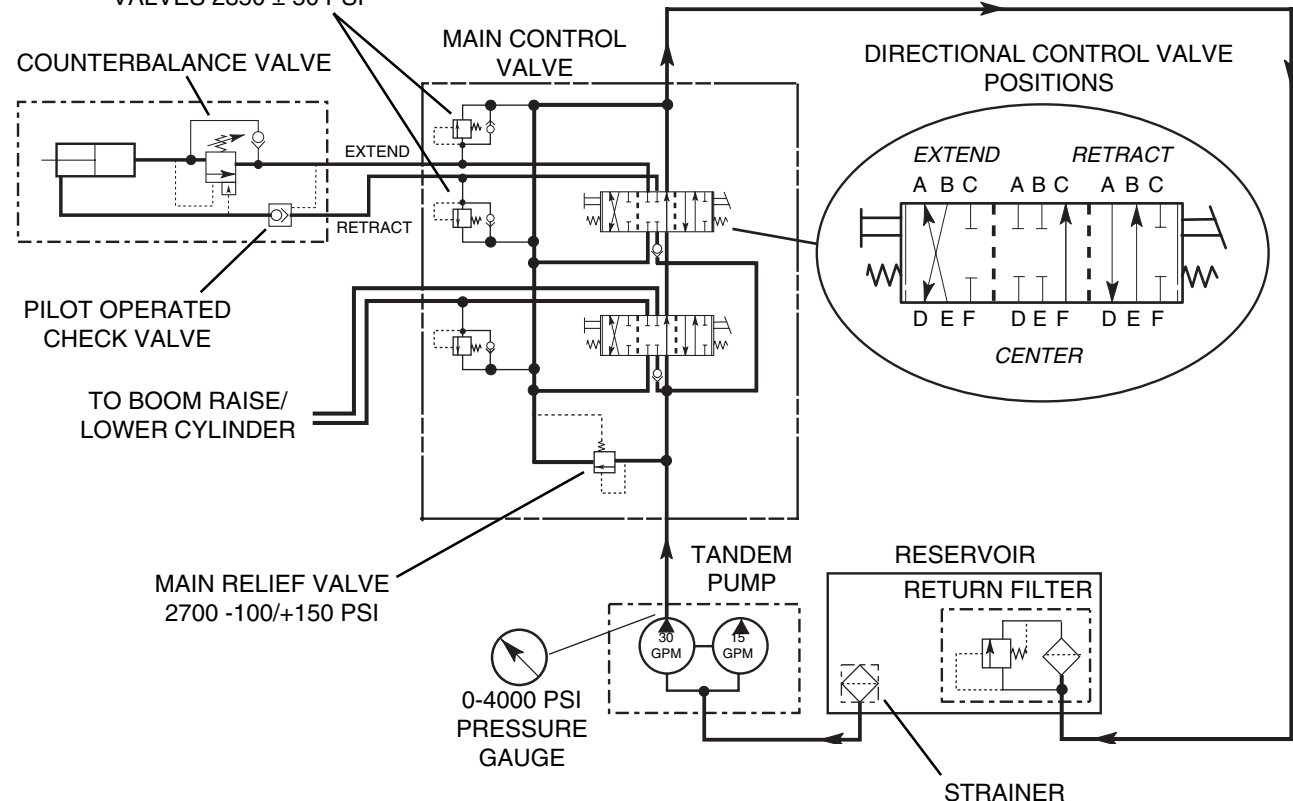
When the joystick is placed in the retract position, the directional control valve spool is shifted so that supply pressure is directed through ports E to B, Fig. 9.5, to the rod side of the boom extend cylinder piston. This supply pressure also pilots the **counterbalance valve**, Fig. 9.5. The open counterbalance valve allows return oil from the base end of the cylinder to return through ports A to D, Fig. 9.5, of the directional control valve to the **return filter** and **reservoir**. If supply pressure reaches 2850 psi (196,4 bar), the **boom retract port relief valve**, Fig. 9.5, will open allowing hydraulic oil to return to the reservoir. If the return

filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

The **counterbalance valve** in the extend cylinder serves two other main functions. One prevents component damage and the other is for safety. These functions can be described as follows:

- If the machine is traveling and the boom runs into an immovable object, pressure will build up on the base end of the cylinder. If the counterbalance valve was not installed, the rod of the cylinder would bend damaging the cylinder. With the counterbalance valve installed the pressure will build up until it reaches 2000 psi (137,8 bar) and then the counterbalance valve will be internally piloted open allowing the pressure to return to the reservoir. This condition will only exist if the cylinder has been extended. If the cylinder is already fully retracted the counterbalance valve will have no effect and the cylinder rod will bend.

BOOM EXTEND/RETRACT PORT RELIEF VALVES 2850 ± 50 PSI



MA3010

Fig. 9.5 Boom Extend/Retract Circuit

- Should any of the hydraulic lines going to the extend cylinder fail, there will be a loss of hydraulic system pressure to the cylinder. *Example:* If there was a hydraulic line failure in the pressurized retract line during retracting, the counterbalance valve would lose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped which would immediately stop boom retraction preventing an elevated load from retracting uncontrolled. The load can be lowered safely to the ground by following the "Emergency Boom Lowering" procedures in your Owners/Operators Manual.

IMPORTANT: DO NOT attempt to reset the counterbalance valve cartridge. In the event that the counterbalance valve cartridge was disabled for emergency boom lowering or any unauthorized adjustments are ever made to this cartridge, remove and replace the cartridge with a new part. Failure to replace this cartridge with a new part may alter the holding characteristics of the counterbalance valve creating an unsafe condition for machine operation.

b. Pressure Checks and Adjustments

Boom Extend Port Relief Valve

- Engage the park lock, place the travel select lever in neutral, level the boom and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

- Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

- Remove the transmission cover from the frame.
- Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.5.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

- Start the engine. Extend and retract the boom several times to purge the system of air.
- Depress the accelerator to full throttle. Place the joystick in the "extend" position and hold until the extend cylinder has fully extended. Continue holding the joystick in the "extend" position until the pressure readings are taken.
- Check the pressure gauge reading. It should read 2850 ± 50 psi ($196,4 \pm 3,4$ bar). If not, adjust the boom extend port relief valve, Fig. 9.3, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
- Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
- Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
- Start the engine. Extend and retract the boom fully several times to purge the system of air.
- Install the transmission cover after adjustment.

Boom Retract Port Relief Valve

- Engage the park lock, place the travel select lever in neutral, level the boom and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

- Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0 - 4000 psi (275,6 bar) in the tandem pump outlet of the 30 gpm section, Fig. 9.5.
5. Start the engine. Extend and retract the boom several times to purge the system of air.
6. Depress the accelerator to full throttle. Place the joystick in the "retract" position and hold until the extend cylinder has fully retracted. Continue holding the joystick in the "retract" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2850 ± 50 psi ($196,4 \pm 3,4$ bar). If not, adjust the boom retract port relief valve, Fig. 9.3, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Extend and retract the boom fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

c. Testing

The boom extend/retract circuit should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Extend and retract the boom several times to purge the system of air.
4. Starting with the boom fully retracted and level, extend the boom at full engine speed. The time required for full extension should be less than 15 seconds (no load).
5. Starting at the fully extended position, retract the boom at full engine speed. The time required to retract the boom fully should be less than 15 seconds (no load).

6. Repeat steps 4 and 5 to recheck performance.
7. If the boom extend/retract circuit test does not meet performance requirements, locate the cause of the problem (refer to Troubleshooting, paragraph 9.8) and correct before putting the vehicle into service.

9.3 MAIN CONTROL VALVE OPERATION ELECTRONIC CONTROL

9.3.1 Electronic

Refer to Section 10, Electrical System.

9.3.2 Control Valve

The control valve has four sections – inlet, outlet and two working sections, one for raise/lower and one for extend/retract, Fig. 9.6. The working sections are mounted between the inlet and outlet sections to form a valve stack. The supply pressure passages are common in the stack as are the return to reservoir and pilot pressure passages.

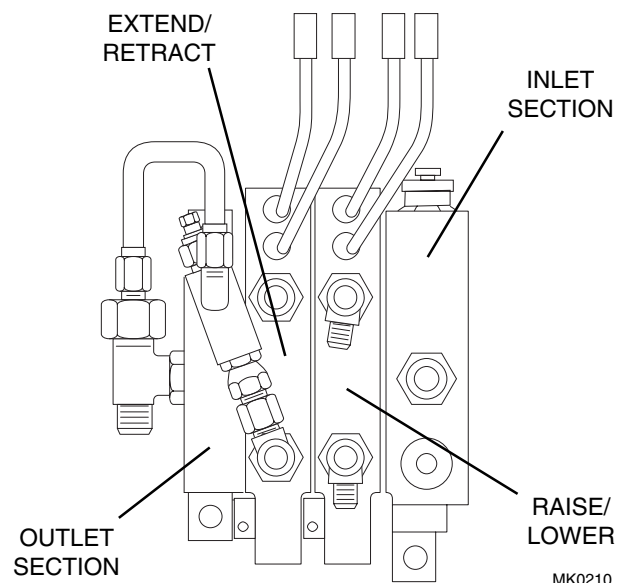


Fig. 9.6 Main Control Valve (Electronic Control)

a. Inlet Section

The inlet section of the control valve contains:

- Pressure reducing valve to supply 200 psi (13,8 bar) pilot pressure to the pulsar solenoids in the working sections.
- A 43 micron stainless steel wire cloth filter for the pilot pressure.
- Pressure compensated flow control valve with pilot-operated relief valve (paragraph b).

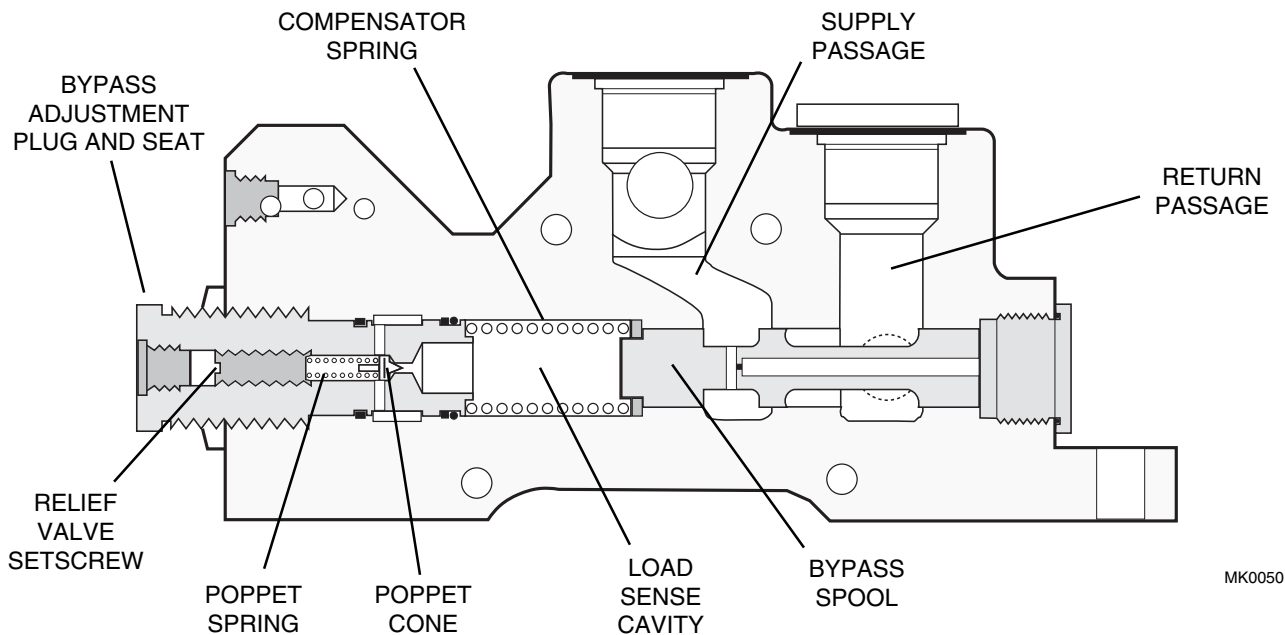


Fig. 9.7 Inlet Section - Sectional View

b. Inlet Unloading Pressure Compensation and Relief

The inlet section bypass spool, Fig. 9.7, is balanced between the system pressure and the load plus spring force pressures. Under static conditions the valve remains closed until the supply oil pressure in the supply passage reaches approximately 200 psi (13,8 bar) and overcomes the compensator spring force. This shifts the spool to open the valve and bypass the oil to return. When a working section is actuated, the combined compensator spring force and load pressure in the load sense cavity shift the bypass spool to close the valve. The spool will shift to open the valve and bypass excess oil to the reservoir once the working sections are supplied with the selected flow rate at the required pressure. Pressure supplied to the working sections is 200 psi (13,8 bar) over load pressure. The bypass pressure can be adjusted with the adjustment plug and seat.

The pilot-operated relief valve maintains load pressure at a preset maximum allowable value. Whenever the load pressure exceeds the poppet spring force, the poppet cone, Fig. 9.7, will unseat causing the bypass spool to relieve flow to the reservoir. The relief valve setting can be adjusted with the setscrew. Refer to paragraph 9.6.2.m for control valve adjustments.

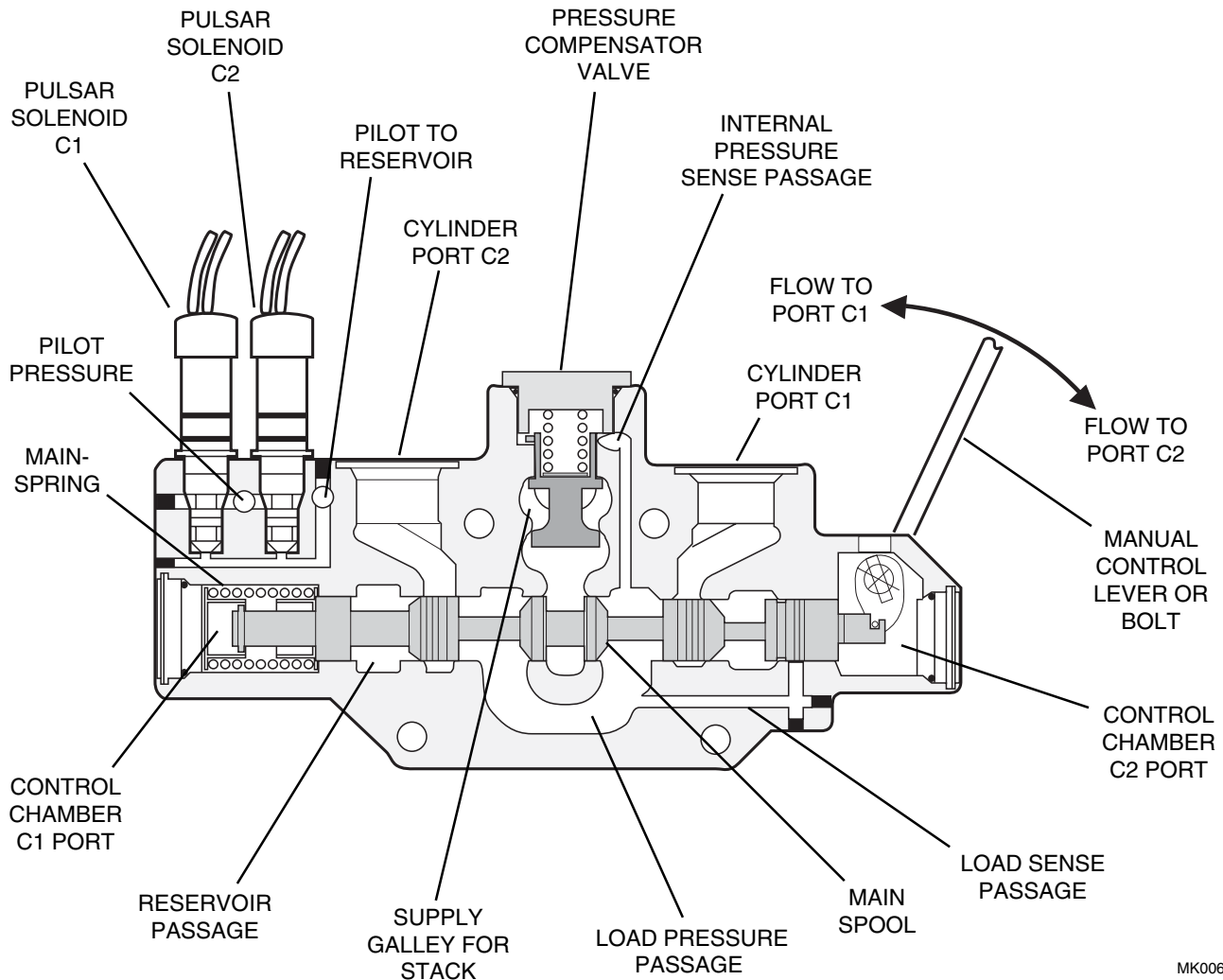
c. Working Sections - Main Spool Control

Pilot pressure is supplied to two pulsar solenoids, Fig. 9.8, in the pilot stage of each working section. The main spool in the main stage is actuated by

either of the two pulsar solenoids, one for each function. The pulsar solenoids are energized 33 times per second by PWM signals from the controller to generate control pressure which is proportional to the PWM on-off cycle, Fig. 9.8. The pulsar solenoids are fitted with matched orifice plates and seals at the return. Oil leaving a pulsar solenoid is restricted by the orifice plate to result in proportional back pressure which is applied to either end of the main spool in the corresponding control chamber.

The position of the main spool is determined by the centering spring and the differential pressure between the two chambers at either end of the spool. In the static condition there is no differential pressure, the main spool is centered, there is no flow at the cylinder ports, and the reservoir and cylinder pressure passages are at reservoir pressure. If no PWM signals are sent to the pulsar solenoids, both valve sections are static, load sensing pressures are vented back to the reservoir, and the inlet compensator valve flow is bypassed to the reservoir at approximately 200 psi (13,8 bar).

When one of the pulsar solenoids is energized by PWM signals, control pressure is applied to one of the control chambers. The differential pressure between the chambers shifts the main spool to allow oil flow across the spool lands to the corresponding cylinder port. Initial metered oil flow occurs at 60 psi (4,1 bar) differential pressure with full flow at 132 psi (9,1 bar). Unused oil is bypassed to the reservoir at approximately 200 psi (13,8 bar) over load pressure.



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Fig. 9.8 Control Valve Working Section - Sectional View

The main spools in the working sections are designed for special flows. The metering lands for both main spools have dual profile angles. This allows proportionally more flow at lower operation speeds and better control overall. The main spools for the extend/retract section also permit greater flow for boom extension versus boom retraction; the ratio is approximately 2 to 1. All main spools are spring loaded to be self-centering.

d. Working Sections - Individual Pressure Compensation

Each working section of the control valve incorporates an individual compensator valve, Fig. 9.9, to

isolate the section from interference as supply or load pressure changes. Under static conditions the supply oil in the supply pressure passage acts against the compensator spring which keeps the valve closed. Whenever the main spool is shifted, the combined spring pressure and load pressure in the internal sensing passage open the compensator spool. Oil flow over the compensator spool land stabilizes when the pressure across the main spool metering land and pressure of the compensator spring are equal. An increase in supply pressure acts on the compensator spool and spring to close the spool and maintain constant oil flow. A decrease in supply pressure acts on the compensator spool and spring to open the spool and maintain constant oil flow.

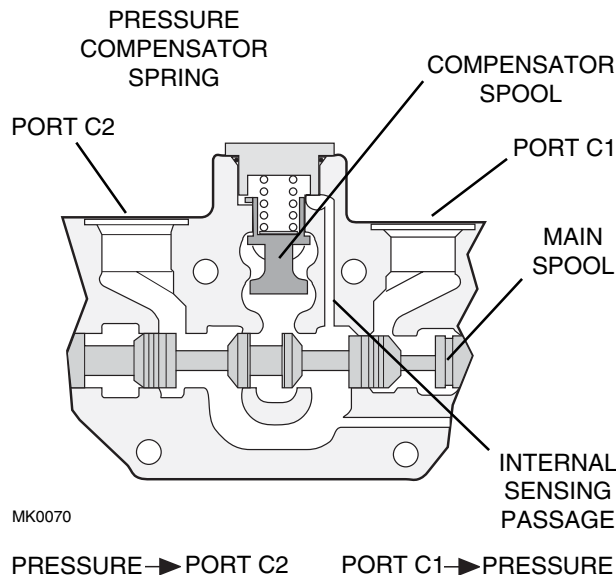


Fig. 9.9 Working Section Compensator Valve with Spool Shifted - Sectional View

e. Manual Override

Working sections can be operated manually using a ball-handle rod, or if not available, a 3/8-16 threaded rod or bolt, Fig. 9.8. This is very useful for checking valve operation or for use in emergency boom operation. The main spool can be shifted 0.25" (6,4 mm) which is equivalent to 22-1/2 degrees of rod movement. The rod is threaded into an adapter which is linked to the main spool through a pivot shaft and clevis. Details of the override arrangement are shown in Fig. 9.42.

f. Outlet Section

The outlet section of the control valve acts as an end cover and manifold for the valve stack. Details of the outlet section arrangement are shown in Fig. 9.40.

9.3.3 Boom Raise/Lower Circuit

a. Description

Hydraulic pressure is applied in the boom raise/lower circuit by the 30 gpm section (rear half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.10. The supply pressure enters the inlet section and is directed to the pilot valve filter, and through the supply passage to the raise/lower working section. When the supply pressure reaches 200 psi (13,8 bar), the **bypass (compensator) valve** opens to return. The inlet **relief valve** is set at 2650 psi (182,6 bar).

The **pilot valve** reduces the pressure to 200 psi (13,8 bar). This filtered supply is directed to the pilot stage and pulsar solenoids in the raise/lower working section.

All return oil flows to the **return filter** and **reservoir**. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

Center Position

When the joystick is placed in the center or neutral position, no PWM signals are sent to the raise or lower pulsar solenoid. The control valve spool is centered so that supply pressure is blocked at port P and supply pressure in the supply passage acts on the compensator spring to keep the valve closed. Load sensing pressure is vented back to the reservoir through the inlet relief valve, Fig. 9.10.

Raise Position

When the joystick is placed in the raise position, PWM signals are sent to the boom raise pulsar solenoid. The control valve spool is shifted so that supply pressure is directed through ports P to C1 to the base end of both left and right boom hoist cylinder pistons. Return oil from the rod end of the boom hoist cylinder pistons is directed back to the control valve through ports C2 to T and the return line to the filter and reservoir. If supply pressure reaches 2650 psi (182,6 bar), the inlet **relief valve** will open allowing hydraulic oil to return to the reservoir, Fig. 9.10.

NOTE: Shifting the raise/lower working section spool manually by moving the optional valve lever toward the control valve will also actuate the hoist cylinder to raise the boom.

Lower Position

When the joystick is placed in the lower position, PWM signals are sent to the boom lower pulsar solenoid. The control valve spool is shifted so that supply pressure is directed through ports P to C2 to the rod end of both left and right boom hoist cylinder pistons. This supply pressure also pilots open the **counterbalance valve**. The open counterbalance valve allows return oil from the base end of the hoist cylinders pistons to be directed back to the control valve through ports C1 to T and the return line to the filter and reservoir. If supply pressure reaches 2650 psi (182,6 bar), the inlet **relief valve** will open allowing hydraulic oil to return to the reservoir, Fig. 9.10.

NOTE: Shifting the raise/lower working section spool manually by moving the optional valve lever **away** from the control valve will also actuate the hoist cylinder to lower the boom.

The counterbalance valve in each boom hoist cylinder serves another main function for safety purposes. This function can be described as follows:

- Should any of the hydraulic lines going to either boom hoist cylinder fail, there will be a loss of hydraulic system pressure to the cylinder(s). *Example:* If there was a hydraulic line failure in the pressurized lowering line during lowering, the counterbalance valve would lose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder

would then be trapped, which would immediately stop boom lowering and prevent an elevated load from falling to the ground uncontrolled. The load can be lowered safely to the ground by following the “Emergency Boom Lowering” procedures in your Owners/Operators Manual.

IMPORTANT: DO NOT attempt to reset the counterbalance valve cartridges. In the event that the counterbalance valve cartridges were disabled for emergency boom lowering or any unauthorized adjustments are ever made to these cartridges, remove and replace **both** cartridges with new parts. Failure to replace these cartridges with new parts may alter the holding characteristics of the counterbalance valves creating an unsafe condition for machine operation.

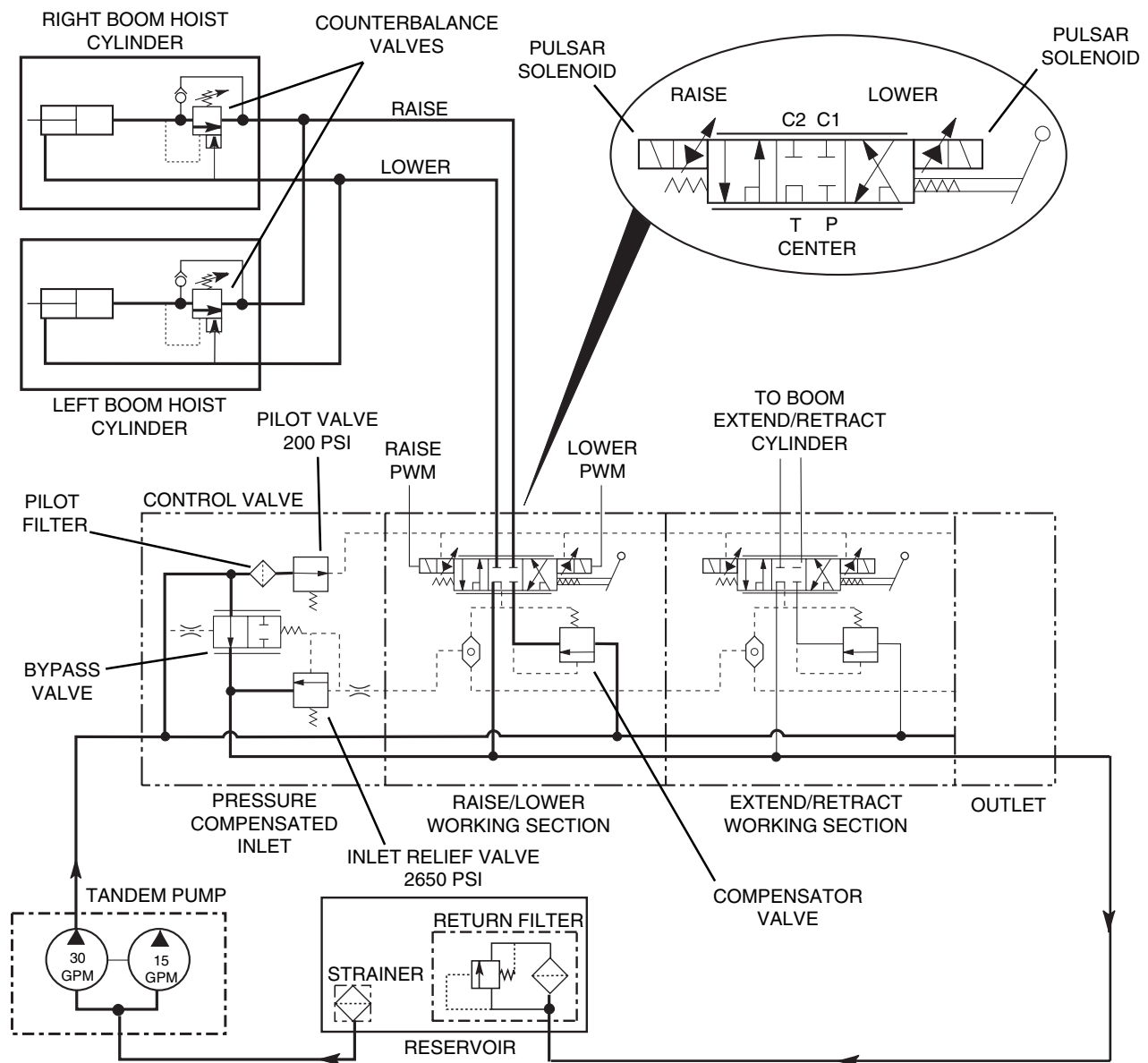


Fig. 9.10 Electronic Control Boom Raise/Lower Circuit

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b. Pressure Checks and Adjustments

Refer to paragraph 9.6.2.h for control valve pressure checks and adjustments.

9.3.4 Boom Extend/Retract Circuit

a. Description

Hydraulic pressure is applied in the boom extend/retract circuit by the 30 gpm section (rear half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.11. The supply pressure enters the inlet section and is directed to the pilot valve filter, and through the supply passage to the extend/retract working section. When the supply pressure reaches 200 psi (13,8 bar), the **bypass (compensator) valve** opens to bypass the oil to return. The inlet **relief valve** is set at 2650 psi (182,6 bar).

The **pilot valve** reduces the pressure to 200 psi (13,8 bar). This filtered supply is directed to the pilot stage and pulsar solenoids in the extend/retract working section.

All return oil flows to the **return filter** and **reservoir**. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

Center Position

When the joystick is placed in the center or neutral position, no PWM signals are sent to the extend or retract pulsar solenoid. The control valve spool is centered so that supply pressure is blocked at port P and supply pressure in the supply passage acts on the compensator spring to keep the valve closed. Load sensing pressure is vented back to the reservoir through the inlet relief valve.

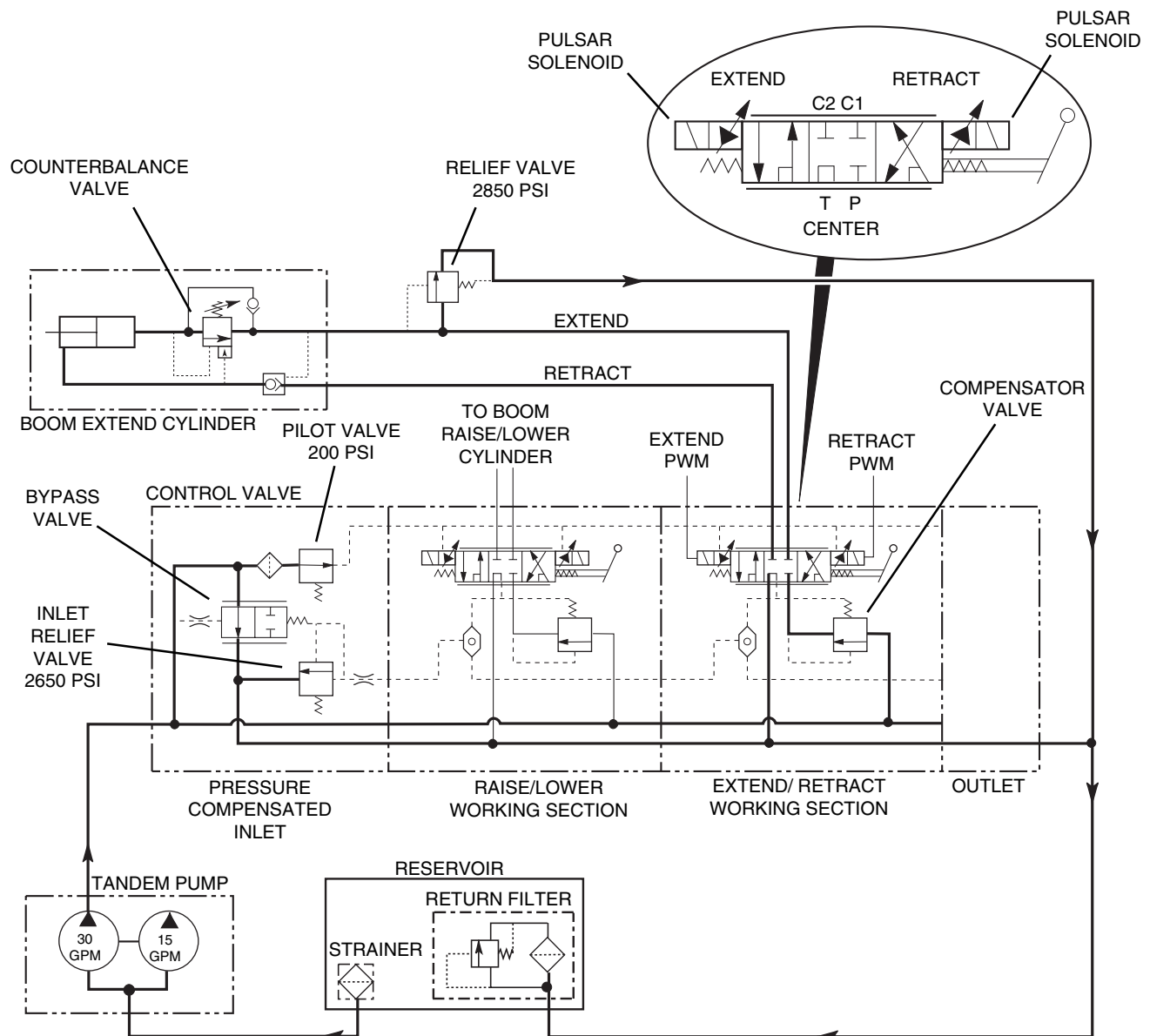


Fig. 9.11 Electronic Control Boom Extend/Retract Circuit

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Extend Position

When the joystick is placed in the extend position, PWM signals are sent to the extend pulsar solenoid. The control valve spool is shifted so that supply pressure is directed through ports P to C1 to the base end of extend cylinder piston. Return oil from the rod end of the boom extend cylinder piston is directed back to the control valve through ports C2 to T and the return line to the filter and reservoir.

There is an additional **relief valve** which is set at 2850 psi (196,4 bar) in the extend line. If the extend supply pressure reaches this pressure, the relief valve will open allowing hydraulic oil to return to the reservoir.

NOTE: *Shifting the extend/retract working section spool manually by moving the optional valve lever **toward** the control valve will also actuate the extend cylinder to extend the boom.*

Retract Position

When the joystick is placed in the retract position, PWM signals are sent to the retract pulsar solenoid. The control valve spool is shifted so that supply pressure is directed through ports P to C2 to the rod end of the extend cylinder piston. This supply pressure also pilots open the **counterbalance valve**. The open counterbalance valve allows return oil from the base end of the extend cylinder piston to be directed back to the control valve through ports C1 to T and the return line to the filter and reservoir. If supply pressure reaches 2650 psi (182,6 bar), the inlet **relief valve** will open allowing hydraulic oil to return to the reservoir.

The counterbalance valve in the extend cylinder serves two other main functions. One prevents component damage and the other is for safety. These functions can be described as follows:

- If the machine is traveling and the boom runs into an immovable object, pressure will build up on the base end of the cylinder. If the counterbalance valve was not installed, the rod of the cylinder would bend damaging the cylinder. With the counterbalance valve installed, the pressure will build up until it reaches 2000 psi (137,8 bar) and then the counterbalance valve will be internally piloted open, allowing the pressure to return to reservoir. This condition will only exist if the cylinder has been extended. If the cylinder is already fully retracted the counter-

balance valve will have no effect and the cylinder rod will bend and other damage may occur.

- Should any of the hydraulic lines going to the extend cylinder fail, there will be a loss of hydraulic system pressure to the cylinder. *Example:* If there was a hydraulic line failure in the pressurized retract line during retracting, the counterbalance valve would lose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped, which would immediately stop boom retracting and prevent an elevated load from retracting uncontrolled. The load can be lowered safely to the ground by following the “Emergency Boom Lowering” procedures in your Owners/Operators Manual.

IMPORTANT: *DO NOT attempt to reset the counterbalance valve cartridges. In the event that the counterbalance valve cartridges were disabled for emergency boom lowering or any unauthorized adjustments are ever made to these cartridges, remove and replace **both** cartridges with new parts. Failure to replace these cartridges with new parts may alter the holding characteristics of the counterbalance valves creating an unsafe condition for machine operation.*

b. Checks and Adjustments

Refer to paragraph 9.6.2.h for control valve pressure checks and adjustments.

9.4 SECONDARY CONTROL VALVE OPERATION

The cable controlled secondary control valve and its associated joystick actuate the grille tilt and slave circuit, the frame tilt circuit, and optional auxiliary circuit.

9.4.1 Control Valve

The control valve has four sections – inlet, outlet and two or three parallel working sections, one for grille tilt and slave cylinder functions, one for frame tilt functions and a optional working section for auxiliary functions. The working sections are mounted between the inlet and outlet sections to form a valve stack. The supply pressure passages are common in the stack as are the return to reservoir and pilot pressure passages.

The secondary control valve is the same type of valve as the cable controlled main control valve and operates the same, only controlling secondary functions and the relief valves have different settings. Refer to paragraph 9.2.1.

9.4.2 Grille Tilt and Slave Circuit

a. Description

Hydraulic pressure is applied in the grille tilt and slave circuit by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a suction screen in the reservoir, Fig. 9.12. Pressure is supplied through the sequence valve and the load sensing steering priority valve to the secondary control valve. Pressure is directed to either side of the grille tilt and slave cylinder pistons by the shifting of a spool in a directional control valve found in the secondary control valve assembly. The spool is shifted by the **grille and frame tilt control lever** and its associated control cable. Control lever positions for tilting the fork are as follows:

Center Position

When the grille and frame tilt control lever is placed in the center or neutral position, the directional control valve spool is positioned so that pump supply pressure is directed through ports D to A, Fig. 9.12, to the return **filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

Up Position

When the grille and frame tilt control lever is placed in the “up” position, the directional control valve spool is positioned so that pump supply pressure is directed through ports E to B, Fig. 9.12, to the base (extend) end of the grille tilt and slave cylinders. The extension of the slave cylinder is fixed by the position of the boom so that only the grille tilt cylinder is extended to tilt the grille down. If supply pressure reaches 2700 -100/+150 psi (186 -6,9/+10,3 bar), the **grille tilt “up” relief valve** will open allowing hydraulic oil to return to the return filter and reservoir, Fig. 9.12.

Return oil from the rod side of the grille tilt cylinder piston is directed back to the directional control valve through ports C to F, Fig. 9.12, to the return filter in the reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

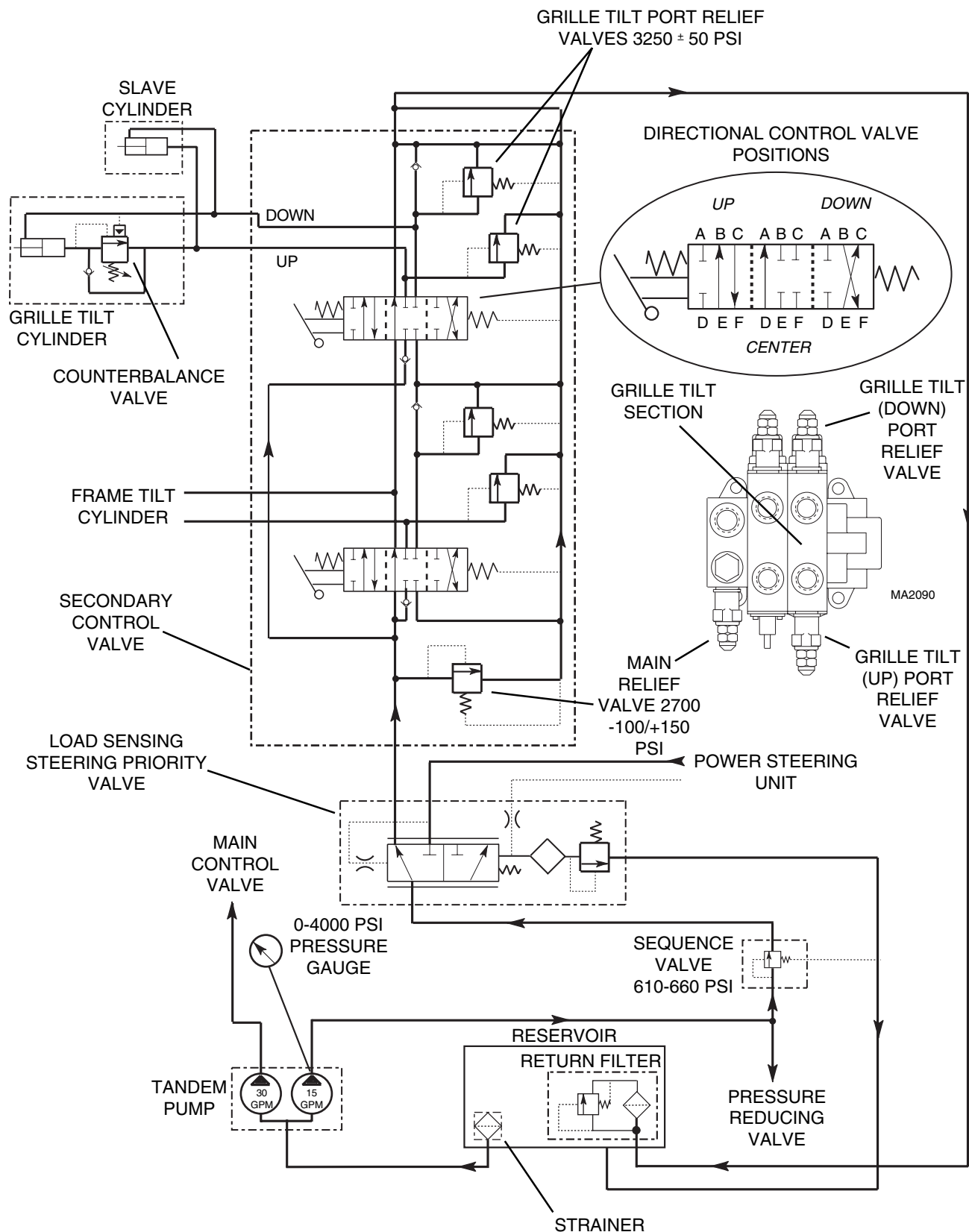
Down Position

When the grille and frame tilt control lever is

placed in the “down” position, the directional control valve spool is positioned so that pump supply pressure is directed through ports E to C, Fig. 9.12, to the rod (retract) end of the grille tilt and slave cylinders. The extension of the slave cylinder is fixed by the position of the boom so that only the grille tilt cylinder is retracted to tilt the grille down. This supply pressure also pilots open the **counterbalance valve**, Fig. 9.12. The open counterbalance valve allows return oil from the base end of the cylinder to return through ports B to F, Fig. 9.12, of the directional control valve to the **return filter** and **reservoir**, Fig. 9-12. If the supply pressure reaches 2700 -100/+150psi (186 - 6,9/+10,3 bar), the **grille tilt “down” relief valve**, Fig. 9.12, will open allowing hydraulic oil to return to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

The counterbalance valve in the grille tilt cylinder serves two other main functions. One prevents component damage and the other is for safety. These functions can be described as follows:

- If the boom is being raised and the grille or load comes in contact with an immovable object, pressure will build up on the base end of the cylinder. If the counterbalance valve was not installed, the rod of the cylinder would bend damaging the cylinder. With the counterbalance valve installed, the pressure will build up until it reaches 2000 psi (137,8 bar) and then the counterbalance valve will be internally piloted open, allowing the pressure to return to reservoir. This condition will only exist if the cylinder has been extended which is the normal position of the cylinder when lifting a load.
- Should any of the hydraulic lines going to the grille tilt cylinder fail, there will be a loss of hydraulic system pressure to the cylinder. *Example:* If there was a hydraulic line failure in the pressurized grille tilt down line during tilting with the load elevated, the counterbalance valve would loose pilot pressure closing off flow returning to the reservoir. The oil in the base end of the cylinder would then be trapped, which would immediately stop tilting and prevent an elevated load from falling off the forks. If a broken line condition would ever exist, immediately retract the boom and lower the load safely to the ground and correct the condition.



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Fig. 9.12 Grille Tilt and Slave Circuit

b. Grille Tilt Cylinder, Slave Cylinder and Raise Cylinder Interaction

The slave cylinder is mounted to the boom in a way that is similar to the raise cylinders, Fig. 9.12. When the boom is raised or lowered, the movement of the slave cylinder follows the movement of the raise cylinders. The slave cylinder shares a common extend hydraulic line with the grille tilt cylinder, and also a common retract line. The movements of the cylinders are interactive.

When the boom is raised, the slave cylinder is extended which causes pressure buildup on the rod end of the piston. This pressure pilots open the **counterbalance valve**, Fig. 9.12, and forces hydraulic oil to flow from the rod end of the slave cylinder to the rod end of the grille tilt cylinder and from the base end of the grille tilt cylinder to the base end of the slave cylinder. The fork tilt cylinder rod retracts to tilt the grille down and compensate for upward boom movement. The amount of grille tilt cylinder rod movement is proportional to slave cylinder rod movement to always keep the grille at the same attitude.

When the boom is lowered, the slave cylinder is retracted which causes pressure buildup on the base end of the piston. Hydraulic oil flow and cylinder and grille action are just the reverse of raising the boom. Oil flows through the pilot-counterbalance valve without piloting.

c. Pressure Checks and Adjustments

Grille Tilt “Up” Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

3. Remove the transmission cover from the frame.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 15 gpm section of the tandem pump, Fig. 9.12.
5. Start the engine. Operate the grille tilt control several times to purge the system of air.
6. With engine at idle, place the grille and frame tilt control lever in the “up” position and hold until the grille tilt cylinder has fully extended. Continue holding the lever in the “up” position until the pressure readings are taken.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

7. Check the pressure gauge reading. It should read 2700 -100/+150 (186 -6,9/+10,3 bar). If not, adjust the grille tilt “up” relief valve, Fig. 9.12, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the grille tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

Grille Tilt “Down” Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.
2. Operate the hydraulic controls after the engine



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

has stopped to relieve any trapped pressure.

3. Remove the transmission cover from the frame.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 15 gpm section of the tandem pump, Fig. 9.12.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the grille tilt control several times to purge the system of air.
6. With engine at idle, place the grille and frame tilt control lever in the "down" position and hold until the grille tilt cylinder has fully retracted. Continue holding the lever in the "down" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 2700 -100/+150 (186 -6,9/+10,3 bar). If not, adjust the grille tilt "down" relief valve, Fig. 9.12. Turn the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic con-

trols after the engine has stopped to relieve any trapped pressure.

9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the grille tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

d. Testing

The grille tilt and slave circuit should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Operate the grille tilt control several times to purge the system of air if necessary.
4. Starting with the grille down fully, tilt the grille up fully at full engine speed. The time required for full tilt up should be 4 to 6 seconds (no load).
5. Starting at the full tilt up position, tilt the grille down fully at full engine speed. The time required for full tilt down should be 3 to 5 seconds (no load).
6. Repeat steps 4 and 5 to recheck performance.
7. If the grille tilt circuit test does not meet performance requirements (refer to Troubleshooting, paragraph 9.8) locate the cause of the problem and correct before putting the vehicle into service.

9.4.3 Frame Tilt Circuit

a. Description

Hydraulic pressure is applied in the frame tilt circuit by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a suction screen in the reservoir, Fig. 9.13. Pressure is supplied through the sequence valve and the load sensing steering priority valve to the secondary control valve. Pressure is then directed to either side of the frame tilt cylinder piston by the shifting of a spool in a directional control valve found in the secondary control valve assembly. The spool is shifted by the **grille and frame tilt control lever** and its associated control cable. Control lever positions for tilting the frame are as follows:

Center Position

When the grille and frame tilt control lever is placed in the center or neutral position, the directional control valve spool is positioned so that pump supply pressure is directed through ports D to A, Fig. 9.13, to the **return filter** and **reservoir**. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,6,9 to 1,03 bar).

Left Position

When the grille and frame tilt control lever is placed in the “left” position, the directional control valve spool is positioned so that pump supply pressure is directed through ports E to C, Fig. 9.13, to the base (extend) end of the frame tilt cylinder piston. This supply pressure also pilots open the pilot-operated check valve on the rod (retract) end of the frame tilt cylinder. If supply pressure reaches 1300 ± 50 psi ($89,6 \pm 3,4$ bar), the **frame tilt “left” relief valve**, Fig. 9.13, will open allowing hydraulic oil to return to the **return filter** and **reservoir**, Fig. 9.13.

Return oil from the rod end of the frame tilt cylinder piston is directed back to the directional control valve through ports B to F, Fig. 9.13, to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

Right Position

When the grille and frame tilt control lever is placed in the “right” position, the directional control valve spool is positioned so that pump applied pressure is directed through ports E to B, Fig. 9.13, to the rod (retract) end of the frame tilt cylinder piston. This supply pressure also pilots open the pilot-operated check valve on the base (extend) end of the frame tilt cylinder. If supply pressure reaches 1300 ± 50 psi ($89,6 \pm 3,4$ bar), the **frame tilt “right” relief valve**, Fig. 9.13, will open allowing hydraulic oil to return to the **return filter** and **reservoir**, Fig. 9.13.

Return oil from the base end of the frame tilt cylinder piston is directed back to the directional control valve through ports C to F, Fig. 9.13, to the return filter and reservoir. If the return filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,69 to 1,03 bar).

Pilot-operated check valves, Fig. 9.13, in the frame tilt cylinder permit free flow on both ends of the cylinder piston when supply pressure is applied to open either pilot-operated check valve. When the grille and frame tilt control lever is not activated, no supply pressure is applied. The two check valves prevent any back flow of hydraulic oil and the frame tilt cylinder is locked in position.

b. Pressure Checks and Adjustments

Frame Tilt Left Relief Valve

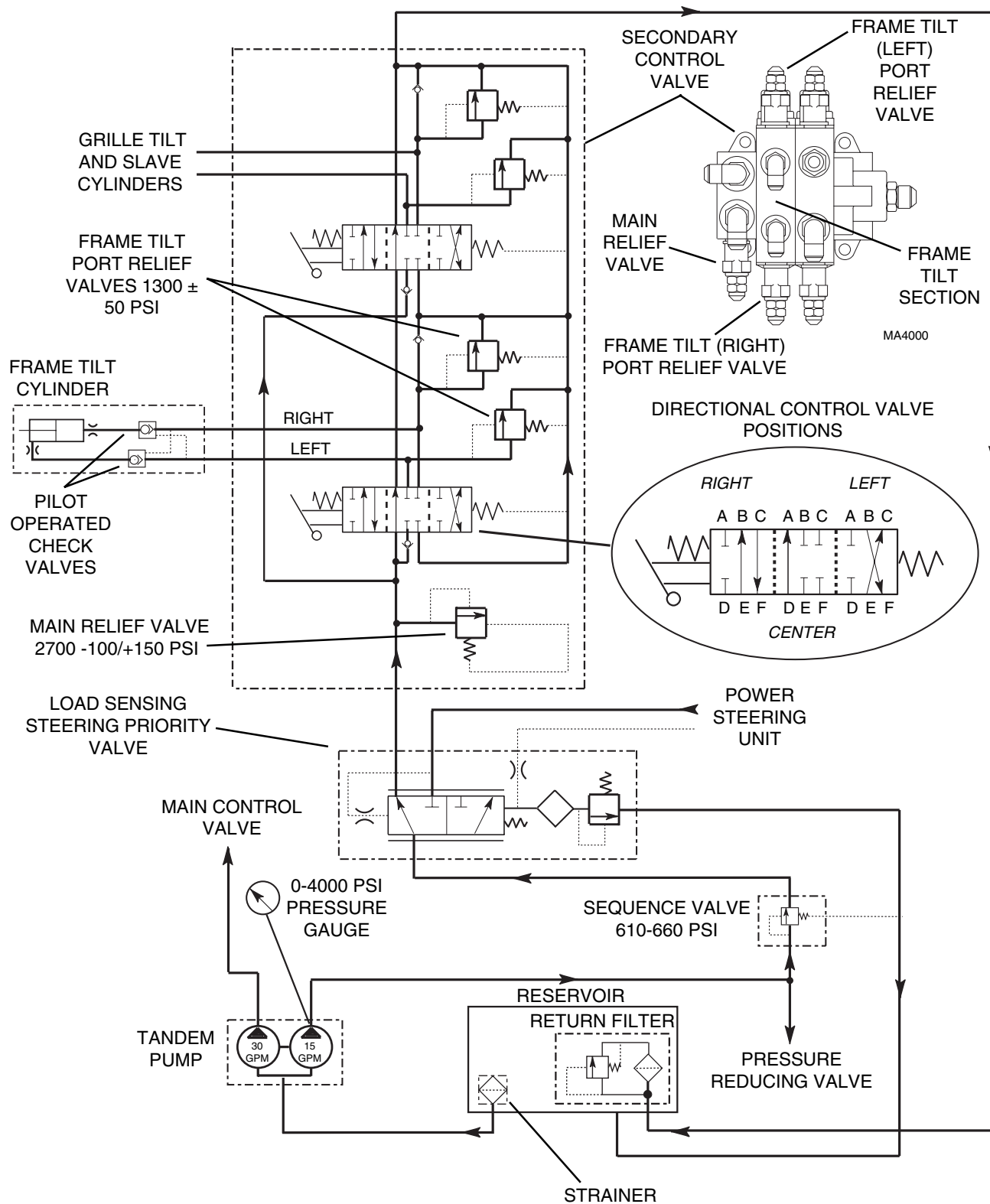
1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



MA3040

Fig. 9.13 Frame Tilt Circuit



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 15 gpm section outlet of the tandem pump, Fig. 9.13.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the frame tilt control several times to purge the system of air.
6. With the engine at idle, place the fork and frame control lever in the "left" position and hold until the frame tilt cylinder bottoms out. Continue holding the lever in the "left" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 1300 ± 50 psi ($89,6 \pm 3,4$ bar). If not, adjust the frame tilt "left" relief valve, Fig. 9.13, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the frame tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

Frame Tilt Right Relief Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.
2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Remove the transmission cover from the frame.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) at the 15 gpm section outlet of the tandem pump, Fig. 9.13.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine. Operate the frame tilt control several times to purge the system of air.
6. With the engine at idle, place the fork and frame control lever in the "right" position and hold until the frame tilt cylinder bottoms out. Continue holding the lever in the "right" position until the pressure readings are taken.
7. Check the pressure gauge reading. It should read 1300 ± 50 psi ($89,6 \pm 3,4$ bar). If not, adjust the frame tilt "right" relief valve, Fig. 9.13, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft (13 ± 2 Nm) after adjustment.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Start the engine. Operate the frame tilt control fully several times to purge the system of air.
11. Install the transmission cover after adjustment.

c. Testing

The frame tilt circuit should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Operate the frame tilt control several times to purge the system of air if necessary.
4. Starting with the frame tilted fully to the left, tilt the frame fully to the right at full engine speed. The time required for frame tilt right should be 8 to 12 seconds (no load).
5. Starting with the frame tilted fully to the right, tilt the frame fully to the left at full engine speed. The time required for frame tilt left should be 7 to 11 seconds (no load).
6. Repeat steps 4 and 5 to check performance.
7. If the frame tilt test does not meet performance requirements (Refer to Troubleshooting, paragraph 9.8) and correct before putting the vehicle into service.

9.4.4 Brake Circuits

(S/N 9B0500 thru OE1179 –
Without Trans. De-Clutch)

a. Description

Hydraulic pressure is normally applied in the service and park lock brake circuits by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.14. A pressure of 610 - 660 psi (42 - 45,5 bar) is maintained by the sequence valve. This pressure is reduced to 525 ± 25 psi ($36,2 \pm 1,7$ bar) at the **pressure reducing valve** prior to entering the solenoid-operated **park lock release valve** and pedal-operated **service brake valve**.

Service Brake Valve

When the brake pedal in the operator's cab is **not depressed**, the brake valve spool is spring-positioned so that hydraulic flow is blocked at port C, Fig. 9.14, no pressure is applied to the service brakes. Return flow from the service brakes passes through ports B to D to the reservoir.

When the brake pedal in the operator's cab is **depressed**, the brake valve spool is positioned so that flow is directed through ports C to A, Fig.

9.14, to the service brake pistons. As pressure is applied, the pistons press the brake discs together slowing or stopping the wheel. The brake pedal will return to the up position when released.

Park Lock Release Valve

When the park lock switch on the instrument panel is placed in the **engaged** (up) position, the park lock release valve solenoid is **de-energized** and the valve spool is spring positioned so that hydraulic flow from the park lock piston is directed through ports B to C in the park lock release valve, Fig. 9.14. With no pressure on the park lock piston, the park lock springs force the discs together, this **engages** the park lock. With the park lock release valve solenoid in the **de-energized** position, pressurized hydraulic oil is blocked at port D, Fig. 9.6. The park lock light on the dash will illuminate whenever the park lock is engaged and the ignition switch is in the RUN position.

When the park lock switch on the instrument panel is placed in the **disengaged** (down) position, the park lock release valve solenoid is **energized** and the valve spool is positioned so that the hydraulic flow is directed through ports D to A in the park lock release valve, Fig. 9.14, to the park lock. With hydraulic pressure being applied to the park lock piston, the park lock springs are compressed. Which **disengages** the park lock discs.

IMPORTANT: *Never engage the park lock while the machine is in motion. The park lock is not designed to be used as a means to slow or stop machine travel and could be damaged as a result.*

b. Pressure Checks and Adjustments

The pressure checks and adjustments are the same as the brake circuit with transmission de-clutch, refer to paragraph 9.4.5.b.

c. Testing

The service brakes should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Bleed the brake system as described in paragraph 9.6.3.g if necessary.

4. Park the forklift on level ground and engage the park lock.
5. Check service brakes with brakes at room temperature. Select second gear and fully apply service brakes. Switch park lock to "disengaged" position. The forklift must not move when engine is brought up to full throttle while transmission selector is shifted to either "forward" or "reverse".
6. If the service brakes do not meet performance requirements, locate the cause of the problem and correct before putting the vehicle into service.

The park lock should be tested whenever repairs or adjustments are made to park lock components.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check park lock with 6000 lbs. on forks.
3. Park up-grade on 30° ramp, shift transmission to neutral, engage the park lock and release service brakes, the forklift must not roll.
4. If the park lock test does not meet performance requirements (refer to Troubleshooting, paragraph 9.8) and locate the cause of the problem and correct before putting the vehicle into service.

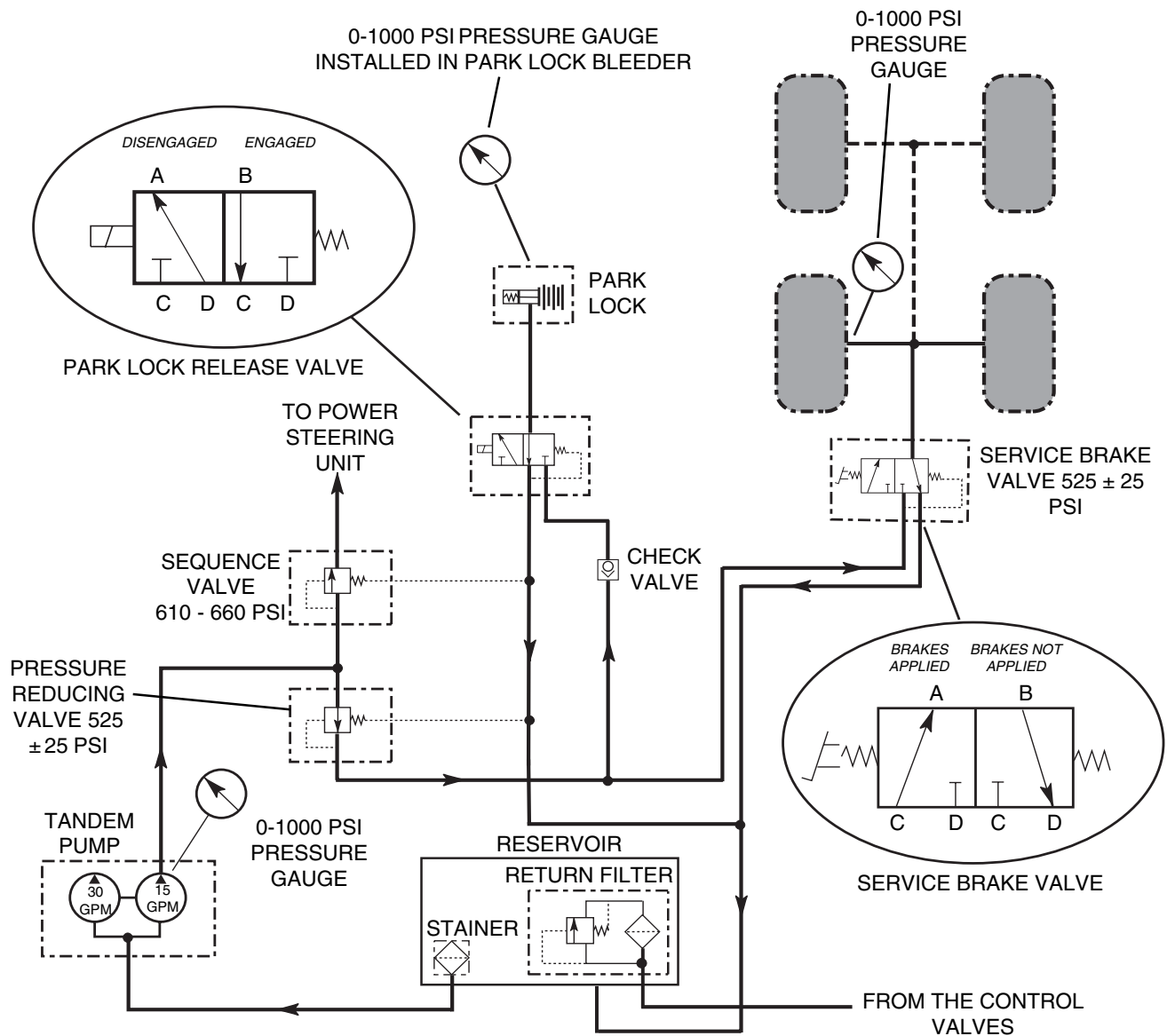


Fig. 9.14 Brake Circuit – Without De-Clutch

MA3050

9.4.5 Brake Circuits (S/N OE1180 and After – With Trans. De-Clutch)

a. Description

Hydraulic pressure is normally applied in the service and park lock brake circuits by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.15. A pressure of 610 - 660 psi (42 - 45,5 bar) is maintained by the sequence valve. This pressure is reduced to 525 ± 25 psi ($36,2 \pm 1,7$ bar) at the **pressure reducing valve** prior to entering the solenoid-operated **park lock release valve** and pedal-operated **service brake valve**.

Service Brake Valve

When the brake pedal in the operator's cab is **not depressed**, the brake valve spool is spring-positioned so that hydraulic flow is blocked at port C, Fig. 9.15, no pressure is applied to the service brakes. Return flow from the service brakes passes through ports B to D to the reservoir.

When the brake pedal in the operator's cab is **depressed**, the brake valve spool is positioned so that flow is directed through ports C to A, Fig. 9.15, to the service brake pistons. As pressure is applied, the pistons press the brake discs together slowing or stopping the wheel. The brake pedal will return to the up position when released.

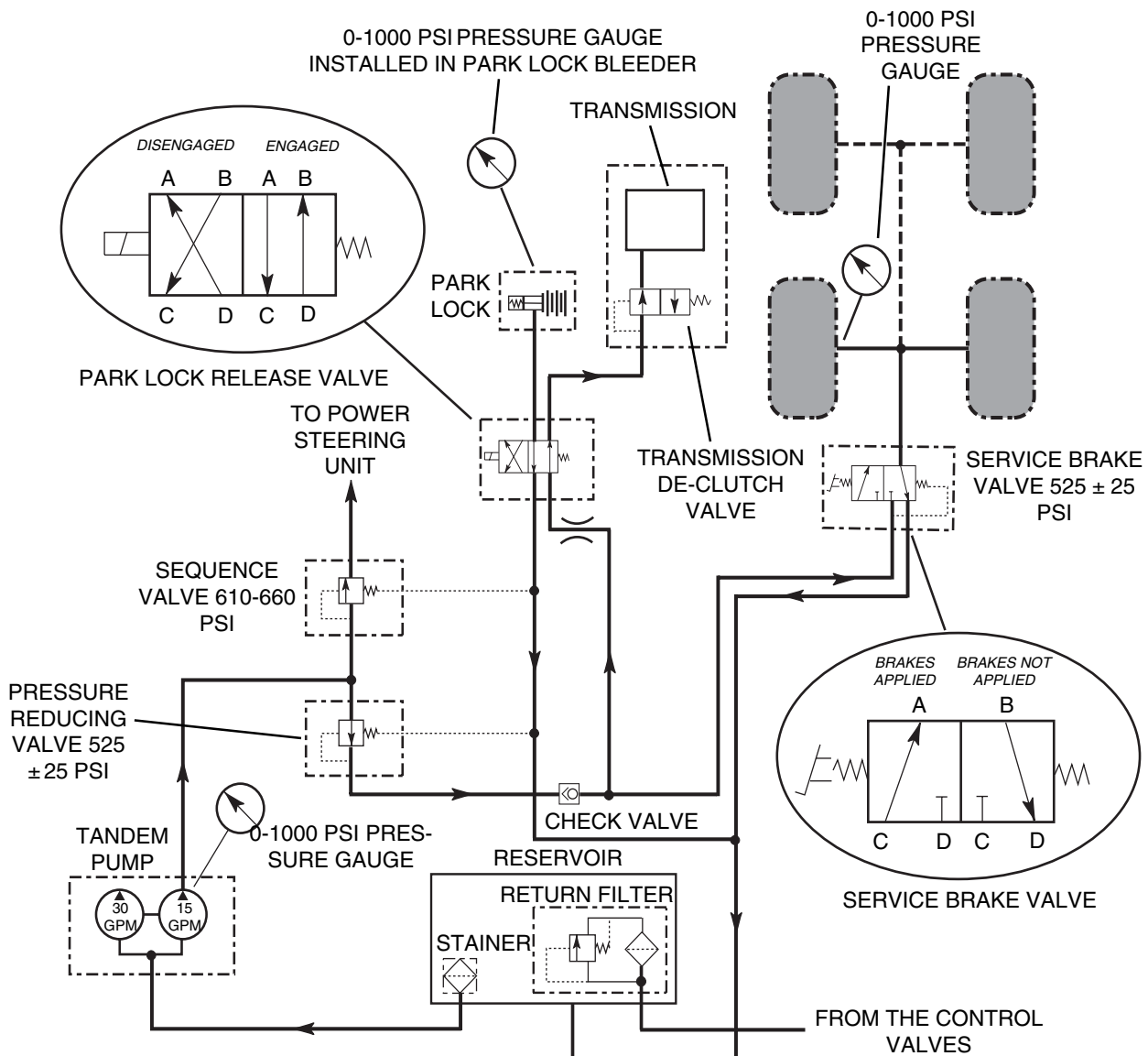


Fig. 9.15 Brake Circuit – With De-Clutch

Park Lock Release Valve and Transmission De-Clutch Valve

When the park lock switch on the instrument panel is placed in the **engaged** (up) position, the park lock release valve solenoid is **de-energized** and the valve spool is spring positioned so that hydraulic flow from the park lock piston is directed through ports A to C in the park lock release valve, Fig. 9.15. With no pressure on the park lock piston, the park lock springs force the discs together, this **engages** the park lock. With the park lock release valve solenoid in the **de-energized** position, pressurized hydraulic oil flows through the park lock release valve through ports D to B, Fig. 9.15. The transmission de-clutch valve spool is shifted so it is piloted open allowing pressurized hydraulic oil to reduce internal control pressure inside the transmission. The reduced internal control pressure in the transmission does not allow engagement of the transmission clutch packs, eliminating transmission drive power to the drive axles. The park lock light on the dash will illuminate whenever the park lock is engaged and the ignition switch is in the RUN position.

When the park lock switch on the instrument panel is placed in the **disengaged** (down) position, the park lock release valve solenoid is **energized** and the valve spool is positioned so that the hydraulic flow is directed through ports D to A in the park lock release valve, Fig. 9.15 to the park lock. With hydraulic pressure being applied to the park lock piston, the park lock springs are compressed. Which **disengages** the park lock discs. With the park lock release valve solenoid energized, the transmission de-clutch valve spool is spring-positioned so that hydraulic oil that was used to de-clutch the transmission can return to the reservoir through ports B to C in the park lock release valve, Fig. 9.15. This permits internal control pressure in the transmission to return to normal, which will allow engagement of the transmission clutch packs when the transmission is shifted in gear.

IMPORTANT: *Never engage the park lock while the machine is in motion. The park lock is not designed to be used as a means to slow or stop machine travel and could be damaged as a result.*

b. Pressure Checks and Adjustments

Sequence Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.
2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Remove the transmission cover from the frame.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Install a tee and pressure gauge capable of measuring 0-4000 psi (0-275,6 bar) in the 15 gpm section outlet of the tandem pump, Fig. 9.15.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine and allow it to run at idle.
6. Check the pressure gauge reading at the tandem pump.
7. Pressure gauge reading should read between 610 - 660 psi (42 - 45,5 bar). If not, adjust the sequence valve, turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
8. Stop the engine. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
9. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
10. Install the transmission cover after adjustment.

Pressure Reducing Valve

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-1000 psi (0-68,9 bar) on a service brake, Fig. 9.15.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Install a pressure gauge capable of measuring 0-1000 psi (0-68,9 bar) on the park lock bleeder fitting, Fig. 9.15.
6. Start the engine and allow it to idle.
7. Depress the brake pedal and continue to hold until a pressure gauge reading is taken at a service brake.
8. Place the park lock switch in the disengaged (down) position and check the pressure gauge reading at the park lock bleeder fitting.
9. Both pressure gauge readings should read 525 ± 25 psi ($36,2 \pm 1,7$ bar). If not, adjust the pressure reducing valve, turning the adjustment screw clockwise to increase or counter-clockwise to decrease pressure.
10. Stop the engine and place the park lock switch in the engaged (up) position. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
11. Remove the pressure gauges and tees from the service brake and park lock and reconnect the hydraulic lines.
12. Install the transmission cover after adjustment.

c. Testing

The de-clutch should be tested whenever repairs or adjustments are made to components of the circuit.

1. Check the de-clutch with the park lock engaged.
2. With the park lock engaged, the transmission must remain in neutral when transmission selection is shifted to "forward" or "reverse".

The service brakes should be tested whenever repairs or adjustments are made to components of the circuit.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check for signs of leakage of hydraulic oil from circuit hoses and other components. Correct any leakage problem before testing.
3. Bleed the brake system as described in paragraph 9.6.3.g if necessary.
4. Park the forklift on level ground and engage the park lock.
5. Check service brakes with brakes at room temperature. Select second gear and fully apply service brakes. Switch park lock to "disengaged" position. The forklift must not move when engine is brought up to full throttle while transmission selector is shifted to either "forward" or "reverse".
6. If the service brakes do not meet performance requirements, refer to Troubleshooting, paragraph 9.8 and locate the cause of the problem and correct before putting the vehicle into service.

The park lock should be tested whenever repairs or adjustments are made to park lock components.

1. Start the engine, park the forklift on level ground and level the frame.
2. Check park lock with 6000 lbs. on forks.
3. Park up-grade on 30° ramp, shift transmission to neutral, engage the park lock and release service brakes, the forklift must not roll.
4. If the park lock test does not meet performance requirements, refer to Troubleshooting, paragraph 9.8 and locate the cause of the problem and correct before putting the vehicle into service.

9.4.6 Power Steering Circuit

a. Description

1. Hydraulic pressure is applied in the power steering circuit by the 15 gpm section (front half) of the **tandem pump**, which draws its fluid through a **suction strainer** in the **reservoir**, Fig. 9.16.
2. When the steering wheel is turned, the **sequence valve**, Fig. 9.16, opens, permitting supply pressure to be directed to the **load sensing steering priority valve**. The load sensing steering priority valve spool will be positioned so supply pressure is applied through ports D to B, Fig. 9.16, to the intake side of the **power steering metering section**. If the supply pressure reaches 2850 ± 150 psi ($196,4 \pm 10,3$ bar), the **steering relief valve** will be piloted open to allow hydraulic oil to flow to the **return filter** in **reservoir**. When the steering wheel is not turned the load sensing steering priority valve spool will be spring positioned so supply pressure is applied through ports C to A, Fig. 9.16, to the **secondary control valve**.
3. The **load sensing steering priority valve** provides:
 - Smooth pressure compensated steering because pressure variations in the steering circuit do not affect steering response or maximum steering rate.
 - True power beyond system capability by splitting the system into two independent circuits. Pressure transients are isolated in each circuit. Only the flow required by the steering maneuver goes to the steering circuit. Flow not required for steering is available for use in the secondary control valve sections using the 15 gpm section of the tandem pump.
 - Provides reliable operation because the steering circuit always has flow priority.
4. The **power steering unit** consists of control valve and metering sections, Fig. 9.16.
 - The **control valve section** contains a mechanically actuated linear spool which is torsion bar centered and is of the open center type. It directs fluid to and from the metering section and steering cylinders and regulates the pressure supplied to the **steering cylinders**.

- The **metering section** consists of a commutator and a bi-directional gerotor element. It meters (measures) the amount of fluid sent to the **steering cylinders**.

No Steering Action

When no steering maneuver is being accomplished, the load sensing steering priority valve spool is positioned so the fluid from the tandem pump is channeled through ports C to A, Fig. 9.16, of the load sensing steering priority valve to the secondary control valve. No fluid is directed to the power steering control valve or the steering cylinders.

Left Turn - 2 Wheel Steer

When a left turn is being made with the steering select switch in 2 wheel steer (center position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to C, Fig. 9.16, to the intake side of the **power steering unit** metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports B to A to the base end of the right front steering cylinder and the rod end of the left front steering cylinder.
3. Return hydraulic oil from each of the front steering cylinders flows through ports J to K of the steer select valve and through ports D to E of the power steering control valve to the return filter in the reservoir.

Left Turn - 4 Wheel Steer

When a left turn is being made with the steering select switch in 4 wheel steer (up position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to C, Fig. 9.16, to the intake side of the **power steering unit** metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports B to A to the base end of the right front steering cylinder and the rod end of the left front steering cylinder.

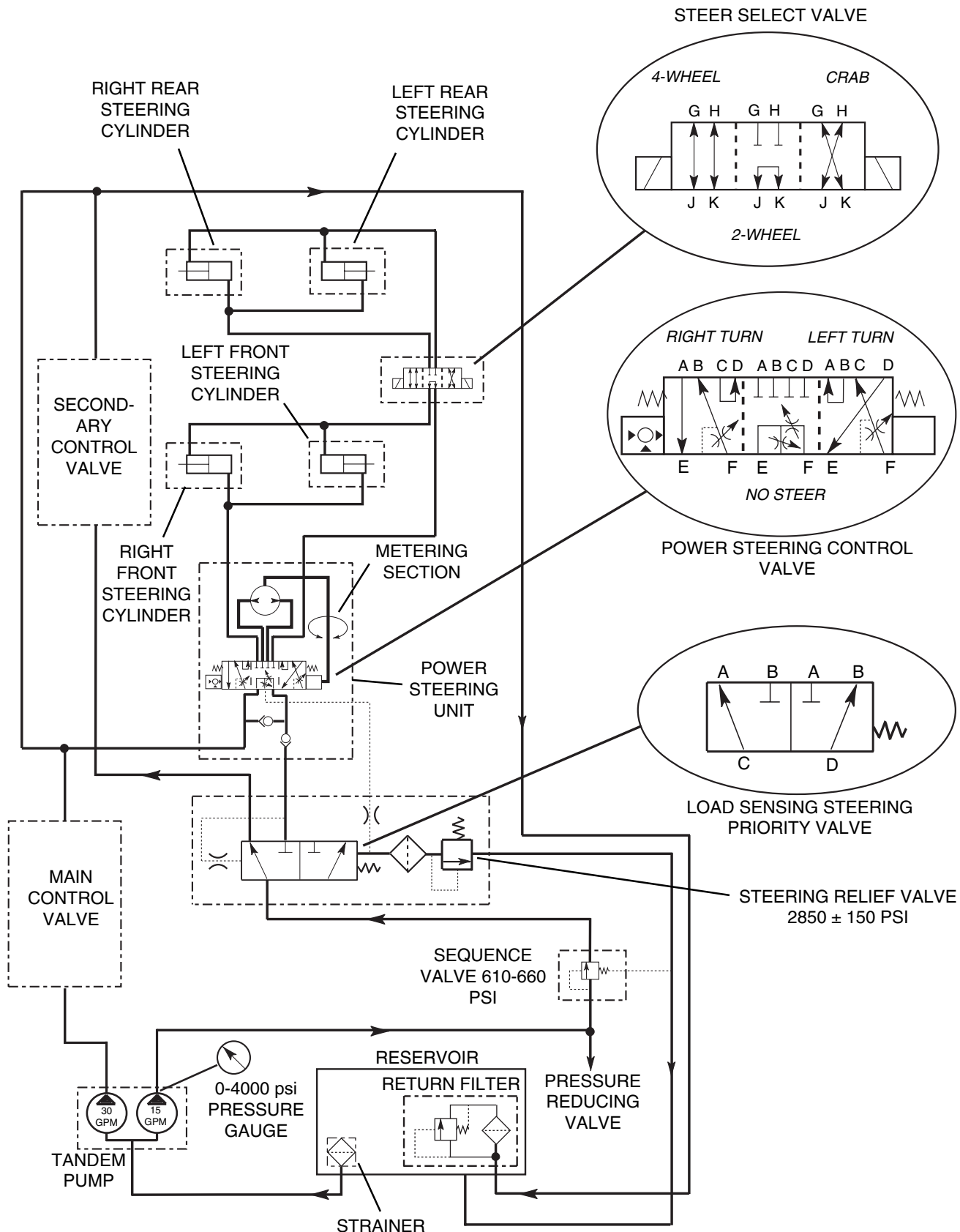


Fig. 9.16 Power Steering Circuit

MA3070

3. The steer select valve solenoid is energized and shifts the valve spool. Oil from the rod end of the right front cylinder and from the base end of the left front cylinder is channeled through ports J to G of the steer select valve to the base end of the rear right cylinder and the rod end of the rear left cylinder.
4. Return oil from each of the rear cylinders is channeled through ports H to K of the steer select valve and through ports D to E of the power steering control valve to the return filter in the reservoir.

Left Turn - Crab Steer

When a left turn is being made with the steering select switch in crab steer (down position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to C, Fig. 9.16, to the intake side of the **power steering unit** metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports B to A to the base end of the right front steering cylinder and the rod end of the left front steering cylinder.
3. The steer select valve solenoid is energized and shifts the valve spool. Oil from the rod end of the right front cylinder and from the base end of the left front cylinder is channeled through ports J to H of the steer select valve to the rod end of the rear right cylinder and the base end of the rear left cylinder.
4. Return oil from each of the rear cylinders is channeled through ports G to K of the steer select valve and through ports D to E of the power steering control valve to the return filter in the reservoir.

Right Turn - 2 Wheel Steer

When a right turn is being made with the steering select switch in 2 wheel steer (center position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to B, Fig. 9.16, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports C to D. Supply oil is routed from port D to port K in the steer select valve.

3. Both steer select valve solenoids are de-energized. Oil is channeled through ports K to J of the steer select valve to the rod end of the right front steering cylinder and to the base end of the left front steering cylinder.
4. Return hydraulic oil from each cylinder flows through ports A to E of the power steering control valve section to the return filter in the reservoir.

Right Turn - 4 Wheel Steer

When a right turn is being made with the steering select switch in 4 wheel steer (up position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to B, Fig. 9.16, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports C to D. Supply oil is routed from port D to port K in the steer select valve.
3. The steer select valve solenoid is energized and shifts the valve spool. Oil is channeled through ports K to H to the rod end of the right rear steering cylinder and the base end of the left rear steering cylinder.
4. Return oil from each of the rear steering cylinders flows through ports G to J of the steer select valve to the rod end of the right front steering cylinder and the base end of the left front steering cylinder.
5. Return oil from each of the front steering cylinders flows through ports A to E of the power steering control valve to the return filter in the reservoir.

Right Turn - Crab Steer

When a right turn is being made with the steering select switch in crab steer (down position):

1. The power steering control valve spool is shifted so that supply pressure is applied through ports F to B, Fig. 9.16, to the intake side of the power steering metering section.
2. A measured amount of hydraulic oil is exhausted from the metering section and routed back to the control valve section where it is channeled through ports C to D. Supply oil is routed from port D to port K in the steer select valve.

3. The steer select valve solenoid is energized and shifts the valve spool. Oil is channeled through ports K to G to the base end of the right rear steering cylinder and the rod end of the left rear steering cylinder.
4. Return oil from each of the rear steering cylinders flows through ports H to J of the steer select valve to the rod end of the right front steering cylinder and the base end of the left front steering cylinder.
5. Return oil from each of the front steering cylinders flows through ports A to E of the power steering control valve to the return filter in the reservoir.

b. Pressure Checks and Adjustments

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the steering wheel after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (275,6 bar) in the 15 gpm section outlet of the tandem pump, Fig. 9.7.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Start the engine and allow it to idle (1000 rpm).
6. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air.

7. Increase engine speed to full throttle and check the pressure gauge reading. It should read between 610 and 660 psi (42 to 45,5 bar). If not, adjust the sequence valve by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
8. Turn the steering wheel completely left or right and hold while checking the pressure gauge reading. It should read 2850 ± 150 psi (196,4 $\pm 10,3$ bar). If not, adjust the steering relief valve by turning the adjustment screw clockwise to increase relief pressure or counter clockwise to decrease relief pressure.
9. Stop the engine and operate the steering wheel after the engine has stopped to relieve any trapped pressure.
10. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
11. Start the engine. Operate the steering wheel several times to purge the system of air (step 6).
12. Install the transmission cover after adjustment or repair.

9.4.7 Optional Auxiliary Circuit

a. Description

Hydraulic pressure is applied in the optional auxiliary circuit by the 15 gpm section of the **tandem pump**, which draws its fluid through a suction strainer in the reservoir, Fig. 9.17. Supply pressure is directed to either a male or female quick connect at the front of the boom by the shifting of a spool in a **directional control valve** found in the secondary control valve assembly. The spool is shifted by an **auxiliary control lever** and its associated control cable. The auxiliary circuit supplies hydraulic pressure for use on various hydraulically operated attachments. Auxiliary control lever positions are as follows:

Center Position

When the auxiliary control lever is placed in the center or neutral position, the directional control valve spool is positioned so that supply pressure is applied through ports D to A, Fig. 9.17, to the return filter in reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

NOTE: The auxiliary attachment control lever in models S/N 0A0995 and before have lever movement forward and back. Forward lever movement translates to Left. Backward lever movement translates to Right.

Left Position

When the auxiliary control lever is placed in the forward position, the directional control valve spool is positioned so that pump applied pressure is directed through ports E to C, Fig. 9.17, to the female auxiliary quick connect coupler. Return pressure is directed through ports B to F to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

Right Position

When the auxiliary control lever is placed in the backward position, the directional control valve spool is positioned so that pump applied pressure is directed through ports E to B, Fig. 9.17, to the male quick connect coupler. Return pressure is directed through ports C to F to the return filter and reservoir. If the filter becomes clogged, hydraulic oil will bypass the filter when the pressure reaches 10 to 15 psi (0,7 to 1,03 bar).

b. Pressure Checks and Adjustments

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover from the frame.
4. Install a tee and pressure gauge capable of measuring 0-4000 psi (0-275,6 bar) in the 15 gpm section outlet of the tandem pump, Fig. 9.8.
5. Start the engine and maintain engine speed at 1000 rpm.

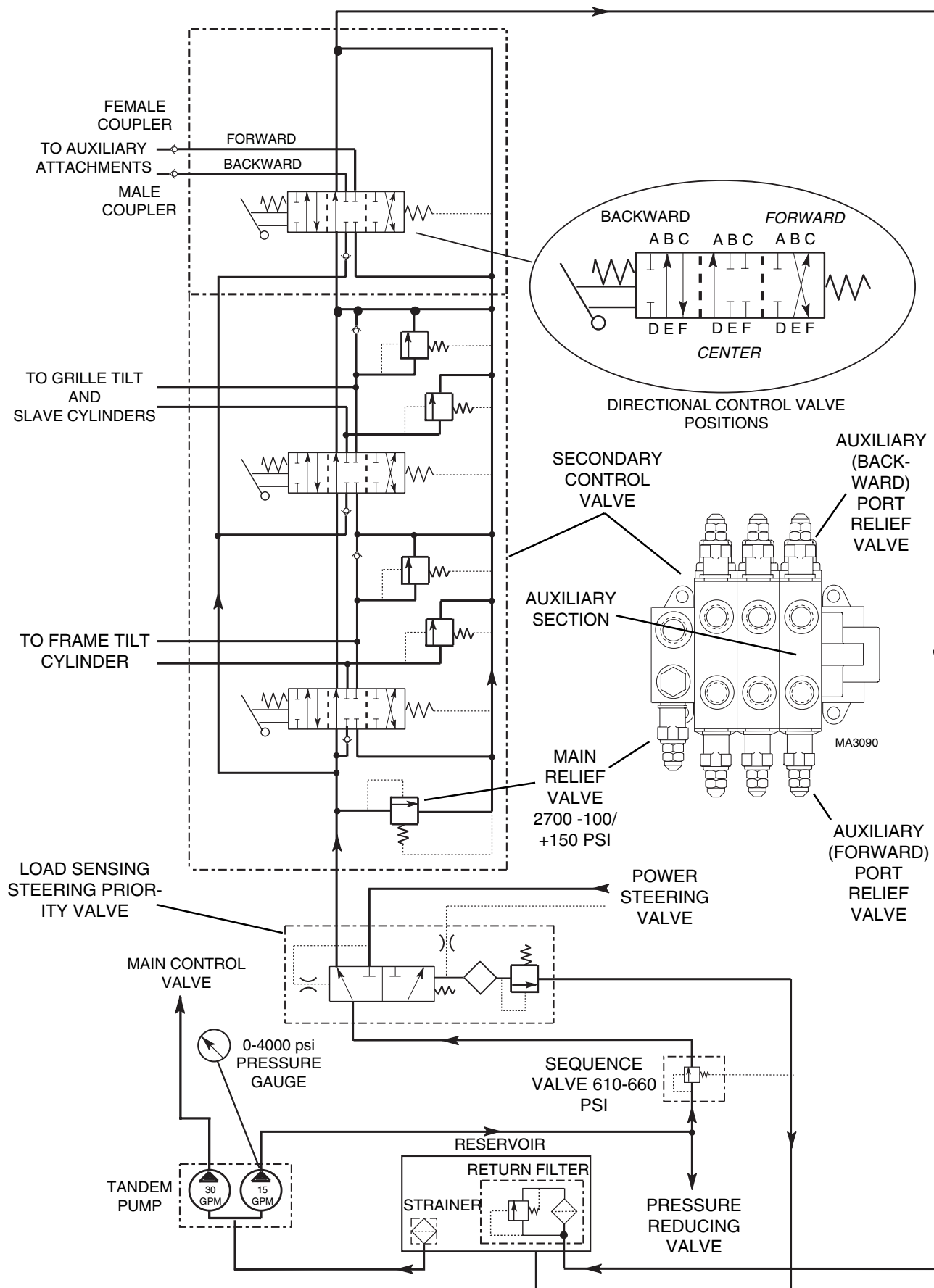


Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

6. Operate the auxiliary control function several times to purge the system of air.
7. Place the auxiliary control lever in the forward or left position and hold until the pressure readings are taken.
8. Check the pressure gauge reading. It should read 2700 -100/+150 psi (186 -6,9/+10,3 bar).

If not, adjust the main relief valve, Fig. 9.17, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure. Torque nuts on relief valve to 10 ± 1.5 lb-ft ($13,5 \pm 2$ Nm) after adjustment.
9. Place the auxiliary control lever in the backward or right position and hold until the pressure readings are taken.
10. Check the pressure gauge reading. It should read 2700 -100/+150 psi (186 -6,9/+10,3 bar).
If not, adjust the main relief valve, Fig. 9.17, by turning the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.
11. Stop the engine. Operate the auxiliary hydraulic control after the engine has stopped to relieve any trapped pressure.
12. Remove the pressure gauge and tee from the tandem pump and reconnect the hydraulic line.
13. Start the engine. Operate the auxiliary control fully several times to purge the system of air.
14. Install the transmission cover after adjustment.



MA3080

Fig. 9.17 Optional Auxiliary Circuit

9.5 CYLINDERS

Rebuild cylinders only in a clean, well lighted area where you can carefully inspect all components. If a cylinder is to remain dismantled for any lengthy period, coat the metal parts that are to be reused with a good preservative and place in protective storage. Refer to specific instructions for removal, rebuilding and installation of each cylinder.

a. General Disassembly Instructions



Warning

Take care when applying heat to parts to prevent severe burns. Avoid the use of excessive heat which will damage parts and make them unusable.

Some parts of cylinders are sealed with a "special organic" sealant and locking compound. Before you attempt to disassemble these parts, remove any accessible seals from the area of the bonded joint. Wipe off any hydraulic oil and heat the joint uniformly to break the bond. A temperature of 300 to 400 °F (149 to 204 °C) will destroy the bond strength of the sealant. Avoid overheating or the parts may become distorted or damaged. Apply sufficient torque or pressure for removal while parts are still hot. Breakdown of sealant will leave a white powdery residue on threads and parts, which must be removed by brushing with a soft brass wire brush prior to reassembly.

Do not attempt to salvage cylinder seals or sealing rings. Any hydraulic component must always be serviced with a complete seal kit during a component rebuild. Repair kits are available.

b. General Cleaning Instructions

Clean all reusable metal parts thoroughly after disassembly and prior to inspection. Use an approved solvent such as trichlorethylene.

c. General Assembly Instructions

1. Before reassembly, be sure parts are clean and free from foreign matter. Use an approved solvent such as trichlorethylene for cleaning.
2. Protect the finish on the rod at all times. Damage to the rod can cause premature seal failure.
3. Use the proper tools for specific installation tasks. Clean tools are required for installation.

4. Do not over stretch seals, wipers and O-rings. Make sure that seals, wipers and O-rings are not twisted or distorted in their grooves.
5. Lubricate piston seals and seal installation path with clean hydraulic oil from a filtered supply.
6. Use a suitable compression tool when installing glands or heads into cylinders to prevent damage to the seals and O-rings. Place a little hydraulic oil on the seals and outside of glands to aid in installation.
7. Follow the manufacturer's instructions when applying primer, locking or retaining compounds which are specified in reassembly procedures. The use of primer is recommended in some cases to decrease cure time. Allow sealant compounds to cure fully. The curing process may be hastened by the use of a heat gun to blow warm, dry air on the parts.
8. Following reassembly, test cylinder at low operating pressure to be sure the piston and rod are moving freely in both directions.
9. Increase the operating pressure to the maximum recommended for the cylinder and check for external leakage and free movement in both directions.
10. Prepare cylinder for installation by retracting piston and capping and plugging the ports.

9.5.1 Boom Hoist Cylinders

Before you disassemble the boom hoist cylinder as described in paragraphs 9.5.2 and 9.5.3, you must identify the cylinder by the manufacturer's stamping at the base of the cylinder. Refer to Fig. 9.19 and Fig. 9.20.

a. Removal

1. Support the boom, Fig. 9.18, in a horizontal position with blocking.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing severe injury.

2. Engage the park lock, place the travel select lever in neutral, and stop the engine.
3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
4. Support the cylinder with a sling or other suitable device.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

5. Remove pin and its locking capscrew and lock nut securing the boom hoist cylinder rod to the outer boom.
6. Start the engine and fully retract cylinder.
7. Disconnect the hydraulic lines from the cylinder and cap or plug the open connections.
8. Remove the pin and snap rings securing the boom hoist cylinder to the frame.
9. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.

9.5.2 "TJB" Boom Hoist Cylinder

a. Disassembly

1. Remove all dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. If necessary to replace, remove the grease fittings (5, Fig. 9.19) and plugs (4 and 6).
4. Remove the counterbalance valve (1) with O-rings (3) and backup rings (2) from tube (7).

IMPORTANT: Do not attempt to reset the boom hoist cylinder counterbalance valves. If replacement is necessary, replace both left and right hoist cylinder cartridges at the same time with new ones.

5. Using a pin spanner wrench, unscrew the gland (14) from the tube.

IMPORTANT: *Protect the finish on the rod at all times.* Damage to the surface of the rod can cause premature seal failure.

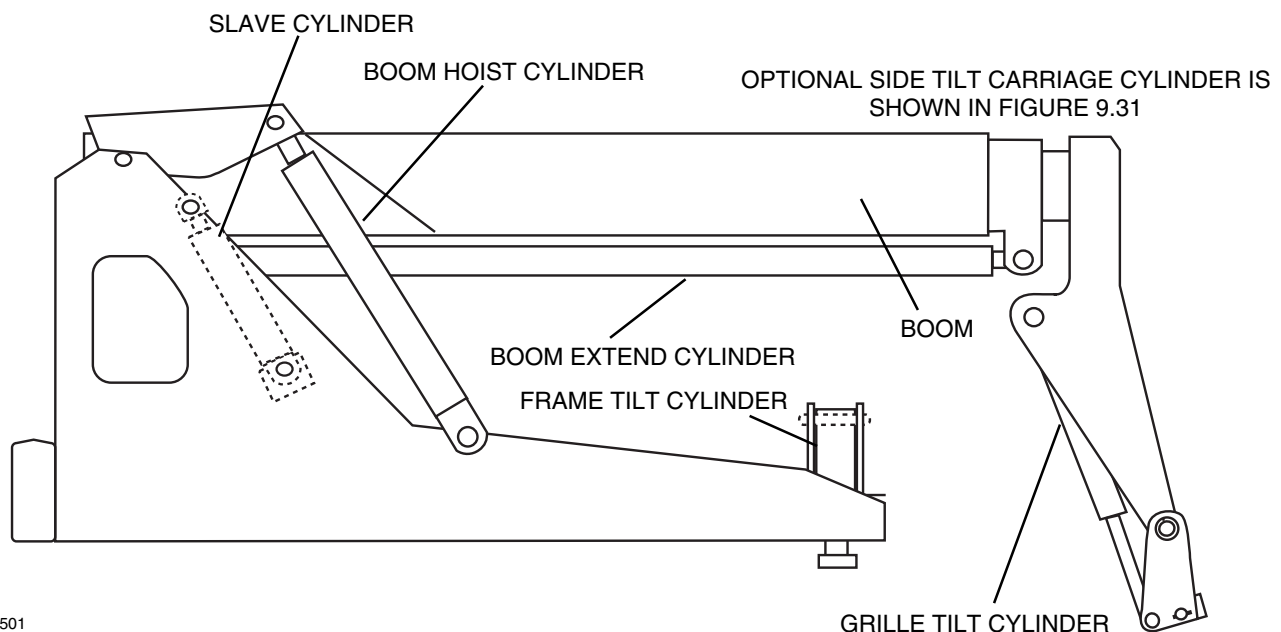
6. Pull the rod (17) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston (9). Keep the rod in line with the tube barrel to prevent binding.

7. Remove the piston seal (10) from the piston.
8. Fasten the eye end of the rod (17) in a soft-jawed vise and put a padded support below the rod near the piston to prevent damage to the rod.

NOTE: It may be necessary to apply heat to break the bond of the sealant between nut (8) and rod (17) before the piston can be removed. Refer to paragraph 9.5.a.

9. Remove the nut (8), piston (9), and gland (14) from the rod.
10. Remove the O-ring (11) from the inside of the piston.



MA0501

Fig. 9.18 Hydraulic Cylinders

11. Remove the O-ring (12), backup ring (13), wiper (16) and rod seal (15) from the gland.
12. If the bushing (18) needs replacement, support the rod (17) in a soft-jawed vise or other acceptable holding equipment. Carefully press or drive bushing from the rod eye.

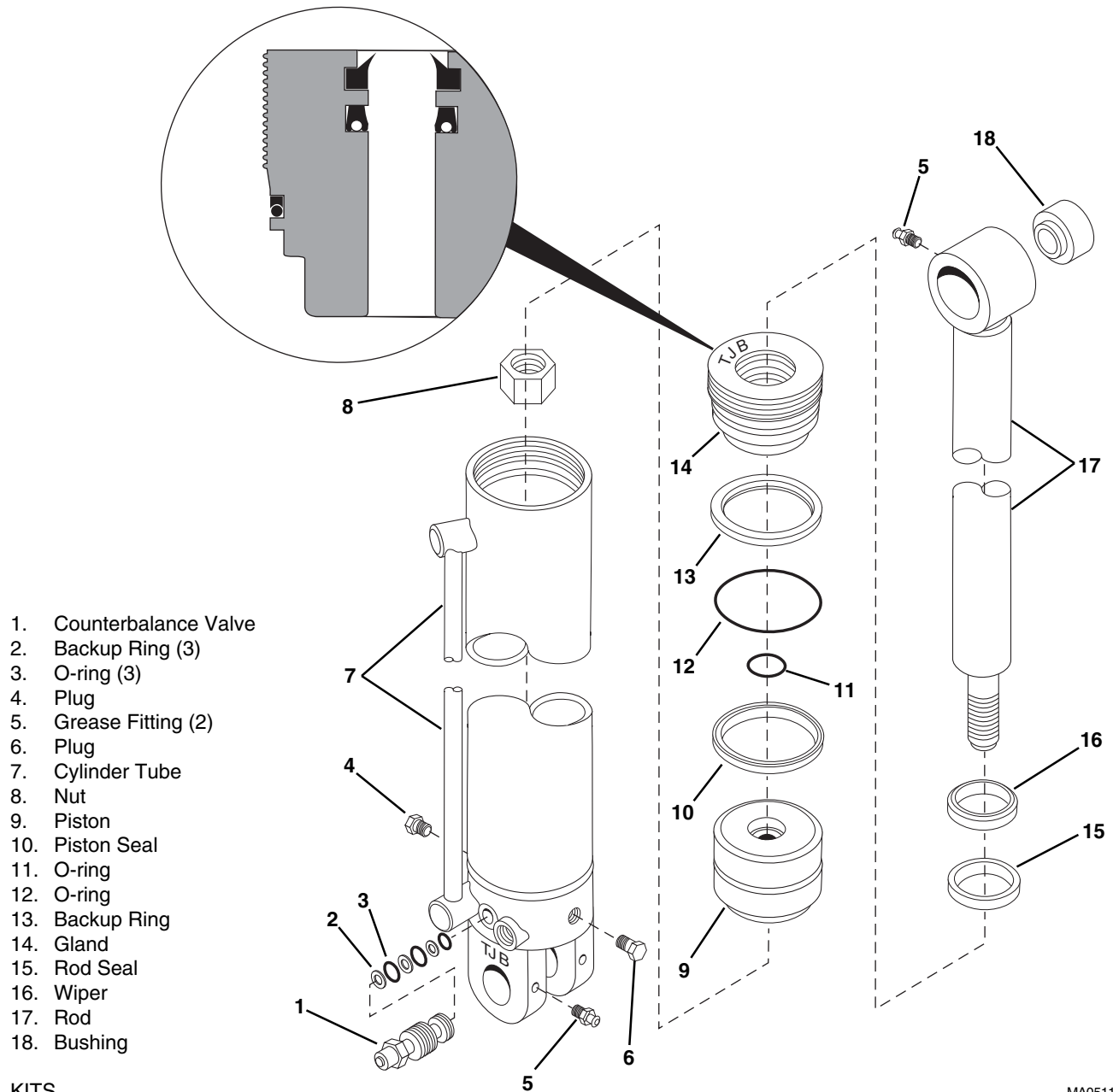
NOTE: It may be necessary to apply heat to break the bond of the sealant between bushing (18) and rod (17) before the bushing can be removed. Refer to paragraph 9.5.a.

b. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean cavities and grooves.

c. Inspection, Repair and Replacement

1. Check that the rod of the boom hoist cylinder is straight. If the rod is bent, install new rod.



KITS

Seal Kit, Boom Hoist Cylinder
(Includes Items 10, 11, 12, 13, 15, and 16)
Seal Kit, Counterbalance Valve
(Includes Items 2 and 3)

MA0511

Fig. 9.19 Exploded View of "TJB" Boom Hoist Cylinder

2. Inspect the inside of the tube for scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut and the bottom of piston with a fine file. Clean parts with trichlorethylene after repair.

d. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Apply Loctite® Primer T and Retaining Compound 609 to the outside diameter of the bushing (18, Fig. 9.19) in accordance with the manufacturer's instructions. Press the bushing into position in the eye of rod so that the bushing is located an equal distance from each side of the rod eye. Allow the compound to cure.
2. Install a new rod seal (15), wiper (16), backup ring (13) and O-ring (12) on the gland (14) as shown in Fig. 9.19.

NOTE: The wiper lips should be toward the outer end of the gland and the rod seal lips toward the inner end of the gland. Use tools that will not damage the seal or wiper. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.

3. Fasten the rod eye in a soft-jawed vise. Put a padded support below and near the other end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (17). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install new O-ring (11) into internal groove on the inside of the piston (9). Carefully push the piston (9) onto the rod to avoid damage to the O-ring.
6. Apply Loctite® Primer T and Threadlocker 271 to the threads on the nut (8) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 575 to 625 lb-ft (782 to 850 Nm). Stake the nut in four places. Allow the Threadlocker to cure.
7. Install a new piston seal (10) on the piston.
8. Fasten the tube (7) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.

9. Lubricate the inside of the tube, outside of the piston (9), seal (10), and O-ring (12) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the piston and gland in order to compress the o-rings, backup rings and seals while inserting the assembled piston, rod, and gland into the tube (7). Remove the compression tool. Using a pin spanner wrench, thread the gland into tube.

IMPORTANT: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

11. Install new O-rings (3) and backup rings (2) on counterbalance valve (1). Use new valve if the valve was removed for replacement. Lubricate outside of the valve with clean filtered hydraulic oil. Install the valve and torque to 45 lb-ft (61.2 Nm).
12. If removed for replacement, install new plugs (4 and 6) and grease fittings (5).
13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
15. Prepare the cylinder for installation by retracting the piston and capping or plugging the ports.

e. Installation

1. Lubricate the hoist cylinder pivot pins with multi-purpose lithium-based grease.
2. Using suitable lifting device, install the boom hoist cylinder, Fig. 9.18, on the forklift securing the base end to the frame with pivot pin and snap rings.
3. Remove all plugs or caps from hydraulic lines and securely tighten lines to the cylinder.
4. Have a helper start the forklift engine.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Position the hoist cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
6. Instruct the operator to raise or lower the hoist cylinder slowly until the rod end eye is aligned with the outer boom mounting holes. Secure the rod end to the boom with pivot pin and its locking capscrew and locknut.
6. Raise the boom as far as it will go; then lower it as far as it will go five times or until the operation of the boom hoist cylinders is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
8. Test boom raise/lower circuit operation as described in paragraph 9.2.2.c.

9.5.3 “BHE” Boom Hoist Cylinder

a. Disassembly

1. Remove all dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. If necessary to replace, remove the grease fitting (26, Fig. 9.20) and plugs (3, 4 and 6).
4. Remove the counterbalance valve (7) with O-rings (8, 10 and 12) and backup rings (9 and 11) from tube (2).

IMPORTANT: Do not attempt to reset the boom hoist cylinder counterbalance valves. If replacement is necessary, replace both left and right hoist cylinder cartridges at the same time with new ones.

5. Using a pin spanner wrench, unscrew the head (22) from the tube.

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

6. Pull the rod (24) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly in the tube, be careful so that head threads in the tube do not damage the piston (13). Keep the rod in line with the tube barrel to prevent binding.

7. Remove the bearing (14) and seal and expander assembly (15) from the piston.

8. Fasten the eye end of the rod (24) in a soft-jawed vise and put a padded support below the rod near the piston to prevent damage to the rod.

NOTE: It may be necessary to apply heat to break the bond of the sealant between capscrew (1) and rod (24) before the piston can be removed. Refer to paragraph 9.5.a.

9. Remove the capscrew (1), piston (13), and head (22) from the rod.
10. Remove the backup rings (16) and O-ring (17) from the inside of the piston.
11. Remove the O-ring (18), backup ring (23), O-ring (21), wiper (19) and rod seal (20) from the head.
12. If bushing (25) needs replacement, support the rod (24) in a soft-jawed vise or other acceptable holding equipment. Carefully press or drive bushing from the rod eye.

NOTE: It may be necessary to apply heat to break the bond of the sealant between bushing (25) and rod (24) before the bushing can be removed. Refer to paragraph 9.5.a.

b. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean cavities and grooves.

c. Inspection, Repair and Replacement

1. Check that the rod of the boom hoist cylinder is straight. If the rod is bent, install new rod.
2. Inspect the inside of the tube for scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut and the bottom of piston with a fine file. Clean parts with trichlorethylene after repair.

d. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c

1. Apply Loctite® Primer T and Retaining Compound 609 to the outside diameter of the bushing (25, Fig. 9.20) in accordance with the manufacturer's instructions. Press the

bushing into position in the eye of rod so that the bushing is located an equal distance from each side of the rod eye. Allow the compound to cure.

2. Install a new rod seal (20), wiper (19), O-ring (21), backup ring (23) and O-ring (18) on the head (22) as shown in Fig. 9.20.

NOTE: *The wiper lips should be toward the outer end of the head and the rod seal lips toward the inner end of the head. Use tools that will not damage the seal or wiper. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.*

3. Fasten the rod eye in a soft-jawed vise. Put a padded support below and near the other end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (24). If necessary, use a soft hammer to drive the head onto the rod.
5. Install new backup ring (16) and an O-ring (17) into internal groove on the inside of the piston (13). Carefully push the piston onto the rod to avoid damage to the O-ring.
6. Apply Loctite® Threadlocker 242 to the threads on the capscrew (1) in accordance with manufacturer's instructions. Install the capscrew in the rod and torque to 2,250 lb-ft (311 Nm). Allow Threadlocker to cure.
7. Install a new bearing (14) and seal and expander assembly (15) on the piston.
8. Fasten the tube (2) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
9. Lubricate the inside of the tube, outside of the piston, bearing (14) and seal and expander assembly (15) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the piston and head in order to compress the o-rings, backup rings and seals while inserting the assembled piston, rod, and head into the tube (2). Remove the compression tool. Using a pin spanner wrench, thread the head into tube.

IMPORTANT: *When sliding the rod and piston assembly into the tube, be careful so that head threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.*

11. Install new O-rings (8, 10 and 12) and backup rings (9 and 11) on counterbalance valve (7). Use new valve if the valve was removed for

replacement. Lubricate outside of the valve with clean filtered hydraulic oil. Install the valve and torque to 45 lb-ft (61.2 Nm).

12. If removed for replacement, install new plugs (3, 4 and 6) and grease fitting (26).
13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
15. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

e. Installation

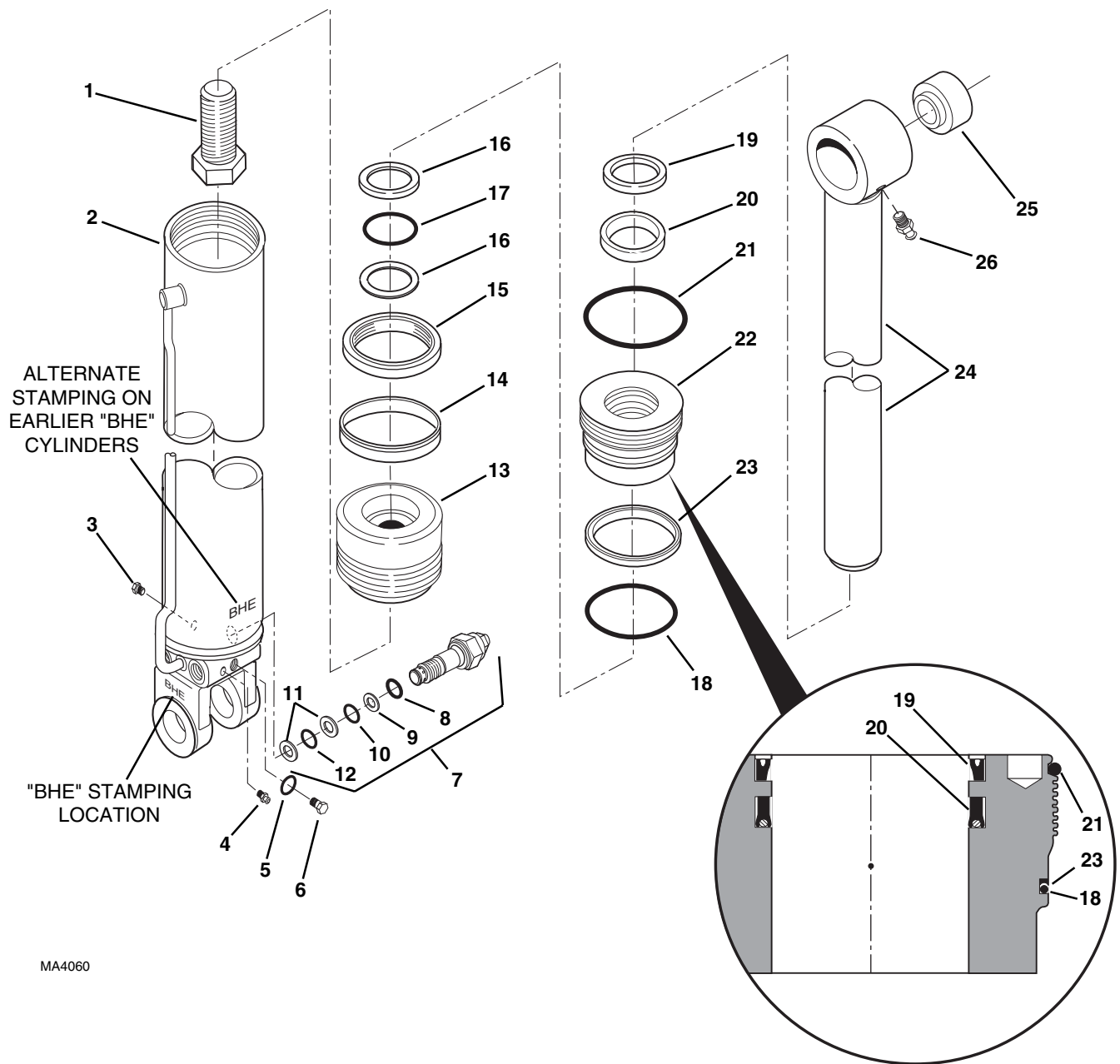
1. Lubricate the hoist cylinder pivot pins with multi-purpose lithium-based grease
2. Using suitable lifting device, install the boom hoist cylinder, Fig. 9.18, on the forklift securing the base end to the frame with pivot pin and snap rings.
3. Remove all plugs or caps from hydraulic lines and securely tighten lines to the cylinder.
4. Have a helper start the forklift engine.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

5. Position the hoist cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
6. Instruct the operator to raise or lower the hoist cylinder slowly until the rod end eye is aligned with the outer boom mounting holes. Secure the rod end to the boom with pivot pin and its locking capscrew and locknut.
6. Raise the boom as far as it will go; then lower it as far as it will go five times or until the operation of the boom hoist cylinders is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
8. Test boom hoist/lower circuit operation as described in paragraph 9.2.2.c.



1. Hex Head Capscrew
2. Barrel
3. Sealing Plug
4. Sealing Plug
5. O-Ring
6. Plug
7. Counterbalance Valve Cartridge
8. O-Ring
9. Backup Ring
10. O-Ring
11. Backup Ring (2)
12. O-Ring
13. Piston
14. Bearing
15. Seal and Expander Assembly
16. Backup Ring (2)

17. O-Ring
18. O-Ring
19. Wiper
20. Rod Seal
21. O-Ring
22. Head
23. Backup Ring
24. Rod and Bushing (Includes Item 25)
25. Bushing
26. Grease Fitting

KITS

- Seal Kit, Boom Hoist Cylinder
(Includes Items 5, 8 thru 12, 14 thru 21, and 23)
- Seal Kit, Counterbalance Valve
(Includes Items 8 thru 12)

Fig. 9.20 Exploded View of "BHE" Boom Hoist Cylinder

9.5.4 Boom Extend Cylinder

Before you disassemble the boom extend cylinder as described in paragraphs 9.5.5 and 9.5.6, you must identify the cylinder by manufacturer's stamping at the base of the cylinder. Refer to Fig. 9.22 and 9.23.

a. Removal

1. Retract the boom and support it in a horizontal and level position with blocking.
2. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

4. Disconnect the hydraulic lines from the extend cylinder and cap or plug open connections.
5. Support the extend cylinder with a sling or other suitable device.
6. Remove the rod end pin and retaining rings attaching the rod end of the extend cylinder to the intermediate boom.
7. Remove the base end pin and retaining rings securing the base end of the cylinder to the outer boom.
8. Remove the cylinder from the forklift using a strap sling and hoist or other suitable equipment.

9.5.5 "TJB" Boom Extend Cylinder

a. Disassembly

1. Remove all dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.

3. Remove the counterbalance valve (14, Fig. 9.22), pilot check valve (15) and related O-rings (18) and backup rings (19) from the tube (13).

IMPORTANT: Do not attempt to reset the extend cylinder counterbalance valve cartridge. If replacement is necessary, replace the cartridge with a new one.

4. Using a pin spanner wrench, unscrew the gland (12, Fig. 9.22) from the tube (13).

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

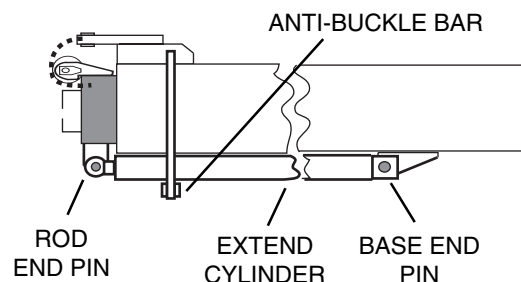
5. Pull the rod and piston assembly straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly out of the tube, be careful so that gland threads in the tube do not damage the piston (5). Keep the rod in line with the tube barrel to prevent binding.

6. Remove piston seal (4) from the piston.

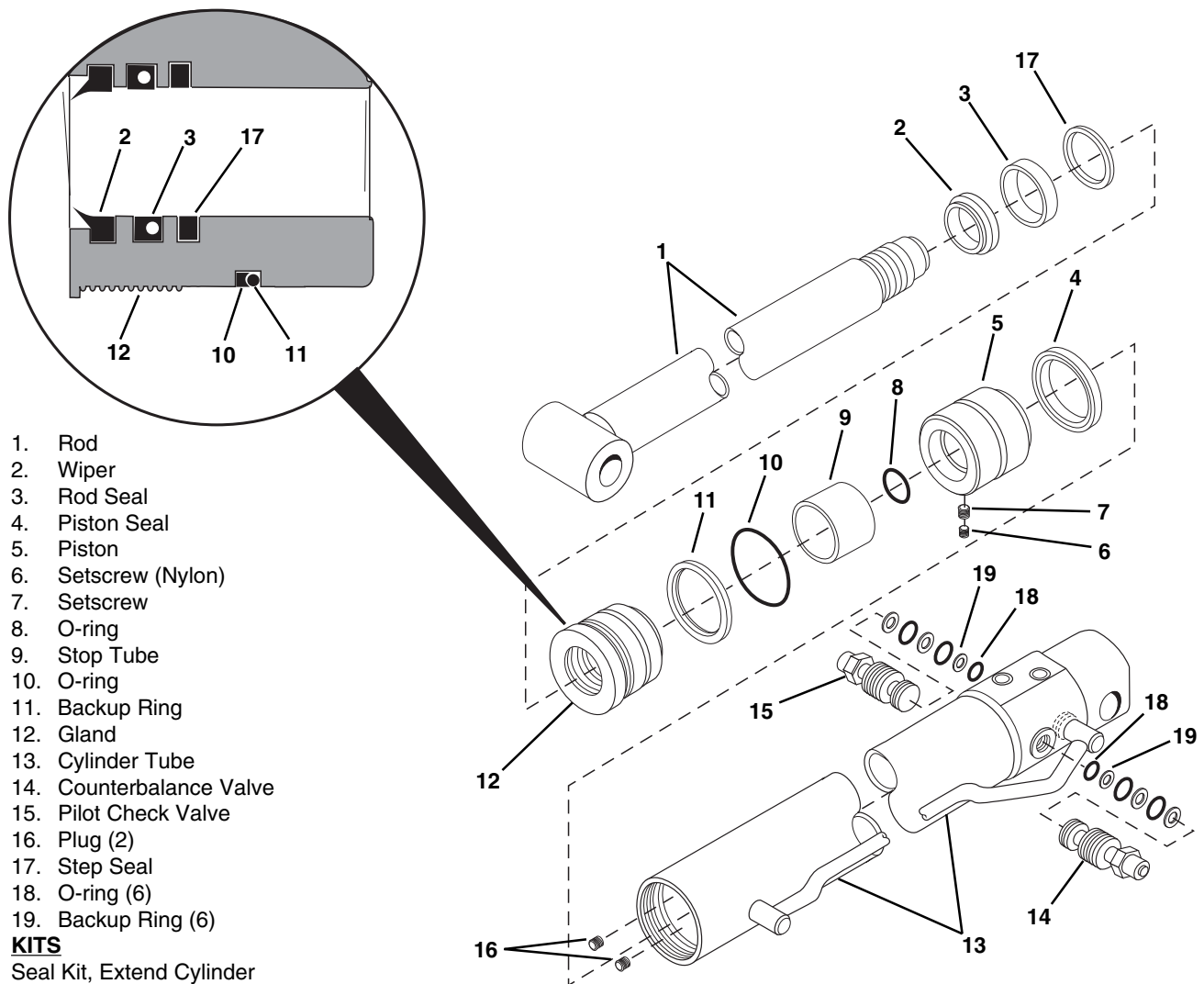
NOTE: It may be necessary to apply heat to break the bond of the sealant between piston (5), setscrew (6) and rod (1) before the piston can be removed. Refer to paragraph 9.5.a.

7. Remove setscrew (7) and nylon setscrew (6) securing piston (5) in place on rod (1).
8. Unscrew the piston from rod. Remove O-ring (8) from inside of the piston.
9. Slide stop tube (9) and gland (12) from the rod.
10. Remove O-ring (10), backup ring (11), wiper (2), rod seal (3), and step seal (17) from the gland.
11. If necessary, remove the plugs (16) from bottom inside of the tube (13)



MA0521

Fig. 9.21 Boom Extend Cylinder Removal



MA0531

Fig. 9.22 Exploded View of "TJB" Boom Extend Cylinder

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube for deep scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Install a new O-ring (10), backup ring (11), wiper (2), rod seal (3), and step seal (17) on the gland as shown in Fig. 9.12.

NOTE: Wiper lip should be toward outer end of gland and rod seal lips (3) and the step of step seal (17) toward the inner end of the gland. Use tools that will not damage the seals. If the backup ring (11) is not flat on both sides, the side with the arc must be toward O-ring (10).

2. Fasten the rod eye in a soft-jawed vise. Place a padded support below and near end of rod to prevent damage to rod (1).

3. Slide the assembled gland and seals onto the rod. If necessary, use a soft hammer to drive the gland on the rod.
 4. Slide the stop tube (9) onto the rod.
 5. Install new O-ring (8) inside internal groove on inside of piston.
 6. Apply Loctite® Primer T and compound 609 to inside threads of piston in accordance with manufacturer's instructions. Carefully screw piston completely onto rod.
 7. Apply Loctite® Threadlocker 242 to setscrews (6 and 7) and install them in the piston.
 8. Install O-ring (8) inside the internal groove of the stop tube and slide stop tube (9) down the rod and against the piston.
 9. Install new piston seal (4) on piston.
 10. Fasten cylinder tube (13) in a soft-jawed vise or other acceptable holding equipment.
 11. If removed, install two plugs (16) in the bottom of the cylinder tube.
 12. Lubricate inside of the tube and outside of the piston and gland with clean hydraulic oil.
 13. Apply a compression sleeve or other suitable tool to the gland and piston in order to compress O-rings, backup rings and seals while inserting the assembled piston, rod and gland into the tube (13). Remove the compression tool. Using a pin spanner wrench, thread the gland into tube.
- IMPORTANT:** When sliding the rod and piston assembly in the tube, be careful so that head threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.
14. Install new O-rings (18) and backup rings (19) on the counterbalance valve (14) and pilot check valve (15). Use new valves if either or both valves were removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque them to 45 lb-ft (61,2 Nm).
 15. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
 16. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.

17. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

b. Installation

1. Using suitable lifting device, install the boom extend cylinder, Fig. 9.21, on the forklift securing the base end of the extend cylinder to the outer boom with a pin and retaining rings and the rod end through the anti-buckle bar.
2. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.
3. Have a helper start the forklift engine.



Warning

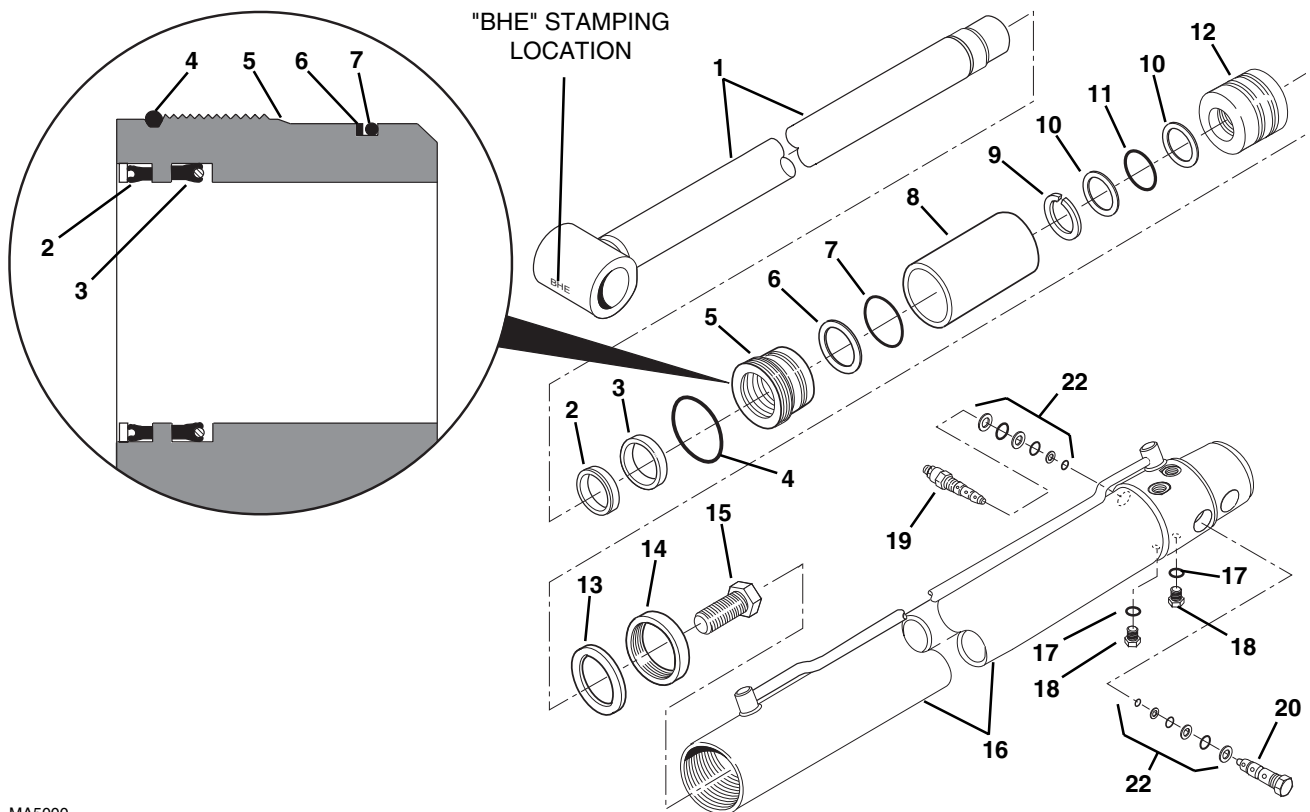
Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Position the extend cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
5. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the intermediate boom mounting holes. Secure the rod end to the boom with pin and retaining rings.
6. Extend the boom as far as it will go; then the retract it as far as it will go five times or until the operation of the boom extend cylinder is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
8. Test boom extend/retract circuit operation as described in paragraph 9.2.3.c.

9.5.6 “BHE” Boom Extend Cylinder

a. Disassembly

1. Remove all dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. Remove the counterbalance valve (19, Fig. 9.23), pilot check valve (20) and related O-rings and backup rings (seal kits) from the tube (16).



MA5000

- | | | | |
|----------------|----------------------------|--------------------------|--|
| 1. Rod | 8. Spacer | 14. Bearing | 21. Seal Kit, Boom Extend Cylinder (Includes Items 2, 3, 4, 6, 7, 10, 11, 13, 14, 17) |
| 2. Wiper | 9. Snap Ring | 15. Hex Head Capscrew | 22. Seal Kit, Counterbalance & Pilot Check Valve (Includes 3 O-Rings & 3 Backup Rings) |
| 3. Rod Seal | 10. Backup Ring (2) | 16. Tube | |
| 4. O-Ring | 11. O-Ring | 17. O-Ring | |
| 5. Head | 12. Piston | 18. Plug | |
| 6. Backup Ring | 13. Seal/Expander Assembly | 19. Counterbalance Valve | |
| 7. O-Ring | | 20. Pilot Check Valve | |

Fig. 9.23 Exploded View of "BHE" Boom Extend Cylinder

IMPORTANT: Do not attempt to reset the extend cylinder counterbalance valve cartridge. If replacement is necessary, replace the cartridge with a new one.

4. Using a pin spanner wrench, unscrew the head (5, Fig. 9.23) from the tube (16).

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

5. Pull the rod and piston assembly straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly out of the tube, be careful so that gland threads in the tube do not damage the piston (12). Keep the rod in line with the tube barrel to prevent binding.

6. Remove seal/expander assembly (13) from the piston.

NOTE: It may be necessary to apply heat to break the bond of the sealant between piston (12), and rod (1) before the piston can be removed. Refer to paragraph 9.5.a.

7. Remove capscrew (15) and pull the piston from rod.
8. Remove O-ring (11) and backup rings (10) from inside of the piston.
9. Pull spacer (8) and head (5) from the rod and remove snap ring (9) from inside of the spacer.
10. Remove O-ring (7), backup ring (6) wiper (2), rod seal (3), and O-ring (4) from the head.

11. If necessary remove the plugs (18) and O-rings (17) from the tube (16).

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube for deep scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.

a. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Install a new O-ring (7), backup ring (6), wiper (2), rod seal (3), and O-ring (4) on the head as shown in Fig. 9.23.

NOTE: Lip of wiper (2) should be toward outer end of head and rod seal (3) toward the inner end of the head. Use tools that will not damage the seals. If the backup ring (6) is not flat on both sides, the side with the arc must be toward o-ring (7).

2. Fasten the rod eye in a soft-jawed vise. Place a padded support below and near end of rod to prevent damage to rod (1).
3. Slide the assembled head and seals onto the rod. If necessary, use a soft hammer to drive the head on the rod.
4. Install the snap ring (9) inside of the spacer (8) and slide the spacer onto rod.
5. Install new backup rings (10) and o-ring (11) inside internal groove on inside of piston (12).
6. Apply Loctite® Threadlocker 242 to capscrew (15) and screw capscrew into the rod and torque to 950 lb-ft (1288,2 Nm).
7. Install a new seal/expander assembly (13) and bearing (14) on piston.
8. Fasten cylinder tube (16) in a soft-jawed vise or other acceptable holding equipment.

9. If removed, install two O-rings (17) and two plugs (18) in the bottom of the cylinder tube.
10. Lubricate inside of the tube and outside of the piston and head with clean hydraulic oil.
11. Apply a compression sleeve or other suitable tool to the head and piston in order to compress O-rings, backup rings and seals while inserting the assembled piston, rod and head into the tube (16). Remove the compression tool. Using a pin spanner wrench, thread the head into tube.

IMPORTANT: When sliding the rod and piston assembly in the tube, be careful so that head threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

12. Install new O-rings and backup rings (22) on the counterbalance valve (19) and pilot check valve (20). Use new valves if either or both valves were removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque them to 45 lb-ft (61,2 Nm).
13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
17. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

b. Installation

1. Using suitable lifting device, install the boom extend cylinder, Fig. 9.21, on the forklift securing the base end of the extend cylinder to the outer boom with a pin and retaining rings and the rod end through the anti-buckle bar.
2. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.

3. Have a helper start the forklift engine.

Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Position the extend cylinder so that the rod is aligned with the rod end mounting holes as much as possible.
5. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the intermediate boom mounting holes. Secure the rod end to the boom with pin and retaining rings.
6. Extend the boom as far as it will go; then the retract it as far as it will go five times or until the operation of the boom extend cylinder is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
8. Test boom extend/retract circuit operation as described in paragraph 9.2.3.c.

9.5.7 Slave Cylinder

a. Removal

1. Raise the boom as required to provide access to the slave cylinder, Fig. 9.18.

Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Engage the park lock, place the travel select lever in neutral, and stop the engine.

Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.

4. Support the slave cylinder with a sling or other suitable device.
5. Remove the capscrew and locknut securing the slave cylinder rod to the outer boom.
6. Start engine and fully retract slave cylinder.
7. Disconnect the hydraulic lines from the cylinder and cap or plug open connections.
8. Remove the retaining ring and pin securing the slave cylinder tube to the frame.
9. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.

b. Disassembly

1. Remove all dirt and grease from cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. If necessary to replace, remove grease fittings (13 and 14, Fig. 9.24)

NOTE: It may be necessary to apply heat to break the bond of the sealant between bushings (1) and rod (12) and tube (2) before the bushings can be removed. Refer to paragraph 9.5a.

4. Carefully press or drive out the bushings (1).
5. Using a pin spanner wrench, unscrew the gland (4) from the cylinder tube (2).

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

6. Pull the rod (12) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly out of the tube, be careful so that gland threads in the cylinder tube do not damage the piston (9). Keep the rod in line with the tube barrel to prevent binding.

7. Remove the piston seal (8) from the piston .
8. Fasten the eye end of the rod in a soft-jawed vise and put a padded support below and near the other the end of the rod to prevent damage to the rod.

NOTE: It may be necessary to apply heat to break the bond of the sealant between nut (3) and rod (12) before the piston can be removed. Refer to paragraph 9.5.a.

9. Remove the nut (3), piston (9), and gland (4) from the rod.

10. Remove the O-ring (7) from inside of the piston.
11. Remove the O-ring (6), backup ring (5), wiper (11) and rod seal (10) from the gland (4).

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod (12, Fig. 9.24) is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube (2) for scoring and other damage. If there is any damage to tube, replace it with new tube.
3. Remove small scratches on the rod or inside the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (3) and the bottom of piston (9) with fine file. Clean parts with trichlorethylene after repair.

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Install new O-ring (6, Fig. 9.24), backup ring (5), wiper (11), and rod seal (10) on the gland (4) as shown in Fig. 9.24.

NOTE: Wiper lip should be toward outer end of gland and piston seal lips toward the inner end of the gland. Use tools that will not damage the seal. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.

2. Fasten the piston rod eye in a vise and put a padded support below and near other end of rod to prevent damage to the rod.
3. Push the assembled gland onto the rod (12). If necessary, use a soft hammer to drive the gland on the rod.
4. Install new O-ring (7) inside of piston (9). Carefully install piston on rod to avoid damage to the O-ring.
5. Apply Loctite® Primer T and Retaining Compound 271 to the threads of the locknut (3) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 450 to 500 lb-ft (610 to 678 Nm). Stake the nut in four places and allow sealants to cure.

6. Install new piston seal (8) on the piston.
7. Fasten cylinder tube (2) in a soft-jawed vise or other suitable holding equipment. Be careful not to damage the tube.
8. Lubricate inside of the tube, piston, and gland O-ring (6) with clean hydraulic oil.
9. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (6) on the gland. Insert the assembled piston, rod and gland into the tube (2). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool.

IMPORTANT: When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

10. Apply Loctite® Primer T and Retaining Compound 609 to outside diameter of bushings (1) in accordance with manufacturer's instructions. Press bushings into both the eye of rod and eye of cylinder tube so that the bushing is located an equal distance from each side of the rod eye. Allow the compound to cure.
11. If removed, install grease fittings (13 and 14).
12. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
13. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
14. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Lubricate the pivot pin with multi-purpose lithium-based grease.
2. Using suitable lifting device, install the slave cylinder, Fig. 9.18, on the forklift securing the base end to the frame with a pin and snap rings.
3. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.
4. Have a helper start the forklift engine.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

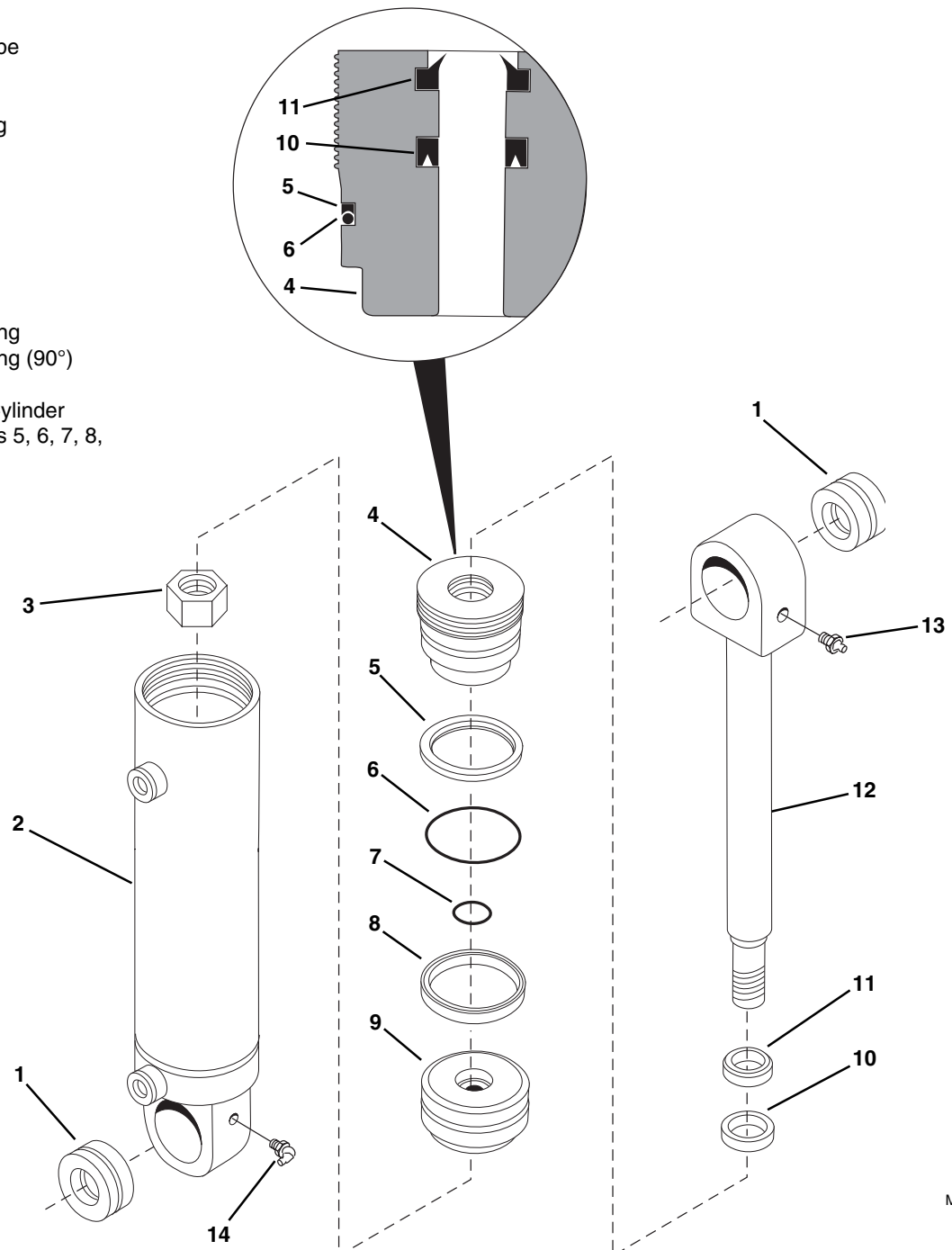
5. Position the slave cylinder so that the rod is aligned with the rod end mounting holes as much as possible.

1. Bushing (2)
2. Cylinder Tube
3. Locknut
4. Gland
5. Backup Ring
6. O-ring
7. O-ring
8. Piston Seal
9. Piston
10. Rod Seal
11. Wiper
12. Rod
13. Grease Fitting
14. Grease Fitting (90°)

KITS

Seal Kit, Slave Cylinder
(Includes Items 5, 6, 7, 8,
10, and 11)

6. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the outer boom mounting holes. Secure the slave cylinder to the outer boom with its locking capscrew and locknut.
7. Tilt grille (forks) up fully, then down fully and then approximately level. Raise the boom as far as it will go; then lower it as far as it will go five times while observing the grille. The grille should hold in the same position during boom raising and lowering in the last two cycles.



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Fig. 9.24 Slave Cylinder Exploded View

8. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/Operators Manual.
9. Test grille tilt circuit operation as described in paragraph 9.4.2.c.

9.5.8 Grille Tilt Cylinder

a. Removal

1. Remove any attachment from the quick attach assembly.
2. Tilt the quick attach assembly fully forward and lower it, face down, to the ground
3. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

4. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



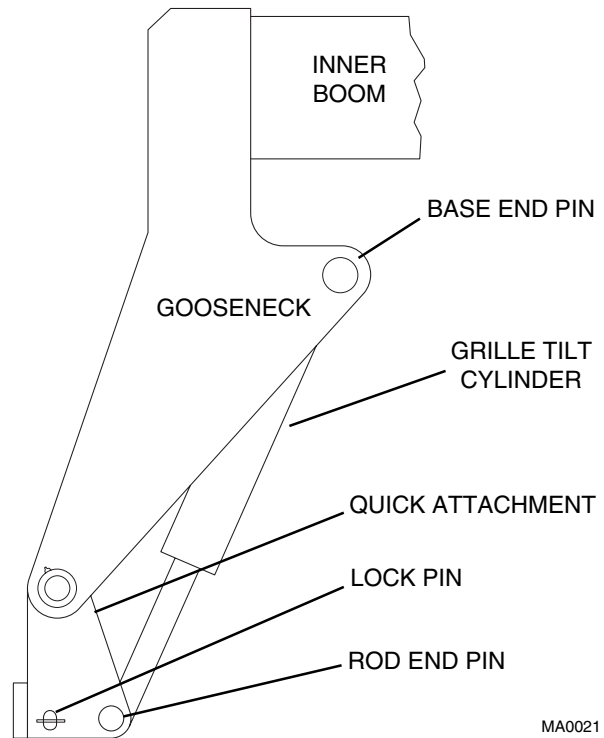
Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

5. Remove the rod end pin, Fig. 9.25, and its locking capscrew and locknut securing the grille tilt cylinder rod to the quick attach.
6. Start the engine and fully retract grille tilt cylinder.
7. Disconnect the hydraulic lines from the cylinder and cap or plug open connections.
8. Support the cylinder and then remove the pin and snap rings securing the grille tilt cylinder tube to the gooseneck.
9. Remove cylinder from forklift using strap sling and hoist or other suitable lifting equipment.

b. Disassembly

1. Remove all dirt and grease from cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.



MA0021

Fig. 9.25 Grille Tilt Cylinder Gooseneck

3. If necessary to replace, remove the grease fittings (14 and 15).
4. Remove the counterbalance valve (13, Fig. 9.26) and three O-rings (16) and backup rings (17) from the tube.
5. Using a pin spanner wrench, unscrew the gland (8) from the tube.

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

6. Pull the rod (11) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston (4). Keep the rod in line with the tube barrel to prevent binding.

7. Remove piston seal (3) from piston (4).
8. Fasten the eye of the rod in a soft-jawed vise and put a padded support below and near other end of rod to prevent damage to the rod.

NOTE: It may be necessary to apply heat to break the bond of the sealant between nut (2) and rod (11) before the piston can be removed. Refer to paragraph 9.5.a.

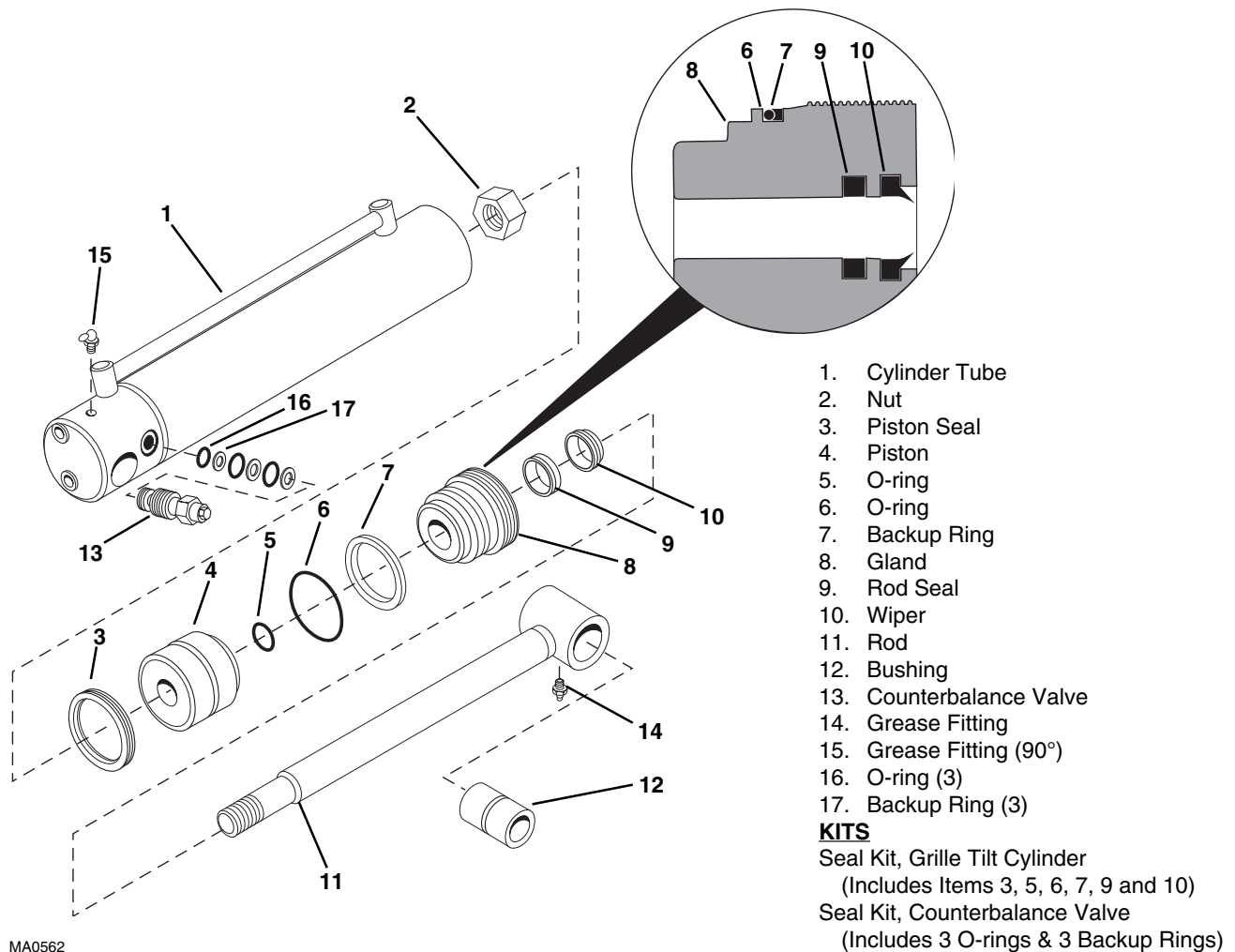


Fig. 9.26 Grille Tilt Cylinder Exploded View

9. Remove nut (2), piston (4), and the gland (8) from the rod.
10. Remove the O-ring (5) from inside of the piston.
11. Remove the O-ring (6), backup ring (7), wiper (10) and rod seal (9) from the gland.
12. If the bushing (12) needs replacement, support the rod (11) in a soft-jawed vise or other acceptable holding device. Carefully press the bushing from the rod.
2. Inspect inside of the tube (1) for scoring and other damage. If there is any damage to the tube, replace it with a new tube.
3. Remove small scratches on piston rod or inside of tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (2) and bottom of the piston (4) with a fine file. Clean parts with trichlorethylene after repair.

c. Cleaning

1. Discard all seals and backup rings. Replace them with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that the rod (11, Fig. 9.26) is straight. If the rod is bent, install new rod.

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Press the bushing (12, Fig. 9.26) into position in the eye of the rod (11) so that the grease groove runout is located toward the center of the eye.
2. Install new O-ring (6), backup ring (7), wiper (10), and rod seal (9) on the gland (8) as shown in Fig. 9.26.

NOTE: Wiper lip should be toward outer end of gland and seal lips toward the inner end of the gland. Use tools that will not damage the seals. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.

3. Fasten the eye of the rod in a soft-jawed vise. Put a padded support below and near end of rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (11). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install new O-ring (5) inside of piston (4). Carefully install the piston on the rod to avoid damage to the O-ring.
6. Apply Loctite® Primer T and Threadlocker 271 to the nut (2) in accordance with the manufacturer's instructions. Install the nut on the piston rod and torque to 450 to 500 lb-ft (610 to 678 Nm). Stake the nut in four places. Allow the compound to cure.
7. Install new piston seal (3) on the piston.
8. Fasten the tube (1) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
9. Lubricate inside of the cylinder tube, piston, and gland O-ring (6) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (6) on the gland. Insert the assembled piston, rod and gland into the tube (1). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool

IMPORTANT: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

11. Install new O-rings (16) and backup rings (17) on the counterbalance valve (13). Use new valve if the valve was removed for replacement. Lubricate outside of the valve with clean filtered hydraulic oil. Install the valve and torque to 45 lb-ft (61 Nm).
12. If removed, install grease fittings (14 and 15).
13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,8 bar) to be sure the piston and rod are moving freely in both directions.

14. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.

15. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Lubricate the rod end pin with a good grade of multi-purpose lithium-based grease.
2. Using a suitable lifting device, install the grille tilt cylinder, Fig. 9.18, on the forklift securing the tube end to the gooseneck, Fig. 9.25, with a pin and snap rings.
3. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Have a helper start forklift engine.
5. Position the grille tilt cylinder so that the rod is aligned with the rod end mounting holes in quick attach as much as possible.
6. Instruct the operator to extend or retract the cylinder slowly until the rod end eye is aligned with the quick attach mounting holes. Secure the rod end of the cylinder to the quick attach with pin, capscrew and locknut.
7. Raise the boom up so that you can observe the grille. Tilt the grille all the way back, then all the way forward. Repeat this cycle at least five times or until the operation of the grille tilt circuit is normal (no jerking or spongy feel).
8. Tilt grille (forks) up fully, then down fully and then approximately level. Raise the boom as far as it will go; then lower it as far as it will go five times while observing the grille. The grille should hold in the same position during boom raising and lowering in the last two cycles.
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/Operators Manual.
10. Test grille tilt circuit operation as described in paragraph 9.4.2.c.

9.5.9 Frame Tilt Cylinder

a. Removal

1. Level the frame. Place blocking between frame and axle to maintain machine stability when frame tilt cylinder is removed.
2. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.
4. Remove the snap rings locking the rod end pin in the axle mounting block. Tap the pin from the mounting block.
5. Start the engine and fully retract the frame tilt cylinder. Then shut engine OFF.



Warning

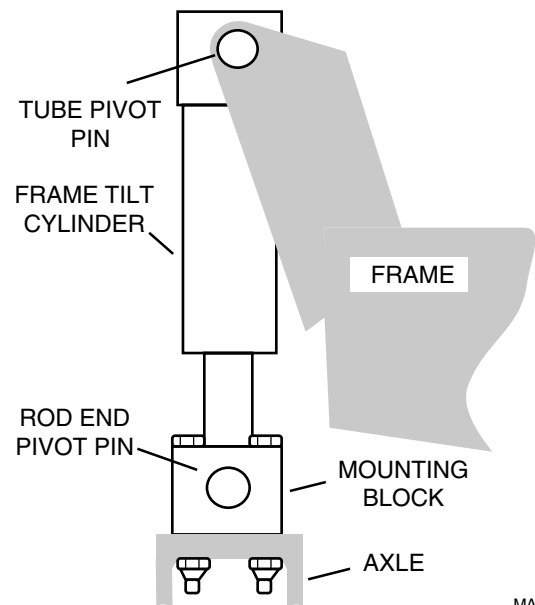
Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Disconnect the hydraulic lines from cylinder and cap or plug open connections.
7. Remove the snap rings and pin securing the frame tilt cylinder tube to the frame, Fig. 9.27.
8. Remove the frame tilt cylinder from the forklift using a strap sling and hoist or other suitable equipment.

b. Disassembly

1. Remove all dirt and grease from cylinder.
2. Fasten the frame tilt cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. Remove both check valves (1, Fig. 9.28) and related O-rings (15) and backup rings (16).
4. Using a pin spanner wrench, unscrew the gland (8) from the tube.

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.



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Fig. 9.27 Frame Tilt Cylinder Pivot Pins

5. Pull the rod (13) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly in the tube, be careful so that gland threads in the tube do not damage the piston (5). Keep the rod in line with the tube barrel to prevent binding.

6. Fasten the eye of rod (13) in a soft-jawed vise and put a padded support below and near other end of the rod to prevent damage to the rod.

7. Remove piston seal (7) from the piston.

NOTE: It may be necessary to apply heat to break the bond of the sealant between nut (4) and rod (13) before the piston can be removed. Refer to paragraph 9.5.a.

8. Remove nut (4), piston (5), and the gland (8) from the rod.
9. Remove O-ring (6) from inside of the piston.
10. Remove O-ring (9), backup ring (10), wiper (12) and rod seal (11) from the gland.
11. If necessary to replace, remove grease fittings (14) and plugs (2).

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (13, Fig. 9.28) is straight. If the rod is bent, install new rod.
2. Inspect inside of the tube (3) for scoring and other damage. If the tube is damaged, replace with new tube.
3. Remove small scratches on the rod or inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (4) and the

1. Check Valve (2)
2. Plug (2)
3. Cylinder Tube
4. Nut
5. Piston
6. O-ring
7. Piston Seal
8. Gland
9. O-ring
10. Backup Ring
11. Rod Seal
12. Wiper
13. Rod
14. Grease Fitting (2)
15. O-ring (6)
16. Backup Ring (6)

KITS

Seal Kit, Frame Tilt Cylinder (Includes Items 6, 7, and 9 thru 12)

Seal Kit, Check Valve
(Includes 3 O-rings & 3 Backup
Rings)

bottom of the piston (5) with a fine file. Clean parts with trichlorethylene after repair.

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. If removed, install the plugs (2) and grease fittings (14).
2. Install new O-ring (9, Fig. 9.28), backup ring (10), wiper (12), and rod seal (11) on gland (8) as shown in Fig. 9.28.

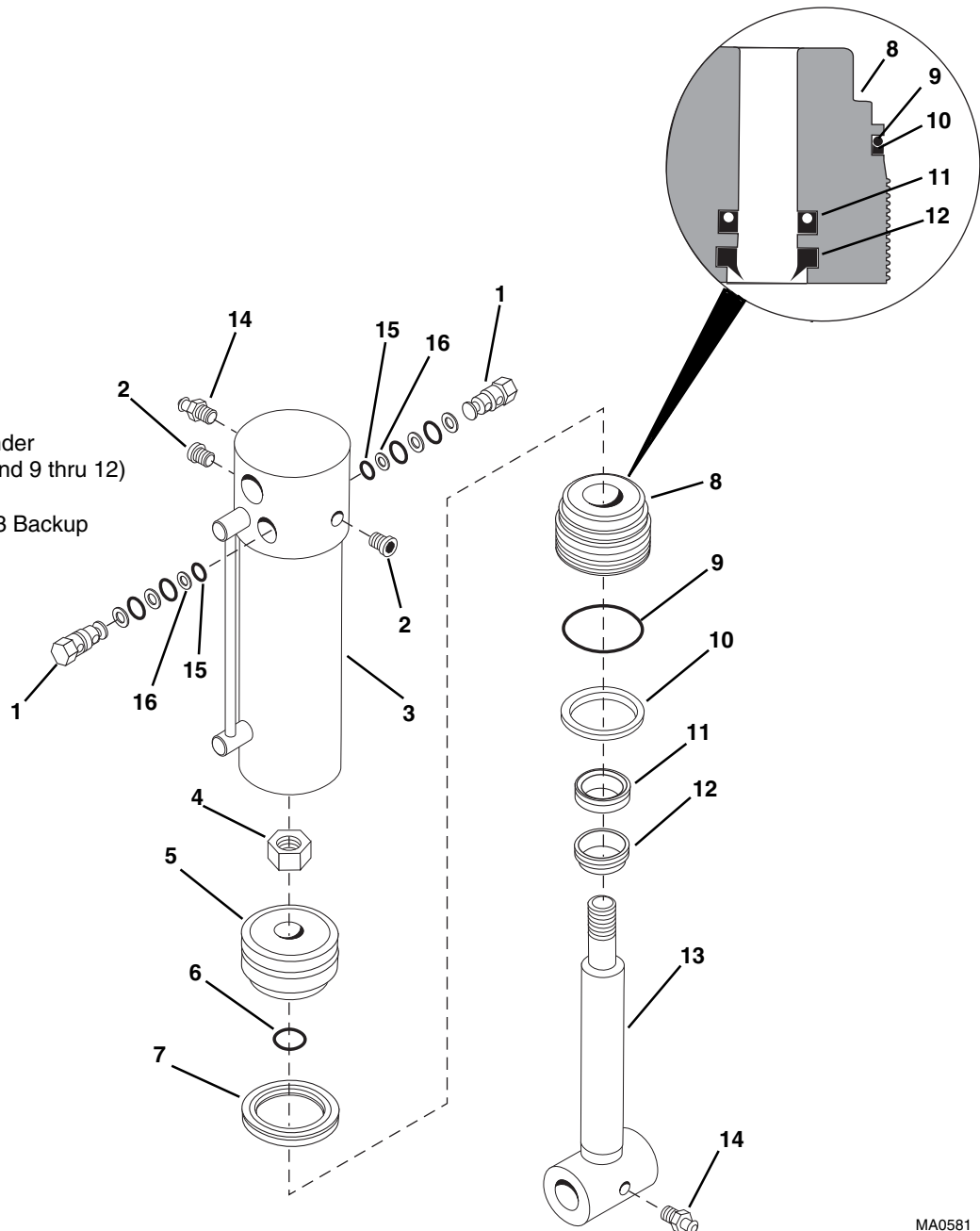


Fig. 9.28 Frame Tilt Cylinder Exploded View

NOTE: The wiper lip should be toward the outer end of the gland and seal lips toward the inner end of the gland. Use tools that will not damage the seals. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.

3. Fasten the eye of the rod in a soft-jawed vise and put a padded support below the other end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (13). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install new O-ring (6) inside of the piston (5).
6. Install the piston on rod.
7. Apply Loctite® Primer T and Threadlocker 271 to the nut (2) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 400 to 450 lb-ft (542 to 610 Nm). Stake the nut in four places.
8. Install a new piston seal (7) on the piston.
9. Fasten the cylinder tube (3) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
10. Lubricate the inside of the tube, piston, and gland O-ring (9) with clean hydraulic oil.
11. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (9) on the gland. Insert the assembled piston, rod and the gland into the tube (3). Remove the compression tool. Using a pin spanner wrench, thread the gland into the tube.

IMPORTANT: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

12. Install new O-rings (15) and backup rings (16) on check valves (1). Use new valves if either valve was removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque to 30 to 35 lb-ft (40,7 to 47,5 Nm).
13. If removed, install plugs (2) and grease fittings (14).
14. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.

15. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.

16. Prepare the cylinder for installation by retracting the piston and capping or plugging the ports.

f. Installation

1. Lubricate the frame tilt cylinder pivot pins with multi-purpose lithium-based grease
2. Using suitable lifting device, install the frame tilt cylinder, Fig. 9.18, on the forklift securing the rod end to the axle mounting block with pivot pin and snap rings.
3. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Have a helper start the forklift engine.
5. Position the frame tilt cylinder so that the base end is aligned with the rod end mounting holes in the frame as much as possible.
6. Instruct the operator to extend or retract the frame tilt cylinder slowly until the base end eye is aligned with the frame mounting holes. Secure the base end to the frame with pivot pin and snap rings.
7. Remove blocking from between axle and frame.
8. Using the fork and frame tilt control lever, tilt the frame full right, then full left at least five complete cycles or until operation of the frame tilt circuit is normal (no jerking or spongy feeling).
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/Operators Manual.
10. Test frame tilt circuit operation as described in paragraph 9.4.3.c.

9.5.10 Steering Cylinder (S/N 3101 & Before)

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Disconnect the hydraulic lines from the steering cylinder and cap or plug open connections.
4. Remove cotter pins (1, Fig. 9.29) and nuts (2) securing the cylinder socket assemblies (3) to carrier (4) and knuckle (5).
5. The steer cylinder socket is a taper fit in knuckle. Use an impact fork to release the socket from the knuckle.
6. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.
7. Measure the total length of the fully retracted cylinder with sockets in place and note or record the distance. Loosen socket clamp and unscrew the socket assembly from the cylinder (3).

b. Disassembly

1. Remove all dirt and grease from the steering cylinder.
2. Determine the direction that the gland (4, Fig. 9.30) will be turning when it is removed so that the lockwire (10) will feed out through the tube hole.
3. Using a sharp object, such as a screwdriver, pry up one end of the lockwire from its hole in the tube (1).
4. Using a spanner wrench, remove the gland allowing the lockwire to work its way out of the tube.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.*

5. Pull rod (3) and attached parts straight out of the tube.

NOTE: *It may be necessary to apply heat to break the bond of the sealant between locknut (12) and rod (3) before the piston can be removed. Refer to paragraph 9.5.a.*

6. Remove locknut (12), piston (2), and gland (4) from the rod (3).
7. Remove rod wiper (5), Z-seal (6), and O-ring (7) from the gland.
8. Remove O-ring (8) and crown seal (9) from the piston.

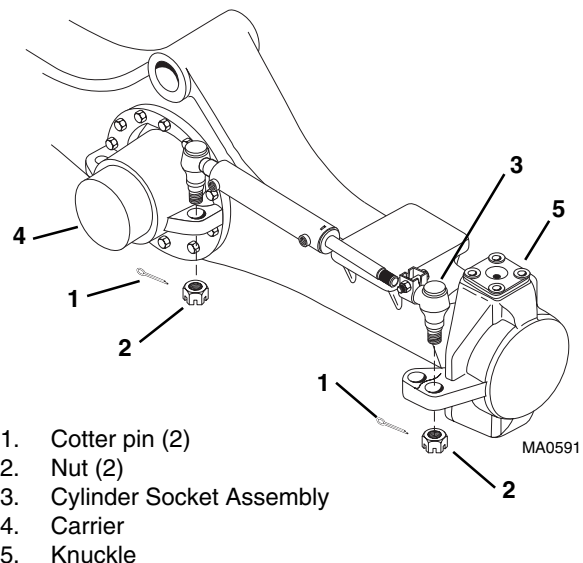


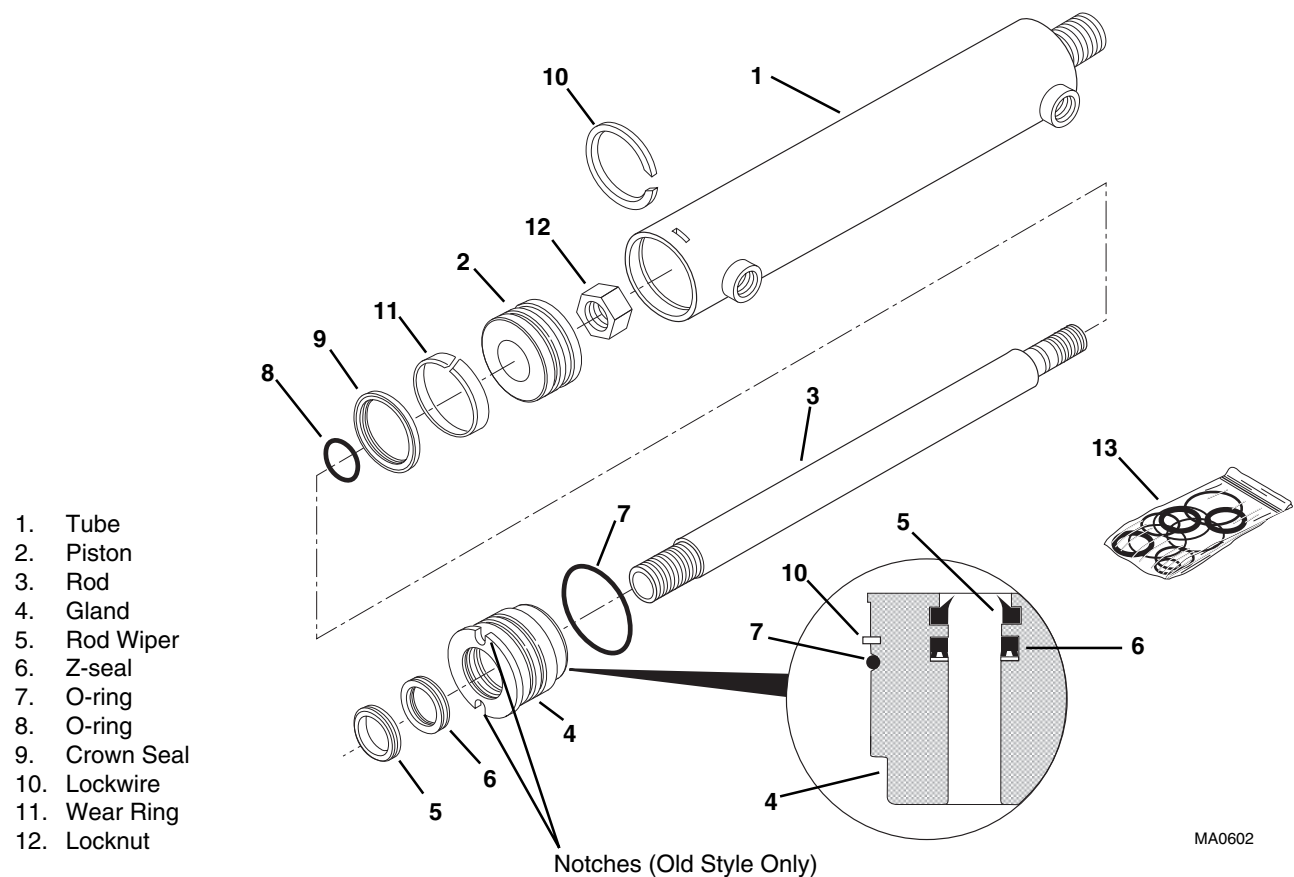
Fig. 9.29 Steering Cylinder Installation

c. Cleaning

1. Discard all seals and lockwire. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (3, Fig. 9.30) is straight and undamaged. If the rod is bent or damaged, install new rod.
2. Inspect inside of tube (1) for scoring and other damage. If there is any damage to the tube, replace it with a new tube.
3. Remove small scratches on inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.

**Fig. 9.30 Steering Cylinder Exploded View (Old Style)**

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Fasten rod (3) in a soft-jawed vise.
2. Install new O-ring (8, Fig. 9.30) inside of piston (2). Carefully install the piston on rod (3) to avoid damage to the O-ring.
3. Apply Loctite® Primer T and Threadlocker 271 to the locknut (12) in accordance with the manufacturer's instructions. Install the locknut and torque it to 90 to 100 lb-ft (122,0 to 135,6 Nm). Allow sealants to cure.
4. Install crown seal (9) on piston (2).
5. Install rod wiper (5), Z-seal (6), and O-ring (7) on the gland (4).
6. Install the assembled gland and seals on rod (3).
7. Lubricate all parts and inside of the tube (1) with clean hydraulic oil.
8. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (7) on the gland. Push the rod assembly straight into the cylinder tube with a steady even pressure until the gland butts up against the tube.
9. Locate the hole in the tube and insert lockwire (10).
10. Using a spanner wrench, rotate the gland 360 degrees to install the lockwire.
11. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
12. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
13. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Screw the socket assemblies (3, Fig. 9.29) onto the retracted cylinder (4). Adjust position of the socket assembly by turning until the total length equals the measured length taken during removal.

NOTE: If there is no accurate recorded cylinder length, the cylinder can be adjusted as described in the following steps.

2. Turn the steering knuckle to full inside turn position on either the left or right side.
3. Adjust the socket assembly position in or out on the rod end, so that the retracted length of the cylinder matches the length required to install the cylinder.

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

4. Install nuts (2) securing the cylinder socket assemblies to the axle carrier (4) and knuckle (5). Torque the nuts to 140 lb-ft (190 Nm) minimum. Install cotter pins (1).
5. Tighten the socket clamp. Torque the clamp bolt and nut to 60 to 70 lb-ft (82 to 95 Nm).
6. Turn the other steering knuckle to its full inside turn position and adjust the cylinder (steps 3 through 5).
7. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

8. Start the engine. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air. The maximum number of turns of the steering wheel should not exceed 4-1/2 turns lock to lock.
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.
10. Test steering circuit operation as described in paragraph 9.4.6.c.

9.5.11 Steering Cylinder (S/N 3102 & After)

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Disconnect the hydraulic lines from the steering cylinder and cap or plug open connections.
4. Remove cotter pins (1, Fig. 9.31) and nuts (2) securing the cylinder socket assemblies (3) to carrier (4) and knuckle (5).
5. The steer cylinder socket is a taper fit in knuckle. Use an impact fork to release the socket from the knuckle.
6. Remove the cylinder from the forklift using a strap sling and hoist or other suitable lifting equipment.
7. Measure the total length of the fully retracted cylinder with sockets in place and note or record the distance. Loosen socket clamp and unscrew the socket assembly from the cylinder (3).

b. Disassembly

1. Remove all dirt and grease from the steering cylinder.
2. Determine the direction that the gland (4, Fig. 9.32) will be turning when it is removed so that the wire retainer (11) will feed out through the tube hole.
3. Using a sharp object, such as a screwdriver, pry up one end of the lockwire from its hole in the tube (1).
4. Using a wrench, remove the gland allowing the wire retainer to work its way out of the tube.

IMPORTANT: *Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.*

5. Pull rod (3) and attached parts straight out of the tube.

NOTE: *It may be necessary to apply heat to break the bond of the sealant between locknut (5) and rod (3) before the piston can be removed. Refer to paragraph 9.5.a.*

6. Remove locknut (5), piston (2), and gland (4) from the rod (3).
7. Remove rod wiper (6), U-cup seal (7), O-ring (8) and back-up ring (14) from the gland.
8. Remove O-ring (9), wear rings (12), piston seal (10) and expander (13) from the piston.

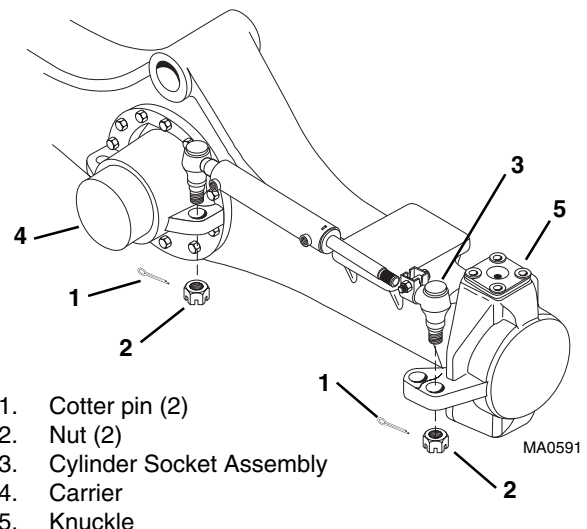


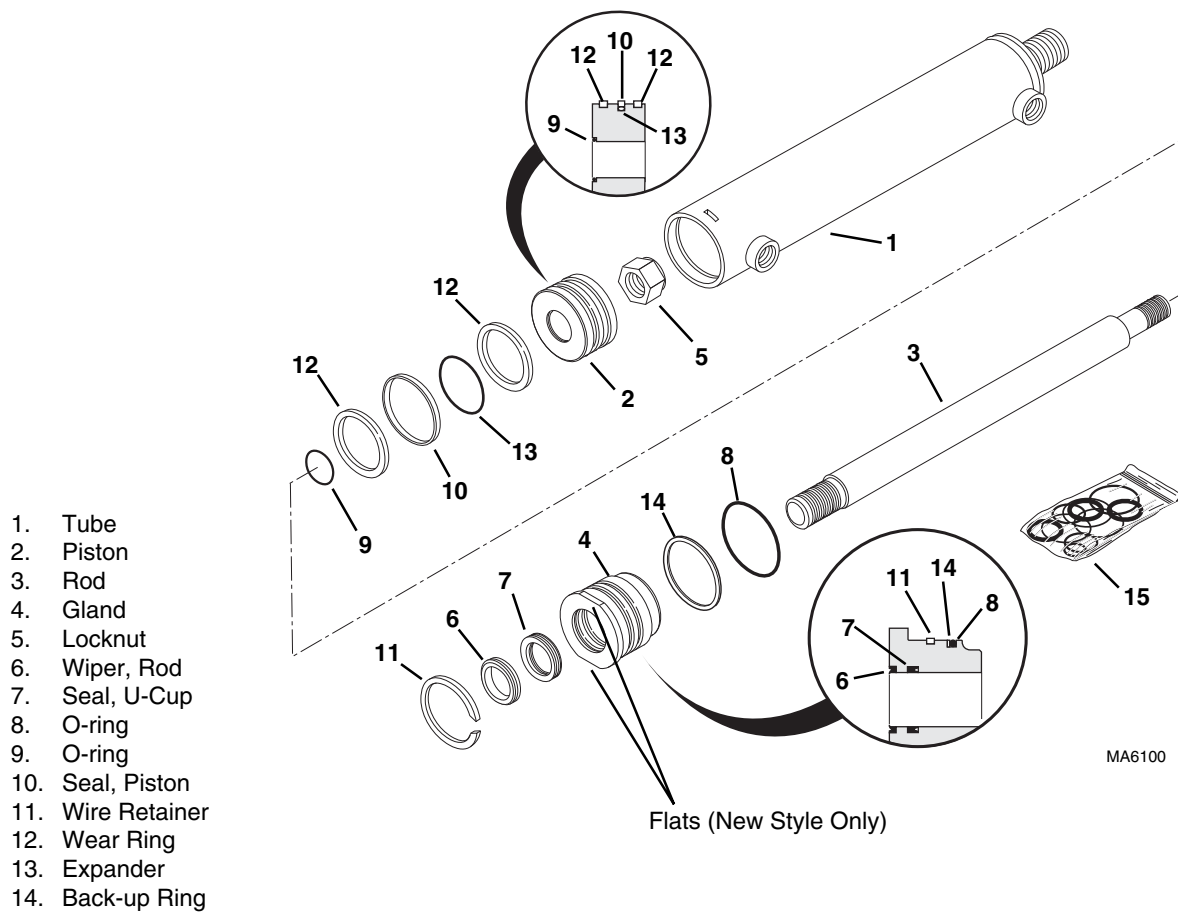
Fig. 9.31 Steering Cylinder Installation

c. Cleaning

1. Discard all seals and wire retainer. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (3, Fig. 9.32) is straight and undamaged. If the rod is bent or damaged, install new rod.
2. Inspect inside of tube (1) for scoring and other damage. If there is any damage to the tube, replace it with a new tube.
3. Remove small scratches on inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.



KITS

15. Seal Kit, Steering Cylinder
(Includes Items 6 thru 14)

Fig. 9.32 Steering Cylinder Exploded View (New Style)

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Fasten rod (3) in a soft-jawed vise.
2. Install new O-ring (9, Fig. 9.32) inside of piston (2). Carefully install the piston on rod (3) to avoid damage to the O-ring.
3. Apply Loctite® Primer T and Threadlocker 271 to the locknut (5) in accordance with the manufacturer's instructions. Install the locknut and torque it to 160 lb-ft (217 Nm). Allow sealants to cure.
4. Install a wear ring (12), expander (13), piston seal (10) and the other wear ring (12) on piston (2).
5. Install rod wiper (6), U-cup seal (7), back-up ring (14) and O-ring (8) on the gland (4).
6. Install the assembled gland and seals on rod (3).
7. Lubricate all parts and inside of the tube (1) with clean hydraulic oil.
8. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (8) on the gland. Push the rod assembly straight into the cylinder tube with a steady even pressure until the gland butts up against the tube.
9. Locate the hole in the tube and insert wire retainer (11).
10. Using a wrench, rotate the gland 360 degrees to install the wire retainer.
11. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
12. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
13. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Screw the socket assemblies (3, Fig. 9.31) onto the retracted cylinder (4). Adjust position of the socket assembly by turning until the total length equals the measured length taken during removal.

NOTE: If there is no accurate recorded cylinder length, the cylinder can be adjusted as described in the following steps.

2. Turn the steering knuckle to full inside turn position on either the left or right side.
3. Adjust the socket assembly position in or out on the rod end, so that the retracted length of the cylinder matches the length required to install the cylinder.

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

4. Install nuts (2) securing the cylinder socket assemblies to the axle carrier (4) and knuckle (5). Torque the nuts to 140 lb-ft (190 Nm) minimum. Install cotter pins (1).
5. Tighten the socket clamp. Torque the clamp bolt and nut to 60 to 70 lb-ft (82 to 95 Nm).
6. Turn the other steering knuckle to its full inside turn position and adjust the cylinder (steps 3 through 5).
7. Remove all plugs or caps from the hydraulic lines and securely tighten the lines to the cylinder.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

8. Start the engine. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air. The maximum number of turns of the steering wheel should not exceed 4-1/2 turns lock to lock.
9. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/Operators Manual.
10. Test steering circuit operation as described in paragraph 9.4.6.c.

9.5.12 Side Tilt Carriage Cylinder (Optional)

a. Removal

1. Place the boom in a horizontal position.
2. Using the side tilt control lever, tilt the carriage all the way to fully retract the side tilt cylinder.
3. Support the side tilt carriage (7, Fig. 9.33) in this position with blocking.
4. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

5. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Remove all dirt and grease from side tilt carriage cylinder (1) and hydraulic lines (2 and 3).
7. Disconnect the hydraulic lines from the cylinder and cap and plug the open connections.
8. Remove snap ring (4) and cylinder rod pin (5) securing the side tilt carriage cylinder rod to side tilt carriage (7).
9. Remove snap rings (4) and cylinder base pin (6) securing the side tilt carriage cylinder tube to pivot base (8).
10. Remove the cylinder from the pivot base using a strap sling and hoist or other suitable lifting equipment.

b. Disassembly

1. Remove any remaining dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.

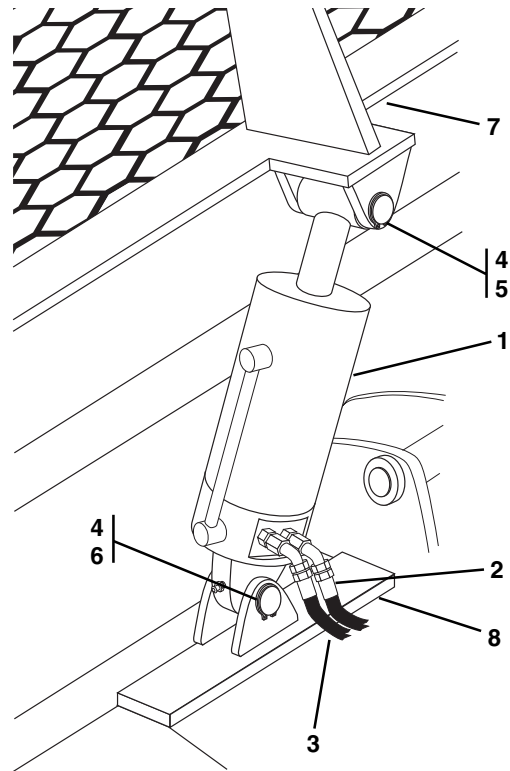
3. Remove check valves (2) and three O-rings (15) and backup rings (16).
4. Using a pin spanner wrench, unscrew gland (4, Fig 9.34) from the tube (1).

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.

5. Pull rod (5) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly from the tube, be careful so that gland threads in the tube do not damage the piston. Keep the rod in line with the tube barrel to prevent binding.

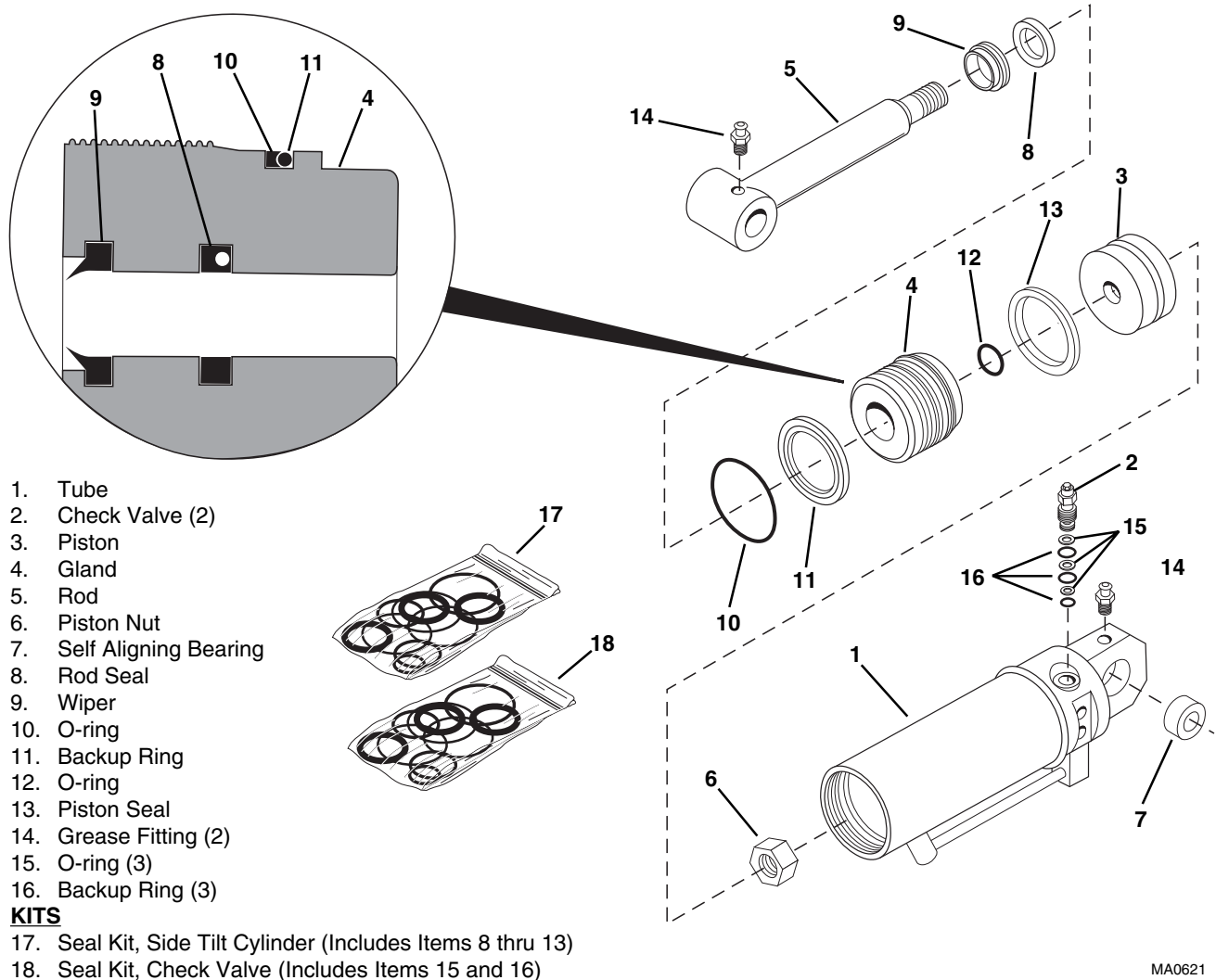
6. Fasten the eye end of the rod (5) in a soft-jawed vise and put a support below the rod near the piston to prevent damage to the rod.



MA0611

1. Side Tilt Carriage Cylinder NOTE: cylinder mounted on left side for early production and right side for later production)
2. Hose Assembly
3. Hose Assembly
4. Snap Ring
5. Cylinder Rod Pin
6. Cylinder Base Pin
7. Side Tilt Carriage
8. Pivot Base

Fig. 9.33 Side Tilt Carriage Cylinder Removal



MA0621

Fig. 9.34 Optional Side Tilt Carriage Cylinder Exploded View

7. Remove piston seal (13) from piston (3).

NOTE: It may be necessary to apply heat to break the bond of the sealant between nut (6) and rod (5) before the piston can be removed. Refer to paragraph 9.5.a.

8. Remove nut (6), piston (3), and the gland (4) from the rod.
9. Remove O-ring (12) from inside of the piston.
10. Remove O-ring (10), backup ring (11), wiper (9) and rod seal (8) from the gland.
11. If necessary to replace, remove grease fittings (14)
12. If bearing (7) needs replacement, press bearing from the cylinder tube.

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.

2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (5, Fig. 9.34) is straight. If the rod is bent, install new rod.
2. Inspect the inside of tube (1) for scoring and other damage. If there is any damage to the tube, replace with new tube.
3. Remove small scratches on the piston rod or inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.
4. Remove staking burrs from the nut (6) and the bottom of piston (3) with a fine file. Clean parts with trichlorethylene after repair.

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. If bearing (7, Fig 9.34) was removed for replacement, press new bearing into eye of tube (1). The bearing should protrude the same distance from each side of the eye.
2. Install new O-ring (10), backup ring (11), wiper (9), and rod seal (8) on gland (4) as shown in Fig. 9.34.

NOTE: The wiper lip should be toward the inner end of the gland and the rod seal toward the outer end of the gland. Use tools that will not damage the seal. If the backup ring is not flat on both sides, the side with the arc must be toward the O-ring.

3. Fasten the rod eye in a soft-jawed vise or other acceptable holding device. Put a padded support below and near the end of the rod to prevent damage to the rod.
4. Push the assembled gland onto the rod (5). If necessary, use a soft hammer to drive the gland onto the rod.
5. Install a new O-ring (12) on the inside of the piston. Carefully install piston (3) on the rod to avoid damage to O-ring.
6. Apply Loctite® Primer T and Threadlocker 271 to the nut (2) in accordance with the manufacturer's instructions. Install the nut on the rod and torque to 350 lb-ft (474,6 Nm). Stake the nut in four places.
7. Install new piston seal (13) on the piston.
8. Fasten the cylinder tube (3) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
9. Lubricate the inside of the tube, piston, and gland O-ring (9) with clean hydraulic oil.
10. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (10) on the gland. Insert the assembled piston, rod and the gland into the tube (3). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool

IMPORTANT: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

11. Install new O-rings (15) and backup rings (16) on check valves (1). Use new valve if either

valve was removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque to 30 to 35 lb-ft (40,7 to 47,5 Nm).

12. If removed, install grease fittings (14).

IMPORTANT

When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seals. Keep the rod in line with the tube barrel to prevent binding.

13. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
14. Increase the operating pressure to the maximum (1750 psi or 120 bar) for the cylinder and check for external leakage and free movement in both directions.
15. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Install the side tilt carriage cylinder (1, Fig. 9.33) on the side tilt carriage (7). Secure the rod end to side tilt carriage (7).
2. Secure the tube end to the pivot base (8) with snap rings (4).
3. Lubricate the pivot pins with multi-purpose lithium-based grease.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Remove all plugs and caps from the hydraulic lines and securely tighten the lines to the cylinder.
5. Start the forklift engine and remove blocking from the carriage.
6. Tilt the side tilt carriage five times through its full range or until the operation of the side tilt carriage is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/Operators Manual.

9.5.13 Swing Carriage Cylinder (Optional)

a. Removal

1. Place the boom in a horizontal position.
2. Using the auxiliary hydraulics control lever, swing the carriage to the centered position.
3. Lower the boom until the carriage is resting firmly on the ground.
4. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

5. Operate the hydraulic controls after the engine has stopped to relieve any trapped pressure.



Warning

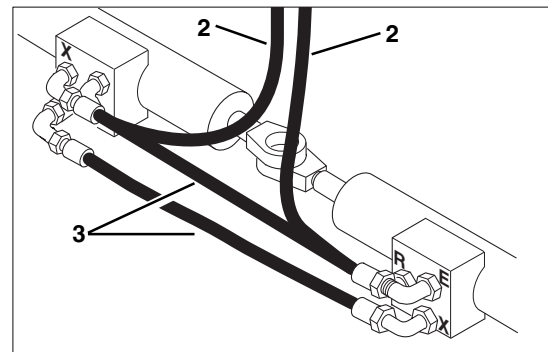
Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Remove all dirt and grease from swing carriage cylinders (1, Fig. 9.35) and hydraulic lines (2 and 3).
7. Tag and disconnect the hydraulic lines (2 and 3) from the cylinders (1) and cap and plug the open connections.
8. Remove bolt and nut holding the center mounting pin (4) to the pivot mount (5). Remove the pin.
9. Remove snap rings (6) and cylinder base end pins (7) from the mounting plates on the carriage. Identify and mark the location of the 1-1/2" I.D. shims (10) at the base end of the cylinder.
10. Remove the cylinders from the pivot mount and the mounting plates using a strap sling and hoist or other suitable lifting equipment. While removing the cylinders identify the locations of the 2" I.D. shims (9) at the rod ends of the cylinders. Be careful not to lose the bearings (8) in each of the cylinder rod ends.

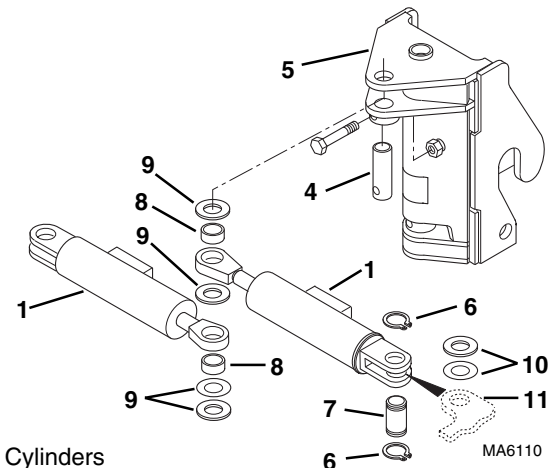
b. Disassembly

1. Remove any remaining dirt and grease from the cylinder.
2. Fasten the cylinder in a soft-jawed vise or other acceptable holding equipment. Do not damage the tube.
3. Remove counterbalance valve (11 Fig. 9.36), relief valve (12) and the O-rings and back-up rings. Remove the orifice (13) from the valve block.
4. Using a pin spanner wrench, unscrew gland (7, Fig 9.36) from the tube (1).

IMPORTANT: Protect the finish on the rod at all times. Damage to the surface of the rod can cause premature seal failure.



Cylinders As Viewed From The Backside



1. Cylinders
2. Auxiliary Hydraulic Hoses
3. Hydraulic Hoses - Cylinder to Cylinder
4. Center Mounting Pin
5. Pivot Mount
6. Snap Rings
7. Cylinder Base End Pins
8. Rod End Bearings
9. Shims - 2" I.D.
10. Shims - 1-1/2" I.D.
11. Mounting Plates

Fig. 9.35 Swing Carriage Cylinder Removal

5. Pull rod (10) and attached parts straight out of the tube.

IMPORTANT: When sliding the rod and piston assembly from the tube, be careful so that gland threads in the tube do not damage the piston. Keep the rod in line with the tube barrel to prevent binding.

6. Fasten the eye end of the rod (10) in a soft-jawed vise and put a support below the rod near the piston to prevent damage to the rod.
7. Remove piston seal (3) and wear ring (2) from the piston (4).

NOTE: It may be necessary to apply heat to break the bond of the sealant between piston (4) and rod (10) before the piston can be removed. Refer to paragraph 9.5.a.

8. Remove piston (4) and the gland (7) from the rod.
9. Remove O-ring (5), backup ring (6), wiper (9) and rod seal (8) from the gland.

c. Cleaning

1. Discard all seals and backup rings. Replace with a complete new seal kit.
2. Clean all metal parts in an approved cleaning solvent such as trichlorethylene. Be sure to carefully clean all cavities and grooves.

d. Inspection, Repair and Replacement

1. Check that rod (10, Fig. 9.36) is straight. If the rod is bent, install new rod.
2. Inspect the inside of tube (1) for scoring and other damage. If there is any damage to the tube, replace with new tube.
3. Remove small scratches on the piston rod or inside of the tube with emery cloth of very fine grit. Use the emery cloth with a rotary motion.

e. Assembly

NOTE: Follow general assembly instructions in paragraph 9.5.c.

1. Install new O-ring (5), backup ring (6), wiper (9), and rod seal (8) on gland (7) as shown in Fig. 9.36.
2. Fasten the rod eye in a soft-jawed vise or other acceptable holding device. Put a padded support below and near the end of the rod to prevent damage to the rod.

3. Push the assembled gland onto the rod (10). If necessary, use a soft hammer to drive the gland onto the rod.
4. Apply Loctite® Primer T and Threadlocker 271 to the piston (4) in accordance with the manufacturer's instructions. Install the piston on the rod and torque to 250 lb-ft (339 Nm).
5. Install new piston seal (3) and wear ring (2) on the piston.
6. Fasten the cylinder tube (1) in a soft-jawed vise or other acceptable holding equipment. Be careful not to damage the tube.
7. Lubricate the inside of the tube, piston, and gland O-ring (5) with clean hydraulic oil.
8. Apply a compression sleeve or other suitable tool to the gland in order to compress the O-ring (5) on the gland. Insert the assembled piston, rod and the gland into the tube (1). Using a pin spanner wrench, thread the gland into the tube. Remove the compression tool

IMPORTANT: When sliding the rod and piston assembly into the tube, be careful so that gland threads in the tube do not damage the piston seal. Keep the rod in line with the tube barrel to prevent binding.

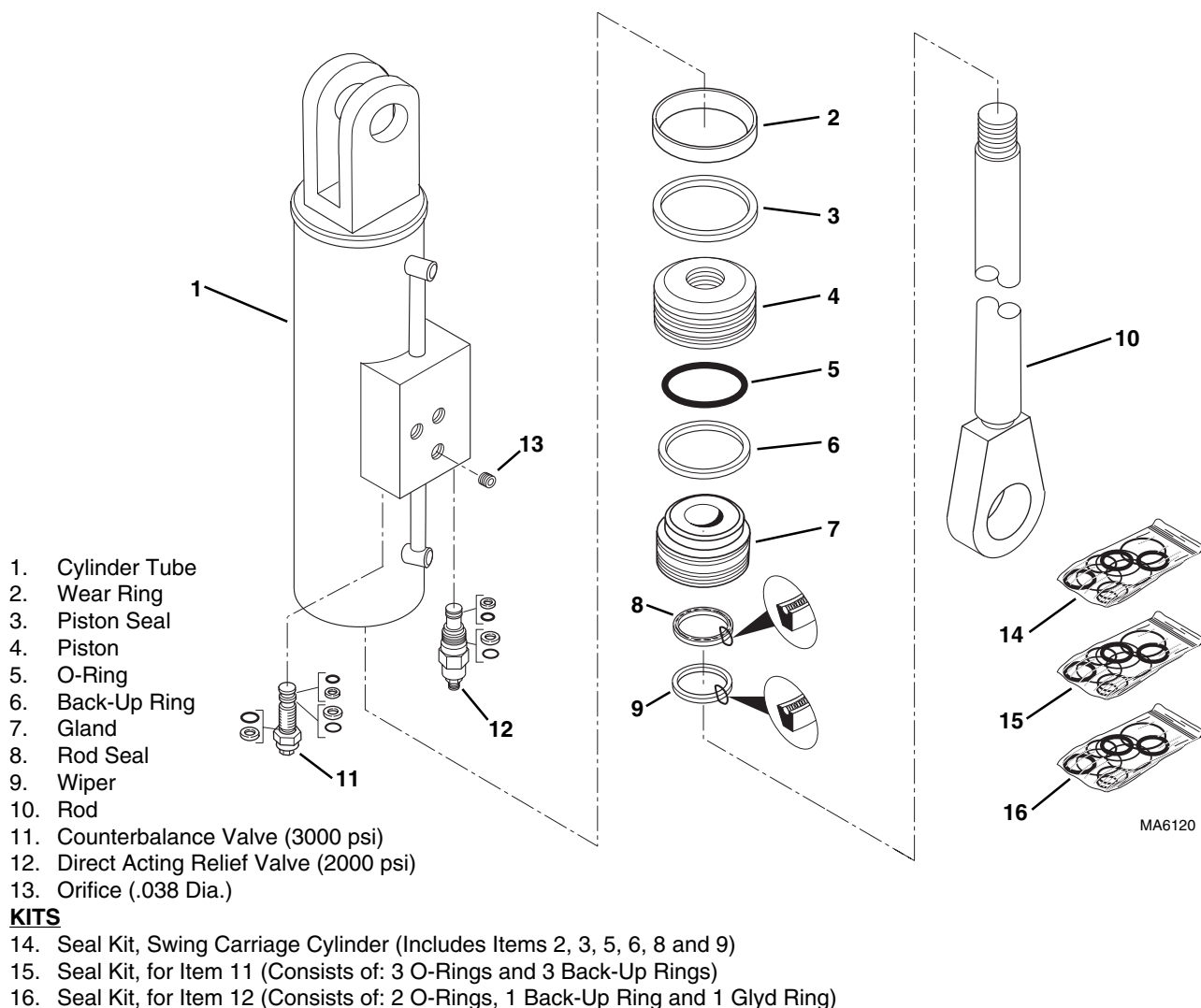
9. Install new O-rings and backup rings on counterbalance and relief valves (11 and 12). Use a new valve if the valve was removed for replacement. Lubricate outside of the valves with clean filtered hydraulic oil. Install the valves and torque to 30 to 35 lb-ft (40,7 to 47,5 Nm).
10. Install the orifice (13) into the valve block.
11. Following reassembly, test the cylinder at low operating pressure (100 psi or 6,9 bar) to be sure the piston and rod are moving freely in both directions.
12. Increase the operating pressure to the maximum (4000 psi or 275 bar) for the cylinder and check for external leakage and free movement in both directions.
13. Prepare the cylinder for installation by retracting the piston and capping and plugging the ports.

f. Installation

1. Install the swing carriage cylinders (1, Fig. 9.35) on the pivot mount (5). Secure the rod ends to pivot mount using the shims (9), bearings (8). Insert the pin (4) and secure with the bolt and nut.
2. Secure the tube end to the mount plates (11) using the shims (10), pins (7) and secure with snap rings (6).
3. Lubricate the pivot pins with multi-purpose lithium-based grease.
4. Remove all plugs and caps from the hydraulic lines and securely tighten the lines to the cylinder.
5. Start the forklift engine.
6. Swing the carriage five times through its full range or until the operation of the swing carriage is normal (no jerks or spongy feel).
7. Shut down the engine. Check the hydraulic oil level and fill as described in the Owners/ Operators Manual.

Warning

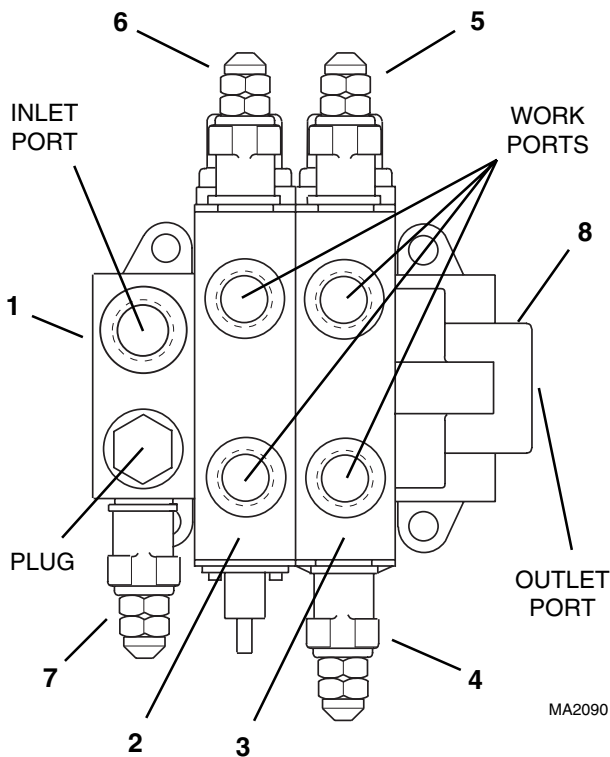
Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

**Fig. 9.36 Swing Carriage Cylinder Exploded View**

9.6 VALVES

9.6.1 Main Control Valve Assembly Cable Control

The main control consists of three relief valves, two parallel working sections, and an inlet and outlet section, Fig. 9.37. For a description of how each component operates in a specific circuit, refer to paragraph 9.2.



1. Inlet Section
2. Boom Raise/Lower Working Section
3. Boom Extend/Retract Working Section
4. Boom Extend Port Relief Valve, set at 2850 ± 50 psi ($196 \pm 3,4$ bar)
5. Boom Retract Port Relief Valve, set at 2850 ± 50 psi ($196 \pm 3,4$ bar)
6. Boom Raise Port Relief Valve, set at 2850 ± 50 psi ($196 \pm 3,4$ bar)
7. Main Relief Valve, set at $2700 -100/ +150$ psi ($186 -6,9/ +10,3$ bar)
8. Outlet Section

Fig. 9.37 Main Control Valve (Cable Control)

a. Main Control Valve Removal

1. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate all of the hydraulic functions (boom raise/lower and extend/retract) after the engine has stopped to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the transmission cover.
4. Remove dirt and grease from the hydraulic lines and fittings, on main control valve (1, Fig. 9.38) and near by components.
5. Tag and disconnect the hydraulic lines from the main control valve and cap or plug the connectors.
6. Tag and disconnect control linkage (4) from main control valve by removing cotter pins (2) and retaining pins (3).
7. Remove the capscrews (5), locknuts (7), and washers (6) securing the control valve to the frame.
8. Remove the main control valve from the forklift.
9. Remove any remaining dirt and grease from the valve assembly.

b. Relief Valve Repair

Disassembly

1. Remove the relief valve from the control valve housing.
2. Unscrew plug (12, Fig. 9.39) and remove the relief valve cartridge from housing (2).
3. Remove and discard O-ring (1) from housing.
4. Remove acorn nut (18) and jam nut (17) from adjustment screw (15).
5. Remove and discard O-rings (16).

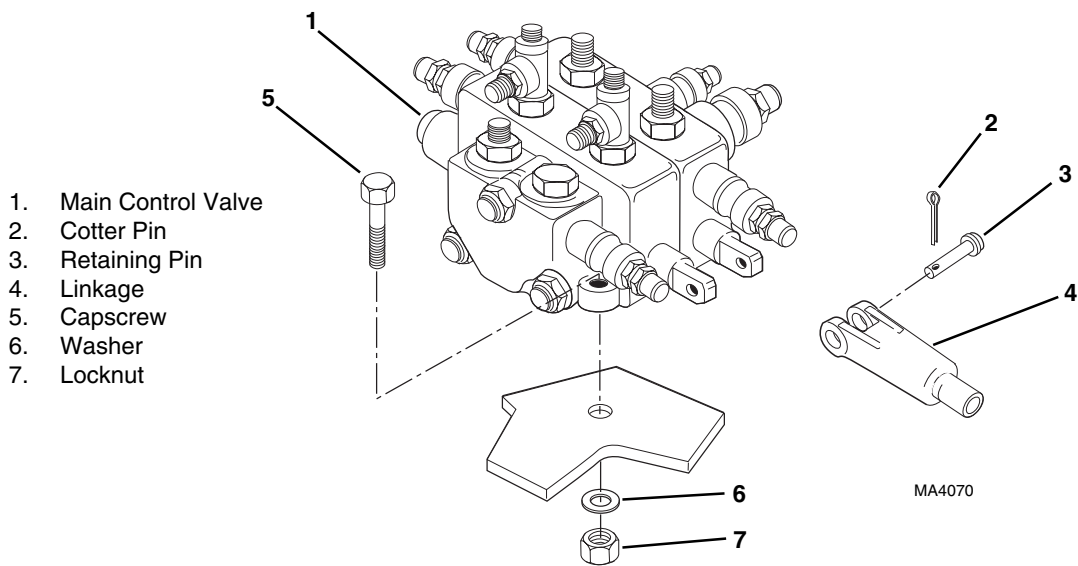


Fig. 9.38 Main Control Valve Installation

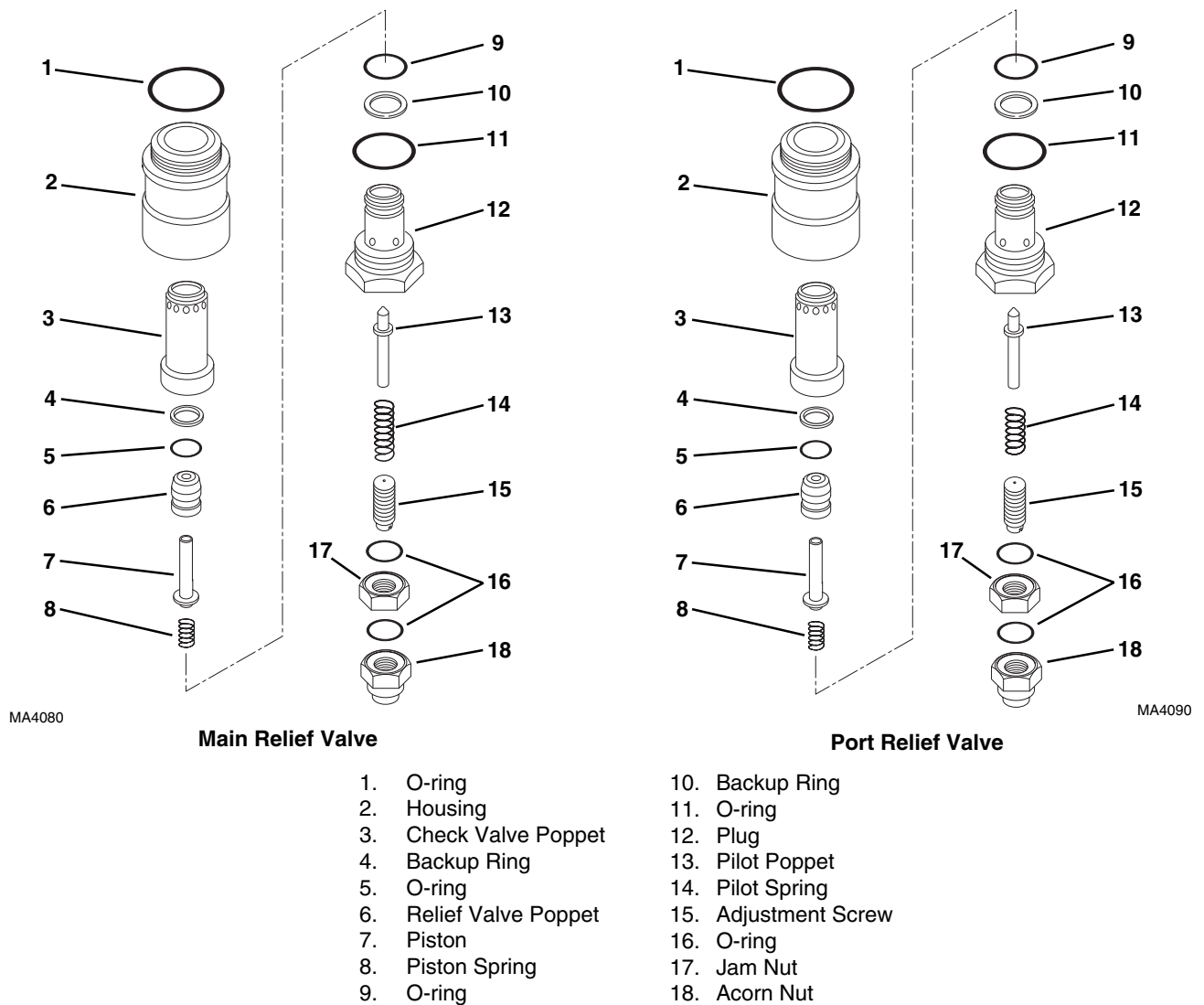


Fig. 9.39 Relief Valves

6. Unscrew adjustment screw (15) from plug (12).
7. Invert the plug. Pilot spring (14) and pilot poppet (13) should drop out.
8. Remove O-rings (9 and 11) and backup ring (10) from the plug.
9. Remove piston spring (8), piston (7) and relief valve poppet (6) from check valve poppet (3).
10. Remove and discard O-ring (5) and backup ring (4) from the relief valve poppet.

Cleaning and Drying

Clean metal parts in an approved solvent such as trichlorethylene and blow dry.

Inspection and Replacement

1. Inspect the poppet seating surfaces. They must be sharp, clean, and free of nicks or excessive wear. Replace the part if worn or damaged.
2. Install new O-rings and backup rings. Repair kits are available, refer to 6036 Parts Manual for kits.
3. Clean out the channel in piston (7, Fig. 9.39) through which fluid passes.
4. Make sure the piston moves freely in the relief valve poppet.

Assembly

1. Lubricate with hydraulic oil and install new O-ring (5, Fig. 9.39) and backup ring (4) on relief valve poppet (6). Stretch O-ring, do not roll it to fit.
2. Lubricate poppet (6) with hydraulic oil and insert into check valve poppet (3) followed by piston (7) and piston spring (8).
3. Lubricate with hydraulic oil and install new O-ring (9), backup ring (10) and O-ring (11) on plug (12). Stretch O-rings, do not roll them to fit.
4. Lubricate exterior of plug (12) and insert into poppet (3).
5. Insert pilot poppet (13) and poppet spring (14) into the plug.
6. Install adjustment screw (15) into the plug.
7. Lubricate and install new O-rings (16) on nuts (17 and 18). Stretch O-rings, do not roll them to fit.
8. Install jam nut (17) and acorn nut (18) on the adjustment screw. Torque nuts on relief valve to 10 ± 1.5 lb-ft ($13,5 \pm 2$ Nm).

9. Install the relief valve cartridge in the housing. The cartridge is a honed fit and may require gentle tapping to install.

IMPORTANT: Care must be taken to avoid damaging the valve's internal lands.

10. Lubricate and install new O-ring (1) on housing (2). Stretch O-ring, do not roll it to fit.
11. Install assembled relief valve in the control valve housing. Torque all relief valves except main relief valve to 40 ± 4 lb-ft ($55 \pm 5,5$ Nm). Torque main relief valve to 60 to 80 lb-ft (82 to 109 Nm).
12. Adjust all relief valves pressure as instructed in paragraph 9.2.

c. Repair of Main Control Valve

Disassembly

To replace seals between the sections of the main control valve:

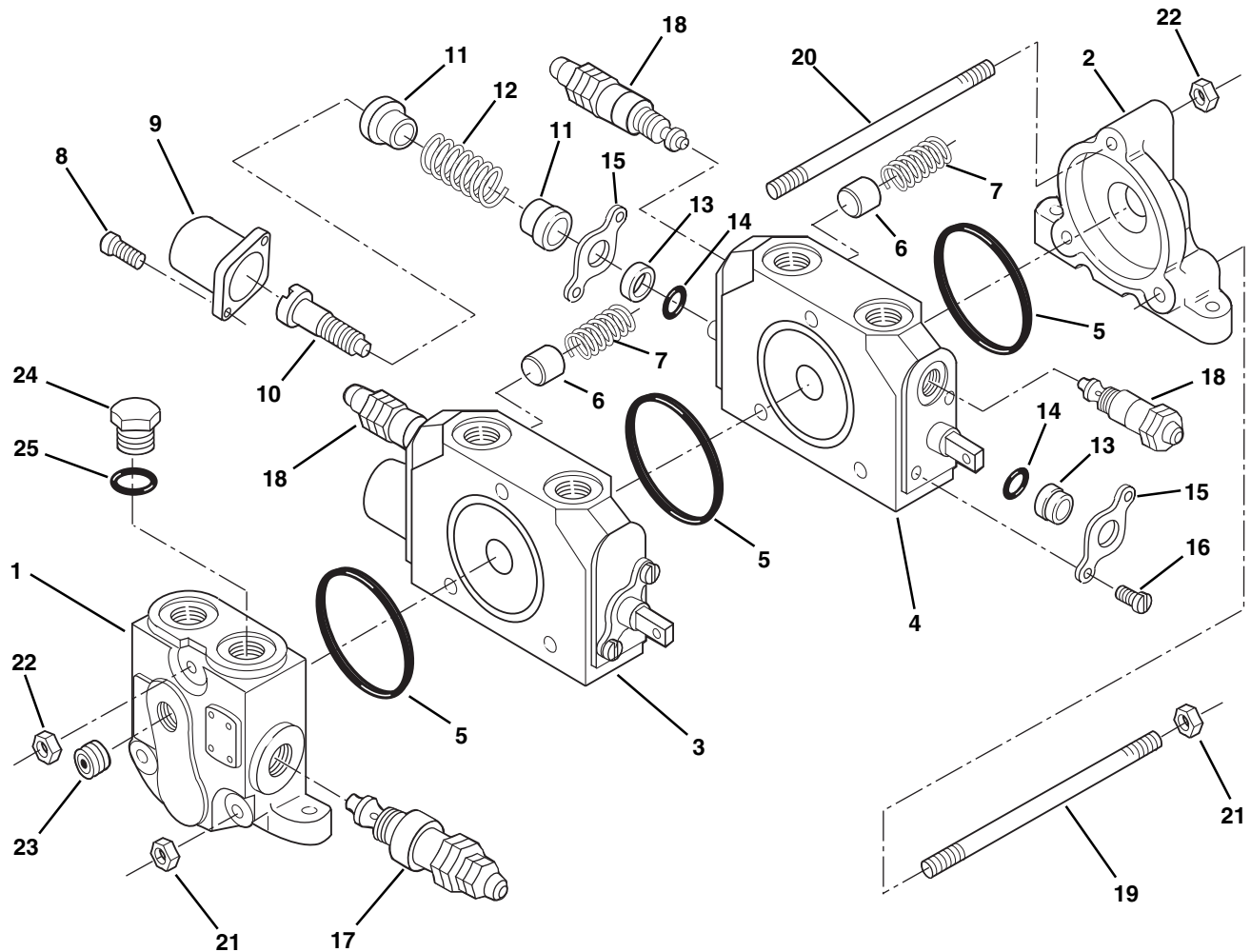
1. Remove nuts (21 and 22, Fig. 9.40) at outlet section (2).
2. Remove outlet section carefully to avoid loosing spring (7).
3. Remove O-ring (5) and discard.
4. Remove check valve spring (7) and check valve poppet (6) from boom extend/retract section (4).
5. Remove boom extend/retract section (4), and repeat steps 3 and 4 for the boom raise/lower section (3).
6. Remove boom raise/lower section (3) and remove O-ring (5).
6. Remove nuts (21 and 22) and tie rods (19 and 20) at inlet section (1).

Cleaning and Drying

Clean all metal parts in an approved solvent such as trichlorethylene and blow dry.

Assembly

1. Thread nuts (21 and 22, Fig. 9.40) onto ends of tie rods (19 and 20) until nuts are flush with the ends of the tie rods.
2. Install new O-ring (5) in boom raise/lower section (3).
3. Install tie rods (19 and 20) from the outside of inlet section (1) through the holes in the inlet section.



MA4010

1. Inlet Section
2. Outlet Section
3. Boom Raise/Lower Section
4. Boom Extend/Retract Section
5. O-ring
6. Check Valve Poppet
7. Check Valve Spring
8. Socket Head Capscrew (2)
9. Spool Cap
10. Spool End
11. Spring Seat (2)
12. Spring
13. Wiper (2)

14. O-ring (2)
15. Seal Plate (2)
16. Round Head Machine Screw (2)
17. Main Relief Valve
18. Port Relief Valve (3)
19. Tie Rod (2)
20. Tie Rod (1)
21. Special Nut (4)
22. Special Nut (2)
23. Plug Assembly
24. Plug
25. O-ring

KITS

See Parts Manual

Fig. 9.40 Main Control Valve Exploded View

4. Install boom raise/lower section (3) over tie rods (19 and 20).
5. Install check valve poppet (6) and check valve spring (7) into boom raise/lower section (3).
6. Install new O-ring (5) in boom extend/retract section (4).
7. Install boom extend/retract section (4) over tie rods (19 and 20).
8. Install check valve poppet (6) and check valve spring (7) into boom extend/retract section (4).
9. Install O-ring (5) in outlet section.
10. Install outlet section (2) over tie rods (19 and 20).
11. Install nuts (21 and 22) on the ends of the tie rods (19 and 20) and tighten the nuts so the rods protrude the same amount from both sides of the valve. Torque nuts (21) to $48 \pm 4.8 \text{ lb-ft}$ ($65 \pm 6.5 \text{ Nm}$). Torque nuts (22) to $75 \pm 7.5 \text{ lb-ft}$ ($102 \pm 10 \text{ Nm}$).

d. Repair of Main Control Valve Sections

When repairing the main control valve, first refer to paragraph b and repair the relief valves. It might be advisable to install seal and spring (repair) kits in all of the relief valves at this time, refer to 6036 Parts Manual for kits.

Disassembly

1. Remove two socket head capscrews (8, Fig. 9.40) and spool cap (9).
2. Remove spool end (10), spring seat (11), spring (12), spring seat (11), seal plate (15), wiper (13) and O-ring (14).
3. Remove two round head machine screws (16), seal plate (15), wiper (13), and O-ring (14).
4. Remove spool from linkage end of valve section.

Cleaning and Drying

Clean all metal parts in an approved solvent such as trichlorethylene and blow dry.

Inspection and Replacement

1. Inspect spool seating surfaces. They must be sharp, clean, and free of nicks or excessive wear. Replace entire section if worn or damaged.
2. Replace all O-rings and backup rings with new ones. Repair kits are available, refer to 6036 Parts Manual for kits.
3. Make sure the piston moves freely in valve section.

Assembly

1. Insert spool in the linkage end of the section.

IMPORTANT. Take care during insertion to avoid damaging the valve's internal lands.

2. Install O-ring (14, Fig. 9.40), wiper (13) and seal plate (15) and secure with two round head machine screws (16).
3. Install O-ring (14), wiper (13), seal plate (15) spring seat (11), spring (12), spring seat (11), spool end (10), spool cap (9) and secure with socket head capscrews (8).

e. Main Control Valve Installation

1. Position the main control valve (1, Fig. 9.38) on the forklift and secure it to frame using capscrews (5), locknuts (7), and washers (6).
2. Install control linkage (4) using retaining pins (3) and cotter pins (2).
3. Connect hydraulic lines to control valve.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Start the forklift engine.
5. Inspect connections at the control valve for leakage.
6. Operate joysticks to test the operation of the control valve and hydraulic system. Refer to paragraph 9.2 for instructions on adjustment of relief valve settings.
7. Install the transmission cover.

9.6.2 Main Control Valve Assembly Electronic Control

The control valve has four sections – inlet, outlet and two working sections, one for raise/lower and one for extend/retract. The working sections are mounted between the inlet and outlet sections to form a valve stack, Fig. 9.41. The supply pressure passages are common in the stack as are the return to reservoir and pilot pressure passages. For a description of how each component operates in a specific circuit, refer to paragraph 9.3. For a description of electronic operation, refer to Section 10.

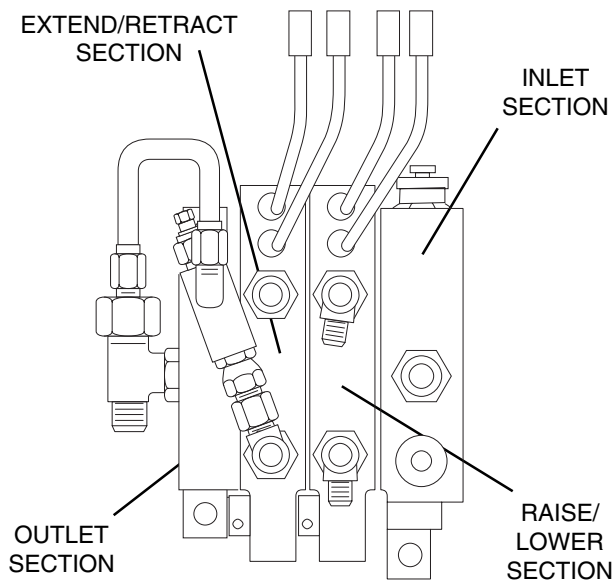


Fig. 9.41 Main Control Valve (Electronic Control)

a. Removal of Control Valve

NOTE: The following procedures are for out of warranty service of the valve only. If the valve is still under warranty it must be replaced as a complete assembly.

The valve is mounted in the frame at vehicle center line, to the right behind the cab, Fig. 9.41.

1. Park forklift on a level surface and engage parking brake. Retract the boom and support it in a horizontal position with blocking. Place travel select lever in neutral and stop the engine. Be sure the forklift is in a secure position before servicing.

Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. **Operate the control valve manually by threading a 3/8 NC x 2" long capscrew into the spool shift collar of each hydraulic function, Fig. 9.46. Actuate all of the hydraulic functions (boom raise/lower, extend/retract) after the engine has stopped to relieve any trapped pressure.**
3. Remove dirt and grease from the hydraulic lines and fittings and control valve using a clean cloth and an approved cleaning solvent such as trichlorethylene. Tag and disconnect the hydraulic lines from the control valve and cap or plug all connections to prevent system contamination.

4. Remove the capscrews (1, Fig. 9.42), nuts (2) and lock washers (3) securing the control valve to the frame. Remove the control valve (4) from the forklift to a clean work area. Wipe the exterior of the valve using a clean cloth and an approved cleaning solvent such as trichlorethylene.

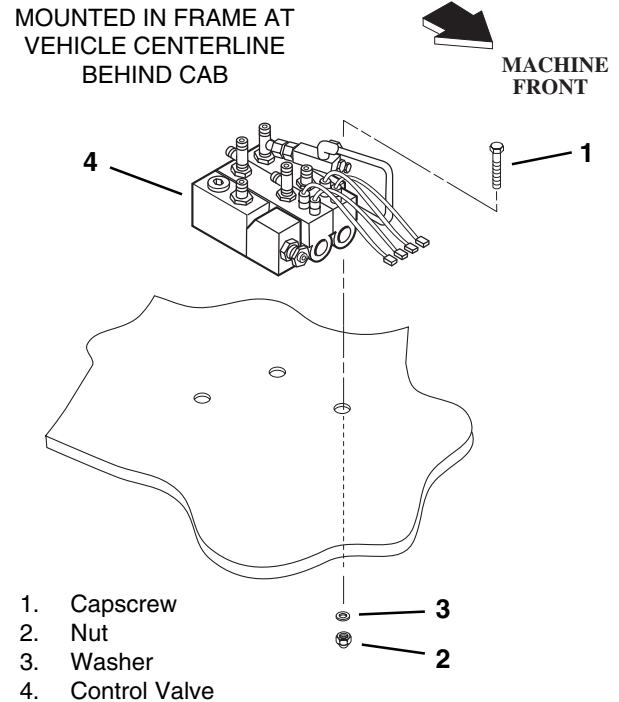


Fig. 9.42 Control Valve Mounting

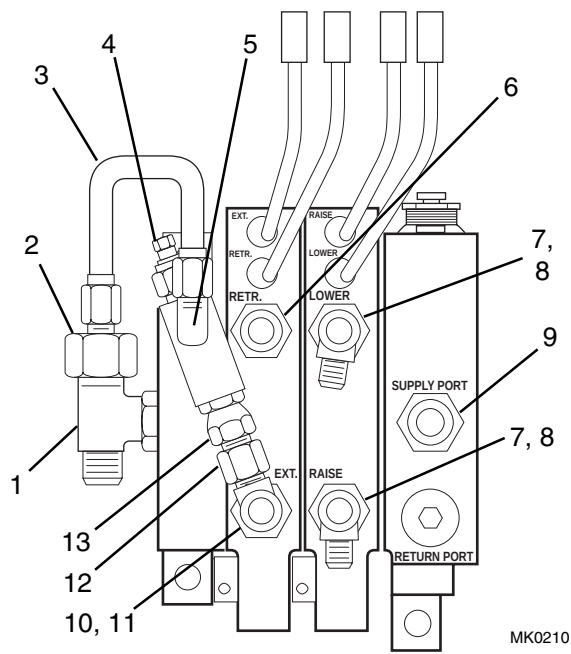
b. Disassembly of Control Valve Into Sections

NOTE: The following procedures are for out of warranty service of the valve only. If the valve is still under warranty it must be replaced as a complete assembly. Disassemble only to the extent necessary to replace defective parts.

1. Remove all fittings, Fig. 9.43, from the control valve.
2. Remove jam nut (1, Fig. 9.44) and hex nut (2) from the tie rod (3) and carefully lift the outlet section (4), the seal plates (5) and the working sections (6 & 7) off of the tie rods (3). Remove and discard all seals from the seal plate.

NOTE: When separating the sections, the load sensing shuttle ball (11) may fall from the cavity between the two working sections only. This ball is a part of each seal plate kit and will be replaced with a new part at assembly. **DO NOT** use this ball between the inlet and raise/lower sections nor between the outlet and extend/retract sections.

3. Unscrew the tie rods (3) from the inlet section (8).



- | | |
|------------------|------------------|
| 1. Branch Tee | 8. Run Tee |
| 2. Tube Reducer | 9. Connector |
| 3. Tube Assembly | 10. Reducer |
| 4. Relief Valve | 11. Run Tee |
| 5. Elbow | 12. Tube Reducer |
| 6. Connector | 13. Connector |
| 7. Reducer | |

Fig. 9.43 Control Valve Hydraulic Fittings

c. Disassembly of the Inlet Section

1. Remove the plug (1, Fig. 9.45), filter (2) and O-ring (3). Discard filter and O-ring. Replace with kit at assembly.
2. To remove the pilot reducing spool (4), remove plug (5), pilot shims (6), spring (7), spring guide (8) and ball (9). Pull spool straight out of cavity.
Note the number of shims (6) used.
3. Remove plug (10) and pull bypass spool (11) from cavity.
4. Loosen locknut (12) and unscrew seat and adjustment plug (13 & 14) from inlet valve section (15). Remove spring (16), washer (17), O-rings (18 & 19) and backup ring (20). Discard O-rings and backup rings.
5. Using an Allen wrench, remove plug (21) and setscrew (22). Shake spring (23) and cone (24) from the plug cavity.
6. If necessary, remove plugs (25 & 26) and orifice screw (27).

Cleaning and Drying

Clean all metal parts in an approved cleaning solvent such as trichlorethylene and blow dry. Immerse metal parts in hydraulic oil if they are to be exposed to air for more than 4 hours.

Inspection

1. Inspect spool seating surfaces. Surfaces should be sharp and clean, and free of nicks or excessive wear. Replace entire section if worn or damaged.
2. Replace all O-rings and backup rings with new ones. Repair kits are available.
3. Inspect all plugs for stripped or damaged threads. Replace if damaged.
4. Inspect filter for damage and replace if necessary.

Assembly

NOTE: Parts kits are available for all sections of the valve. Have the proper kits on hand before starting the assembly procedure. Refer to the Parts Manual for kit part numbers.

1. Slide cone (24, Fig. 9.45) and spring (23) into plug cavity. Install setscrew (22) and plug (21). **DO NOT** bottom out the setscrew. This may damage the cone and create a severe over-pressure situation when the valve is put back into service.
2. Install new O-rings (18 & 19) and new backup ring (20) on adjustment plug and seat (13 & 14). Assemble locknut (12) to plug. Install compression spring (16) and spring washer (17) on adjustment plug. Carefully slide adjustment plug assembly into the cavity.
3. Coat the bypass spool with a thin layer of hydraulic oil. Install bypass spool (11) and plug (10) with new O-ring into inlet section.
4. Install pilot reducing spool (4), valve ball (9), spring guide (8), spring (7), pilot shims (6) and plug (5), with new O-ring into cavity of valve. Check that plug is properly seated.

NOTE: The number of shims (6, Fig. 9.45) installed should be the same as removed unless shims must be added or removed to adjust pilot pressure. Refer to paragraph 5.9.5.a.

5. Replace O-ring (3) on filter (2) and slide into section cavity. Install plug (1) with new O-ring.
6. Replace plugs (25 & 26) and orifice screw (27), if removed.

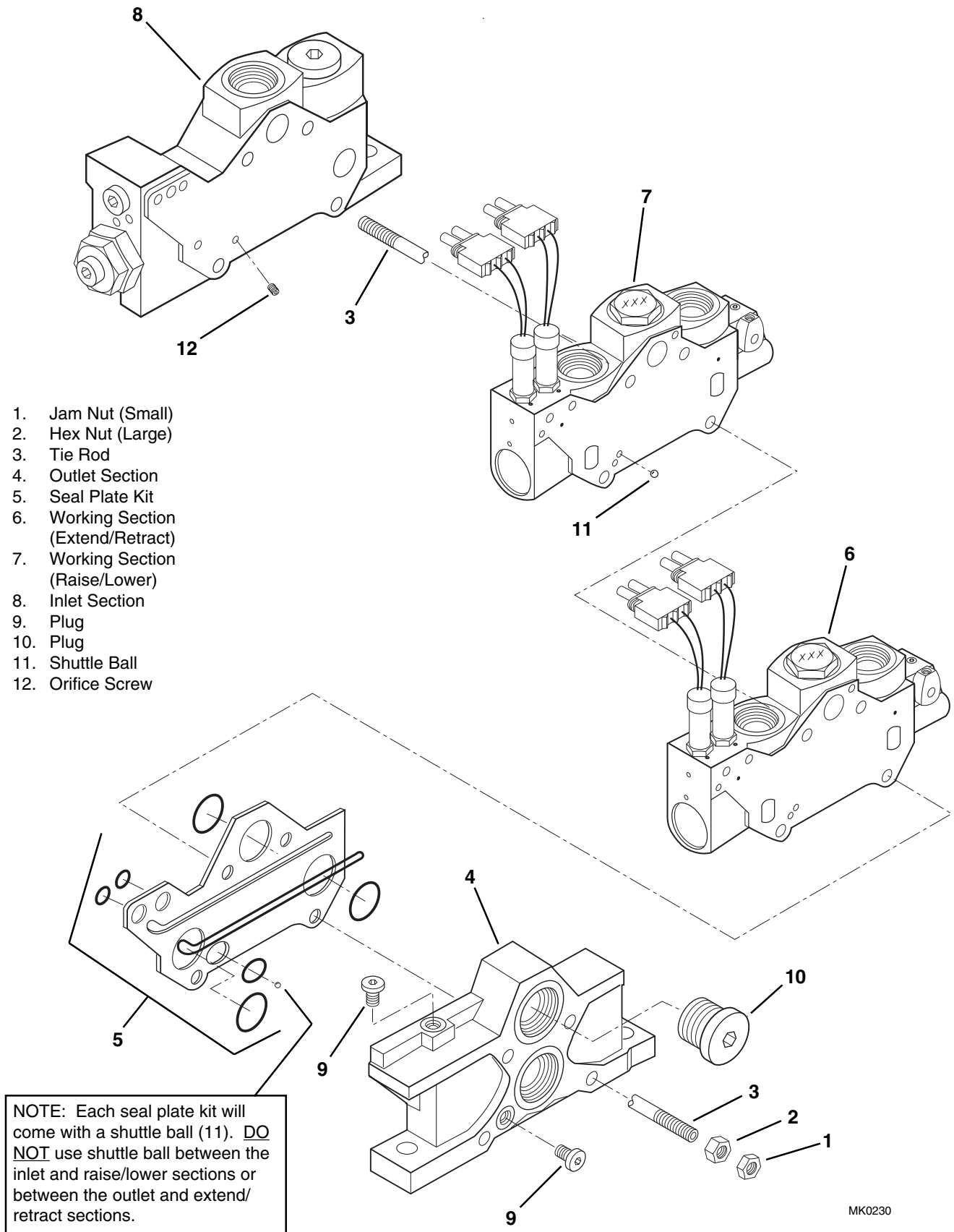
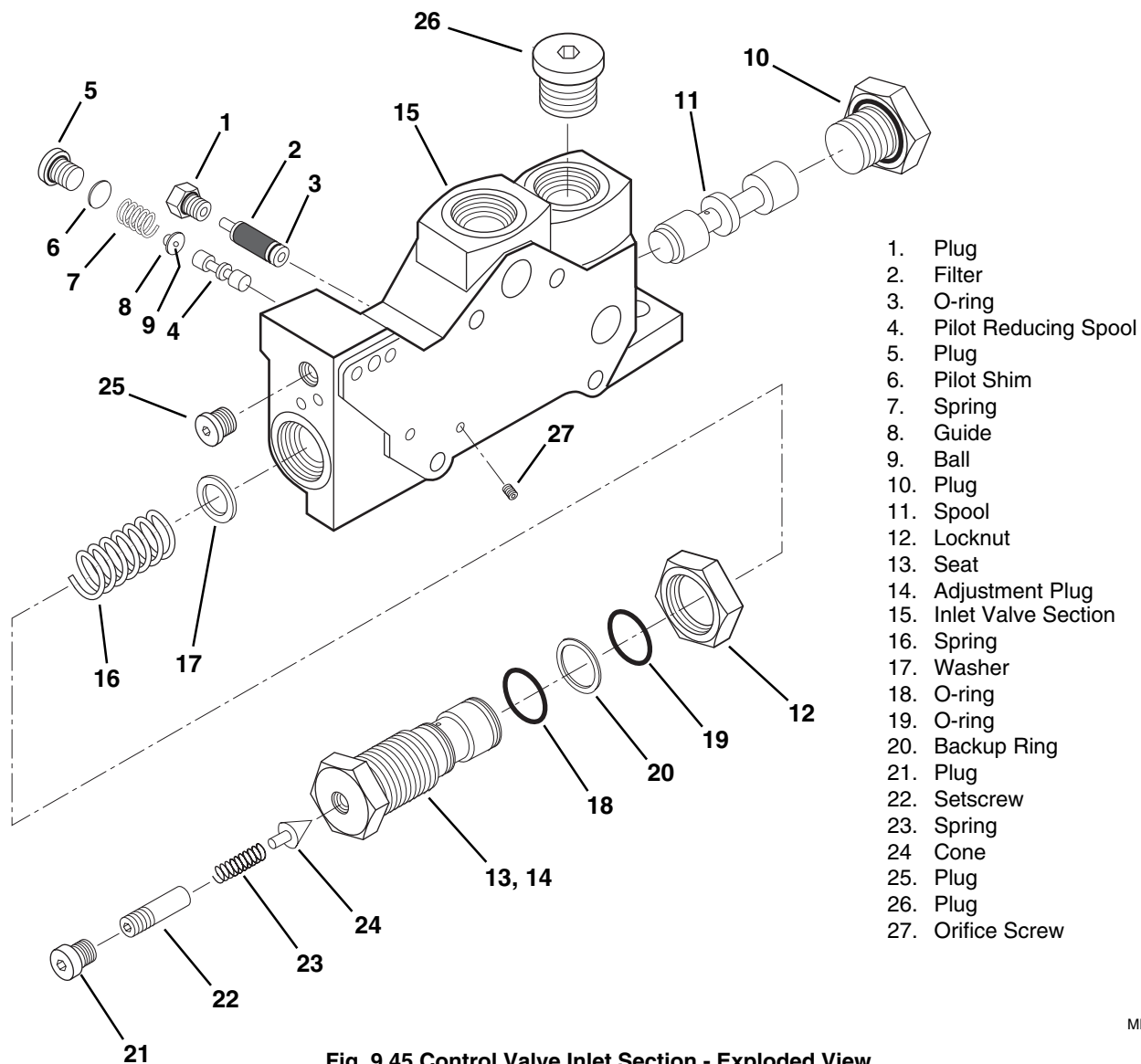


Fig. 9.44 Control Valve Sections - Exploded View



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Fig. 9.45 Control Valve Inlet Section - Exploded View

d. Disassembly of a Working Section

1. Unscrew the pulsar solenoid cartridges (1, Fig. 9.46) from the section body. Using a pick, remove the O-ring (2) from the bottom of the solenoid cavity. Remove the disk (3) from the cavity with a pencil magnet.
2. Remove the retaining rings (4 & 5) from the valve section using a snap ring tool. Thread the manual override handle (6) or a 3/8-16 bolt approximately 2 inches long, into the valve section. Rotate the handle or bolt away from the valve until the end plug (7) pops out. Remove and discard the O-ring (8).
3. Insert a hooked tool into the spring guide and pull the spool assembly (9) out of the valve section. Remove plug (10) and O-ring (11). Discard O-ring.
4. To remove the override handle from the working section remove set screw (12) and pull knob (13), handle (6), nut (14) and adapter (15) from the section. To remove linkage, remove plug (16) and spring pin (17). Pull shaft (18) and O-rings (19) from valve section and clevis (20). Remove clevis and dowel pin (21).

NOTE: When removing the spool always pull the spool out as straight as possible, as damage to the spool and/or bore could occur.

5. To remove the compensator spool (22), unscrew plug (23) and remove and discard O-ring (24). Remove compensator spring parts (25) and discard. Remove retaining ring (26) and carefully lift compensator spool (22) out of the cavity.

Cleaning and Drying

Clean all metal parts in an approved cleaning solvent such as trichlorethylene and blow dry. Immerse metal parts in hydraulic oil if they are to be exposed to air for more than 4 hours.

Inspection

1. Visually inspect the pulsar solenoid wires and connectors for damage. Check for loose, exposed or crimped wires. Replace damaged pulsar solenoids.
2. Inspect the spools and working section for nicks and burrs. Remove minor damage to the spool surface using a hard Arkansas stone. If severe damage to the spool and/or bore is noted, replace the working section and spool as an assembly.
3. Inspect compensator spring for damage. Replace faulty spring with compensator spring kit.
4. Inspect all threaded surfaces for stripping or other damage. Replace parts as necessary.

e. Assembly of a Working Section

NOTE: Refer to *Parts Manual* for the necessary kits required to reassemble the working section.

1. Coat the compensator spool (22, Fig. 9.46) with a thin coat of clean hydraulic oil and carefully slide the spool into the cavity. Install retaining ring (26).
2. Install compensator spring kit (25) in accordance with the instructions packaged in the parts kit. Replace O-ring (24) on plug (23) and install plug into working section (28). Torque plug to 80 to 85 lb-ft (109 to 116 Nm).
3. To install override linkage, if removed, assemble clevis (20) on working section and install dowel pin (21) and shaft (18) with new O-rings (19). Install spring pin (17) and plug (16). Install adapter (15) and secure with setscrew (12). Assemble nut (14), handle (6) and knob (13).

4. Install a new O-ring (11) on plug (10) and assemble plug to valve. Install retaining ring (4).

NOTE: Exercise extreme caution when installing the spool into the bore as damage to the spool and/or bore could occur.

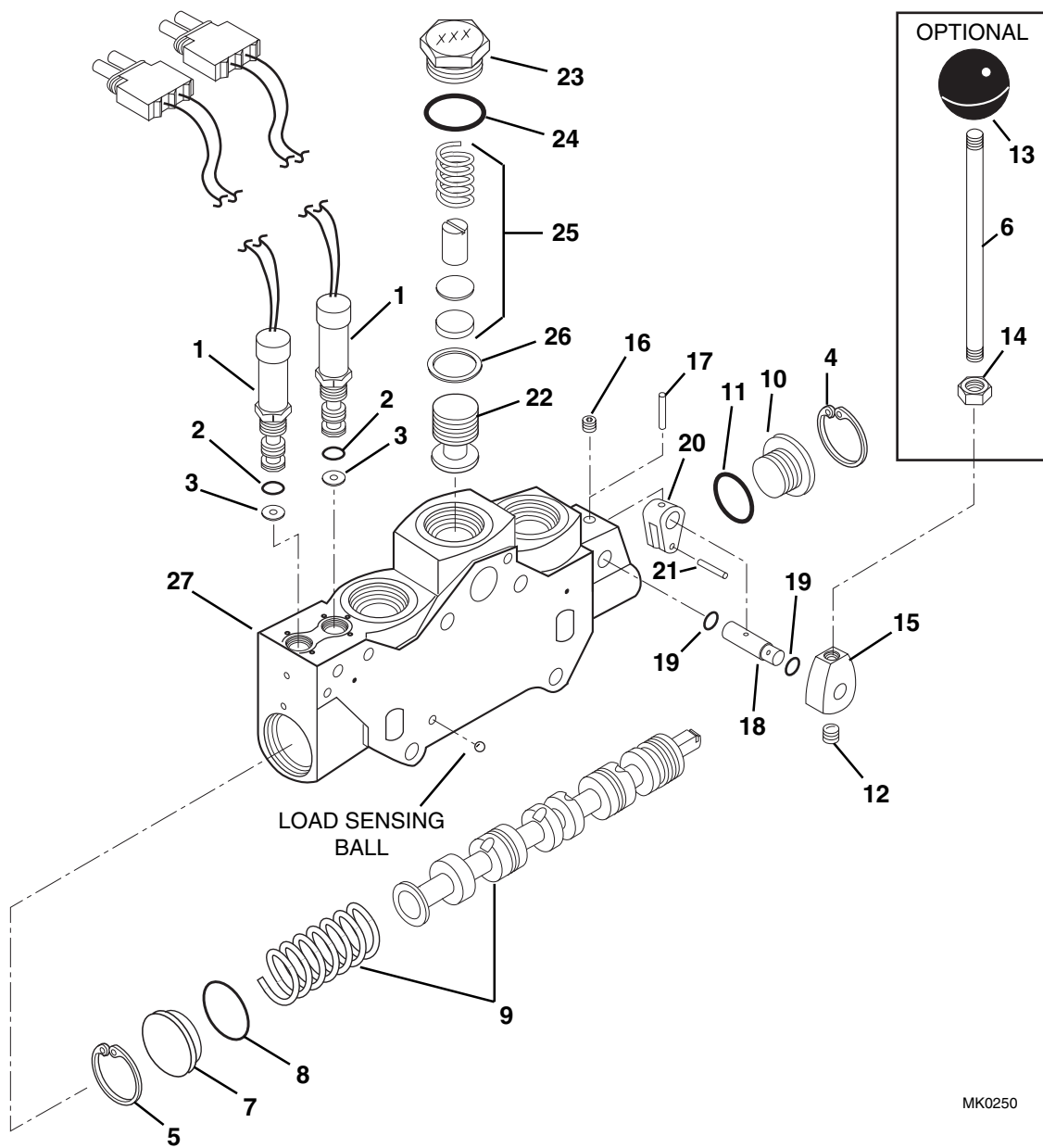
5. Coat the spool (9) with a thin layer of clean hydraulic oil. Thread the manual override handle (6) or a 3/8-16 bolt approximately 2 inches long, into the valve section.
6. Rotate the handle or bolt fully downward away from the valve. Carefully slide the spool straight into the bore with the spool linkage groove facing upward. Slide the spool in until it contacts the override linkage, then rotate the handle or bolt upward to pull the spool the rest of the way into the bore. Rotate the handle slightly back and forth to check for proper installation.
7. Assemble a new O-ring (8) on plug (7) and push plug into valve bore. Install the retaining ring (5) and check that it has seated completely.
8. Use the manual override handle or bolt to fully shift the spool in both directions. Spool movement should be free of binding and capable of returning with spring force only. Check that end plugs (7 & 10) are securely seated.

NOTE: Each pulsar solenoid comes paired with its own orifice disk. In addition, the pulsar solenoid with disks and O-rings are packaged in pairs as a cartridge kit. If replacement is necessary, use the complete cartridge for a working section. DO NOT mix components.

9. Insert the new orifice disk (3) and push down flush to the bottom of the cavity.
10. Install the new O-ring (2) and check for proper seating.
11. Install the new pulsar solenoid (1) and torque to 6.5 lb-ft (8,8 Nm).

Repair of the Outlet Section

The outlet section is made up of an end cover body (4, Fig. 9.44), two small plugs (9) and one large plug (10). If damage to the body or any of the plugs is noted, replace as necessary.



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- | | |
|------------------------------|----------------------------|
| 1. Pulsar Solenoid Cartridge | 14. Nut |
| 2. O-ring | 15. Adapter |
| 3. Orifice Disk | 16. Plug |
| 4. Retaining Ring | 17. Spring Pin |
| 5. Retaining Ring | 18. Shaft |
| 6. Handle | 19. O-ring |
| 7. End Plug | 20. Clevis |
| 8. O-ring | 21. Dowel Pin |
| 9. Spool Assembly | 22. Compensator Spool |
| 10. Plug | 23. Plug |
| 11. O-ring | 24. O-ring |
| 12. Setscrew | 25. Compensator Spring Kit |
| 13. Knob | 26. Retaining Ring |
| | 27. Working Section |

Fig. 9.46 Control Valve Working Section - Exploded View

f. Assembly of Control Valve Sections

NOTE: Whenever a control valve has been disassembled, it will be necessary to replace the seal plates used between the sections. This valve requires three (3) seal plate kits (5, Fig. 9.44) to assemble the valve after service.

1. Lay the inlet section (8) down and install the tie rods (3) vertically into the section. Hand tighten until each rod bottoms out in the threaded hole.
2. Open one seal plate kit (5) and verify the parts included: seven (7) O-rings, one (1) shuttle ball and one (1) seal plate.

NOTE: DO NOT use a shuttle ball between the inlet and raise/lower sections nor between the outlet and extend/retract sections.

3. Be sure the surface of the inlet section and the seal plate are clean and free of foreign material. Place the seal plate over the tie rods and onto the inlet section. Install all O-rings except the large elongated one.
4. Using "white lithium" grease, brush a thin layer over the elongated O-ring groove and insert the large O-ring so that it adheres to all sides of the O-ring groove. A blunt tool may be required for this procedure.
5. Verify that all mating surfaces of raise/lower working section are clean and free of foreign material. Slide working section (7) over the tie rods taking care not to damage the surface of the working section.
6. Open a second seal plate kit (5) and verify the parts included: seven (7) O-rings, one (1) shuttle ball and one (1) seal plate.

NOTE: DO NOT use a shuttle ball between the inlet and raise/lower sections nor between the outlet and extend/retract sections.

7. Be sure the surface of the raise/lower working section and the seal plate are clean and free of foreign material. Place the seal plate over the tie rods and onto the working section. Install all O-rings except the large elongated one.
8. Using "white lithium" grease, brush a thin layer over the elongated O-ring groove and insert the large O-ring so that it adheres to all sides of the O-ring groove. A blunt tool may be required for this procedure.

9. Install the shuttle ball (11) on the raise/lower working section.
10. Verify that all mating surfaces of the extend/retract working section are clean and free of foreign material. Slide working section (7) over the tie rods taking care not to damage the surface of the working section.
11. Open a third seal plate kit (5) and verify the parts included: seven (7) O-rings, one (1) shuttle ball and one (1) seal plate.

NOTE: DO NOT use a shuttle ball between the inlet and raise/lower sections nor between the outlet and extend/retract sections.

12. Be sure the surface of the extend/retract working section and the seal plate are clean and free of foreign material. Place the seal plate over the tie rods and onto the working section. Install all O-rings except the large elongated one.
13. Using "white lithium" grease, brush a thin layer over the elongated O-ring groove and insert the large O-ring so that it adheres to all sides of the O-ring groove. A blunt tool may be required for this procedure.
14. Verify that all mating surfaces of the outlet section (4) are clean and free of foreign material. Slide outlet section over the tie rods taking care not to damage the surface of the outlet section.
15. Install the four (4) large nuts (2) onto the tie rods and hand tighten. Carefully lay the valve onto the mounting pads and tighten the nuts to 15-17 lb-ft (20-23 Nm) torque using a cross pattern in 2-1/2 lb-ft (6,10 Nm) increments.
16. Install all four (4) small nuts (1) onto the rods and tighten to 15-17 lb-ft (20-23 Nm) torque using a crossing pattern in 2 lb-ft (5 Nm) increments.
17. Install manual handle or a 3/8 NC x 2" long capscrew into the spool shift collars and shift each spool. Check that each spool operates freely to full "on" in both directions and returns to neutral with spring force only.
18. Install fittings on the control valve as shown in Fig. 9.43.

g. Installation of Control Valve in the Vehicle

NOTE: Be sure that the boom is retracted and supported in a horizontal position with blocking. Be sure that the forklift is in a secure position before installation.

1. Position the main control valve (4, Fig. 9.42) on the forklift and secure it to the frame using capscrews (1), lock washers (3) and nuts (2).

NOTE: Lines were tagged at disassembly to allow for proper assembly. Refer to Figure 9.43 for proper line installation.

2. Remove caps or plugs used to protect hydraulic system, and replace all hoses. Check all lines to be sure they are secure.
3. Start the engine.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

4. Inspect connections at the control valve for leakage.
5. Operate the joystick to test the operation of the control valve and the hydraulic system. Refer to the following paragraph 9.6.2.h for control valve adjustments.
6. Perform full system calibration.

h. Control Valve Adjustments

Perform adjustments of the control valve in vehicle.

Park forklift on a level surface and engage parking brake. Retract the boom and support it in a horizontal position with blocking. Place travel select lever in neutral and stop the engine. Be sure the forklift is in a secure position before servicing.

Pilot Pressure Checks

Since pilot pressure is the net pressure available above reservoir pressure to the pilot stage, both pressure values are significant. It is recommended to use pressure gauge(s) with a range no higher than 500 psi (34,5 bar). If a differential pressure gauge or two standard pressure gauges are available, reservoir pressure and pilot pressure can be measured at the same time which is desirable since time and effort are saved. If one pressure gauge is used, proceed as follows:



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury. Operate the control valve manually by threading a 3/8 NC x 2" long capscrews into the spool shift collar of each hydraulic function, Fig. 9.46. Actuate all of the hydraulic functions (boom raise/lower, extend / retract) after the engine has stopped to relieve any trapped pressure.



Warning

Should it be necessary to remove parts for service, be sure the area around the parts is cleaned thoroughly with an accepted solvent before removing any parts from the control valve to prevent system contamination.

1. Remove the plug (9, Fig. 9.44) from the control valve. Install the pressure gauge in the port.
2. Start the engine. Note and record the reservoir pressure reading on the pressure gauge.
3. Shut OFF the engine and **relieve system pressure.**
4. Remove the pressure gauge from the control valve and install the plug (9, Fig. 9.44).
5. Remove the plug (5, Fig. 9.47) from the inlet section of the control valve. Install the pressure gauge in the port.
6. Start the engine. Note pilot pressure reading on the pressure gauge. The difference between the pilot pressure and reservoir pressure (step 2) should be 205 - 215 psi (14,1 - 14,8 bar). If the pressure differential is not correct, pilot shims (6, Fig. 9.45) must be added (to increase pilot pressure) or removed (to decrease pilot pressure). This must be done after the system has been secured. Check pilot pressure after any repair.
7. Shut OFF the engine and **relieve system pressure.**
8. Remove the pressure gauge from the control valve and install the plug (5, Fig. 9.47).
9. Perform Calibration 1 after repair.

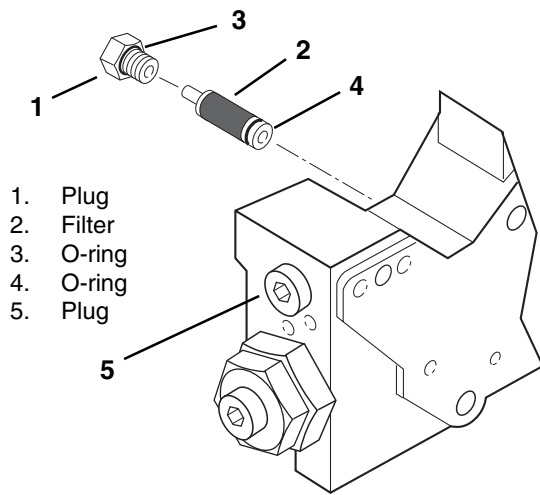


Fig. 9.47 Inlet Bypass Filter

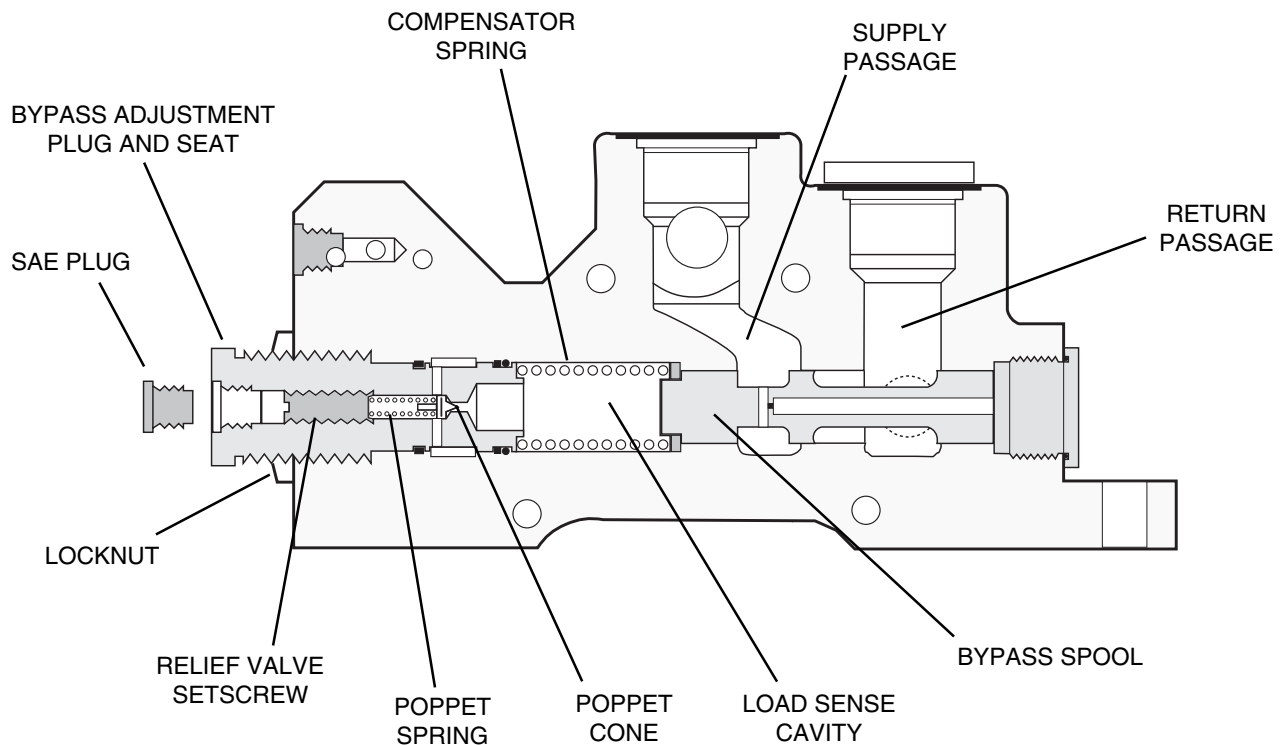


Warning

Never bottom out adjustments. This can result in severe over pressure conditions and cause personal injury or even death.

Bypass and Relief Adjustment

1. Loosen the locknut, Fig. 9.48. Turn the bypass adjustment plug carefully in or out until the pressure gauge reads 200 - 210 psi (13,8 - 14,5 bar). While holding the plug setting, tighten the locknut to 60 - 70 lb-ft (81,6 - 95,2 Nm).
2. Remove the SAE plug. Adjust the relief valve setscrew carefully until the poppet just cracks at a pressure gauge reading of 2650 psi (183 bar).
3. Install SAE plug.
4. Shut off the engine. **Operate the control valve manually by threading a 3/8 NC x 2" long capscrew into the spool shift collar of each hydraulic function, Fig. 9.46. Actuate all of the hydraulic functions (boom raise/lower, extend/retract) after the engine has stopped to relieve any trapped pressure.**
5. Remove pressure gauge and tee and from control valve. Install connector and connect supply hose to control valve connector.



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Fig. 9.48 Control Valve Inlet Section (Sectional View)

9.6.3 Brake Valve

a. Removal

1. Retract the boom and support it in a horizontal and level position.
2. Engage the park lock, place the travel select lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

3. Operate the brake pedal after the engine has stopped to relieve any trapped pressure.
4. To gain access to brake valve (3, Fig. 9.49), remove four hex head screws and lock washers (1), to detach the lower panel (2) which is located under the dash.

5. Tag and disconnect the three hydraulic hoses (5, Fig. 9.49) and remove the three connectors (4) from the right side of the service brake valve. Plug the open hoses and ports.



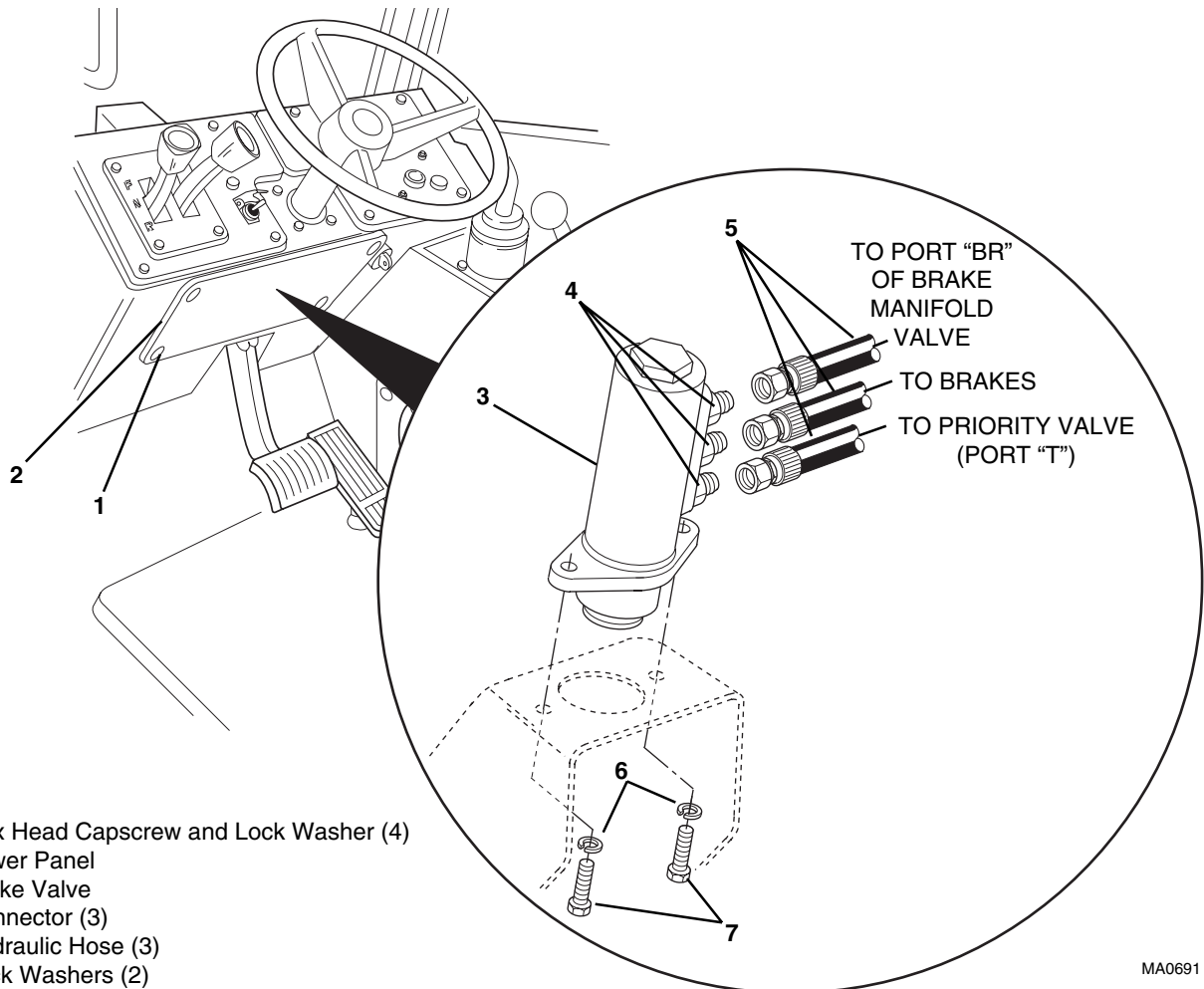
Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

6. Remove capscrews (7, Fig. 9.49) and lock washers (6) which secure valve to the mounting bracket.
7. Remove the service brake valve from the machine.

b. Disassembly

1. Remove ring (1, Fig. 9.50) and boot (2) from housing (13).



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Fig. 9.49 Brake Valve Installation

2. Remove piston (3), shim or shims (4), and springs (5 and 6) from housing bore.
3. Carefully remove O-ring (7) to avoid scratching the housing bore.
4. Carefully remove retaining ring (8) to avoid scratching housing bore.
5. Remove washer (9), plunger (10) and spring (12) from housing bore.
6. Remove cup (11) from plunger (10).
7. Remove plug (23) from housing (13).
8. Remove O-ring (22), cup (20) and back-up ring (21) from plug (23).
9. Remove washer (19), sleeve (18), spring (17) and guide (16) from the housing bore.

10. Remove valve and ball assembly (15) from housing bore.
11. Remove O-ring (14) from the valve and ball assembly.

c. Cleaning and Drying

Clean all metal parts in an approved cleaning solvent such as trichlorethylene and blow dry.

d. Inspection, Repair and Replacement

1. Inspect valve bore for deep grooves or other damage. If there is any damage to the bore, replace the entire brake valve.
2. Remove small scratches in the bore using emery cloth of very fine grit. Use the emery cloth with a rotary motion.

NOTE: Some valves may not have a sleeve (18).

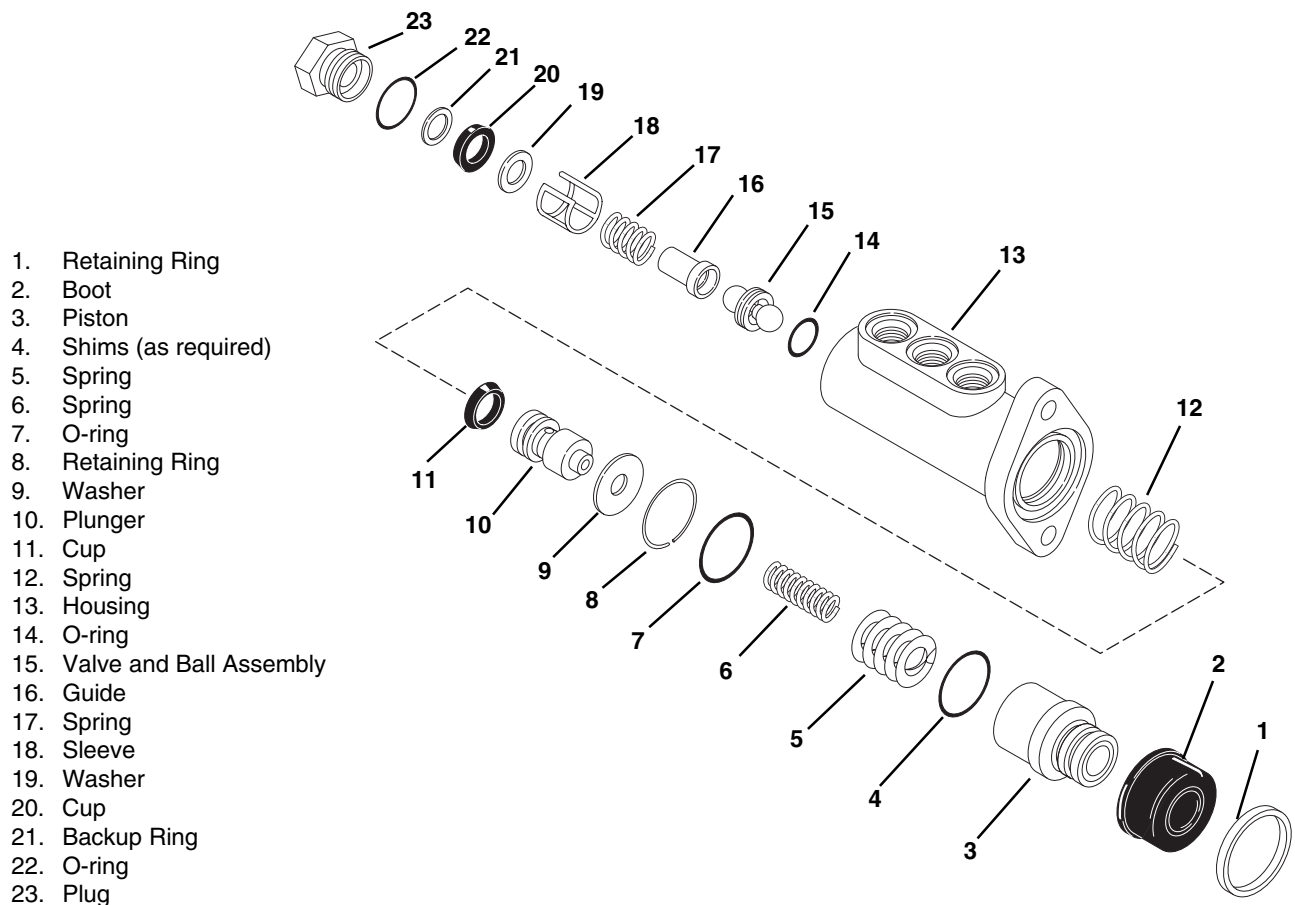


Fig. 9.50 Brake Valve Exploded View

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e. Assembly

1. Install new O-ring (14, Fig. 9.50) in the seat on valve and ball assembly (15) and insert into housing bore so that the seat end is located on the plug end of the brake valve.
2. Install guide (16), spring (17), sleeve (18) and washer (19) in the housing bore.

NOTE: It is desirable to install a new sleeve (18) in all units. The sleeve is part of the valve repair kit. Position the sleeve over the spring (17) and up against the seat flange.

3. Insert new back-up ring (21) and new cup (20) inside end of plug (23). Note the order of backup ring and cup.
4. Install new O-ring (22) on the plug and install in housing (13).
5. Install new cup (11) and spring (12) on plunger (10). Note that the cup lip should be facing toward the plug (pressure) end of the brake valve.
6. Insert assembled plunger into the housing bore.
7. Install washer (9) in the housing bore.
8. Carefully install retaining ring (8) in housing bore to avoid scratching the housing bore.
9. Install new O-ring (7) in housing bore.
10. Install springs (5 and 6), shim or shims (4) and piston (3) in housing bore.
11. Install boot (2) and retaining ring (1) in housing (16).

f. Valve Installation

1. Lower brake valve (3, Fig. 9.49) into position on the mounting bracket.
2. Install capscrews (7) and lock washers (6) to secure valve.
3. Remove plugs or caps as required and connect the tagged hydraulic lines to the brake valve.
4. Install lower panel (2) with capscrews and lock washers (1) after bleeding and checking brake system.

g. Bleeding the Brake Lines

Bleed the brake lines very carefully as soon as the brake valve is installed in the machine. Air in the system will not allow the brakes to release properly and may severely damage them. Bleed the brakes whenever there is reason to suspect that air has entered the braking system.

1. Place the transmission in neutral, start the engine and engage parking brake.
2. Install one end of an 18 to 24 inch (457 to 610 mm) length of transparent 1/4 inch (6 mm) inside diameter tubing over the brake bleeder, Fig. 9.51. Place the other end of this tubing in a suitable transparent container which is partially filled with hydraulic oil. The end of the tubing must be below the oil level in the container.



Warning

The pressure at the brakes is 525 psi (36,2 bar). Do not open the bleeder without holding tubing on the bleeder to prevent releasing a jet of oil that could cause personal injury.

3. While holding the tubing firmly on the bleeder, open the bleeder with a suitable small wrench. Have an assistant depress the brake pedal. Close the bleeder when air bubbles no longer appear in the oil. Release the brake pedal and remove the tubing from the bleeder.
4. Repeat steps 2 and 3 for the brakes on the other wheels.
5. Discard the oil which was collected in the container.
6. Check level in reservoir and fill as described in the Owners/Operators Manual.

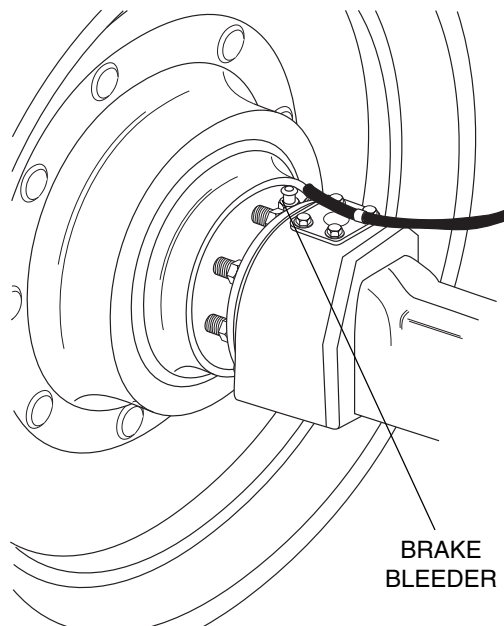
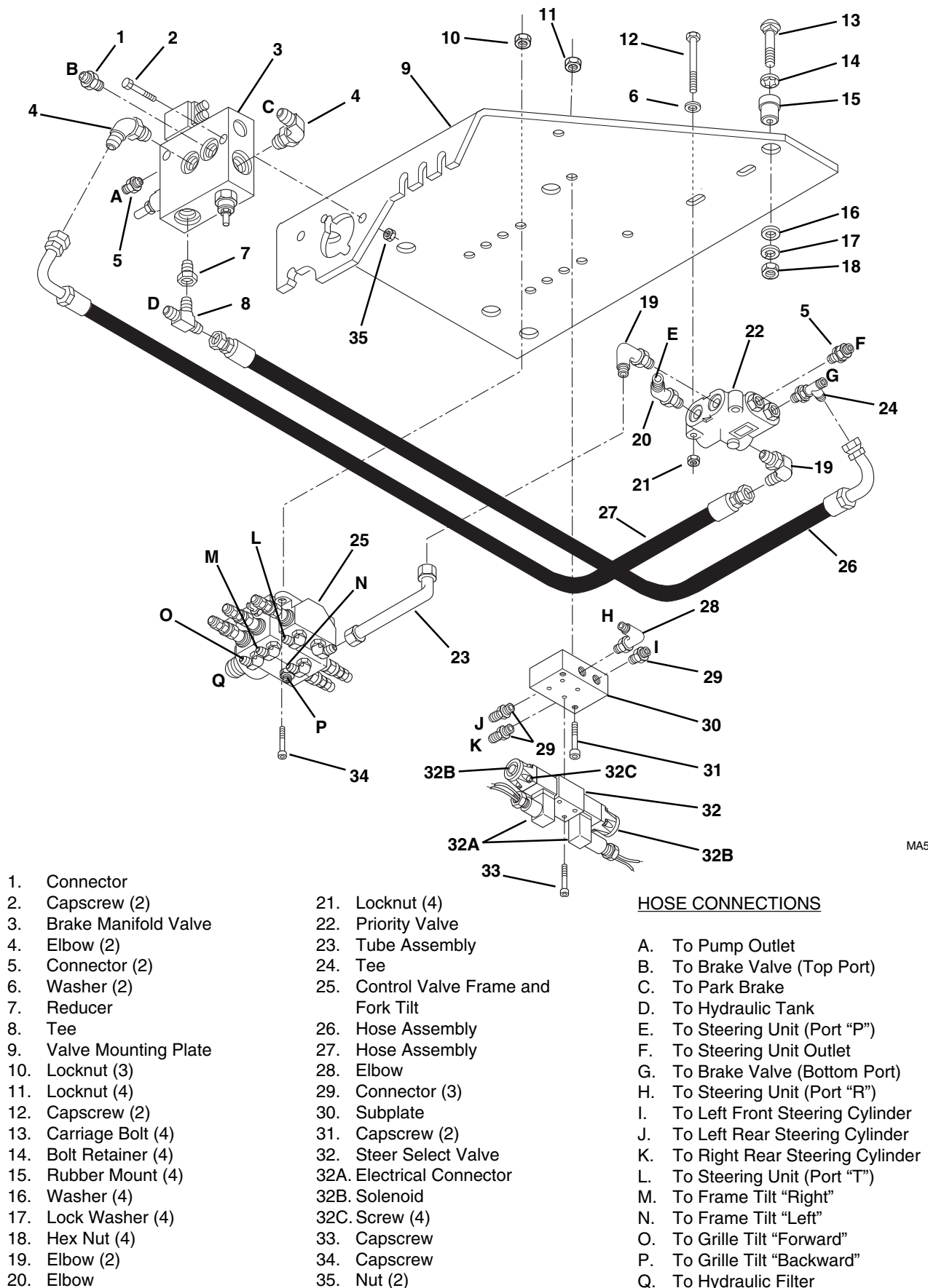


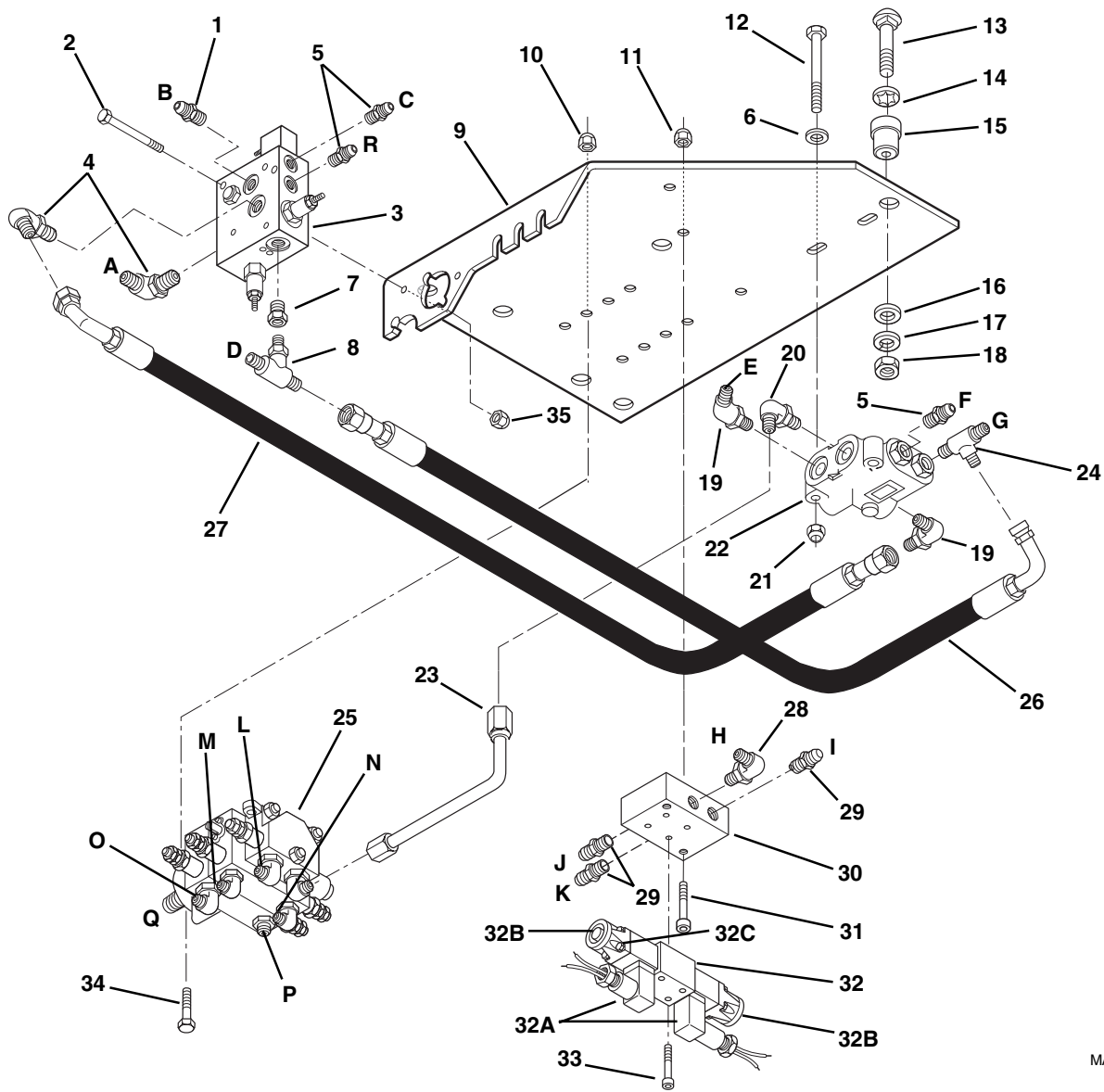
Fig. 9.51 Brake Bleeder

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Fig. 9.52 Valve Plate Assembly (w/o De-Clutch) - Exploded Underside View (S/N 9B0500 thru 0E1179)



MA5030

1. Connector
2. Capscrew (2)
3. Brake Manifold Valve
4. Elbow (2)
5. Connector (2)
6. Washer (2)
7. Reducer
8. Tee
9. Valve Mounting Plate
10. Locknut (3)
11. Locknut (4)
12. Capscrew (2)
13. Carriage Bolt (4)
14. Bolt Retainer (4)
15. Rubber Mount (4)
16. Washer (4)
17. Lock Washer (2)
18. Hex Nut (4)
19. Elbow (2)
20. Elbow

21. Locknut (4)
22. Priority Valve
23. Tube Assembly
24. Tee
25. Control Valve Frame and Fork Tilt
26. Hose Assembly
27. Hose Assembly
28. Elbow
29. Connector (3)
30. Subplate
31. Capscrew (2)
32. Steer Select Valve
- 32A. Electrical Connector
- 32B. Solenoid
- 32C. Screw (4)
33. Capscrew
34. Capscrew
35. Nut (2)

HOSE CONNECTIONS

- A. To Pump Outlet
- B. To Brake Valve (Top Port)
- C. To Park Brake
- D. To Hydraulic Tank
- E. To Steering Unit (Port "P")
- F. To Steering Unit Outlet
- G. To Brake Valve (Bottom Port)
- H. To Steering Unit (Port "R")
- I. To Left Front Steering Cylinder
- J. To Left Rear Steering Cylinder
- K. To Right Rear Steering Cylinder
- L. To Steering Unit (Port "T")
- M. To Frame Tilt "Right"
- N. To Frame Tilt "Left"
- O. To Grille Tilt "Forward"
- P. To Grille Tilt "Backward"
- Q. To Hydraulic Filter
- R. To Transmission De-clutch

Fig. 9.53 Valve Plate Assembly (with De-Clutch) - Exploded Underside View (S/N OE1180 and After)

9.6.4 Valve Plate Assembly

The secondary control valve (25), brake manifold valve assembly (3), steer select valve, and priority valve are mounted on the valve plate located under the cab (Fig. 52 and 53).

Machines without transmission de-clutch installed (S/N 9B0500 thru OE1179) are shown in Figure 52.

Machines with transmission de-clutch installed (S/N OE1180 and After) are shown in Figure 53.

9.6.5 Brake Manifold Valve Assembly (Without Trans. De-clutch, S/N 9B0500 thru OE1179)

The park lock release solenoid valve, pressure reducing valve, and sequence valve are installed in the brake manifold valve block.

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

2. Remove the electrical connector from the solenoid (Fig. 9.54) on brake manifold valve.
3. Slowly loosen fittings at brake manifold valve as required (3, Fig. 9.52) to relieve any trapped pressure.
4. To check a solenoid, apply 12 Vdc momentarily to the solenoid leads and listen for an audible click that indicates spool movement. If there is no sound, the solenoid is probably defective. Refer to Section 10 for additional electrical test of the steer select valve.
6. Tag and disconnect hydraulic hoses from connectors (1 and 5, Fig. 9.52), elbows (4) and tee (8) on brake manifold valve (3). Cap or plug the hoses.

6. Remove two nuts (35) and capscrews (2) and remove assembled brake manifold valve (3) from valve plate (9).
7. Remove connectors (1 and 5) elbows (4) tee (8) and reducer (7) from the brake manifold valve (Fig. 9.52).

b. Disassembly

1. Remove check valve, park lock release solenoid valve, pressure reducing valve and sequence valve from brake manifold valve.

NOTE: There are no serviceable parts in the brake manifold valve block other than the removable valves shown (Fig. 9.54); do not disassemble.

c. Cleaning

Without submerging the electrical portion of the brake manifold valve block, clean manifold valve block and the other valves removed in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect solenoid, electrical connectors and wiring and replace if damaged.
2. Inspect the seals on the check valve, park lock release solenoid valve, pressure reducing valve, and sequence valve. Refer to the parts manual for the correct seal kits for each valve and replace seals if damaged.

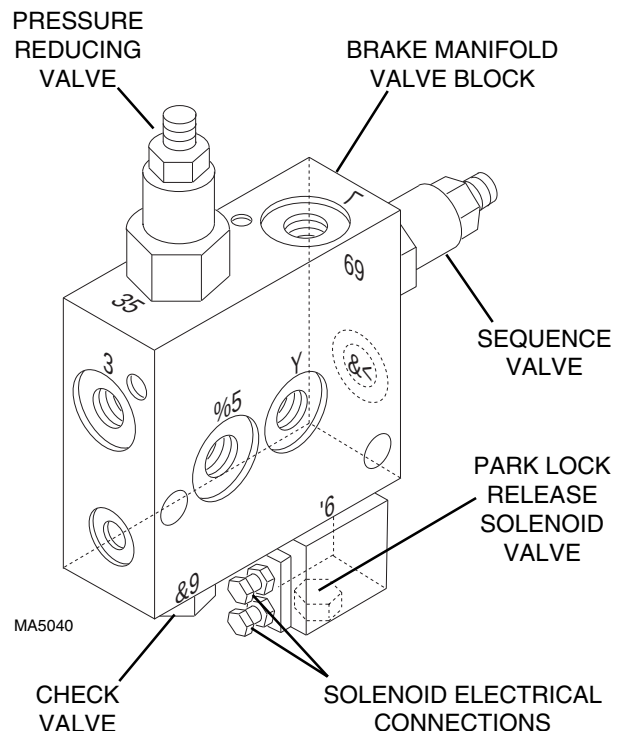


**Fig. 9.54 Brake Manifold Valve Assembly
(Without Trans. De-clutch, S/N 9B0500 thru OE1179)**

e. Installation

1. Lubricate with hydraulic oil and install the check valve, park lock release solenoid valve, pressure reducing valve, and the sequence valve into the brake manifold valve (Fig. 9.54).
2. Install connectors (1 and 5), elbows (4), reducer (7), and tee (8) into the brake manifold valve.
3. Install the assembled brake manifold on the valve plate (9) using two capscrews (2) and nuts (35).
4. Connect the hoses to connectors (1 and 5), elbows (4), and tee (8).
5. Connect the electrical connector to the park lock release solenoid valve (Fig. 9.54).
6. Start the engine and operate the brake pedal and park lock switch several times to purge the brake system of air.
7. Bleed the brake system as described in paragraph 9.6.3.g if necessary.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

8. Refer to paragraph 9.4.5.b for pressure checks and adjustments, and paragraph 9.4.5.c for testing.

9.6.6 Brake Manifold Valve Assembly (With Trans. De-clutch, S/N OE1180 and After)

The park lock release solenoid valve, pressure reducing valve, and sequence valve are installed in the brake manifold valve block.

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen fittings at brake manifold valve as required (3, Fig. 9.53) to relieve any trapped pressure.



Warning

Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove the electrical connector from the solenoid (2, Fig. 9.55) on brake manifold valve.
4. To check a solenoid, apply 12 Vdc momentarily to the solenoid leads and listen for an audible click that indicates spool movement. If there is no sound, the solenoid is probably defective. Refer to Section 10 for additional electrical test of the steer select valve.
5. Tag and disconnect hydraulic hoses from connectors (1 and 5, Fig. 9.53), elbows (4) and tee (8) on brake manifold (3). Cap or plug the hoses.
6. Remove two nuts (35) and capscrews (2) and remove assembled brake manifold valve (3) from valve plate (9).
7. Remove connectors (1 and 5), elbows (4), tee (8), and reducer (7) from the brake manifold valve.

b. Disassembly

1. Remove check valve, park lock release solenoid valve, pressure reducing valve and sequence valve from brake manifold valve block (Fig. 9.55).

NOTE: There are no serviceable parts in the brake manifold valve block other than the removable valves shown (Fig. 9.55); do not disassemble.

c. Cleaning

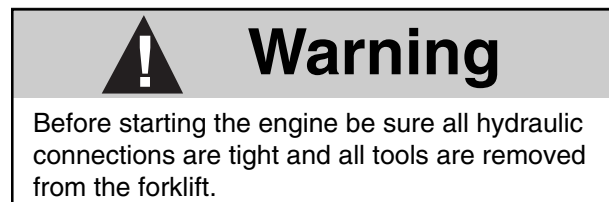
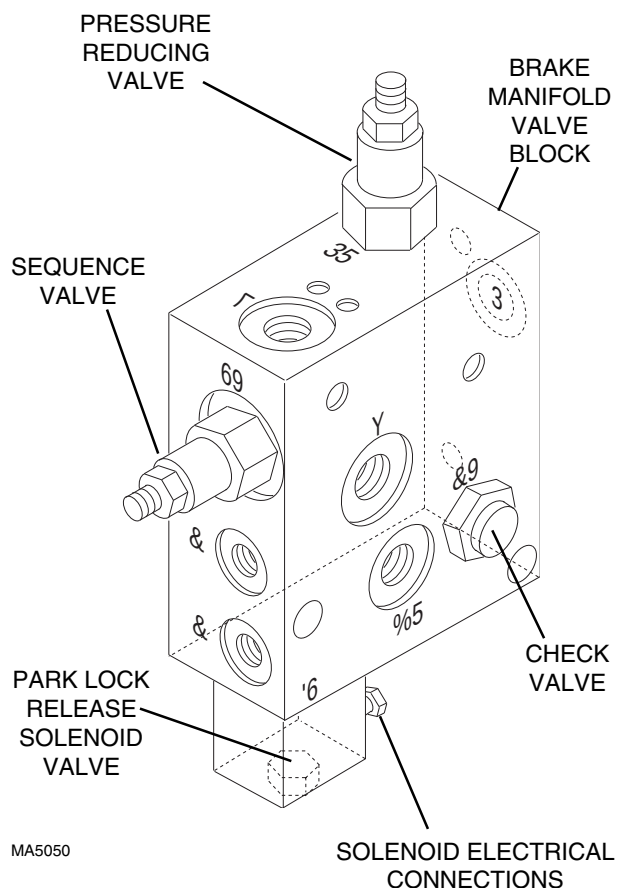
Without submerging the electrical portion of the brake manifold valve block, clean manifold valve block and the other valves removed in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect solenoid, electrical connectors and wiring and replace if damaged.
2. Inspect the seals on the check valve, park lock release solenoid valve, pressure reducing valve, and sequence valve. Refer to the parts manual for the correct seal kits for each valve and replace seals if damaged.

e. Installation

1. Lubricate with hydraulic oil and install the check valve, park lock release solenoid valve, pressure reducing valve, and the sequence valve into the brake manifold valve (Fig. 9.55).
2. Install connectors (1 and 5), elbows (4), reducer (7), and tee (8) into the brake manifold valve.
3. Install the assembled brake manifold valve on the valve plate (9) using two capscrews (2) and nuts (35).
4. Connect the hoses to connectors (1 and 5), elbows (4), and tee (8).
5. Connect the electrical connector to the park lock release solenoid valve (Fig. 9.55).



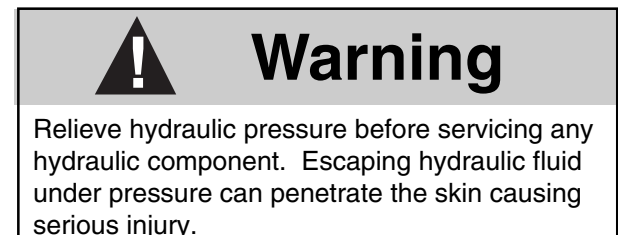
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**Fig. 9.55 Brake Manifold Valve Assembly
(With Trans. De-clutch S/N OE1180 and After)**

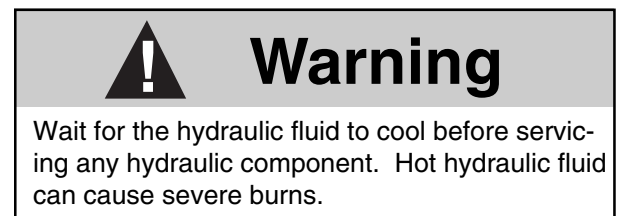
6. Start the engine and operate the brake pedal and park lock switch several time to purge the brake system of air.
7. Bleed the brake system as described in paragraph (9.6.3.g) if necessary.
8. Refer to paragraph 9.4.5.b for pressure checks and adjustments, and paragraph 9.4.5.c for testing.

9.6.7 Steer Select Valve**a. Removal**

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.



2. Slowly loosen fittings at steer select valve as required (32, Fig. 9.52 or 9.53) to relieve any trapped pressure.
3. Remove the electrical connectors (32A) from the solenoids (32B) on steer select valve (32).



4. To check a solenoid, apply 12 Vdc momentarily to the solenoid leads and listen for an audible click that indicates spool movement. If there is no sound, the solenoid is probably defective. Refer to Section 10 for additional electrical test of the steer select valve.

NOTE: If no service is required for valve subplate (30, Fig. 9.52 or 9.53), proceed to step 5.

5. Tag and disconnect hydraulic hoses from connectors (29) and elbow (28) on valve subplate (30).
6. Remove two nuts (29) and capscrews (31) and remove assembled valve (32) and subplate (30).
7. Remove connectors (29) and elbow (28) from the subplate.

8. Remove steer select valve (32) from the subplate by removing four capscrews (33).
9. Remove and discard O-rings between subplate and steer select valve.

b. Disassembly

NOTE: *There are no serviceable parts in the steer select valve; do not disassemble.*

Replace solenoid(s) if defective. Remove four screws (32C) to detach each solenoid.

c. Cleaning

Without submerging the electrical portion of the steer select valve, clean valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect solenoids, electrical connectors and wiring and replace if damaged.
2. Replace entire steer select valve if damaged.

e. Installation

1. Install four new O-rings in base ports of steer select valve (32, Fig. 9.52 or 9.53).
2. Position the steer select valve on valve subplate (30) and secure with four capscrews (33).

NOTE: *If the valve subplate was removed for service, continue with steps 3 through 5.*

3. Install connectors (29) and elbow (28) in the subplate.
4. Place the assembled steer select valve and valve subplate on mounting plate (9). Install two capscrews (31) and nuts (11) to secure.
5. Connect hydraulic hoses to connectors (29) and elbow (28).
6. Install electrical connectors.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

f. Bleeding Steering System

1. Start the forklift engine and run at idle.
2. Turn the steering wheel fully left to right and back (lock to lock) several times in all three steering modes until they operate smoothly. This should purge the steering system of air.

9.6.8 Priority Valve

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.



Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Slowly loosen the fittings at the priority valve (22, Fig. 52 or 53).
3. Tag and disconnect the tube and hose assemblies from elbows (20), connector (5), and tee (24).
4. Remove nuts (21), capscrew (12), washer (6), and remove the priority valve from the valve plate (9).
5. Remove hydraulic fittings from priority valve as required.

b. Disassembly

NOTE: *There are no serviceable parts in the priority valve; do not disassemble.*

c. Cleaning

Clean the priority valve in an approved cleaning solvent and blow dry.

d. Inspection and Replacement

1. Inspect the priority valve for wear, scoring, and other damage. Replace entire priority valve if damaged.

e. Installation

1. Install the hydraulic fittings in the same ports and positions as removed.
2. Install the priority valve onto the valve plate with capscrews (12), washers (6), and nuts (21).
3. Install the tube and hose assemblies to the proper fittings.



Warning

Before starting the engine be sure all hydraulic connections are tight and all tools are removed from the forklift.

9.7 PUMPS

9.7.1 Main Tandem Pump

a. Removal

1. Engage the park lock, place the travel selector lever in neutral, and stop the engine.

Warning

Relieve hydraulic pressure before servicing any hydraulic component. Escaping hydraulic fluid under pressure can penetrate the skin causing serious injury.

2. Operate the hydraulic joystick to relieve any trapped pressure in the 30 gpm section of the tandem pump. Slowly loosen the upper outlet port fitting on the 15 gpm pump section to relieve any trapped pressure.

Warning

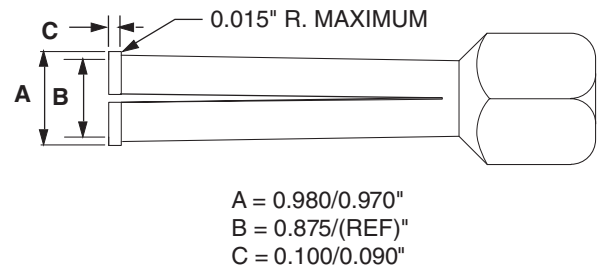
Wait for the hydraulic fluid to cool before servicing any hydraulic component. Hot hydraulic fluid can cause severe burns.

3. Remove hex head capscrews (5, Fig. 9.58), lock washers (6), and both clamp halves (4) on the main pump inlet line. Disconnect the hose elbow (3) from the pump inlet. Remove and discard the O-ring (7) from the elbow.
4. Disconnect small pump outlet hose (8).
5. Disconnect large pump outlet hose (9).
6. Remove connector (10) and elbow (11) from the pump outlets.
7. Remove capscrews (12) and lock washers (13) that attach the main tandem pump (14) to the transmission. Remove and discard the pump gasket (15).

b. Tools Required for Pump Repair

The following tools are required for tandem pump disassembly and assembly:

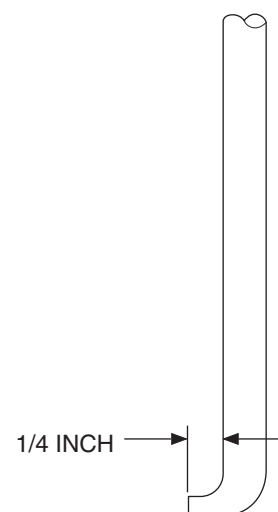
1. A bushing puller made from Collet 33863 of Blind Hole Puller Set 981 by Owatonna Tool Company or an equivalent puller from another supplier. Modify this collet as shown in Fig. 9.56.



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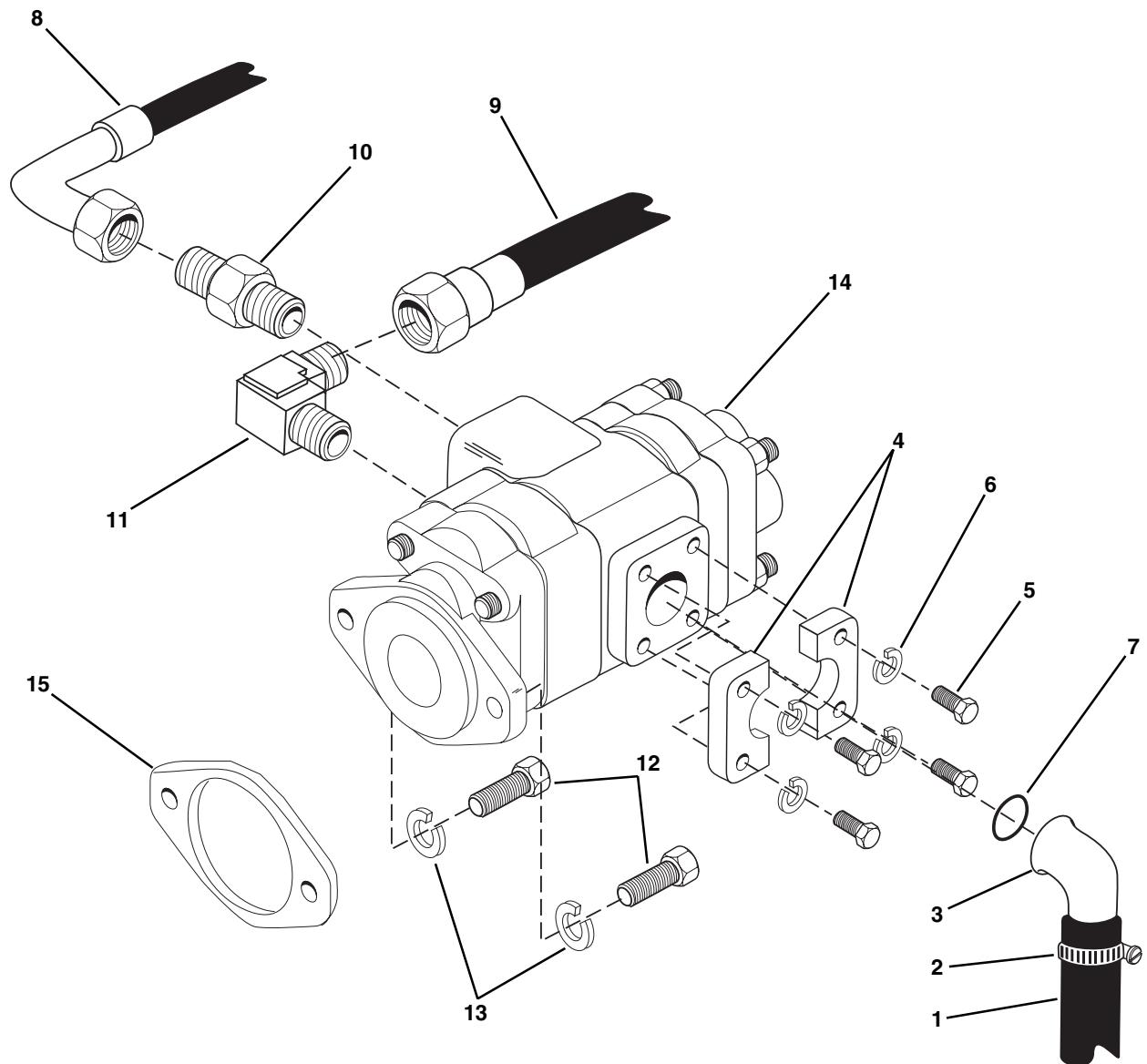
Fig. 9.56 Bushing Puller

2. A seal removal tool made by heating the tip of an old screwdriver and bending it as shown in Figure. 9.57. Grind off the tip to fit the notch behind the shaft seal.
3. A bushing installation tool made from A.I.S.I. 8620 Heat Treated Bearing Quality Steel as shown in Figure. 9.59.
4. A special steel sleeve made from bar stock which is 1-1/8 or 1-1/4" diameter by 4-5/8" (117,5mm) as shown in Figure 9.60. This sleeve is used to insert the drive shaft through the lip seal without damage.
5. A lip seal installation bar made from bar stock which is 1-3/4" in diameter by 2" long. Break edges slightly.



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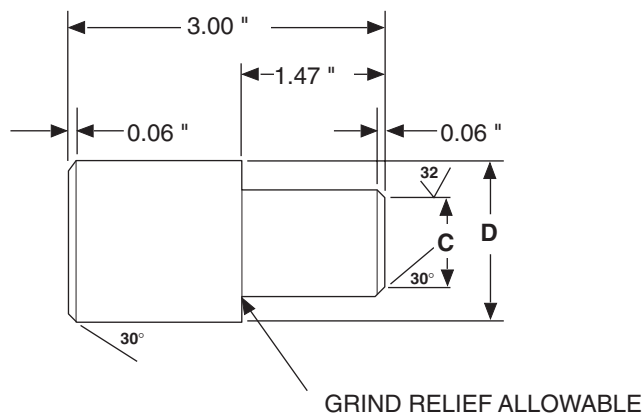
Fig. 9.57 Seal Removal Tool



1. Hose Clamp
2. Inlet Hose
3. Elbow
4. Clamp Half (2)
5. Capscrew (4)
6. Lock Washer (4)
7. O-ring
8. Small Pump Outlet Hose
9. Large Pump Outlet Hose
10. Connector
11. Elbow
12. Capscrew (2)
13. Lock Washer (2)
14. Main Tandem Pump
15. Pump Gasket

MA0781

Fig. 9.58 Main Tandem Pump Installation



C = 1.054 PLUS 0.000, MINUS 0.002"
D = 1.250" DIAMETER

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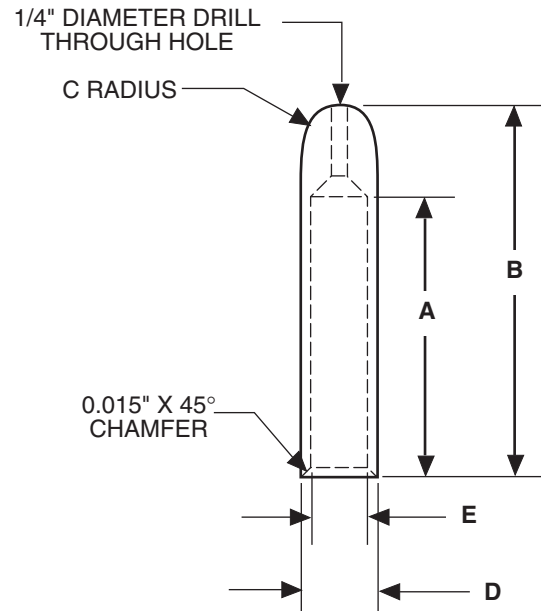
Fig. 9.59 Bushing Installation Tool

6. The following tools will also be required:

- arbor press
- awl
- steel ball, 1-1/2" diameter
- clean lintless cloths
- deburring tool (an old file with the cutting teeth ground off)
- machinist's hammer
- soft hammer
- Permatex Aviation Form-A-Gasket No. 3 Non-hardening Sealant or equivalent
- medium grit Carborundum stone
- oil and grease
- snap ring pliers
- prick punch
- scale (1/32" or 1/64" graduations)
- small screwdriver
- torque wrench
- vise with 8" minimum open spread

c. General Repair Precautions

1. To facilitate repair of the pump and before any work is done, first read and understand all of the steps used in the disassembly and assembly instructions.
2. The first requirement of good maintenance of hydraulic equipment is cleanliness. Make sure you disassemble and assemble your hydraulic equipment in a clean area.



A = 3-3/8"
B = 4-1/2"
C = 9/16" R
D = 1.065 PLUS 0.000, MINUS 0.002"
E = 1.002 PLUS 0.002, MINUS 0.000"

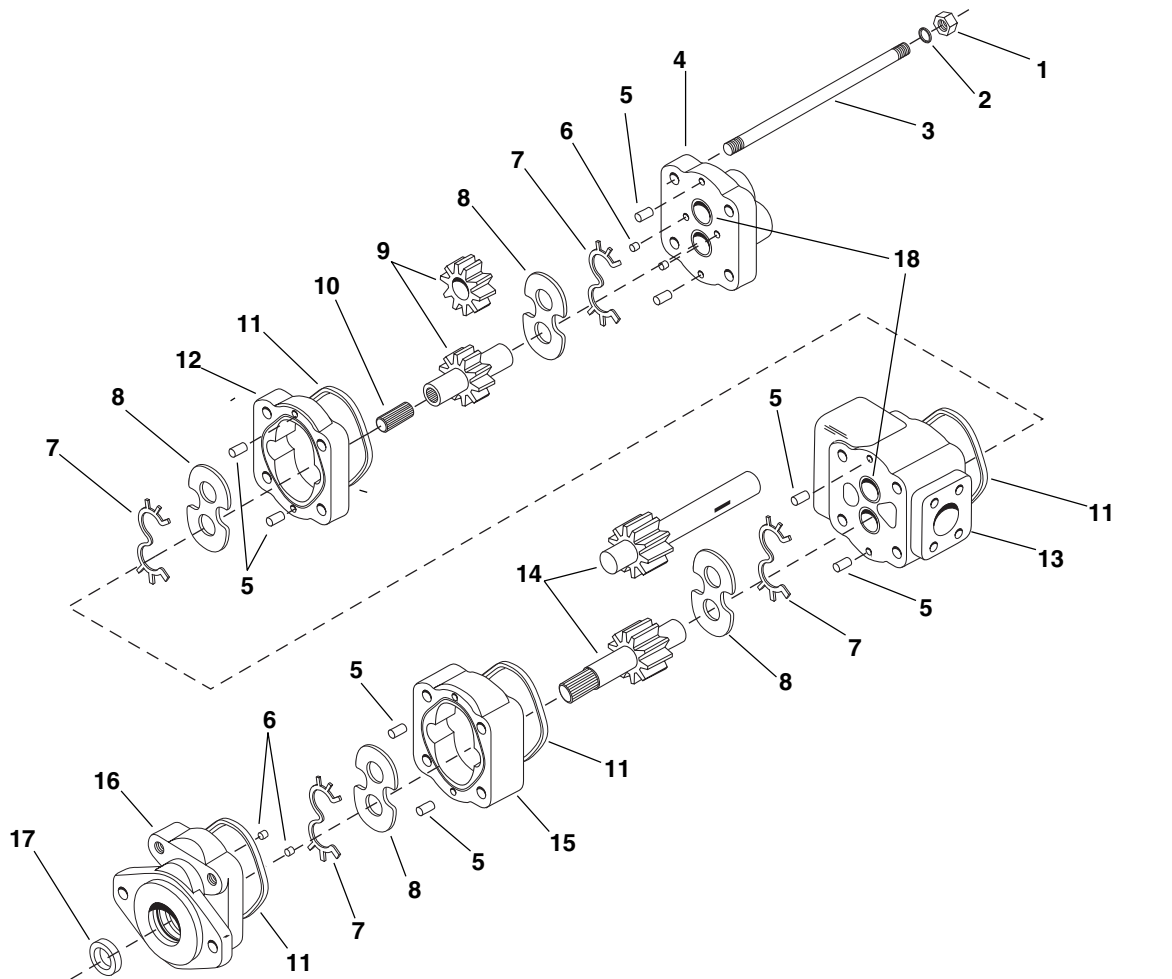
MA0821

Fig. 9.60 Special Steel Sleeve

3. If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and serious damage to parts.
4. Match mark exterior surface of housings before separating the parts. Align match marks during assembly.
5. Gears are closely matched. Gears must be kept together as sets when removed from a unit. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals. **Always replace matched parts as a set.**
6. Do not grip machined surfaces in a vise to prevent damage to fine surfaces.
7. If parts are difficult to fit during assembly, tap gently with a soft hammer. Never use an iron or steel hammer to tap parts.
8. Never hammer bushings into bores; use an arbor press.

d. Disassembly Instructions

1. Prepare to disassemble the pump by placing it in a vise with the drive shaft pointing down.
2. Use a socket wrench to remove four hex nuts (1, Fig. 9.61), studs (3), and washers (2).
3. Lift off port end cover (4). If prying is necessary, be careful not to damage the machined surfaces. Dowel pins (5) will remain in either port end cover or gear housing. Do not remove dowel pins unless damaged.
4. Remove seal (7) and thrust plate (8).
5. Carefully remove drive and driven gear set (9). Avoid tapping the gear teeth together or against other hardened surfaces to avoid possible chipping. Keep the matched gears in a set together.
6. Remove seal (11). Lift gear housing (12) from the bearing carrier. If prying is necessary, take care not to damage machined surfaces.
7. Lift or pry off the bearing carrier housing (13). Take care not to damage contact face and edges. Dowel pins will remain in either the bearing carrier or the gear housing. Do not remove dowel pins unless damaged.



- | | |
|---------------------|-----------------------------|
| 1. Hex Nut (4) | 10. Connecting Shaft |
| 2. Washer (4) | 11. Sp-R Gasket Seal (4) |
| 3. Stud (4) | 12. Gear Housing |
| 4. Port End Cover | 13. Bearing Carrier Housing |
| 5. Dowel Pin (8) | 14. Gear Shaft Set |
| 6. Plug (4) | 15. Gear Housing |
| 7. Channel Seal (4) | 16. Shaft End Cover |
| 8. Thrust Plate (4) | 17. Lip Seal |
| 9. Gear Set | 18. Bushing (8) |

PA0552

Fig. 9.61 Main Tandem Pump

8. Remove connecting shaft (10). Remove thrust plate (8), seal (7) and seal (11).
9. Remove integral gear set (14). Keep these together as they are a matched set. Be careful not to damage the machined surfaces of the gears.
10. Remove thrust plate (8), seal (7) and seal (11).
11. Lift or pry off the first section gear housing (15). Be careful not to damage machined surfaces.
12. Remove thrust plate (8), seal (7) and seal (11).
13. Grip the shaft end cover (16) in a vise with the mounting face down. Remove double lip seal (17) by inserting the special seal removal tool (Fig. 9.57) into the notch between the double lip seal and the shaft end cover. Tap the seal out and discard. Remove and discard all rubber and polymer seals.

e. Cleaning

Clean metal tandem pump components in an approved cleaning solvent and blow dry.

f. Inspection, Repair and Replacement

1. If either a dowel (5 Fig. 9.61) or a dowel hole is damaged, the dowel or machined casting, or both, must be replaced. Pull defective dowels as required.
2. Examine thrust plates (8,) and replace if necessary. The thrust plates seal the gear section at the sides of the gears. Wear here will allow internal slippage, that is, oil will bypass within the pump. A maximum 0.002" (0,05 mm) wear is allowable. Replace thrust plates if they are scored, eroded or pitted. Check center of thrust plates where the gears mesh. Erosion here indicates oil contamination. Pitted thrust plates indicate cavitation or oil aeration. Discolored thrust plates indicate overheating, probably due to insufficient oil.
3. Examine the drive and driven gear set (9). Replace as a matched set if there is scoring on the gear hubs; scoring, grooving, or burring of the outside diameter of the teeth, or nicking, grooving, or fretting of teeth surfaces.
4. Examine the gear housings (12 and 15) and replace it if necessary. Wear in excess of 0.007 inch (0,18 mm) cut-out necessitates replacement of the gear housing. Place a straight-edge across bore. If you can slip a 0.007 inch (0,18 mm) feeler gauge under the

straight-edge in the cut-out area, replace the gear housing. Pressure pushes the gears against the housing on the low pressure side. As the hubs and bushings wear, the cut-out becomes more pronounced. Excessive cut-out in a short period of time indicates excessive pressure or oil contamination. If the relief valve settings are within prescribed limits, check for shock pressures or tampering. Withdraw oil sample and check it and tank for dirt. Where cut-out is moderate, 0.007 inch (0,18 mm) or less, gear housing is in good condition and may be reused.

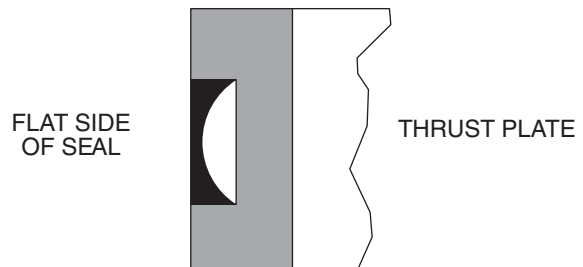
5. Examine integral gear shaft set (14). Examine the gears as described in paragraph 3 above. Examine all drive shafts and replace if there is any wear detectable by touch in the seal area or at the drive coupling. Maximum allowable wear is 0.002 inch (0,05 mm). Wear in the shaft seal area indicates oil contamination. Wear or damage to splines, keys, or keyways necessitates replacement.
6. If gears are replaced, bushings (18) must be replaced. Bushings should fit into bore with a heavy press fit. Inspect all bushings for scoring or discoloration and replace if necessary. Use a bushing puller (Fig. 9.56) to remove bushings.
7. Replace all rubber and polymer seals, including all O-rings, channel seals, shaft seals and gasket seals.
8. Examine the plugs (6) in the shaft end and port end covers to make sure that the plugs are in the proper position and tight. There should be two plugs in both the shaft end and port end. Replace any plugs which are damaged or cannot be tightened.

g. Assembly

1. Stone all machined surfaces with a medium grit Carborundum stone.
2. If bushings have been removed, deburr the bushing bores with fine emery cloth.
3. Rinse parts in an approved solvent. Air blast all parts and wipe with a clean lintless cloth before starting assembly.
4. Grip shaft end cover (16, Fig. 9.61) in vise with mounting face down. If plugs (6) were removed, screw new plugs in tightly. Stake plug with prick punch at both ends of screwdriver slot and around edges. Peen the edge of the hole 1/32 to 1/16" (0,79 mm to 1,59 mm) with a 1-1/2" diameter steel ball.

NOTE: If new plugs are being installed, coat threads with Loctite® Threadlocker 242.

5. If removed, install new dowels (5) as needed. Be sure dowel holes are clean and free of burrs. Gently tap in new dowels with a soft hammer.
6. Assembly of bushings in shaft end cover (16), bearing carrier housing (13) and port end cover (4).
 - a. Install any new bushings in drive bores with groove to top of unit (12 o'clock). Assemble bushings in driven bores with the groove to bottom of unit (6 o'clock).
 - b. Press bushings into the bores, one at a time using the special installation tool (Fig. 9.59) and an arbor press. Be sure the grooves are positioned as stated in step 6a. Bushings must be pressed into the bores flush with the casting face. Be sure to support the castings so they are square and level.
 - c. Repeat Steps 1 and 3 (stone and rinse parts).
7. Before inserting a new lip seal (17) in the shaft end cover (16), coat the outer edge of the lip seal and its recess with Permatex Aviation Form-A-Gasket No. 3 nonhardening sealant or equivalent. With the metal side of the lip seal up, press it into the mounting flange side of the shaft end cover with an arbor press and special installation bar (paragraph 9.4.2b). Be careful not to damage the lip of the seal. Press in until flush with the recess. Wipe off excess sealant.
8. Lubricate new gasket seals (11) and insert them into the grooves in both sides of all gear housings.
9. Position the first gear housing (15) over the shaft end cover (16) and dowels. Tap it with a soft hammer until it rests tightly against the shaft end cover. Be careful not to pinch the gasket seal (8). Also be sure the large rounded core is on the inlet side
10. Assemble new channel seals (7) into the grooves in all the thrust plates (8) with the flat side of the seal facing away from the thrust plate (Fig. 9.62).
11. Gently slip thrust plate (8) with seal (7) through the gear housing and into place on the shaft end cover (16). The channel seal should face the shaft end cover. The relief groove in the plate should face the outlet side of the pump.
12. Slide the driven gear and shaft through the housing (15) and into the bushing in the shaft end cover (16). Coat the steel sleeve tool (Fig. 9.60) with hydraulic oil inside and out. Place the lightly lubricated drive shaft inside the sleeve and slide both through the shaft end cover with a twisting motion until the integral gear rests against the thrust plate. Avoid damaging the double lip seal (17). Squirt clean hydraulic oil over the gears.
13. Slip thrust plate (8) with seal (7) over gear journals and into housing bore. The flat side of the seal should face up with the relief groove facing the outlet side.
14. Position the bearing carrier housing (13) over the gear housing (15) so that the bushings receive the journals of the drive and driven gears. Be sure to line up dowel pins with the dowel holes
15. Insert the connecting shaft (10) into the spline of the drive gear shaft. Position the second gear housing (12) on the bearing carrier housing as described in step 8.
16. Place the thrust plate (8) with seal (7) in the gear housing as described in step 11. Insert the drive and driven gears of the second section gear set (9) in their respective bearings. Make certain the gears are in contact with the face of the thrust plate.
17. Slip thrust plate (8) with seal (7) over gear journals and into housing bore. The flat side of the seal should face up with the relief groove facing the outlet side.
18. Place port end cover (4) over the gear journals. Align the dowel pins (5) with the holes in the mating casting. Being careful not to pinch the gasket seal (11), tap the port end cover lightly in the center between bearing bores to engage the dowels and to move parts together in a final seating.



MA0831

Fig. 9.62 Channel Seal Installation

19. Thread four studs (3), washers (2) nuts (1) into shaft end cover (16) and tighten alternately or cross corner. Rotate the drive shaft with a 6 inch wrench to make certain there is no binding in the pump. After the fasteners are tight and you are sure there is no internal binding, torque the diagonally opposite fasteners to 200 lb-ft (271,2 Nm).

h. Installation

1. Place a new gasket (15, Fig. 9.58) and main tandem pump (14) in position on the transmission and secure using two hex head capscrews (12) and lock washers (13). Torque capscrews to 75 lb-ft (101,7 Nm).
2. Fill the pump inlet port and outlet ports with hydraulic oil to provide initial lubrication
3. Install elbow (11) and connector (10) to the pump outlets.
4. Install small pump outlet hose assembly (8) and large pump outlet hose assembly (9).
5. Install O-ring (7) in elbow (5). Position clamp halves (6) and elbow (5) on pump inlet and secure with four lock washers (4), and four hex head capscrews (3). Torque capscrews to 75 lb-ft (101,7 Nm).
6. Check hose clamp (1) to be sure it is secure.

i. Recommended Test Procedure

Perform pump testing in accordance with procedures in SAE Handbooks. Refer to Hydraulic Pump Test Procedure SAE J745c.

1. Be sure to run the pump in the clockwise direction (from the drive end). Driving the pump in the wrong direction will build up pressure behind the shaft seal, damaging it and requiring replacement.
2. Be sure there is an adequate supply of oil for the pump, at least one gallon of oil for each gpm of pump capacity.
3. If one section of the tandem pump is being tested, make sure that the other section which is not being tested is adequately supplied with oil. If any of the sections run dry, or if plugs are left in ports, serious and permanent damage will result.
4. Use a good quality Grade 46 hydraulic oil rated at 215 SSU at 100 °F $\pm$ 5 °F (38 °C $\pm$ 3 °C). Refer to Specifications in this section.
5. The feed line must be of adequate size with no more than 5" mercury vacuum adjacent to

the pump inlet. As a rule, the feed line must provide a feed flow velocity not in excess of 8 feet per second.

6. Run the pump at least two minutes at no load and moderate speed (not below 400 or over 1500 rpm). If the pump becomes excessively hot, shut down immediately and locate the problem source.
7. Gradually increase pressure on pump, in 500 psi increments until the desired test pressure has been reached. This should take about five minutes.
8. Average Output Specifications at 3500 psi (241 bar)

Pump Section	Speed (RPM)	Output (GPM)
30 gpm	1000	11
30 gpm	1500	18
30 gpm	2000	24
30 gpm	2500	30
15 gpm	1000	7
15 gpm	1500	11
15 gpm	2000	15.5
15 gpm	2500	20

j. Recommended Start-up Procedure for New or Rebuilt Pump

After connecting the lines and mounting the replacement unit, startup as follows:

1. Make sure that the pump suction line is securely clamped at the pump inlet and the reservoir.
2. Disconnect the fuel run solenoid to prevent the engine from starting.
3. Turn the ignition switch to START position and crank the engine for 15 to 25 seconds. This will prime the main tandem pump.
4. Turn the ignition switch OFF.
5. Reconnect the fuel run solenoid.

IMPORTANT: *DO NOT operate any boom or steering functions during pump test.*

6. Start the engine and operate the pump at least two minutes at no load and at a speed of over 400 rpm but below 1500 rpm. During this break-in period, the unit should run free and not develop any excessive amount of heat. If the unit operates properly, speed and pressure can then be increased to normal operating settings.

9.8 TROUBLESHOOTING

Trouble	Probable Cause	Remedy
Cannot Lower Elevated load	Ruptured hoist or extend hose	Lower load using Emergency Boom Lowering instructions in Owners/Operators Manual.
	Loss of engine power or hydraulic pump failure	Lower load using Emergency Boom Lowering instructions in Owners/Operators Manual.
	Faulty main control valve	Repair main control valve (para 9.6.1 or 9.6.2).
Cavitation and Noise	Fluid level in reservoir is low	Add fluid. Refer to Owners/Operators Manual.
	Filler/breather is clogged	Clean or replace filler/breather.
	Air leaks in suction line	Using an oil can containing system fluid, squirt a little fluid on each joint of the suction line and tighten any joint where fluid stopped the noise. Double clamp if necessary.
	Loose tandem pump mounting hardware	Tighten mounting capscrews to 75 lb-ft (101,7 Nm).
	Loose pump sections	Tighten hardware to 200 lb-ft (271,2 Nm). Refer to para 9.7.1.
	Defective tandem pump	Repair pump (para 9.2.1 or 9.3.1).
Ruptured Hose	Damaged hose due to tight bend	Replace hose and install without tight bends or twists.
	Pressure setting for main relief valve is too high	Check and set the main relief valve (para 9.2.1 or 9.3.1).
Hose Cover Separated from Wire	Hose is twisted	Replace and make sure the hose does not turn as swivel fitting is tightened.
Damaged Threads on Fittings	Connections are too tight or cross threaded	Repair hose fittings if possible or replace hose.
Boom Hoist or Extend Function Slow or Malfunctioning	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Set relief valves (para 9.2.2 and 9.2.3 or 9.3.3 and 9.3.4).
	Internal leakage in cylinders	Repair cylinders as required (para 9.5.1 and 9.5.4).
	Internal leakage in control valve	Repair control valve as required (para 9.2.1 or 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.7.1).

Trouble	Probable Cause	Remedy
Boom Hoist or Extend Function Drifts Grille Tilt Slow or Mal-functioning	Defective counterbalance valve or cylinder seals	Repair or replace cylinders seals and/or counterbalance valves as required (para 9.5).
	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Check and set relief valve (para 9.2, 9.3, or 9.4).
	Internal leakage in cylinders	Repair cylinders as required (para 9.5).
	Internal leakage in control valve	Repair control valve as required (para 9.2.1 or 9.3.1).
Grille Tilt Drifts	Defective tandem pump	Repair tandem pump (para 9.7.1).
	Defective grille tilt or slave cylinders	Repair or replace cylinder (para 9.5.8 and 9.5.7).
Frame Tilt Slow or Mal-functioning	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Check and set relief valve (para 9.4.3).
	Internal leakage in cylinders	Repair cylinders as required (para 9.5.9).
	Internal leakage in control valve	Repair control valve as required (para 9.2.1 or 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.7.1).
Frame Tilt Drifts	Defective check valves or frame tilt cylinder	Repair or replace cylinder and check valves (para 9.5.9).
Service Brakes Grab	Excessive hydraulic pressure	Adjust pressure reducing valve (para 9.6.5 or 9.6.6).
	Low disc brake oil	Check and add oil to planetary wheel ends. Refer to Operator's Manual.
	Brake pedal not adjusted correctly	Adjust pedal linkage (para 4.3.1).
Service Brakes Spongy	Air in brake line	Bleed brake lines (para 9.6.3.g).
	Insufficient hydraulic pressure	Adjust pressure reducing valve (para 9.4.4 or 9.4.5).

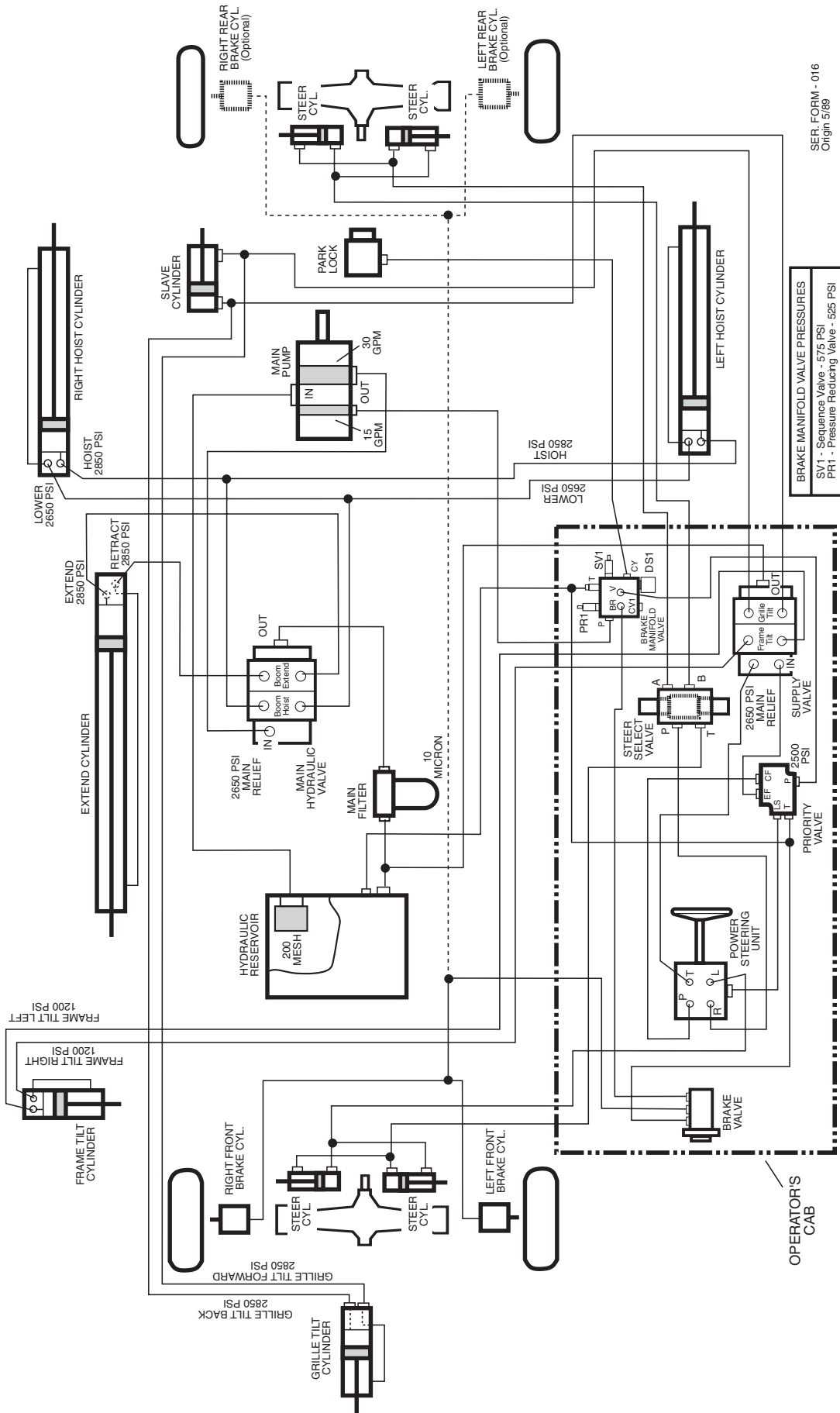
Trouble	Probable Cause	Remedy
Service Brakes Fail to Release	Brake pedal not adjusted correctly	Adjust pedal linkage (para 4.3.1).
	Faulty brake valve plunger, piston, or spring	Repair brake valve as required (para 9.6.3).
Service Brake Failure	Ruptured hydraulic hose	Replace hose. Bleed brake lines (para 9.6.3.g).
	Faulty brake valve spring, plunger, piston or valve	Repair brake valve as required (para 9.6.3).
	Pressure reducing valve failure	Install pressure reducing valve cartridge (para 9.6.5 or 9.6.6).
	Insufficient pressure at sequence valve	Adjust or replace cartridge (para 9.6.5 or 9.6.6).
	Defective discs or leakage within brake	Repair service brakes using repair kits as required (para 5.2.2).
Park Lock Brake Fails to Release	Ruptured hydraulic hose	Replace hose.
	Defective park lock switch	Replace park lock switch (para 10.7.4).
	Park lock release valve fails to shift	Replace solenoid or valve (para 9.6.5 or 9.6.6).
	Defective park lock	Install seal kit or other kits in park lock as required (para 5.2.6).
Park Lock Brake Fails to Set	Corrosion, binding or worn parts in park lock	Install repair kits in park lock as required (para 5.2.6).
	Defective solenoid	Replace solenoid (para 9.6.5 or 9.6.6).
	Defective switch	Replace switch (para 10.7.4).
Power Steering Failure (Total)	Ruptured hydraulic hose	Replace hose.
	Faulty power steering unit	Repair or replace power steering unit.
	Tandem pump failure	Repair tandem pump (para 9.7.1).
No 4-Wheel or Crab Steering or Failure to Change Mode	Defective solenoid in steer select valve	Repair steer select valve (para 9.6.7).
	Faulty steer select switch or wiring	Replace switch or repair wiring as required (para 10.7.7).
	Broken spring in steer select valve	Repair steer select valve (para 9.6.7).

Trouble	Probable Cause	Remedy
Steers too Slowly	Steer relief valve not set correctly	Check and set relief valve (para 9.4.6).
	Defective sequence valve	Install new cartridge or replace valve (para 9.6.5 or 9.6.6).
	Steering cylinder leakage	Install cylinder seal kit(s) (para 9.5.10 or 9.5.11).
Front or Rear Wheels Not Parallel in Two or Four Wheel Steering	Wheel misalignment	Check and adjust wheel alignment as needed per paragraph 5.2.5.
	External leakage in system	Check and tighten connections at valves, pump and cylinders. Repair or replace defective hose.
	Internal leakage in cylinder	Install cylinder seal kit(s) (para 9.5.10 or 9.5.11).
	Internal leakage in power steering unit	Repair or replace power steering unit.
	Defective steer select valve	Replace steer select valve (para 9.6.7).
Steering is Spongy or Noisy	Air in steering lines	Check and tighten loose connections. Operate steering to purge system of air.
	Faulty power steering unit	Repair or replace power steering unit.
Auxiliary Equipment Slow or Malfunctions	External fluid leakage at tubes, hoses or fittings	Check and tighten connections at valves, pumps and cylinders. Repair or replace faulty hose(s).
	Faulty relief valve setting	Check and set frame tilt relief valve (para 9.1.4).
	Internal leakage in cylinder	Repair cylinder as required (para 9.4.3).
	Internal leakage in control valve	Repair control valve as required (para 9.2.1 or 9.3.1).
	Defective tandem pump	Repair tandem pump (para 9.7.1).
Auxiliary Equipment Drifts or Creeps	Leakage in auxiliary cylinder(s)	Repair or replace cylinder(s) or check valve (para 9.5.12).
Tandem Pump Fails to Deliver Fluid	Low level in reservoir	Check and fill hydraulic reservoir as described in Owners/Operators manual.
	Filler/breather on reservoir is dirty	Clean or replace filler/breather.
	Suction strainer clogged	Clean strainer as described in Owners/Operators manual.
	Suction line is restricted or loose	Clean or replace suction line and/or tighten if loose

Trouble	Probable Cause	Remedy
Tandem Pump Fails to Deliver Fluid	Fluid viscosity is too heavy to pick up prime	Check working temperature and service and change fluid in system if necessary
	Worn, broken or stuck parts in pump	Repair tandem pump (para 9.7.1).
Cylinder Fails to Move When Control Valve is Actuated	Faulty hose	Repair or replace hose.
	Damaged cylinder	Repair or replace cylinder as required (para 9.5).
	Defective main control valve	Inspect and repair as required (para 9.6.1 or 9.6.2).
Cylinder Movement is Jerky	Air trapped in cylinder or in hydraulic line	Inspect fluid for foam and bubbles. Check and tighten connections. Bleed cylinder and lines as required.
	Binding of cylinder rod or piston	Repair or replace cylinder (para 9.5).
	Rod seal installed improperly	Disassemble cylinder and repair (para 9.5).
	Binding of base end or rod end bearing	Repair or replace bearing in applicable component
	Defective counterbalance cartridges (Hoist cylinders)	Replace cartridges (9.5.1).
Cylinder Movement is Sluggish	Control valve not fully engaged	Engage control valve fully. Be sure that valve linkage and drain lines are unrestricted.
	Internal leakage or binding in cylinder	Repair or replace cylinder (para 9.5).
Cylinder Piston Rod Drifts or Creeps	Worn piston seals	Install cylinder seal kit (para 9.5).
	Internal leaking in control valve	Inspect control valve and install seal kit (para 9.6.1 or 9.6.2).
	Tube is out-of-round	Replace tube and install seal kit (para 9.5).
Relief Valve Doesn't Hold Pressure Setting	Spring broken or has taken a "set"	Disassemble valve, inspect and clean. Install seal and spring kit (para 9.6.1).
	Poppet stuck due to dirt or deposits	Clean all foreign material from parts and check operation (para 9.3.6). Poppets must slide freely in valve body. If poppets slide freely, install seal and spring kit. If poppets still stick, replace valve.
Directional Control Valve Does Not Return	Excessive clearances between valve body and poppets	Excessive clearances will cause internal leakage. Replace relief valve.

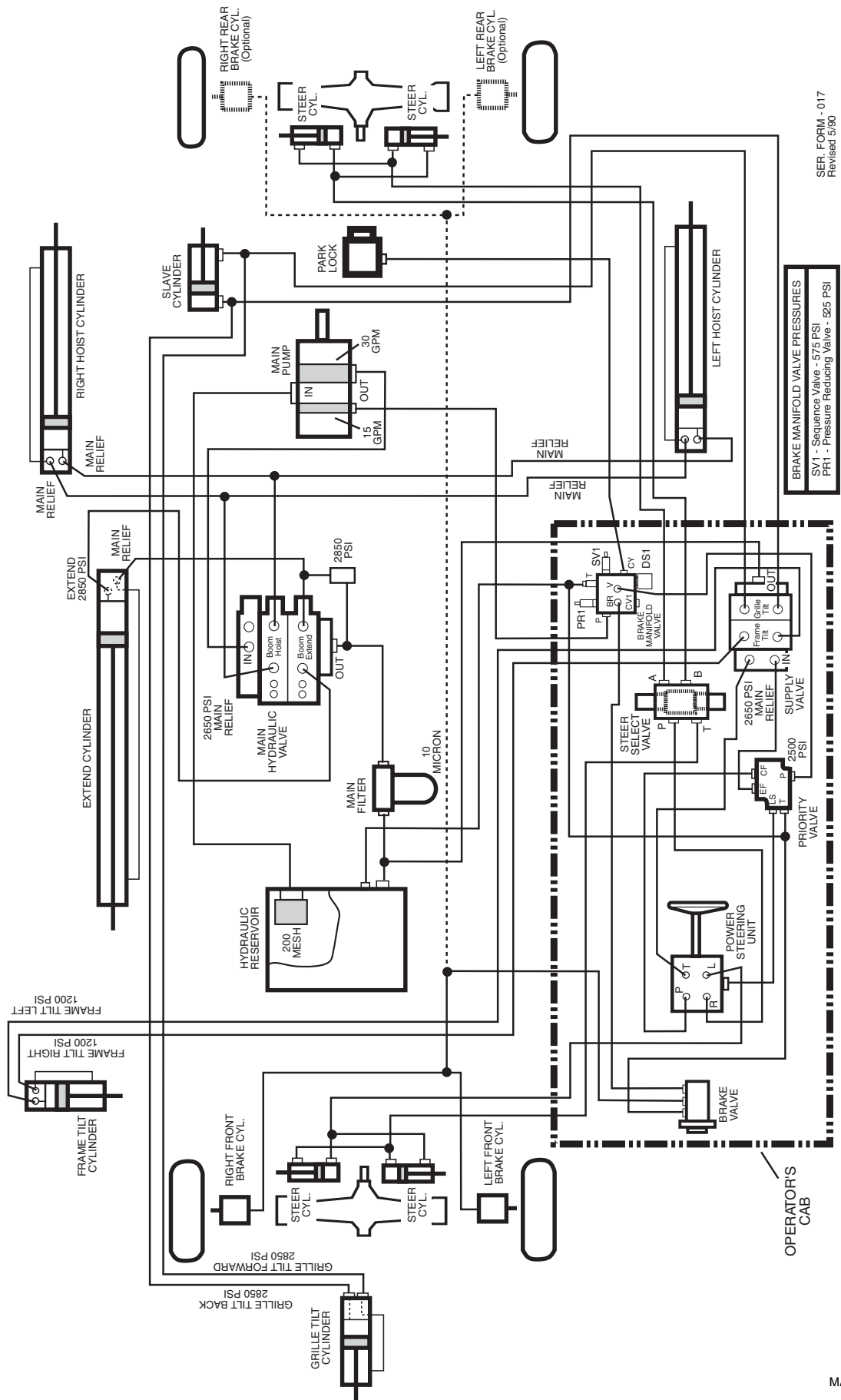
Trouble	Probable Cause	Remedy
Directional Control Valve Difficult to Shift	Binding valve cable linkage	Check cable linkage and lubricate or free up as required.
	Broken internal parts	Disassemble control valve and replace broken parts (para 9.6).
	Scored valve body bore causing leakage between spool and body	Inspect valve body and spool and replace valve section if scored (para 9.6).
	Broken centering spring	Disassemble valve and replace broken spring (para 9.6).
Directional Control Valve Does Not Return	Too much friction in linkage connecting valve to operating lever	Clean and lubricate the linkage and make sure it operates freely.
	Dirt in valve	Disassemble and clean control valve thoroughly (para 9.6).
Shifting of Operator Lever Fails to Cause Spool in Directional Control Valve to Shift	Sheared pin in connection to valve	Check all joints for faulty connections.
	Check main control valve for broken spool	Replace applicable valve section.

6036 HYDRAULIC SCHEMATIC - S/N 9B0500 thru OE1179 (Cable Control Joystick without Trans. De-clutch)



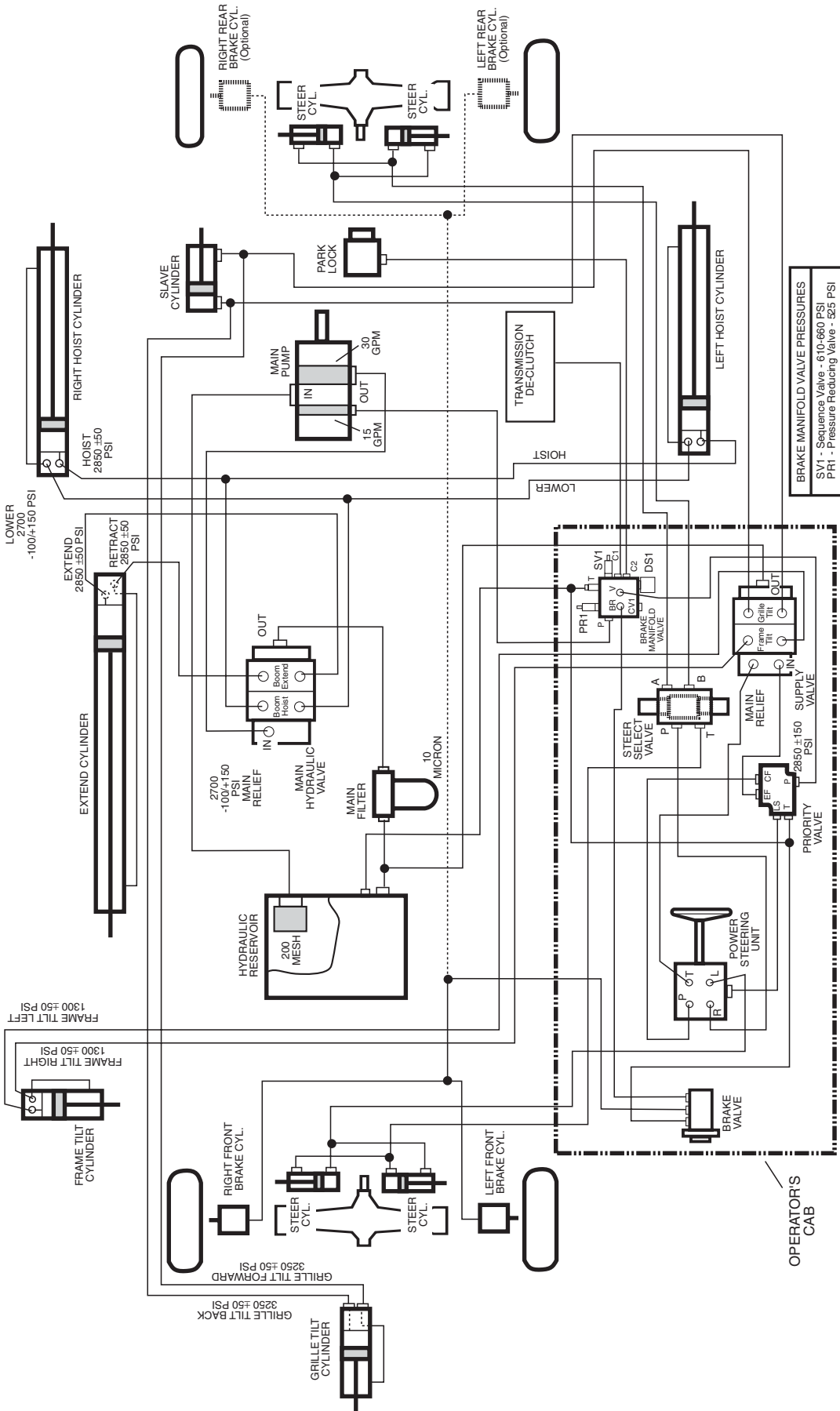
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**6036 HYDRAULIC SCHEMATIC - S/N 9B0500 thru OE1179
(Electronic Control Joystick without Trans. De-clutch)**

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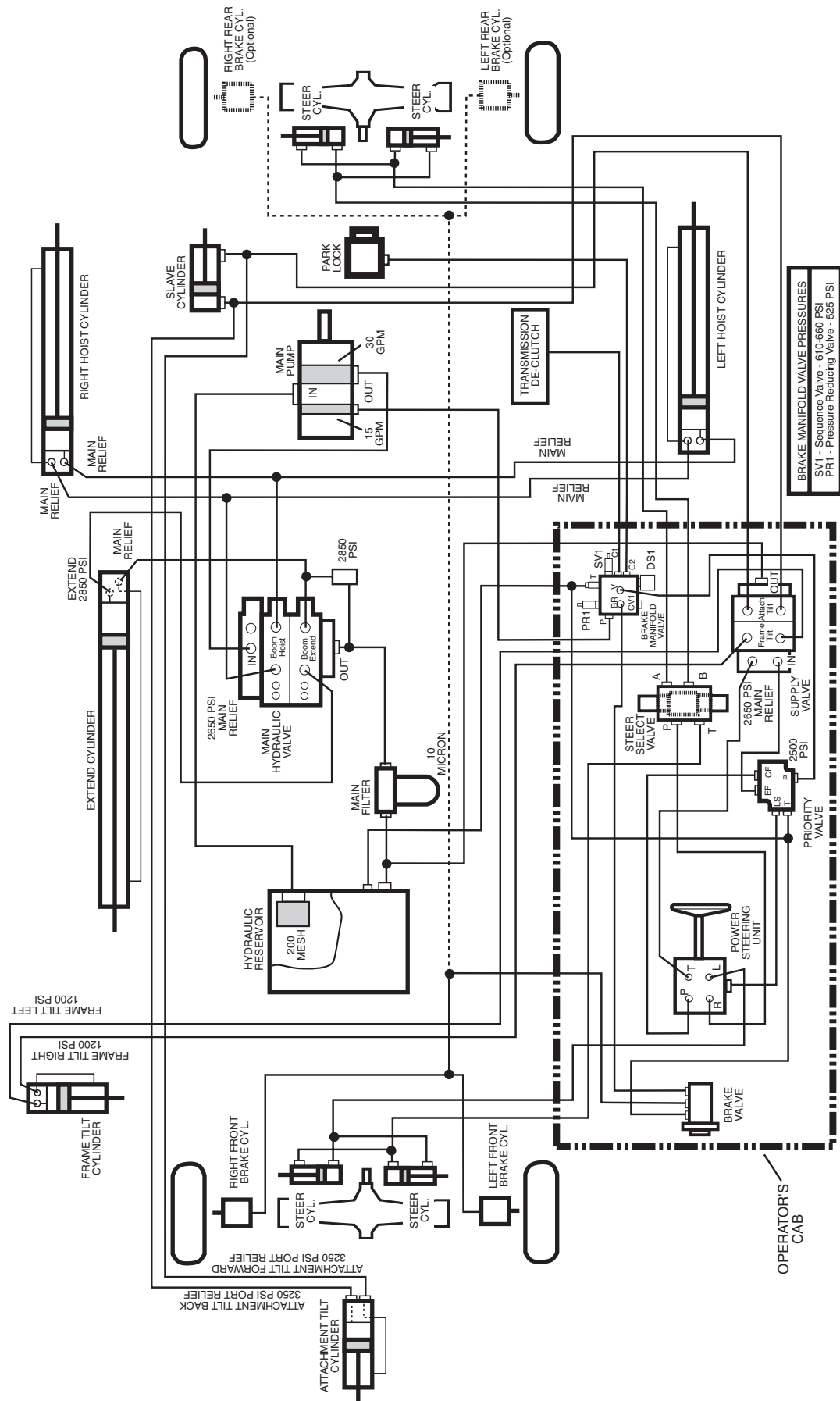
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6036 HYDRAULIC SCHEMATIC - S/N OE1180 and After **(Cable Control Joystick with Trans. De-Clutch)**

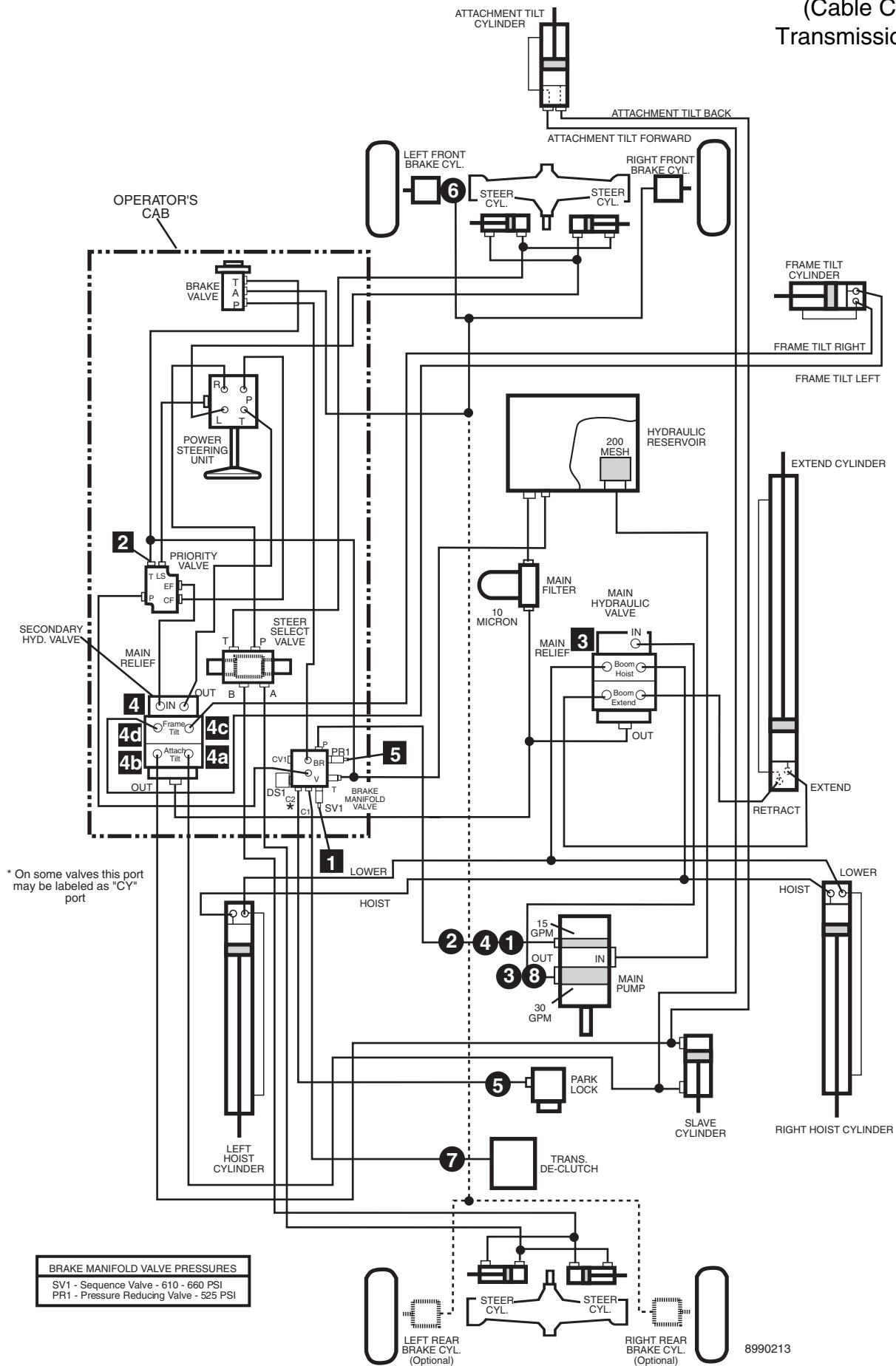


MA5080

6036 HYDRAULIC SCHEMATIC - S/N OE1180 and After (Electronic Control Joystick wth Trans. De-Clutch)



HYDRAULIC DIAGRAM (Cable Controlled with Transmission De-Clutch)



MA6090

8990213

HYDRAULIC TESTING

Engine Information

Idle 1,050 ± 50 rpm
Full Speed 2,730 ± 130 rpm

Hydraulic Oil Information

Oil Type - 10W, meets MIL-L-2104C or ISO Grade 46
Capacity - Reservoir 24 gal. (90,8 liter)
Capacity - System 38 gal. (143,8 liter)

Note: To adjust relief settings or pressure reducing settings, turn the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.

The hydraulic oil temperature for the pump flow test should be between 100° F (38° C) and 120° F (49° C) (tank hot to the touch) during testing.

Equipment Needed To Perform Tests - From Kit P/N 7118782

Circuit	Gauge	Fittings
1 2 4	4,000 PSI Gauge (275,6 bar)	#8 Run Tee Swivel Nut PD38TX Test Nipple
3	4,000 PSI Gauge (275,6 bar)	#12 Run Tee Swivel Nut PD38TX Test Nipple
5 7	1,000 PSI Gauge (68,9 bar)	#4 Union PD34BTX Test Nipple
6	1,000 PSI Gauge (68,9 bar)	#4 Run Tee Swivel Nut PD34BTX Test Nipple

To check flow readings a flow meter capable of measuring 60 gpm (3,8 ltr/sec) and a load valve capable of 6,000 psi (413,4 bar) will be required (not included with kit P/N 7118782).

TEST LOCATION	Hydraulic Pump Flow Test
1	2,000 psi (137,8 bar) load @ Engine Speed of 2,500 ± 25 rpm — Flow rate should be 14 to 16 GPM (0,9 to 1,0 ltr/sec)
8	2,000 psi (137,8 bar) load @ Engine Speed of 2,500 ± 25 rpm — Flow rate should be 28 to 32 GPM (1,8 to 2,0 ltr/sec)

TEST LOCATION	ADJUST. LOCATION	COMPONENT DESCRIPTION	PRESSURE READINGS	PRESSURE TEST PROCEDURES
1	1	Sequence Valve	610 - 660 psi (42 - 45,5 bar)	With engine at idle. Check pressure. If pressure is not correct, adjust or replace the sequence valve cartridge (See Note).
2	2	Steering Relief	2,850 ± 150 psi (196,4 ± 10,3 bar)	With engine at full throttle. Turn steering wheel to full turn any direction and hold. Check pressure. If pressure is not correct, adjust or replace the relief cartridge.
3	3	Main Control Valve Relief	2,700 -100/+150 psi (186 -6,9/+10,3 bar)	With engine at full throttle. Move joystick fully into boom lower function until function has reached a stall condition. Hold joystick in stall condition and check pressure. If pressure is not correct, adjust or replace the relief cartridge (See Note).
	N/A	Hoist Port Relief	2,850±50 psi (196,4±3,4 bar)	CONSULT FACTORY
	N/A	Extend Port Relief	2,850±50 psi (196,4±3,4 bar)	CONSULT FACTORY
	N/A	Retract Port Relief	2,850±50 psi (196,4±3,4 bar)	CONSULT FACTORY
4	4	Secondary Control Main Valve Relief	2,700 -100/+150 psi (186 -6,9/+10,3 bar)	With engine at idle. Move attachment tilt joystick to the function to be tested until the function has reached a stall condition. Hold function in the stall condition and check pressure. If pressure is not correct, adjust or replace the relief cartridge (See Note).
	4a	Attachment Tilt Port Relief - Forward	3,250 ± 50 psi (224 ± 3,4 bar)	CONSULT FACTORY
	4b	Attachment Tilt Port Relief - Backward	3,250 ± 50 psi (224 ± 3,4 bar)	CONSULT FACTORY
	4c 4d	Frame Tilt Port Relief Left & Right	1,300 ± 50 psi (89,6 ± 3,4)	With engine at idle. Frame tilt to the left until the cylinder reaches the stall condition and check pressure. If pressure is not correct, adjust or replace the relief cartridge (See Note). Repeat for frame tilting to the right.
5	5	Pressure Reducing Valve And Park Lock Valve	525 ± 25 psi (36,2 ± 1,7 bar)	With engine at idle. Switch park lock to the disengaged position. Check pressure. If pressure does not reach minimum, verify both the sequence valve and pressure reducing valve pressures. If both pressures are correct, check park lock solenoid. If solenoid is functioning properly, check park lock switch.
6	N/A	Brake Valve (Service Brake)	525 ± 25 psi (36,2 ± 1,7 bar)	With engine at idle. Depress brake pedal and hold. If pressure does not reach minimum, verify sequence valve pressure. If sequence pressure is correct, verify pressure reducing valve pressure. If pressure reducing pressure is correct, replace brake valve. Bleed brakes.
7	5	Trans. De-Clutch (s/n 1179 & After Only) * See Below	525 ± 25 psi (36,2 ± 1,7 bar)	With engine at idle and emergency brake engaged check pressure. If pressure is not correct, adjust or replace the relief cartridge (See Note).

*Some units prior to s/n 1179 may be equipped with Trans. De-Clutch.

9.9 SPECIFICATIONS

HYDRAULIC SYSTEM

System Capacity	38 gallons (143,8 liters)
Reservoir Capacity	24 gallons (90,8 liters)
Hydraulic Oil Level (all cylinders retracted)	Oil level to be visible in reservoir sight gauge when oil is cold (room temperature). Fill and maintain system level with clean, filtered hydraulic oil.
Type of Hydraulic Oil	<p>Anti-wear hydraulic oil per ISO Grade 46 or ASTM. Viscosity SSU 215 at 100 °F (38 °C) including the following:</p> <p>Amoco Rykon 46 Arco Duro AW-S-215 Benz Petraulic 46-LC Chevron AW 46 Citgo Pacemaker XD-46 Gulf Harmony 46 AW Mobil DTE-25 Shell Tyllus 46 Sun Sunvis 821 WR Texaco Rando HD-46 I</p>
Interval for Hydraulic Oil Change	Annual
Filter Capacity	1 quart (0,95 liters)
Interval for Hydraulic Filter Change	After first 50 hours of operation, every 1000 hours of operation thereafter, or after any hydraulic component failure and repair
Relief Valve Settings:	
Steering Relief (15 gpm pump)	2850 ± 150 psi (196,4 ± 10,3 bar)
Main Hydraulic Relief (30 gpm pump)	2700 -100/+150 psi (186 -6,9/+10,3 bar)
Main Hydraulic Relief (15 gpm pump)	2700 -100/+150 psi (186 -6,9/+10,3 bar)
Boom Hoist Relief	2850 ± 50 psi (196 ±3,4 bar)
Boom Extend Relief	2850 ± 50 psi (196 ±3,4 bar)
Grille Tilt Reliefs	3250 ± 50 psi (224 ±3,4 bar)
Frame Tilt Reliefs	1300 ±50 psi (89,6 ±3,4 bar)
Sequence Valve Setting	610 - 660 psi (42 - 45,5 bar)
Pressure Reducing Valve Setting	525 ± 25 psi (36,2 ± 1,7 bar)

9.9 SPECIFICATIONS (cont.)

HYDRAULIC SYSTEM (CONT)

Performance:	
Boom Extend, Horizontal, No Load	12 to 15 seconds
Boom Retract, Horizontal, No Load	10 to 13 seconds
Boom Raise, No Load	11 to 13 seconds
Boom Lower, No Load	8 to 10 seconds
Grille Tilt Up, No Load	4 to 6 seconds
Grille Tilt Down, No Load	3.5 to 5.5 seconds
Frame Tilt Full Left to Full Right, No Load	8 to 12 seconds
Frame Tilt Full Right to Full Left, No Load	7 to 11 seconds
Steering Wheel Turns, Lock to Lock	4.0 to 4.5 turns

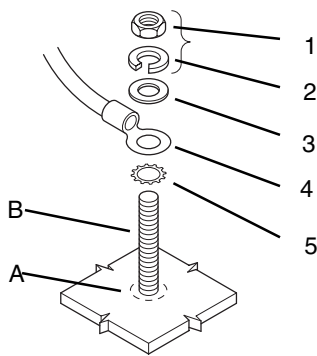
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SECTION 10

ELECTRICAL SYSTEM

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MA0871

- A. The area around the base of the stud (the outside diameter of lock washer (5)) shall be free of paint.
- B. Stud, bolt, or capscrew
1. Hex nut or lock nut
 2. Tooth or slot type lock washer
 3. Flat washer
 4. Electrical ground or grounds
 5. Tooth type lock washer

Fig. 10.1 Recommended Sequence of Parts for Electrical Wire Grounding

10.1 SYSTEM COMPONENTS

The electrical system produces, stores, distributes and uses electricity in the operation of the forklift.

Electricity is produced by an engine-driven alternator which has a solid state voltage regulator. Current from the alternator charges the battery and powers components.

The battery provides power for starting the engine and supplements the output of the alternator during periods of peak demand.

Other electrically powered components include a horn, neutral start switch, steer select valve; park lock release valve, reverse switch and backup alarm; an hourmeter, a fuel level sender and gauge, and a cluster of warning lights.

A forklift may have the following electrical options:

- a lighting system with headlights, tail lights, directional signals, emergency flashers, rear work lights and boom light;
- an enclosed cab with air circulating and heater fans and a windshield washer and wiper

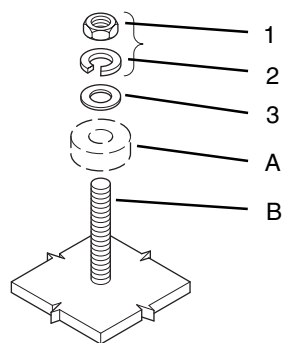
10.1.1 Service Warnings and Recommendations



Warning !

- DO NOT disconnect the battery while the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.
- DO NOT disconnect any wiring without first stopping the engine, turning all electrical switches to the OFF position and disconnecting the battery ground cable from the battery.
- DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors and diodes.
- DO NOT connect a battery into the system without checking for correct polarity and voltage.
- DO NOT "flash" connections to check for current flow. No matter how brief the contact the transistors may be ruined.
- Wear safety glasses when working near batteries.
- All lead-acid batteries generate hydrogen gas which is highly flammable. If ignited by a spark or flame, the gas may explode violently causing spraying of acid, fragmentation of the battery, and possible severe personal injuries, particularly to the eyes.
- Avoid battery acid. In case of contact with acid, flush immediately with water.
- Charge batteries only in a well-ventilated area. Always be sure battery chargers are OFF when connecting to or disconnecting from batteries.
- See Delco Remy Service Bulletin 1B115 and 1B-116 for additional safety information and procedures.

These instructions assume that all wires are connected and routed as designed. Take into account any disconnected and rerouted wires before you begin any diagnosis. By referring to the wiring diagrams, you can test circuits for continuity or shorts by using a conventional test light, ohmmeter, multimeter or low reading voltmeter.



MA0881

- A. Partial sectional view of component to be grounded
- B. Stud, bolt or capscrew
- 1. Hex nut or lock nut
- 2. Tooth or slot type lock washer or locking nut with slotted type lock washer
- 3. Flat washer

Fig. 10.2 Recommended Sequence of Parts for Electrical Grounding of a Component at a Mechanical Support

10.1.2 Effective Ground Connections

Effective ground connections are essential to the efficient operation of electrical components. The sequence for installing attaching parts at electrical grounds is shown in Figs. 10.1 and 10.2. Refer to special grounding instructions for the optional windshield washer reservoir and cab heater.

10.2 WARNING DEVICES

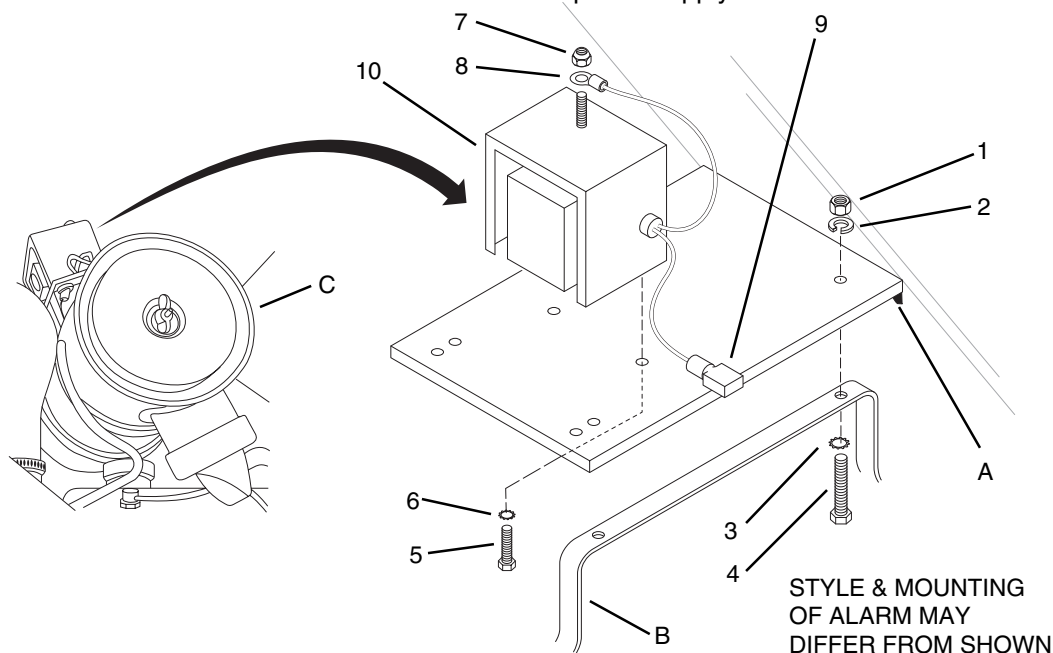
Warning devices are a horn and a backup alarm.

Warning lights indicate when engine coolant reaches 210 °F (99 °C), when engine oil pressure falls below 4 psi (0,3 bar), when the alternator isn't producing voltage, and when hydraulic oil exceeds 250 ± 5 °F (121 ± 3 °C). Please refer to paragraph 10.8.4.

10.2.1 Horn

Press the momentary-contact horn button (2, Fig. 10.17) on the control console to sound the horn (49, Fig. 10.7) which is located near the gear drop box or under the cab in later models. The sound is produced by a solenoid-actuated diaphragm in the horn that develops a resonating air column in the horn projector.

If the horn doesn't sound when you press the horn button, check for an open circuit breaker, corrosion on the horn mounting, or a loose wire. Test the horn switch for continuity when the horn button is pressed. If these tests do not reveal the problem, remove the horn from the forklift and test the horn using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply.



MA0891

- A. Mounting plate is welded to and supported by forklift frame
- B. Air cleaner mounting band
- C. Air cleaner assembly
- 1. Hex nut
- 2. Lock washer
- 3. Tooth type lock washer
- 4. Hex head bolt
- 5. Hex head bolt
- 6. Tooth type lock washer
- 7. Lock nut
- 8. Ground wire
- 9. Wire 31
- 10. Backup Alarm

Fig. 10.3 Backup Alarm as Viewed Through the Engine Door on Right Side of the Forklift

10.2.2 Backup Alarm and Reverse Switch

A backup alarm sounds when the forward-neutral-reverse travel select lever is in reverse. The alarm is located above the air cleaner in the engine compartment. It is energized by a reverse switch that is mounted on the transmission shifter under the left front console panel.

a. Backup Alarm Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Disconnect alarm wiring.
3. While supporting the backup alarm, remove two bolts (5, Fig. 10.3) and lock washers (6).
4. Lift backup alarm (10) from forklift.

b. Backup Alarm Disassembly

Do not disassemble the backup alarm.

c. Backup Alarm Cleaning and Drying

Without submerging the backup alarm, clean the alarm using an approved solvent and dry with a lint-free cloth.

d. Backup Alarm Inspection and Replacement

1. Test backup alarm by using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply.
2. Replace backup alarm if it malfunctions.

e. Backup Alarm Installation

1. While positioning backup alarm on mounting plate, secure alarm to plate using two lock washers (6) and two capscrews (5).
2. Connect alarm wiring.
3. Connect negative (–) cable to the batteries.
4. Test backup alarm.

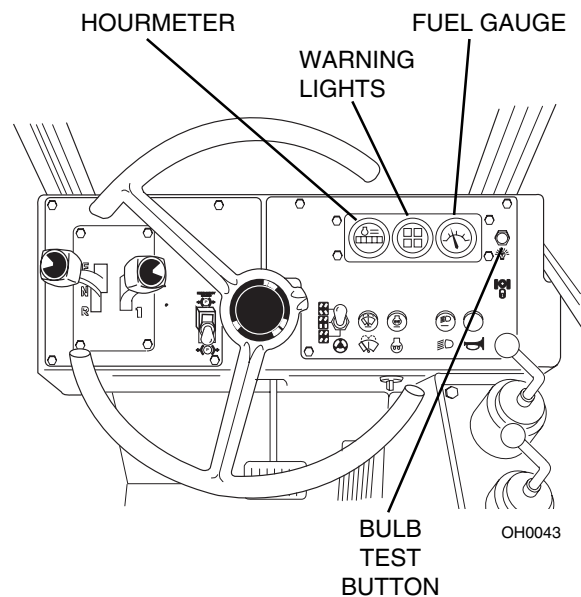
f. Reverse Switch

Please refer to paragraph 10.7.6 for reverse switch instructions.

10.2.3 Warning Lights

There are four warning lights in a cluster between the hourmeter and fuel gauge. When you turn the ignition key to the RUN position the Engine Oil Pressure and Alternator Charge indicators will light. This is a normal condition. While the engine is running, all lights should be OFF. However, if any of the lights go ON a potentially dangerous condition exists.

Directly to the right of the instrument cluster is a warning light bulb test button. With ignition switch in RUN and the engine OFF, depress this button to test all four warning lights. If any of the lights are burnt out, replace the bulb(s) immediately. You will find the bulb number in the Electrical Specifications Table at the end of this section.



Engine Oil Pressure—Indicates low engine oil pressure.



Engine Water Temperature—Indicates high coolant temperature.



Alternator Charging—Indicates alternator is not charging.



Transmission Oil Temperature—Indicates high transmission Oil Temperature.

OA0751

Fig. 10.4 Warning Lights Signal Dangerous Operating Conditions

10.3 WIRING HARNESSES

The forklift has harnesses (Fig 10.5) for cab and engine wiring. A forklift with an optional lighting system will have a separate lighting harness (1, Fig 10.30 or 10.30A). Each wire within a harness is identified by a wire number on the electrical schematic and on both ends of each wire.

a. Removal

1. Remove a wiring harness only if damaged or unusable.
2. You may prefer to install the new harness as you remove the old harness.
3. Tag the terminal locations of all wires, harness clips and tie wraps as you remove the old harness as required to permit identical installation of the new harness.

b. Disassembly

When replacing wires, it is important that the correct gage size be used. Never replace a wire with one of a smaller gage size.

c. Cleaning and Drying

Clean a wiring harness using a natural bristle brush and the same detergents you would use to clean the forklift. Allow to air dry with surface temperatures not to exceed 300 °F (149 °C).

d. Inspection and Replacement

Replace a harness only if damaged or unusable. If you must splice a wire or repair one that is broken, always use rosin core solder to bond the splice. Use insulating tape to cover all splices or bare wires.

e. Installation

The harnesses are held securely in place by clips or other devices to prevent chafing or wearing of the insulation due to vibration. Be careful to install harness clips and tie wraps in the locations tagged on the forklift and the old harness in step a.

10.4 CIRCUIT BREAKERS AND/OR FUSES

10.4.1 Circuit Breakers S/N 9B500 thru 1882

Circuit breakers, (Fig 10.5) protect the electrical system. The breakers are mounted inside the right console on the outside cab wall below the fork and frame tilt control lever. A breaker will trip if there is a shorted or grounded wire in the applicable circuit. It will automatically reset once it cools.

A circuit breaker has a bimetallic arm and a pair of contact points. When the current exceeds preset limits, the arm gets hot, bends, and opens the contact points. This shuts off the current through the circuit and protects against damage or fire.

If a breaker continually trips, check the system for shorts, grounds or defective components.

Under normal operating conditions a circuit breaker should never require replacement. However, if a breaker doesn't automatically reset, the breaker is defective and must be replaced.

The ignition switch feed for the entire electrical system is protected by a 40 A circuit breaker (4, Fig. 10.5), the horn, backup alarm and optional cab heater fan by a 10 A circuit breaker (2), and the control circuits by two 6 A circuit breakers (1 and 3). A forklift with an enclosed cab has an additional 6 A circuit breaker (5) that protects the windshield washer/wiper switch and the circulation fan.

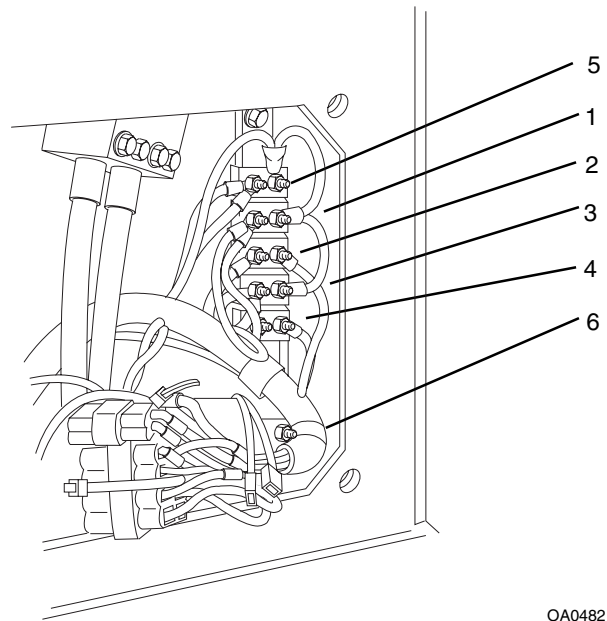
An optional light package includes head lights and a rear work light, and stop, directional, hazard (emergency flasher) and tail lights in a circuit which is protected by a 15 A circuit breaker (6).

a. Removal of Individual Circuit Breaker and Circuit Breaker Bracket

1. Disconnect negative (–) cable (2, Fig. 10.16) from batteries.
2. Tag and disconnect wiring from circuit breaker by removing hex nuts and lock washers.
3. Each circuit breaker is held in the circuit breaker bracket by spring tension only. Remove circuit breaker by inserting small slot screwdriver between circuit breaker bracket and left edge of circuit breaker and tilt breaker out of bracket.
4. Disconnect wiring from all of the circuit breakers in the bracket.
5. Remove two nuts, lock washers and two washers and slide bracket over the studs.

b. Installation of Circuit Breaker Bracket and Individual Circuit Breaker

1. Slide circuit breaker bracket over two studs and secure using two washers, lock washers and hex nuts.
2. Position the terminal marked “BAT” on the circuit breaker terminal plate to your right and snap each circuit breaker into bracket using a small slot screwdriver.
3. Secure tagged wiring to respective terminals using lock washers and hex nuts.
4. Connect battery ground cable to the battery.
5. Check operation of circuits.



OA0482

1. Circuit breaker, 6 A, protects steering select valve circuit
2. Circuit breaker, 10 A, protects horn and backup alarm (and optional cab heater fan) circuit
3. Circuit breaker, 6 A, protects instrument panel, park lock solenoid switch
4. Circuit breaker, 40 A, protects ignition system feed for entire electrical system
5. Circuit breaker, 6 A, protects enclosed cab windshield washer/wiper and circulation fan circuits (this breaker is optional and will not be found on forklifts with an open cab)
6. Circuit breaker, 15 A, protects the optional lighting package

Fig. 10.5 Circuit Breakers

10.4.2 Fuses and Circuit Breaker S/N 1883 and After

The fuses and circuit breaker, (Fig 10.6) protect the electrical system. The fuses and breaker are mounted inside the right console on the outside cab wall below the fork and frame tilt control lever. The breaker will trip if there is a shorted or grounded wire in the applicable circuit. It will automatically reset once it cools. The fuses will blow if there is a shorted or grounded wire in the applicable circuit.

If the breaker continually trips, or a fuse continually blows, check the system for shorts, grounds or defective components.

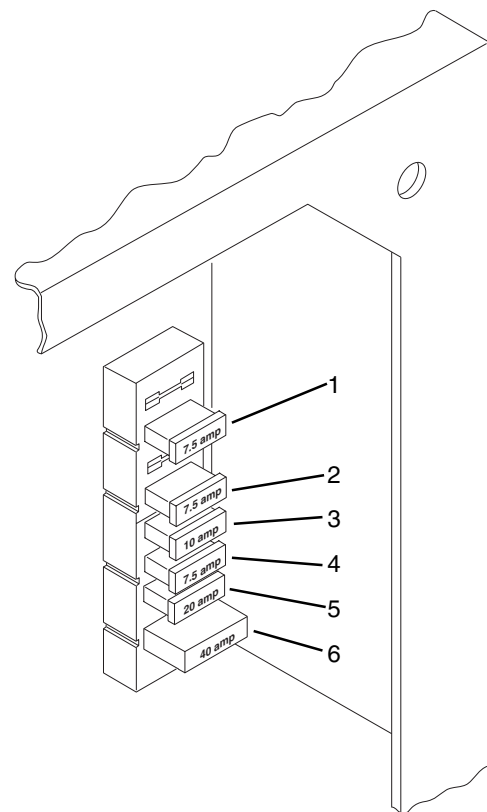
Under normal operating conditions the circuit breaker should never require replacement. However, if the breaker doesn't automatically reset, the breaker is defective and must be replaced.

The ignition switch feed for the entire electrical system is protected by a 40 A circuit breaker (6, Fig. 10.6), the horn, backup alarm and optional cab heater fan by a 10 A fuse (3), and the control circuits by two 7.5 A fuses (2 and 4). A forklift with an enclosed cab has an additional 7.5 A fuse (1) that protects the windshield washer/wiper switch and the circulation fan.

An optional light package includes head lights, rear work lights, stop, directional, hazard (emergency flasher), tail lights and a boom worklight in a circuit which is protected by a 20 A fuse (5).

a. Removal of Individual Fuses and Circuit Breaker

To remove a blown fuse or a defective circuit breaker simply pull the fuse or circuit breaker straight out and replace by pushing the correct size fuse or new circuit breaker straight into the holder.



OA1090

1. Fuse, 7.5 A, protects enclosed cab windshield washer/wiper and circulation fan circuits (this fuse is optional and will not be found on forklifts with an open cab)
2. Fuse, 7.5 A, protects steering select switch and valve circuit
3. Fuse, 10 A, protects horn and backup alarm (and optional cab heater fan) circuit
4. Fuse, 7.5 A, protects warning lights, emergency brake solenoid switch, fuel gauge and hourmeter
5. Fuse, 20 A, protects the optional lighting package
6. Circuit breaker, 40 A, protects ignition system feed for entire electrical system

Fig. 10.6 Fuses and Circuit Breaker

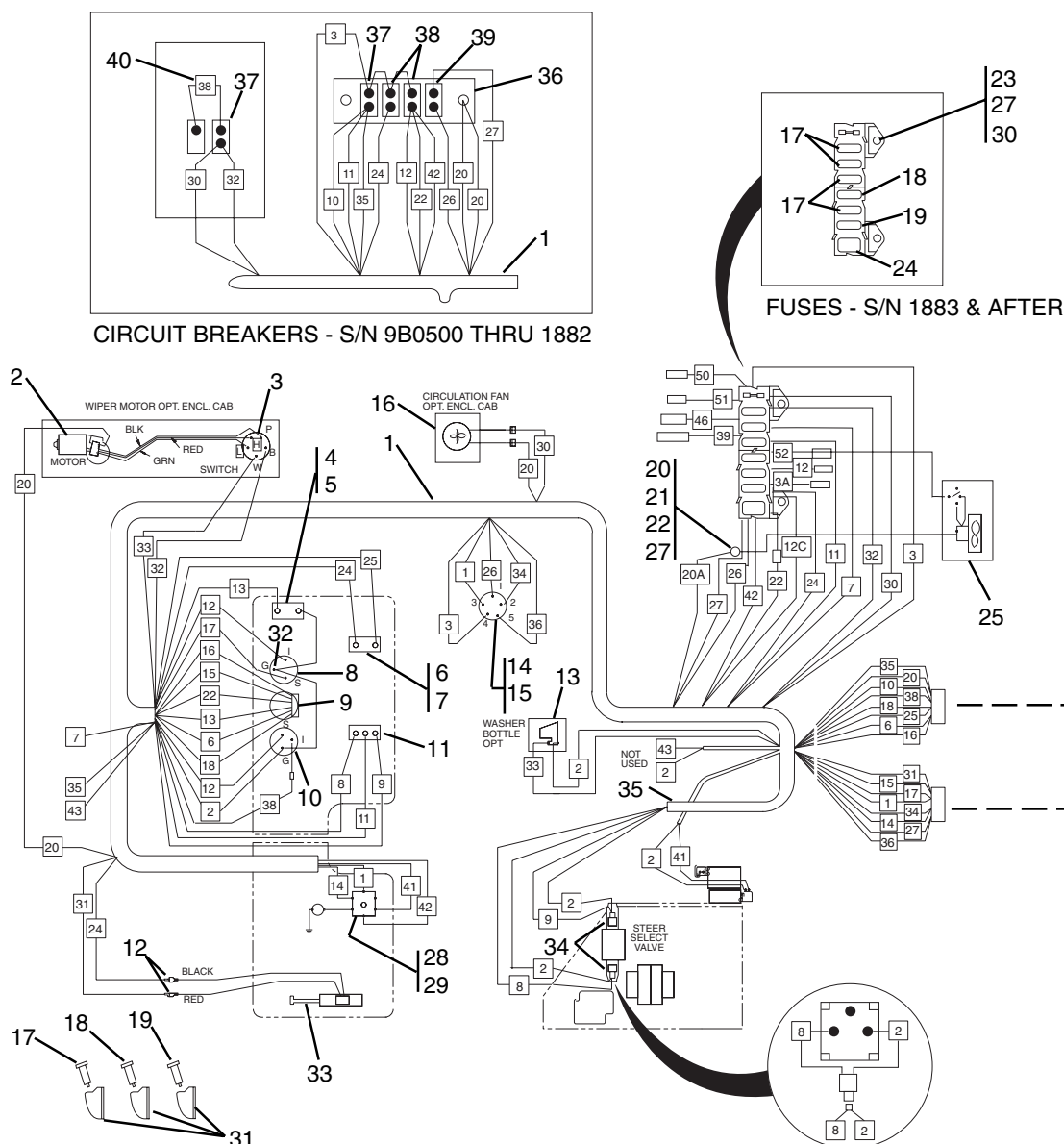
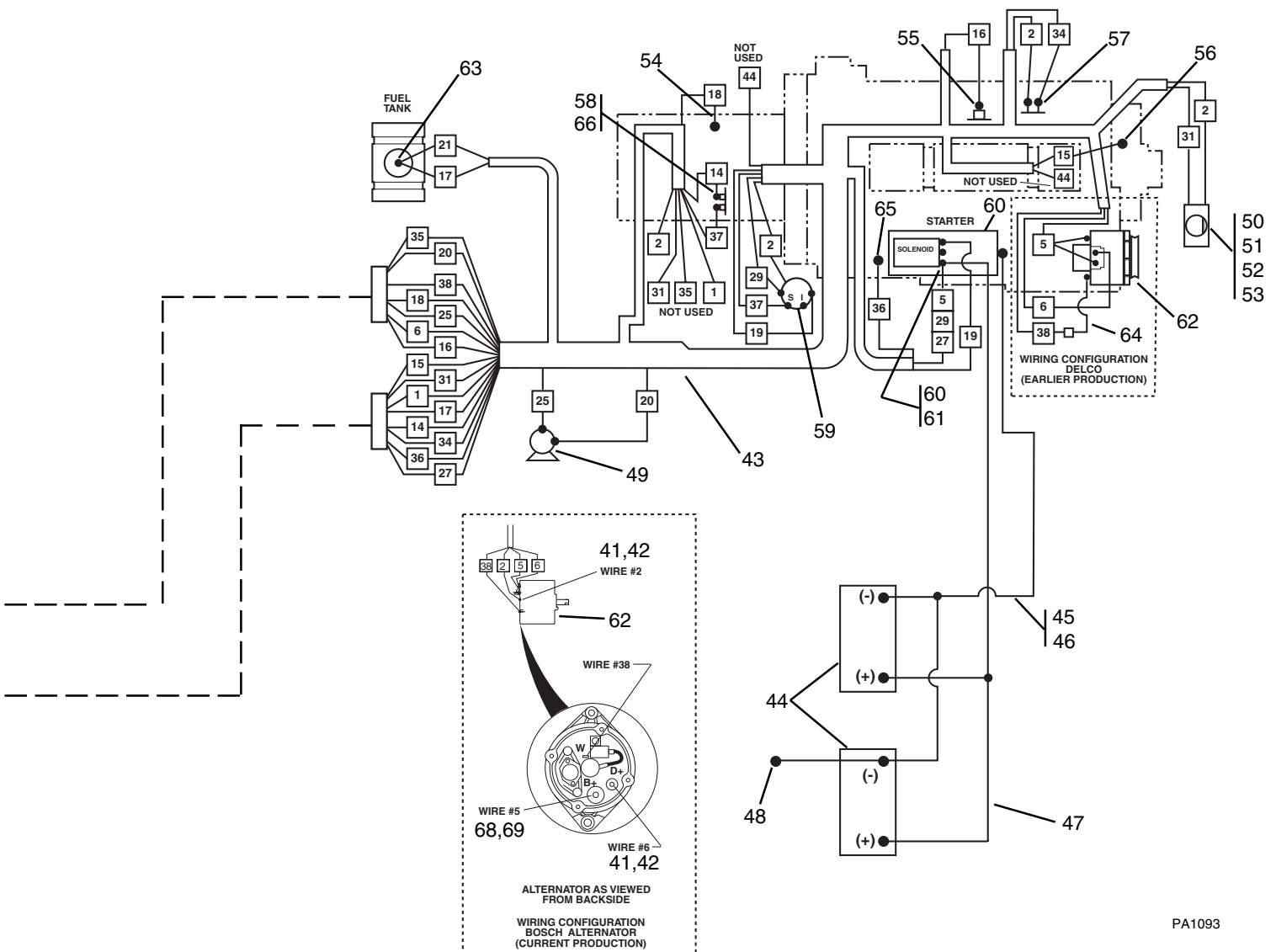


Fig. 10.7 Drawing 1 Cab Harness and Components of Electrical System - Perkins Engine Only

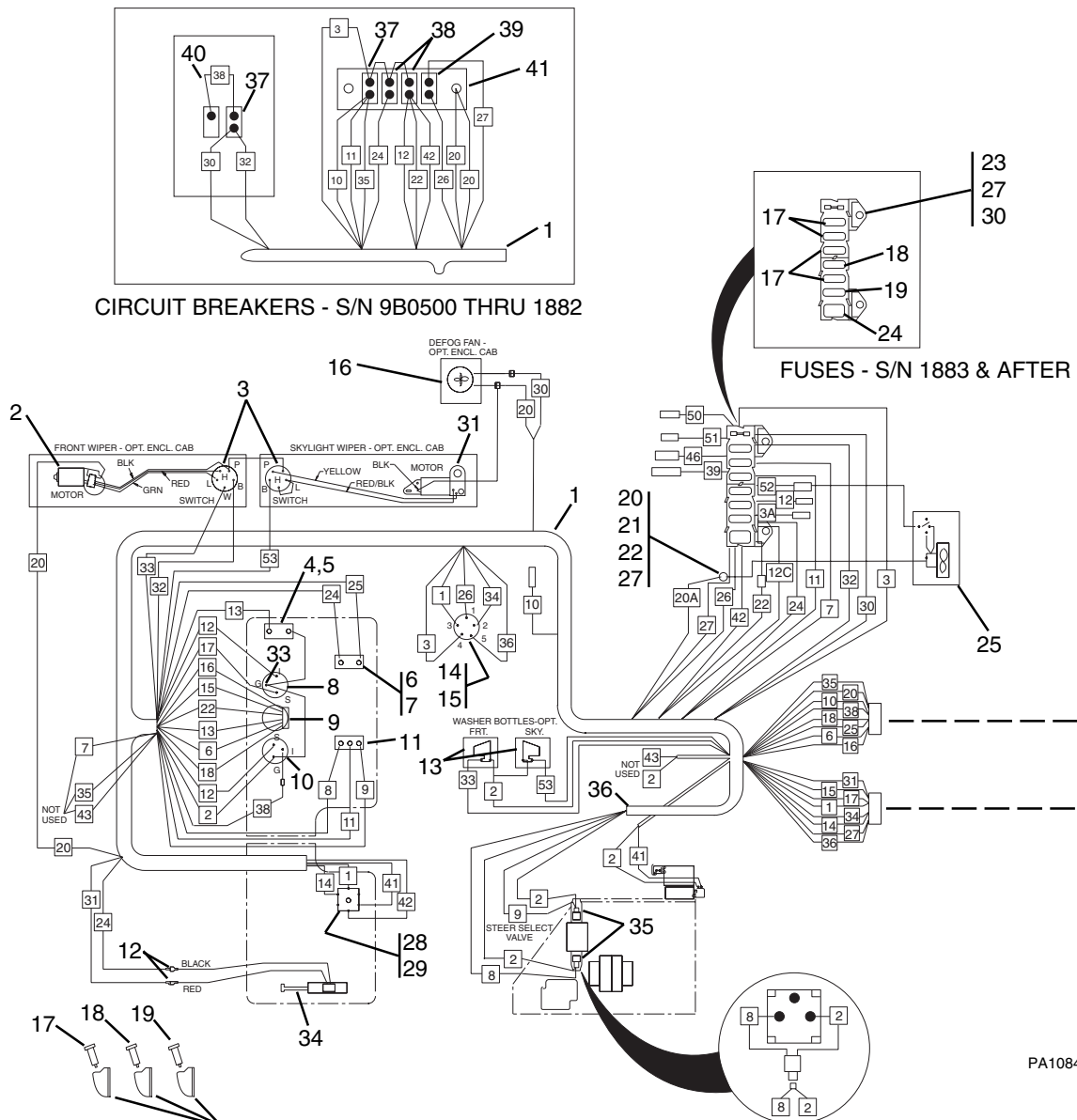


PA1093

- | | |
|--|--|
| 41. Lockwasher, M5 | 56. Sender, Water Temperature |
| 42. Nut, Hex, M8 | 57. Solenoid, Fuel Run |
| 43. Harness, Engine | 58. Switch, Neutral Start |
| 44. Battery, 12 Volt | 59. Relay, Starter |
| 45. Cable, Battery-Negative | 60. Starter |
| 46. Cable, Starter Ground (Not Shown) | 61. Solenoid, Starter |
| 47. Cable, Battery-Positive | 62. Alternator |
| 48. Screw, Washer Hd, Type B, 3/8 x 3/4 | 63. Sender, Fuel Level |
| 49. Horn | 64. Wire Assembly |
| 50. Backup Alarm | 65. Plug, Thermo Start |
| 51. Screw, Hex Hd Cap, 1/4-20 x 1-1/4 Gr 5 | 66. Screw, Round Hd Machine, #8-32 x 1/4 |
| 52. Nut, Hex, 1/4-20 | 67. Tie Wrap (Not Shown) |
| 53. Lockwasher, 1/4 | 68. Nut, Jam, M10 |
| 54. Switch, Transmission Temperature | 69. Lockwasher, M8 |
| 55. Sender, Low Oil Pressure | |

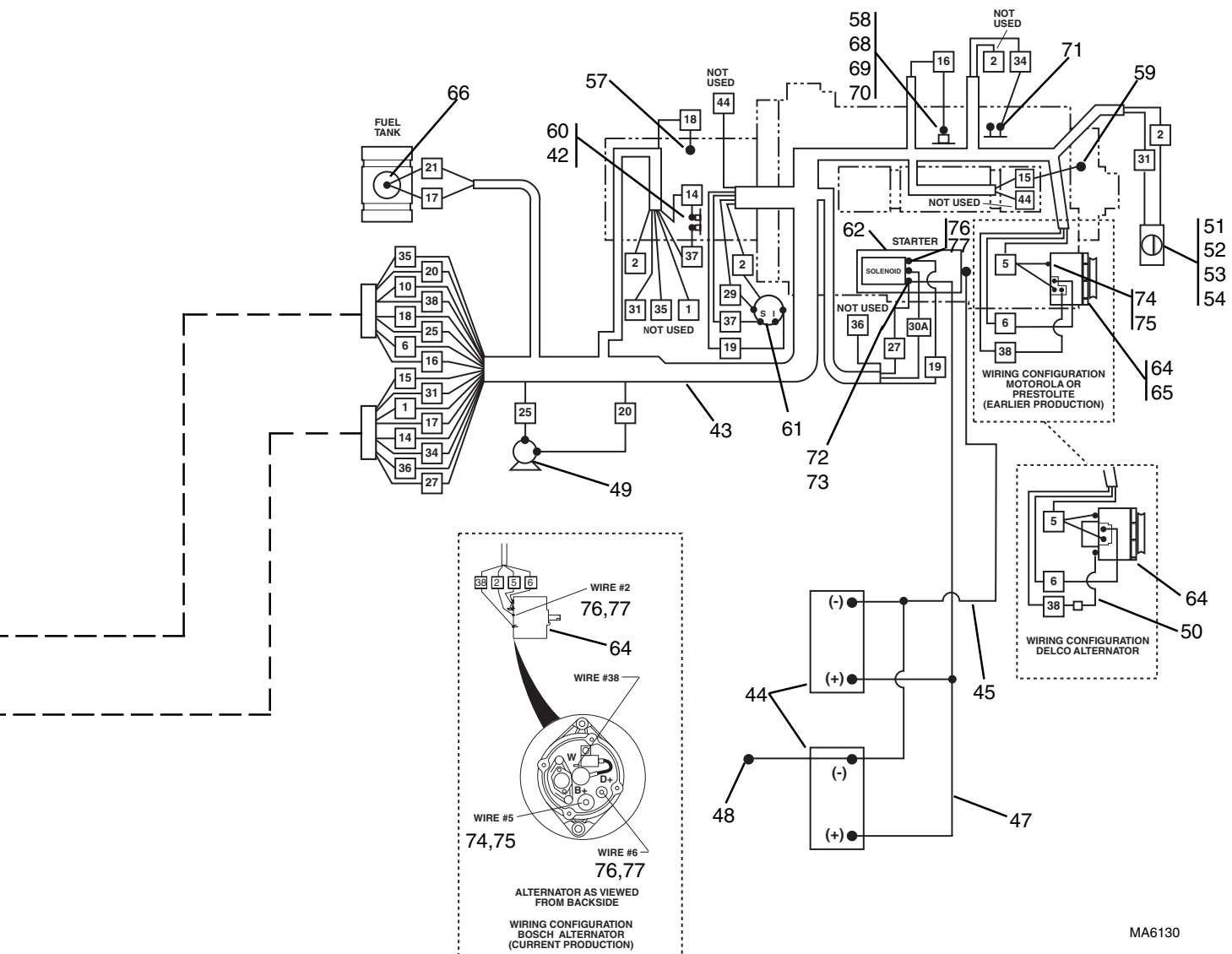
Fig. 10.7 Drawing 2 Engine Harness and Components of Electrical System - Perkins Engine Only

Model 6036/6036T S/N 9B0500 thru 14833



1. Harness, Cab
2. Motor Kit, Windshield Wiper
3. Switch, Windshield Washer/ Wiper
4. Switch, Test
5. Boot, Test Switch
6. Button, Horn
7. Boot, Horn Button
8. Gauge, Fuel
9. Gauge, Warning Lights
10. Hourmeter
11. Switch, Steer Select
12. Terminal, Male
13. Washer Reservoir Assembly
14. Switch, Ignition (w/Keys)
15. Key, Ignition (Not Shown)
16. Fan, Circulation
17. Fuse, 7.5 Amp (4 Required on Closed Cab)
18. Fuse, 10 Amp
19. Fuse, 20 Amp (Optional Light Package)
20. Nut, Hex, 1/4
21. Washer, Flat, 1/4
22. Lockwasher, Internal Tooth, 3/8
23. Nut, Hex, #10
24. Circuit Breaker, 40 Amp
25. Switch Kit, Heater
26. Wrap, Tie (Not Shown)
27. Lockwasher, 1/4
28. Switch, Brake
29. Guard, Switch
30. Lockwasher, #10
31. Sky Light Wiper Motor (Optional)
32. Clip, Spare Fuse
33. Terminal, Ring #10
34. Switch, Reverse
35. Solenoid, Steer Select Valve
36. Tie Wrap
37. Circuit Breaker, 6 Amp (3 Required on Closed Cab)
38. Circuit Breaker, 10 Amp
39. Circuit Breaker, 40 Amp
40. Wire Assembly (Closed Cab Only)
41. Bracket, Circuit Breaker

Fig. 10.7 Drawing 3 Cab Harness and Components of Electrical System - Cummins Engine Only



MA6130

- 42. Screw, Round Hd Machine, Type B, 3/8 x 3/4
- 43. Harness, Engine
- 44. Battery, 12 Volt
- 45. Cable, Battery-Negative
- 46. Cable, Starter Ground (Not Shown)
- 47. Cable, Battery-Pos
- 48. Screw, Washer Hd, Type B, 3/8 x 3/4
- 49. Horn
- 50. Wire Assembly
- 51. Backup Alarm
- 52. Screw, Hex Hd Cap, 1/4-20 x 1-1/4
- 53. Nut, Hex, 1/4-20
- 54. Lockwasher, 1/4
- 55. Nut, Hex, 5/16-18
- 56. Lockwasher, 7/16
- 57. Switch, Transmission Temperature
- 58. Sender, Low Oil Pressure
- 59. Sender, Water Temperature

- 60. Switch, Neutral Start
- 61. Relay, Starter
- 62. Starter (Includes Solenoid)
- 63. Tie Wrap (Not Shown)
- 64. Alternator
- 65. Fan, Alternator
- 66. Sender, Fuel Level
- 67. Washer, Flat, 5/16
- 68. Nut, Hex, Brass, #8-32
- 69. Lockwasher, External Tooth, #8
- 70. Terminal, Slip-On Male, #10 SCR
- 71. Solenoid, Fuel Run, 12 Volt
- 72. Lockwasher, M10
- 73. Nut, Jam, M10
- 74. Lockwasher, M8
- 75. Nut, Hex, M8
- 76. Lockwasher, M5
- 77. Nut, Jam, M5

Fig. 10.7 Drawing 4 Engine Harness and Components of Electrical System - Cummins Engine Only

Model 6036/6036T S/N 9B0500 thru 14833

Electrical System Circuits - Perkins Engines

Use with Fig. 10.7 (Drawing 1 & 2) Electrical System

Wire No.	Color	Gauge	Function
1-1B	White	14	Starter, Key Switch and Brake Release Switch
2-2G	Black	16	All Grounds
3&3A	Purple	10	Power
5	Red	12	Power from Alternator to Circuit Breakers/Fuses
6	Yellow	18	Alternator
7&7A	Brown	16	NOT USED
8	Green/White	14	Steer Select Switch
9	Green/Black	14	Steer Select Switch
10	Tan	14	NOT USED
11	Light Green	14	Steer Select Switch
12-12C	Dark Blue	14/16	Power to Circuit Breakers/Fuses & breakers/Fuses to Hourmeter & Fuel Gauge
13	Yellow/Red	18	Power to Test Switch
14	White/Blue	14	Brake Release Switch
15	Light Blue	18	Water Temperature Switch
16	Brown	18	Oil Pressure Switch
17	Gray	18	Fuel Sender
18	Green	18	Transmission Temperature Switch
19	Red/White	12	Starter Relay to Starter
20-20C	Black	14	Harness Ground, Circuit Breaker/Fuse Ground, Optional Wiper & Fan Ground
21	Black	18	Fuel Sender to Ground
22	White	18	Power to Warning Lights
24-24B	Orange/Green	14	Power from Circuit Breakers/Fuses to Horn Button and Reverse Switch
25	Orange/Black	14	Horn Switch to Horn
26	Red	10	Power from Circuit Breakers/Fuses to Ignition Switch
27	Red	10	Power to Circuit Breakers/Fuses and Starter
29	Red	12	Power from Alternator to Starter Relay
30	Gray/White	14	Power to Optional Fan
31	Orange/Red	16	Reverse Switch to Back-up Alarm
32	Gray/White	14	Power from Circuit Breaker/Fuse to Optional Wiper Switch
33	Gray/Brown	16	Optional Washer Switch to Washer Bottle
34	Red/Black	16	Ignition Switch to Fuel Shut Off Solenoid
35	Brown/White	16	NOT USED
36	Yellow/Red	10	Ignition Switch to Thermo Start
37	Dark Blue	14	Neutral Start to Starter Relay
38	Orange	16	Hourmeter to Alternator
39	Red/Gray	16	NOT USED
41	Dark Blue/White	14	Brake Release Switch to Brake Release Solenoid
42	Tan	14	Power from Circuit Breaker/Fuse to Brake Release Switch
43	Brown/Green	16	NOT USED
44	Brown/Yellow	16	NOT USED
46	White/Orange	16	NOT USED
50	White/Yellow	14	OPEN
51	White/Red	14	OPEN
52	Orange	14	Power from Circuit Breaker/Fuse to Optional Heater

Electrical System Circuits - Cummins Engines

Use with Fig. 10.7 (Drawing 3 & 4) Electrical System

Wire No.	Color	Gauge	Function
1-1B	White	14	Starter, Key Switch and Brake Release Switch
2-2G	Black	16	All Grounds
3&3A	Purple	10	Power
5	Red	12	Power from Alternator to Circuit Breakers/Fuses
6	Yellow	18	Alternator
7&7A	Brown	16	NOT USED
8	Green/White	14	Steer Select Switch
9	Green/Black	14	Steer Select Switch
10	Tan	14	NOT USED
11	Light Green	14	Steer Select Switch
12-12C	Dark Blue	14/16	Power to Circuit Breakers/Fuses & breakers/Fuses to Hourmeter & Fuel Gauge
13	Yellow/Red	18	Power to Test Switch
14	White/Blue	14	Brake Release Switch
15	Light Blue	18	Water Temperature Switch
16	Brown	18	Oil Pressure Switch
17	Gray	18	Fuel Sender
18	Green	18	Transmission Temperature Switch
19	Red/White	12	Starter Relay to Starter
20-20C	Black	14	Harness Ground, Circuit Breaker/Fuse Ground, Optional Wiper & Fan Ground
21	Black	18	Fuel Sender to Ground
22	White	18	Power to Warning Lights
23	Orange/Green	16	NOT USED
24-24B	Orange/Green	14	Power from Circuit Breakers/Fuses to Horn Button and Reverse Switch
25	Orange/Black	14	Horn Switch to Horn
26	Red	10	Power from Circuit Breakers/Fuses to Ignition Switch
27	Red	10	Power to Circuit Breakers/Fuses and Starter
28	Purple/White	16	NOT USED
29	Red	12	Power from Alternator to Starter Relay
30	Gray/White	14	Power to Optional Fan
30A	Red/White	14	EPA Turbo Engines Only (S/N 3617 & After)-Fuel Shut Off Solenoid to Starter
31	Orange/Red	16	Reverse Switch to Back-up Alarm
32	Gray/White	14	Power from Circuit Breaker/Fuse to Optional Wiper Switch
33	Gray/Brown	16	Optional Washer Switch to Washer Bottle
34	Red/Black	16	Ignition Switch to Fuel Shut Off Solenoid
35	Brown/White	16	NOT USED
36	Yellow/Red	10	NOT USED
37	Dark Blue	14	Neutral Start to Starter Relay
38	Orange	16	Hourmeter to Alternator
39	Red/Gray	16	NOT USED
41	Dark Blue/White	14	Brake Release Switch to Brake Release Solenoid
42	Tan	14	Power from Circuit Breaker/Fuse to Brake Release Switch
43	Brown/Green	16	NOT USED
44	Brown/Yellow	16	NOT USED
46	White/Orange	16	NOT USED
47	Orange/White	16	NOT USED
49	Red/Blue	16	NOT USED
50	White/Yellow	14	OPEN
51	White/Red	14	OPEN
52	Orange	14	Power from Circuit Breaker/Fuse to Optional Heater
53	Gray/Green	16	Optional Wiper/Washer Switch to Washer Bottles

10.5 STARTING CIRCUIT

When you turn the ignition key to start the engine with the transmission in neutral, the starting circuit actuates a starter relay, a starter solenoid, a starter and a fuel run solenoid. The fuel run solenoid opens a valve which supplies fuel to the injection pump.

PERKINS ONLY: When starting in a cold environment, turning the key to a position between run and start for a few moments before starting, will supply current to a thermo start plug in the intake manifold. The plug ignites a fuel-air mixture in the intake manifold to facilitate cold weather starting.

The starting circuit functions as follows:

1. Current from the batteries (1, Fig. 10.8) flows through the positive battery cable (2) to the starter solenoid.
2. It then flows to circuit breaker (3) and to terminal "1" of the ignition switch (4).
3. When the key is turned to the START position, current flows through contacts in the ignition switch to the emergency brake switch (5).
4. If the emergency brake is set, current flows through contacts in the brake switch to the neutral start switch (6).
5. If the transmission select lever is in neutral, current flows through contacts in the neutral start switch to energize the coil of the starter relay (7). The relay closes contacts which allow current to energize the starter solenoid and operate the starter.
6. When the solenoid and related mechanisms cause the starter pinion to engage a gear on the flywheel, the starter motor rotates the gear, crankshaft and related components in the engine.
7. When the ignition key was turned in step 3, the fuel run solenoid opened a valve to supply fuel to the fuel injection pump. As the starter rotated the engine components, the fuel injection pump and related lines and injectors supplied fuel to the cylinders.
8. When the pistons compress this injected fuel, ignition occurs, the engine runs and the starter pinion retracts.
9. As the engine runs, it operates an alternator which recharges the battery which was used during the starting cycle.
10. When the ignition key is released after starting, it returns to a neutral position where it directs current to circuit breakers which distribute current for the operation of forklift controls, gauges and equipment.
11. When the ignition key is turned to the OFF position, contacts within the ignition switch are opened and the fuel run solenoid valve closes, blocking the flow of fuel to the fuel injection pump.

10.5.1 Testing Starter in Forklift

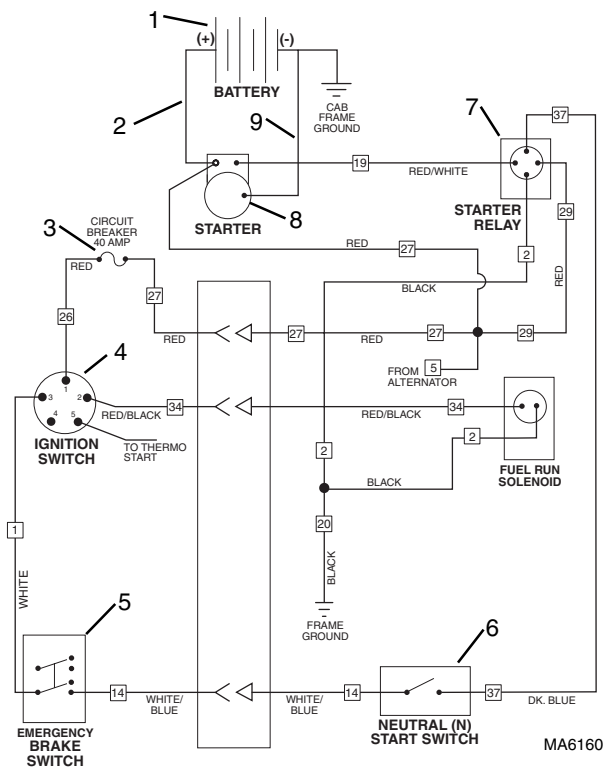
General Starter Checks

If nothing happens when you turn the ignition key:

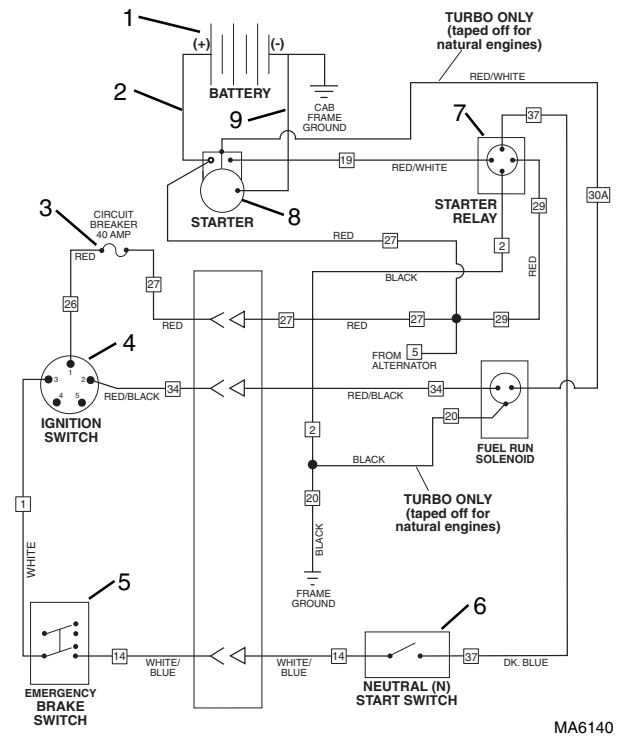
1. The 40 A circuit breaker may be open and require replacement;
2. There may be a defect in the ignition switch, ignition wiring, or starter solenoid;
3. Check the condition of the batteries as described in paragraph 10.6.2. Clean the battery posts and the connectors at each end of the battery cables. Also check the ground cable between the starter mounting bolt and the frame.
4. Check for broken wires and damaged insulation on the wires. Replace all broken or damaged wiring.
5. Check all connections at the starter solenoid, key switch, and wiring harness plugs. Clean and tighten all connections.
6. If the starter still does not run after you do these checks, check the starting circuit.

Starter Circuit Checks

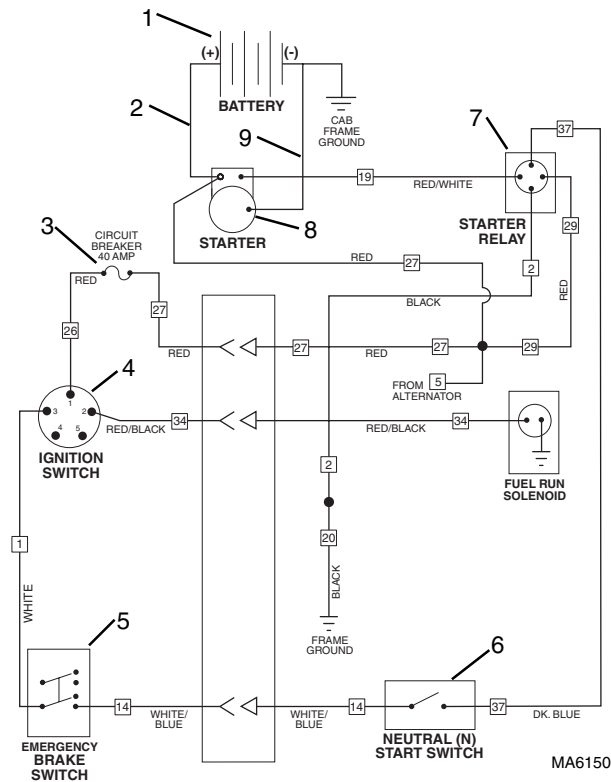
1. With the key turned to the RUN position, use a jumper wire to try shorting the positive battery cable to the solenoid starter connection. If the starter now cranks, the problem is in the wiring circuit. If the solenoid fails to "click" the starter is probably defective.
2. If you hear a "whirring" noise but the engine does not crank, the starter is spinning but is not engaging the flywheel. The starter drive or solenoid that pushes the drive forward to engage the flywheel may be defective. Missing teeth on the flywheel can also prevent the starter from cranking the engine.
3. If the starter only "clicks", it might indicate discharged batteries or a loose or corroded battery cable connection(s). Check battery charge and condition first.



Perkins Engines Only



Cummins Engines Only (S/N 3617 & After)



Cummins Engines Only (S/N 3616 & Before)

1. Battery, 12 V
2. Positive Battery Cable
3. Circuit Breaker, 40 A
4. Ignition Switch
5. Emergency Brake Switch
6. Neutral Start Switch
7. Starter Relay
8. Starter
9. Negative Battery Cable

Fig. 10.8 Starting Circuit

10.5.2 Starter

The starter is located behind the left access door at the back of the engine. The starter drive engages teeth on the flywheel when cranking the engine.

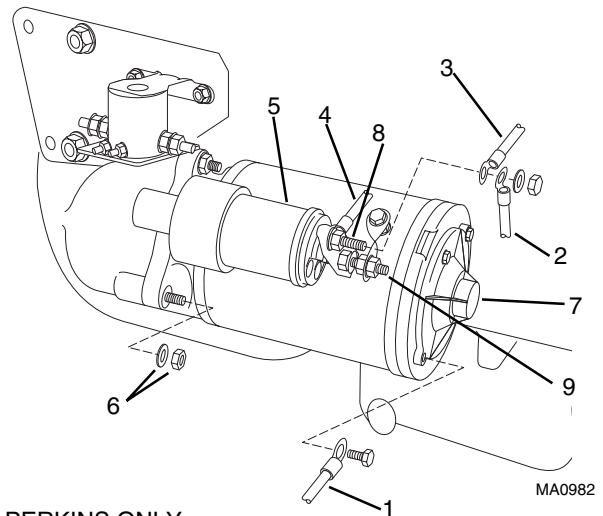
a. Removal

Remove the starter only if it fails. To remove the starter:

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Tag and disconnect the negative ground cable (1, Fig. 10.9) from the starter.
3. Tag and disconnect the positive cable (2) and other wiring (3, 4 and 10 on some models) from the starter solenoid (5), paying attention to the sequence in which the wires are installed on the terminal.
4. Loosen but do not remove the three hex nuts or bolts (6) that secure the starter to the flywheel housing. Be careful when you remove the nuts or bolts because the starter is heavy and it will fall if not supported. Using one hand to support the starter, remove the nuts and lock washers or bolts (6) and lift the starter (7) from the forklift.

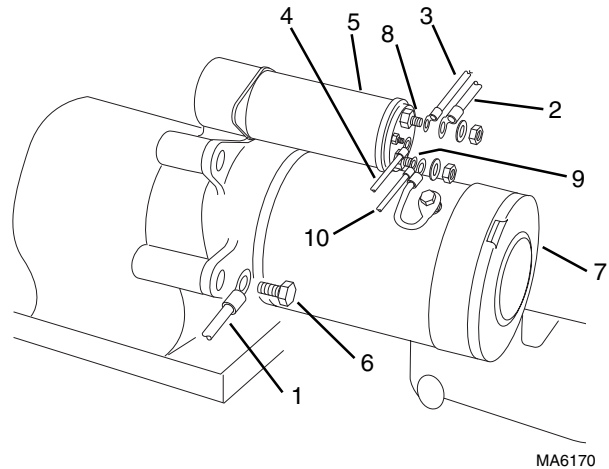
b. Cleaning and Drying

1. While the starter is out wipe away any grease or dirt that has accumulated around the starter hole.
2. If the starter is to be reinstalled, clean the exterior of the starter with an approved solvent without submerging the starter or allowing the solvent to contact the bushings.
3. Dry the starter using a clean, lint-free cloth.



PERKINS ONLY

- | | |
|--------------------------|---------------------------|
| 1. Negative ground cable | 7. Starter |
| 2. Positive cable | 8. Battery terminal |
| 3. Wire 27 | 9. Starter motor terminal |
| 4. Wire 19 | |
| 5. Starter solenoid | |
| 6. Mounting Hardware | |



CUMMINS ONLY

- | | |
|--------------------------|--|
| 1. Negative ground cable | 7. Starter |
| 2. Positive cable | 8. Battery terminal |
| 3. Wire 27 | 9. Starter motor terminal |
| 4. Wire 19 | 10. Wire 30A Turbo Only (S/N 3617 & After) |
| 5. Starter solenoid | |
| 6. Mounting Hardware | |

Fig. 10.9 Starter Removal

c. Periodic Maintenance

The starter motor requires no routine maintenance beyond the occasional inspection of the electrical connections which must be clean and tight, brush wear and the commutator.

d. Installation

1. Position the starter on the flywheel housing, install three lock washers (6, Fig 10.9) and three nuts (three bolts on later models), and torque the nuts to 3.4 lb-ft (4,6 Nm) and the bolts to 32 lb-ft (43 Nm).
2. Connect all the wires to the starter solenoid (5).
3. Connect the positive (+) battery cable (2) to the starter.
4. Connect the positive (+) cable (2) to the positive terminals on the batteries.
5. Connect the negative (-) cable (1) to the negative terminals on the batteries.
6. Connect the ground cable (1) to the starter.

10.5.3 Starting Motor Relay

The starting motor relay, Fig. 10.10, consists of a movable contact with a fixed coil in a weather-proof casing.

The relay is internally grounded and is equipped with two large terminals and one small terminal. The two large terminals are for connection between the batteries and the starting motor. The small terminal is located on the lower side of the relay.

Turning the ignition switch, with the transmission in neutral, allows current to flow through the relay coil via terminal to the ground point on the casing. The flow of current energizes the coil forming a magnetic field which attracts a movable contact. When the contacts fully close, current from the batteries is allowed to flow to the starting motor through the relay.

Once the key switch is released, the flow of current to the coil is stopped thereby breaking the magnetic field and allowing the return spring to open the contacts. This action stops the current flow from the batteries to the starting motor.

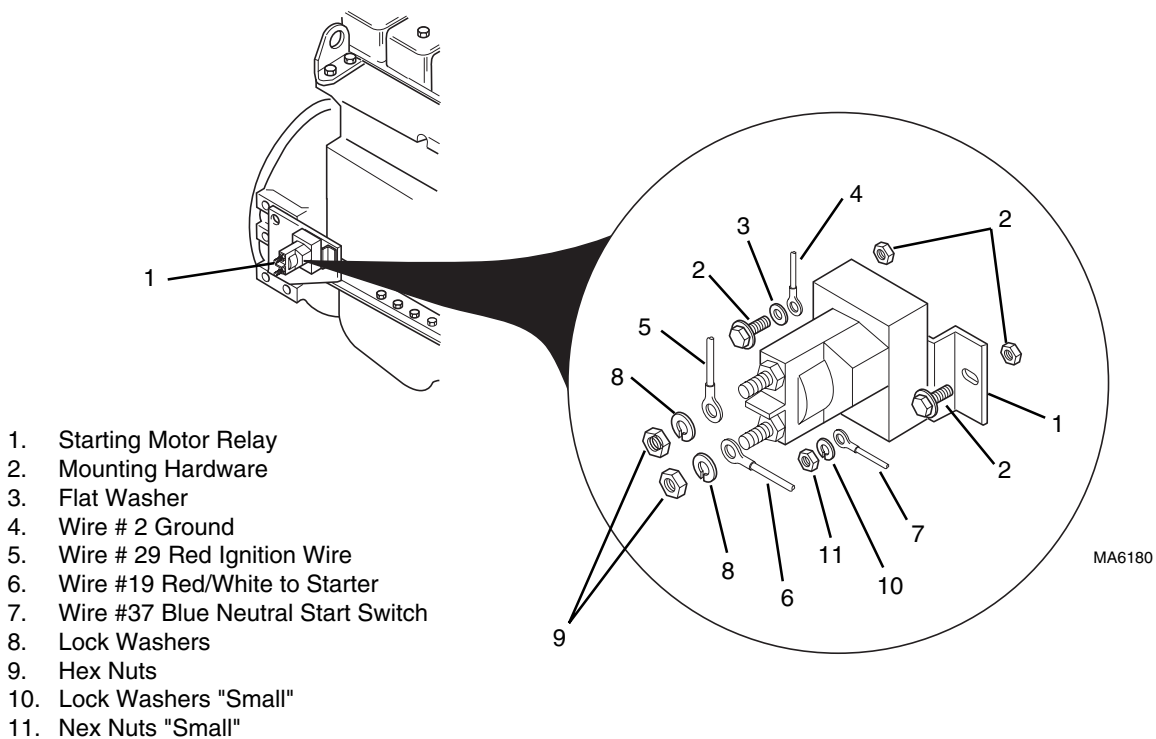


Fig. 10.10 Starting Motor Relay

a. Removal of Starting Motor Relay and Relay Mounting Plate

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Disconnect the red wire #29 (5, Fig. 10.10) by removing hex nut (9) and lock washer (8).
3. Disconnect the red/white wire #19 (6) by removing hex nut (9) and lock washer (8).
4. Disconnect the blue wire #37 (7) by removing the "small" hex nut (11) and "small" lock washer (10).
5. Remove starting motor relay (1) from relay mounting plate by removing two elastic lock nuts (2) from behind plate. On the left side of the starter motor relay, remove a flat washer (3) and ground wire #2 (4) along with the washer hd. screw (2). Then remove the other washer hd. screw (2).
6. If necessary, remove relay mounting plate by removing two capscrews and two flat washers from the plate.

b. Disassembly of Starting Motor Relay

IMPORTANT: Do not disassemble starting motor relay; service only as a complete assembly.

c. Cleaning and Drying

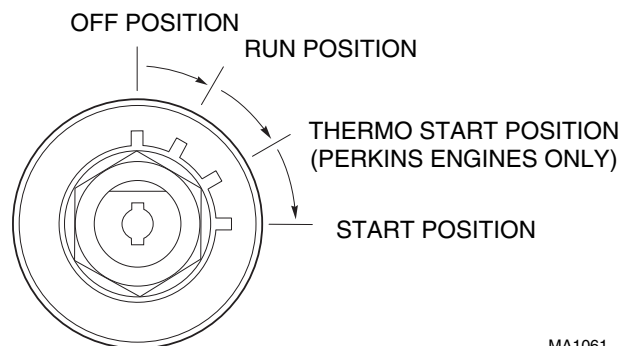
Without submerging the starting motor relay, clean the relay using an approved solvent and dry with a clean cloth.

d. Inspection and Replacement

1. Test the operation of the relay by connecting a 12 Vdc positive source to the positive (upper) terminal and the negative lead to the mounting bracket; replace the relay if you don't hear the contacts close.
2. Inspect the general condition of the casing and terminals and replace the relay if damaged.

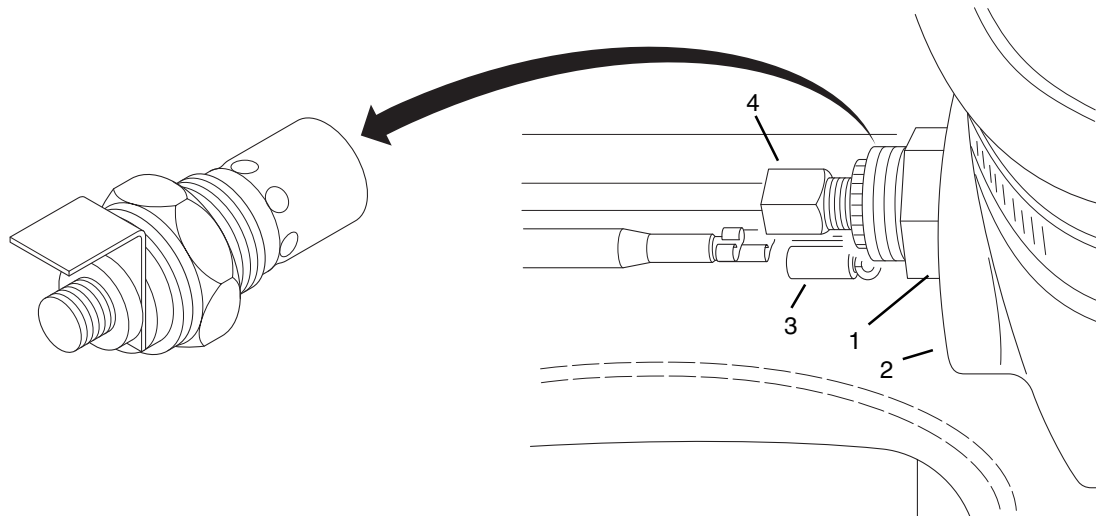
e. Installation

1. If it was removed, position the relay mounting plate on the engine and secure it with two capscrews and two lock washers.
2. Install washer hd. screw (2) through flat washer (3) and wire (4) and through the LEFT hole in the relay bracket. Insert end of screw through relay mounting plate and secure the screw with a elastic lock nut (2). Repeat this installation through the right hole in the relay bracket but without using a flat washer under the washer hd. screw.
4. Install wire #37 (7) from neutral start switch by installing lock washer (10) and hex nut (11) onto the threaded stud.
5. Connect wire #19 (6) by installing lock washer (8) and hex nut (9).
6. Connect wire #29 (5) by installing lock washer (8) and hex nut (9).



MA1061

Fig. 10.11 Ignition Key Switch



MA1071

1. Thermo Start Plug 2. Intake Manifold 3. Electrical Terminal 4. Fuel Line Fitting

Fig. 10.12 Thermo Start Plug for Cold Weather Starting

10.5.4 Thermo Start Plug for Cold Weather Starting - Perkins

When the ignition key switch, Fig. 10.11, is turned to the Thermo Start position, a Thermo Start plug (1, Fig. 10.12) ignites a fuel/air mixture in the intake manifold (2) to facilitate cold weather starting.

To use this starting aid for cold weather starting, turn key to the Thermo Start position and hold it there for fifteen to twenty seconds. With the throttle pedal fully depressed, turn the key to the START position to engage the starter motor.

If the engine doesn't start within fifteen seconds, return the switch to the THERMO START position for ten seconds and then reengage the starter motor by turning key to the START position.

As soon as the engine starts, allow key to return to the RUN position.

If the engine should fail to start, check the electrical connection to the Thermo Start plug.

In the event of difficult starting, check that fuel is reaching the Thermo Start plug by unscrewing the inlet fuel connection. If fuel is reaching the Thermo Start plug, the plug itself may not be working correctly. This can be checked by removing the air cleaner and watching the cold starting aid while the equipment is used. When the starting switch is turned to the THERMO START position, the element should become red hot, and on engagement of the starter motor, ignition of the fuel should take place.

The engine is fitted with an efficient cold starting aid and no responsibility can be accepted for any damage caused by unauthorized starting aids.

a. Removal

1. Tag and disconnect wire at electrical terminal (3, Fig. 10.12).
2. Disconnect fuel line (4).
3. Remove Thermo Start plug.

b. Disassembly

Do not disassemble the Thermo Start plug.

c. Cleaning and Drying

Without submerging the Thermo Start plug, clean the exterior of the plug in an approved solvent and dry using a clean lint-free cloth.

d. Inspection and Replacement

1. Examine the bore of the fuel channel for any contamination and clean as required.
2. Test the coil of the Thermo Start plug using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply. If the coil doesn't heat, replace the Thermo Start plug.

e. Installation

1. Install the Thermo Start plug.
2. Connect fuel line (4, Fig. 10.12).
3. Connect wire at electrical terminal (3).

10.6 CHARGING CIRCUIT

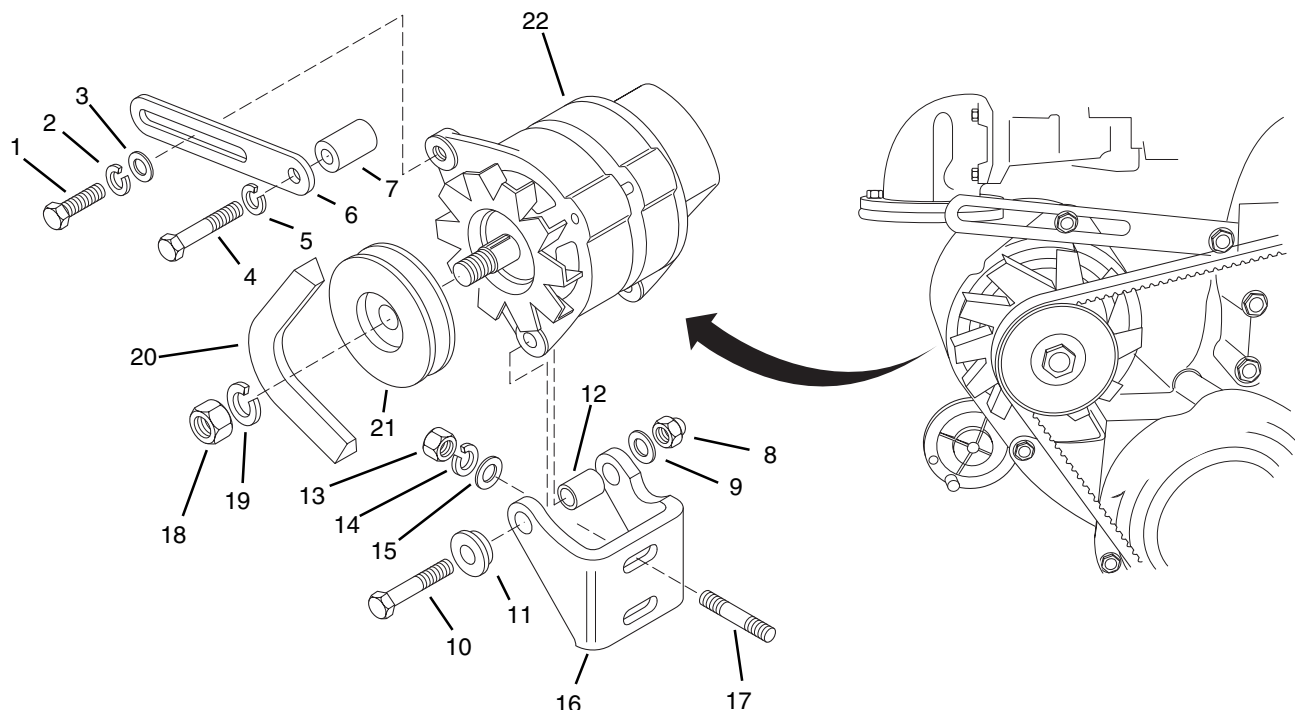
10.6.1 Alternator

a. Alternator Removal - Perkins

1. Disconnect negative (–) cable (2, Fig. 10.16) from batteries.
2. Remove screw (1, Fig. 10.13), lock washer (2), and washer (3) from tapped hole in alternator.
3. Remove screw (4), lock washer (5), lever (6), and spacer (7) from tapped hole in engine.
4. While supporting the weight of the alternator (22), remove self-locking nut (8), washer (9), screw (10), sleeve (11), and sleeve (12); lift the alternator from the forklift and carry it to a clean work bench.
5. If necessary, remove hex nuts (13), washers (14), washers (15), bracket (16), and stud (17).
6. If necessary, remove hex nut (18), washer (19), belt (20), and pulley (21).

Alternator Removal - Cummins

1. Disconnect negative (–) cable (2, Fig. 10.16) from batteries.
2. Remove the belt (3, Fig. 10.14) by carefully lifting the tensioner (2) with a 1/2" square drive installed in the square hole in the tensioner bracket.
3. Tag and remove all the wires from the rear of the alternator (1).
4. Remove the lower mounting capscrew (4) holding the alternator to the lower mounting tab (5).
5. While supporting the alternator with one hand remove the upper mounting "longer" capscrew (6) from the upper mounts (7).



MA1111

1. Screw	4. Bolt	8. Self-locking Nut	12. Sleeve	16. Bracket	20. Belt
2. Lock Washer	5. Lock Washer	9. Washer	13. Nut	17. Stud	21. Pulley
3. Washer	6. Lever	10. Screw	14. Washer	18. Hex Nut	22. Alternator
	7. Spacer	11. Sleeve	15. Washer	19. Washer	

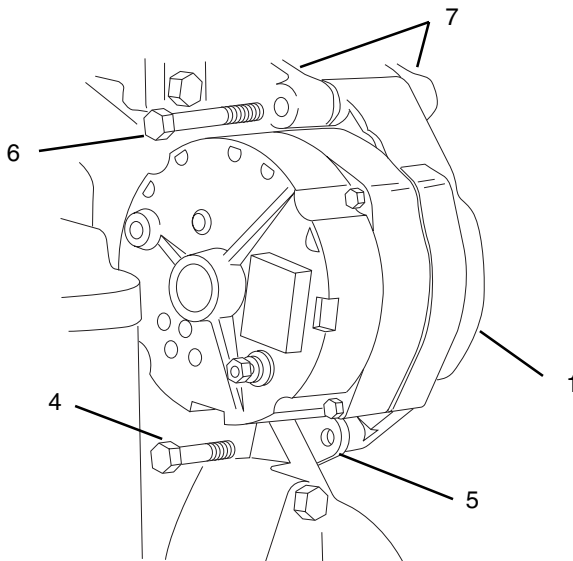
Fig. 10.13 Alternator Removal - Perkins Engines

b. Alternator Installation - Perkins

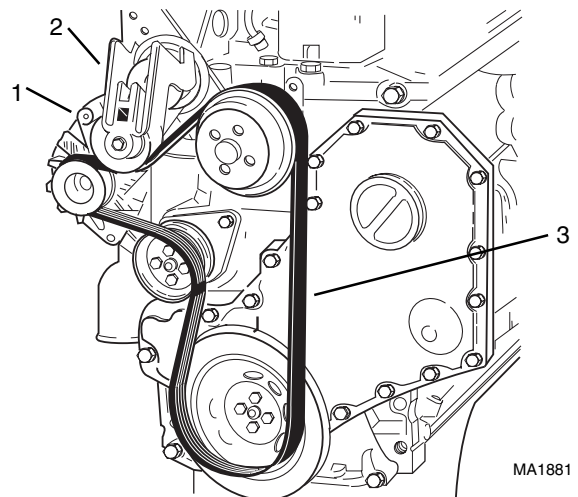
1. If necessary, install pulley (21, Fig. 10.13), belt (20), washer (19), and hex nut (18).
2. If necessary, install stud (17), bracket (16), washers (15) and washers (14).
3. Position alternator (22) on the engine and install sleeve (12), sleeve (11), screw (10), washer (9), self-locking nut (8).
4. Install spacer (7), lever (6), lock washer (5), and screw (4).
5. Install washer (3), lock washer (2) and screw (1).
6. Connect negative (-) cable (2, Fig. 10.16) to batteries.

Alternator Installation - Cummins

1. Position the alternator between the upper mounts (7, Fig. 10.14). Line up the holes and insert the upper mounting "longer" capscrew through the backside mount, alternator and thread into the front mount. Do Not tighten at this time.
2. Line up the lower hole in the alternator with the lower mounting tab (5) and insert the lower mounting capscrew (4).
3. Now tighten the lower and upper mounting capscrews securely.
4. Reattach all the wires to the proper terminals on the backside of the alternator.
5. Use the 1/2" square drive to lift the tensioner bracket (2) and reassemble the alternator belt onto the pulleys. Be sure the tensioner is pivoting freely to provide the proper tension on the belt.
6. Connect the negative (-) battery cable (2, Fig. 10.16) to the batteries.



MA6190



MA1881

- | | |
|----------------------------|-------------------------------------|
| 1. Alternator Assembly | 5. Lower Mounting Tab |
| 2. Tensioner Bracket | 6. Upper Mounting "Longer" Capscrew |
| 3. Alternator Belt | 7. Upper Mounts |
| 4. Lower Mounting Capscrew | |

Fig. 10.14 Alternator Removal - Cummins Engines

10.6.2 Batteries



Warning !

All lead-acid batteries generate hydrogen gas which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, and possible severe personal injuries. Wear safety glasses when working near batteries. In case of contact with acid, flush immediately with water.

a. Description

The batteries supply power to the starter and ignition systems to crank the engine. They supply the extra power required when the electrical load requirements of the forklift exceed the supply from the charging system in case of a alternator or charging failure, and acts as a voltage stabilizer in the electrical system, smoothing out or reducing temporarily high voltage.

With the correct cables properly attached, and with the batteries properly mounted, the batteries never need periodic maintenance.

When starting the forklift, crank for a maximum of 15 seconds, then rest for two minutes to avoid burning up the starter. Do not idle excessively.

Keep the batteries from freezing by maintaining a full charge. A completely discharged battery will freeze at 18 °F (8 °C).

Water never has to be added to the batteries. There are no filler caps. Each battery is sealed, except for small vent holes in the cover. The vents allow what small amount of gasses that are produced in the battery to escape. The special chemical composition inside the battery reduces gassing to a very small amount at normal charging voltages. Besides reducing gassing, the special chemistry greatly reduces the possibility of over-charge damage.

The vents require keeping the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out the vent hole.

DO NOT exceed this 45° angle when carrying or installing a battery.

Evidence of electrolyte leakage does not necessarily mean a battery is defective.

The battery has top post terminals. Securely tighten clean cable clamps to the posts. Grease or special spray sealers may be applied over the connections.

b. Visual Inspection of a Battery

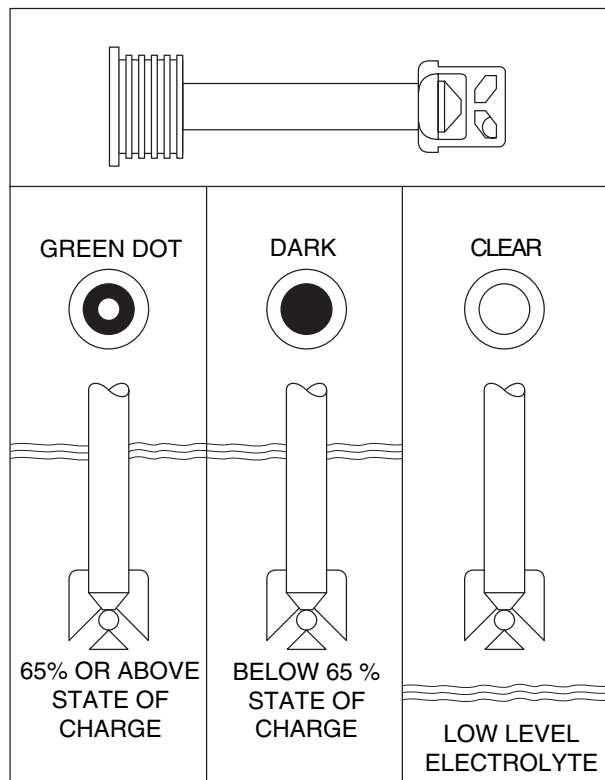
Inspect for damage such as a cracked or broken case or cover that could permit loss of electrolyte. If obvious physical damage is noted, replace battery. Handle the battery with care. Determine cause of damage and correct as needed.

c. Built-In Hydrometer

A special temperature-compensated hydrometer is built into the cover of each battery to show at a glance the battery's state-of-charge. The hydrometer has a green ball within a cage which is attached to a clear plastic rod; refer to Fig. 10.15.

It is important when observing the hydrometer that the battery have a clean top to see the correct indication. A flashlight may be required in some poorly lit areas.

IMPORTANT: Always look straight down when viewing the hydrometer.



MA1201

Fig. 10.15 Typical Hydrometer Operation

The green ball will float at a predetermined specific gravity of the electrolyte that represents about a 65 percent state-of-charge. When the green ball floats, it rises within the cage and positions itself under the rod. Visually a green dot then shows in the center of the hydrometer; refer to Fig. 10.15. The built-in hydrometer provides a guide for battery testing and charging.

In testing, the GREEN DOT means the battery is charged enough for testing. If the green dot is not visible and the center of the hydrometer has a DARK appearance, it means the battery must be charged before the test procedure is performed.

In charging, the appearance of the green dot means that the battery is sufficiently charged. Charging can be stopped to prevent overcharging.

The hydrometer on some batteries may be CLEAR or light yellow; refer to Fig. 10.15. This means the fluid level may be below the bottom of the rod and attached cage. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping, or normal battery wear out.

IMPORTANT: *Whenever this clear or light yellow appearance is present when looking straight down on the hydrometer, always tap the hydrometer lightly with a small screwdriver to dislodge any gas bubbles that may be giving a false indication of low electrolyte level. If the clear or light yellow appearance remains, and if a cranking complaint exists that is caused by the battery, replace the battery.*

Complete hydrometer information is printed on a label on top of the battery. Refer to this label to accurately interpret hydrometer appearance.

d. Battery Load Test

1. Remove cable clamps and be sure parts are clean for a good connection.

2. Attach voltmeter and battery load tester clamps to posts.
3. Remove surface charge from any battery that has just been on charge IF THE GREEN DOT IS VISIBLE. This includes batteries in the vehicle having been charged by the vehicle alternator. *Do not remove surface charge from batteries that have been in storage.* To remove surface charge, apply a 300-ampere load across the terminals for 15 seconds. Then turn off load and wait for 15 seconds to allow the battery to recover.
4. Battery temperature should be estimated by touch and also by the surrounding temperature it was exposed to during the preceding few hours before testing. Select the nearest estimated temperature in the table below and determine the minimum voltage which must be maintained while the battery supplies a specified electrical load
5. Apply a 260 A load test. Observe voltage after 15 seconds with load connected; then turn off load.
6. If voltage is below value determined in step 4, replace battery.
7. If voltage is at or above value determined in step 4, battery is good and may be returned to service.
8. Check the charge acceptance of the battery one more time before discarding it.

e. Battery Charging

1. Do not charge battery if hydrometer is clear or light yellow; replace battery.
2. Charge rates between 3 and 50 amperes are generally satisfactory as long as spewing of electrolyte does not occur or the battery does not feel excessively hot [over 125 °F (52 °C)]. Battery temperature can be estimated by touching or feeling the battery case. If spewing occurs or temperature exceeds 125 °F (52 °C), the charging rate must be reduced or temporarily halted to permit cooling.

Relation of Battery Temperature to Minimum Voltage

Temperature	(21 °C) 70 °F & Above	(10 °C) 50 °F	(-1 °C) 30 °F	(-10 °C) 15 °F	(-18 °C) 0 °F	Below 0 °F
Minimum Voltage	9.6	9.4	9.1	8.8	8.5	8.0

- The battery is sufficiently charged when the green dot in the built-in hydrometer is visible. No further charging is required. Shake or tilt the battery at hourly intervals during the charging to mix the electrolyte and see if the green dot appears.
- Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25-ampere charging rate for 2 hours would be 50 ampere-hour charge to the battery. In most cases, batteries whose load test values are less than 200 amperes (see Battery Testing Procedure) will have the green dot visible after at least a 50 ampere-hour charge. Most batteries whose load test values are greater than 200 amperes will have the green dot visible after at least a 75 ampere-hour charge. In the event that the green dot does not appear after this amount of charging, continue charging for another 50 or 75 ampere-hours. If the green dot still does not appear, replace the battery.

The time required for a charge will vary due to the following conditions:

- *Size of Battery.* For example, a completely discharged large heavy-duty battery requires more than twice the recharging as a completely discharged small passenger car battery.
- *Temperature.* For example, a longer time will be needed to charge any battery at 0 °F than at 80 °F. When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, then in time the battery will accept a higher rate as the battery warms.
- *State-of-Charge.* A completely discharged battery requires more than twice as much charge as a one-half-charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.
- *Charger Capacity.* A charger which can supply only 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

f. Troubleshooting

If a battery has tested good and then has not performed satisfactorily in service for no apparent reason, the following are some of the more important factors that may point to the cause of trouble:

1. Vehicle accessories inadvertently left on overnight.
2. Defects in the charging system, such as slipping fan belt, high wiring resistance, or faulty alternator.
3. A vehicle electrical load exceeding the alternator capacity, with the addition of electrical devices, such as radio equipment, air conditioner, window defoggers or light systems.
4. Defects in the electrical system, such as shorted wires.
5. Extended slow speed driving with many accessories turned on.
6. Loose or poor battery cable-to-post connections, previous improper charging of a run-down battery, or loose hold-downs.
7. High-resistance connections or defects in the starting system.
8. Long periods of vehicle storage without disconnecting the batteries. Small current drains of vehicle accessories which are connected all the time can discharge the batteries in a six- to eight-week period. Batteries left in a discharged condition for a prolonged period of time are subject to freezing and can become difficult to recharge.

g. Jump Starting with Auxiliary (Booster) Battery

Both booster and discharged battery should be treated carefully when using jumper cables. Follow exactly the following procedure for this negative ground system, being careful not to cause sparks:

1. Engage park lock and place transmission in neutral. Turn off lights, optional heater and other electrical loads.
2. Observe charge indicator. If indicator is light, replace battery. If charge indicator is dark and has a green dot in the center, failure to start is not due to a discharged battery and the cranking system should be checked. If charge indicator is dark but the green dot does not appear in the center, proceed as follows:

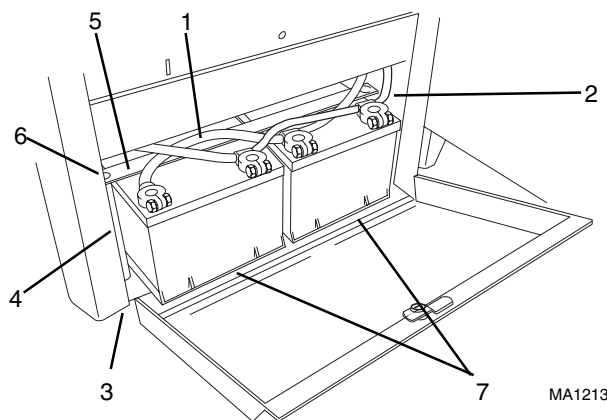
3. Attach one end of one jumper cable to the positive terminal of the **booster battery** and the other end of the same cable to positive terminal of **discharged battery**. **DO NOT PERMIT** vehicles to touch each other as this could establish a ground connection and counteract the benefits of this procedure.
4. Attach one end of the remaining negative cable to the negative terminal of the **booster battery** and the other end to a ground at least 12 inches from the battery of the vehicle being started. (**DO NOT CONNECT DIRECTLY TO THE NEGATIVE POST OF THE DEAD BATTERY**).



Warning

Any procedure other than the above could result in:

- Personal injury caused by electrolyte squirting out the battery vent;
- Personal injury or property damage due to battery explosion.
- Damage to the charging system of the booster vehicle or of the immobilized vehicle.



1. Positive (+) cable
2. Negative (-) cable
3. Two self-locking nuts (2)
4. Spacers (2)
5. Hold Down Strap
6. Bolts (2)
7. Batteries

Fig. 10.16 Battery Removal

h. Battery Removal

1. Prepare to remove the battery(s) by unlocking and opening door to battery compartment.
2. Disconnect the negative cable (2, 10.16) from the batteries.
3. Disconnect positive cable (1) from batteries.
4. Remove the two self-locking nuts (3) from below the cab floor and lift the spacers (4), hold down strap (5) and bolts (6) from the battery compartment.
5. Carefully lift the battery(s) from the battery compartment.

i. Battery Inspection, Cleaning and Drying

1. Periodically look for any accumulation of dirt or corrosion on top of the battery, corroded terminals and cables, broken or loose terminal posts, and container or cover that is broken or cracked.
2. Scrub the exterior of the battery and cable terminals by using a nonmetallic brush which has been dipped in a mixture of baking soda and water.
3. Dry the battery with a clean cloth.
4. Check the voltage regulator setting at every periodic maintenance inspection. Overcharging is a common cause of battery failure. The voltage setting should be 13.6 to 13.8, and never more than 14.0 V.

j. Battery Installation

1. Place batteries in battery compartment.
2. Install bolts (6, Fig. 10.16), spacers (4), hold down strap (5), and two self-locking nuts (3). **DO NOT OVERTIGHTEN**. Be sure hold-down strap is properly attached to keep batteries from bouncing. Vibration is very harmful to a battery.
3. Connect positive (+) cable (1) to the batteries.
4. Connect negative (-) cable (2) to batteries.
5. Close and lock door to battery compartment.

k. Service Test Specifications

- Load Test Amperage is 260.
- SAE/BCI reserve capacity in minutes is 95 minutes.
- Cold cranking current (SAE SPEC J537h) is 525 A at 0 °F (-18 °C)
- For battery warranty contact your local Delco distributor.

10.7 SWITCHES AND SOLENOIDS

10.7.1 Ignition (Key) Switch

By using the key, the ignition switch (5, Fig. 10.17) may be turned clockwise from the OFF position to the RUN, THERMO START (Perkins only) AND START positions. The THERMO START (Perkins only) AND START positions are spring-loaded to return to the RUN position and must be manually held in place for cold starting or normal starting. When starting in cold weather, momentarily hold the key in the THERMO START position (Perkins only) before turning it fully to the START position.

- In the OFF position, the entire electrical system is shut down (there is power to ignition switch and to starter solenoid only).
- In the RUN position, all controls and indicators are operable.
- In the RUN position with the Park Lock engaged, oil pressure and alternator lights must be ON. Press Bulb Check switch; remaining warning lights must turn ON.
- Perkins Only - In the THERMO START position, the ignition switch energizes the Thermo Start plug (Fig. 10.12) which ignites a fuel/air mixture in the intake manifold to facilitate cold weather starting. Refer to paragraph 10.5.5 for Thermo Start plug removal and installation instructions.
- In the START position (with the parking lock engaged and the travel select lever in neutral) the starter pinion engages the flywheel to start the engine.

If the key binds in the lock, check for a sticky, painted or bent key. If key is sticky, clean key. If key is painted, remove paint. If key is bent, straighten key. If the key is straight and usable, sprinkle some powdered graphite on the sides of the key and insert key in lock several times to distribute the graphite. If the lock should fail to accept key or fail to turn due to freezing temperatures, warm the key switch using a hair dryer or use a liquid lock deicer to lower the freezing point and evaporate the moisture within the lock.

IMPORTANT: Use only graphite or a liquid lock deicer within the lock. Severe lock malfunctions may require the services of a locksmith.

a. Removal

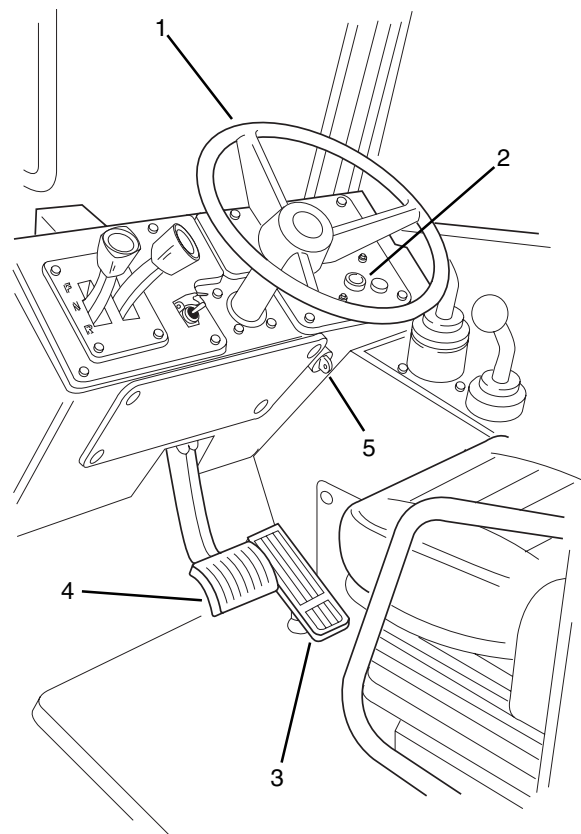
1. Prepare to remove ignition switch by removing lower panel (7, Fig. 10.18) next to the switch.
2. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
3. Remove the hex nut which secures the switch to the console.
4. Carefully tilt the switch as required to reposition switch in lower panel opening.
5. Tag and disconnect the wires from the switch.

b. Disassembly

Do not disassemble the ignition switch.

c. Cleaning and Drying

Without submerging the switch, clean the exterior of the switch with an approved solvent and dry with a clean lint-free cloth.



OH0050

- | | |
|----------------------|--------------------------|
| 1. Steering Wheel | 4. Service Brake Pedal |
| 2. Horn | 5. Ignition (Key) Switch |
| 3. Accelerator Pedal | |

Fig. 10.17 Forklift Operating Components

d. Inspection and Replacement

1. Key should insert and turn freely in switch. If the key binds in the lock, check for a bent key. If the key is straight, sprinkle some powdered graphite on the sides of the key and insert key in lock several times to distribute the graphite.

IMPORTANT: Use only graphite or a liquid lock deicer within the lock. Severe lock malfunctions may require the services of a locksmith.

2. Refer to the table below. Using an ohmmeter or continuity tester, check for continuity as follows:

		SWITCH POSITION			
		OFF	RUN	THERMO START	START
Switch Terminals	1 - BAT		X	X	X
	2 - IGN		X	X	X
	3 - START				X
	4 - ACC		X		
	5 - HEAT			X	X

3. Replace the switch if it fails the tests in step 2.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the panel.
3. Install hex nut.
4. Connect negative (–) cable (2, Fig. 10.16) to the batteries.
5. Install lower panel (7, Fig. 10.18).

10.7.2 Neutral Start Switch

The neutral start switch, Fig. 10.19, prevents the engine from being started with the transmission in forward or reverse.

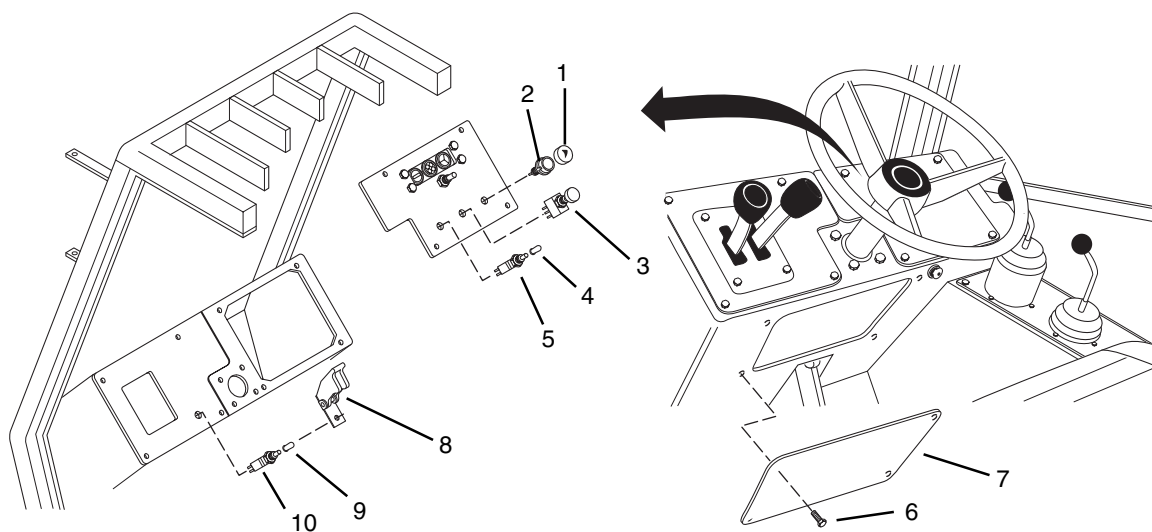
The switch is located on the transmission control valve assembly. The switch is normally open and is closed when a switch actuating pin presses a spring-loaded ball in the neutral start switch.

Test the neutral start circuit as follows:

- Starter **MUST NOT** operate with travel select lever in FORWARD or REVERSE positions.
- Starter **MUST NOT** operate when park lock is DISENGAGED.
- Starter **MUST** operate with travel select lever in NEUTRAL position.

If the starter fails to rotate the engine with the travel select lever in NEUTRAL and the ignition key in the START:

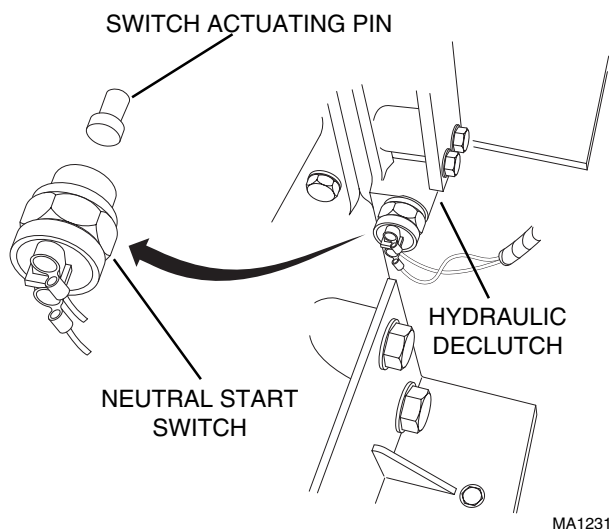
1. Check for problems in the shift lever linkage.
2. Check the neutral start switch, it may not be closing.
3. Remove the switch from the control valve assembly and check the actuator pin in the control valve assembly for free movement.
4. Make a continuity check across the terminals of the switch with the actuator ball manually depressed. If circuit is open replace the neutral start switch.



- | | | | |
|------------------------|---------------------------|-----------------|----------------------|
| 1. Seal Cap | 4. Seal Cap | 7. Lower Panel | 9. Seal Cap |
| 2. Horn Button | 5. Steering Select Switch | 8. Switch Guard | 10. Park Lock Switch |
| 3. Washer/Wiper Switch | 6. Capscrew, hex hd | | |

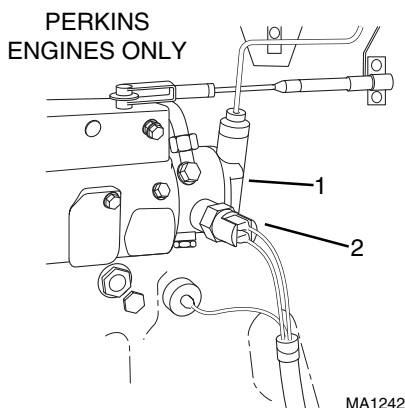
Fig. 10.18 Removal of Switches and Indicators

MA1222



1. Neutral Start Switch
2. Switch Actuating Pin
3. Control Valve Housing Assembly
4. Forward, Neutral and Reverse Valve Spool
5. Oil Seal
6. Valve Spool Stop

Fig. 10.19 Neutral Start Switch



1. Fuel Injector Pump
2. Fuel Run Solenoid

10.7.3 Fuel Run Solenoid

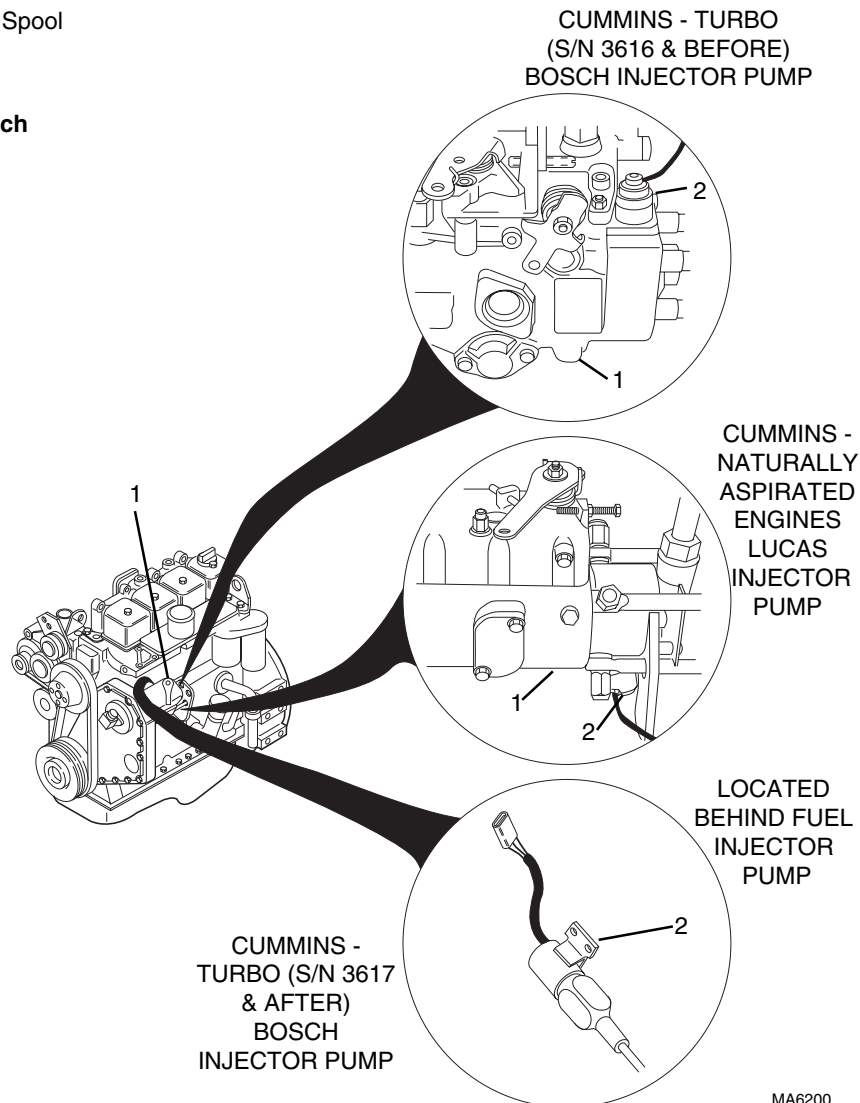
The fuel run solenoid valve (2, Fig. 10.20) lets fuel enter the injection pump when the ignition key is turned to START or RUN. Use the figure below to determine the location and style of the fuel injector pump on your engine. The fuel run solenoids are located as follows:

Perkins - On the side of the pump.

Cummins Turbo (S/N 3616 & Before) - On the top front of the pump.

Cummins Naturally Aspirated - On the bottom toward the front of the pump.

Cummins Turbo (S/N 3617 & After) - The assembly is bolted to the backside of the injector pump and connected to a mechanical linkage.



MA6200

Fig. 10.20 Fuel Run Solenoid

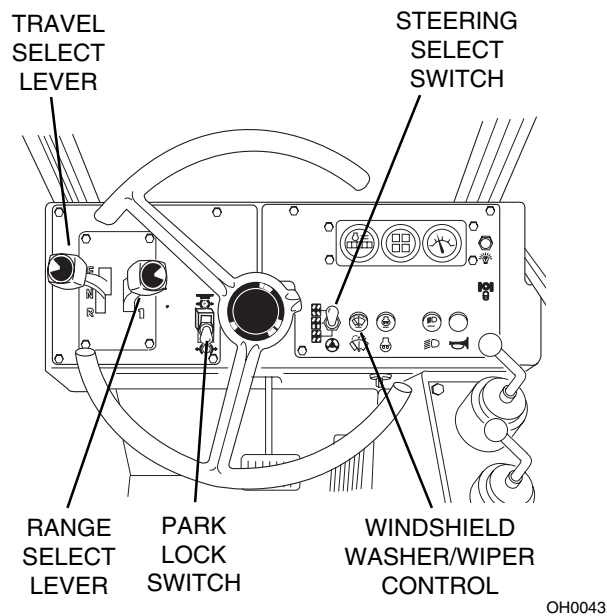


Fig. 10.21 Control Panel

a. Removal

1. Engage the park lock, place the travel select lever in neutral, and turn the ignition switch to OFF.
2. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
3. Unlock and open the right engine access door to gain access to the fuel injection pump.
4. Tag and remove electric wires or pull electrical connector apart for S/N 3617 & after turbo engines.
5. A plunger and spring may fall from the solenoid when it is removed from the fuel injection pump except for S/N 3617 & after turbo engines see step 6. Be prepared to catch these parts when you remove the solenoid. Use an appropriate wrench to turn the solenoid counterclockwise.
6. S/N 3617 & after turbo remove the solenoid from the backside of the injector pump by removing the two bolts holding the solenoid to the mounting plate. Remove the nut holding the linkage to the arm on the pump. Save all the hardware for reassembly.
7. Discard the O-ring.

b. Disassembly

Do not disassemble the fuel run solenoid.

c. Cleaning and Drying

Without submerging the electrical components, clean the fuel run solenoid using a approved solvent and dry using a clean lint-free cloth.

d. Inspection and Replacement

1. Prepare to test the fuel run solenoid by assembling the valve at a bench.
2. Energize the solenoid using 12 Vdc to see if the plunger retracts. Replace fuel run solenoid if it doesn't retract.

e. Installation

1. Clean exterior of fuel injection pump.
2. Install a new O-ring on the fuel run solenoid.
3. Remove protective plug from fuel injection pump.
4. With spring and plunger in solenoid, turn fuel run solenoid into fuel injection pump, being careful to avoid cross threading. Tighten until snug. S/N 3617 & after turbo see step 5.
5. S/N 3617 & after turbo line up the holes in the solenoid with the holes in the mounting plate and secure in place with the two bolts. Assemble the linkage end of the solenoid to the arm on the injector pump with the hex nut. Tighten all hardware securely.
6. Connect electric wires and connect negative cable to batteries.
7. Close and lock the engine access door.
8. Prepare to test fuel run solenoid by clearing personnel and any obstructions from the area around the forklift.
9. Start the engine.
 - If engine starts the solenoid is functioning.
 - If engine fails to start, solenoid may have a poor ground connection. Check voltage at solenoid.
10. Check for fuel oil leakage around solenoid.

10.7.4 Park Lock Switch

The park lock switch, Fig. 10.21, has two positions, engaged and disengaged. To engage, lift cover and flip lever up. To disengage, lower switch cover.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from batteries.
2. Prepare to remove park lock switch, Fig. 10.21, by removing the lower panel which is located below the switch.
3. Tag and disconnect electric wires from the switch.
4. Remove hex nut cap seal and the hex nut which secures switch to left front console panel.
5. Remove switch guard.

b. Disassembly

Do not disassemble the park lock switch.

c. Cleaning and Drying

1. Clean and condition the hex nut cap seal using an appropriate vinyl cleaner.
2. Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity and shorting in the ENGAGED and DISENGAGED positions.
2. Replace switch if it fails the tests in step 1.

e. Installation

1. Connect electric wires as tagged during switch removal.
2. Position park lock switch, Fig. 10.21, under panel.
3. Position switch guard over switch stem.
4. Install hex nut and hex nut cap seal.
5. Connect negative (–) cable (2, Fig 10.16) to batteries.
6. Prepare to test park lock engagement and disengagement by clearing the area around the forklift of persons and any obstructions to forklift travel.
 - To test for engagement, engage the park lock switch, place the drive in forward or reverse and second or medium gear and apply full throttle. The forklift should remain motionless in both forward and reverse positions.
 - To test for disengagement, firmly depress service brake pedal, disengage park lock switch, place drive in forward or reverse and first or low gear, and slowly press the throttle pedal while releasing the brake pedal. The park lock should release and the forklift should be free to travel.

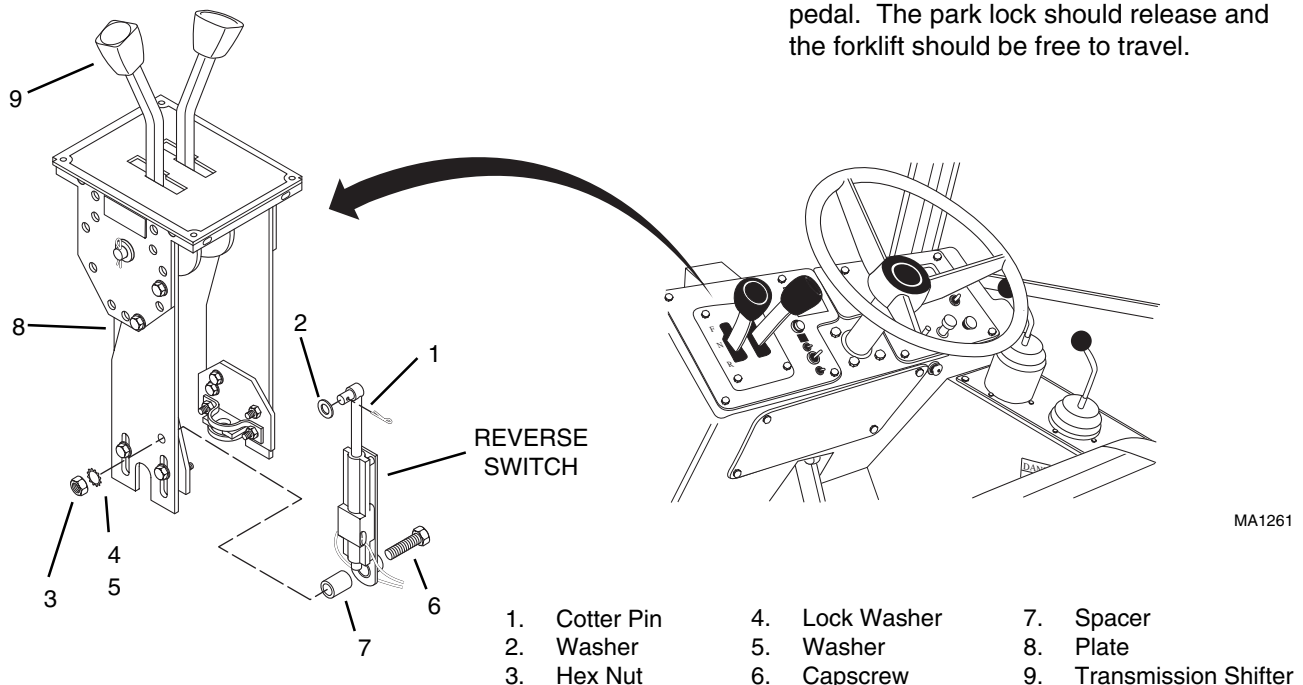


Fig. 10.22 Reverse Switch

10.7.5 Reverse Switch

The reverse switch, Fig. 10.22, causes a backup alarm to sound at the rear of the forklift when the travel select lever is shifted into REVERSE. The reverse switch has two positions, reverse and neutral. Place travel select lever in REVERSE to test alarm. Reverse alarm must NOT sound in FORWARD or NEUTRAL.

a. Removal

1. Prepare to remove reverse switch by removing lower panel (7, Fig. 10.18) located below switch.
2. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
3. Tag and disconnect the wires from the switch.
4. Observe and mark hole location at top of switch and remove cotter pin (1, Fig. 10.22).
5. Disengage switch arm and remove washer (2) at pivot.
6. Remove hex nut (3), lock washer (4) and washer (5) at bottom of switch.
7. Remove capscrew (6), spacer (7) and switch from transmission shifter (9).

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity in the reverse position and shorting in the neutral position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

1. Connect electric wires as tagged during switch removal.
2. Install capscrew (6, Fig. 10.22) through lower mounting hole in switch.
3. Install spacer (7) on screw and place screw in mounting hole in transmission shifter.
4. Install washer (5), lock washer (4) and hex nut (3). Torque nut to 80 to 85 lb-in. (9 to 9,6 Nm).
5. Install washer (2) on pivot at top of switch arm and place pivot in hole marked during removal.
6. Install cotter pin (1) in pivot.
7. Check for smooth operation of travel select lever.
8. Connect negative (–) cable (2, Fig 10.16) to batteries.
9. Place travel select lever in REVERSE and turn ignition switch to ON; the backup alarm should sound.
10. Install lower panel (7, Fig. 10.18).

10.7.6 Steering Select Switch

The steering select switch, Fig. 10.21, has three positions, up for 4 wheel steer, center for 2 wheel steer, and down for crab steer. The switch is a single pole, double throw, toggle switch with three screw terminals.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from batteries.
2. Prepare to remove steer select switch, Fig. 10.21, by removing lower panel (7, Fig. 10.18).
3. Tag and disconnect the wires from the switch.
4. Remove hex nut which secures switch to right front console panel.

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect switch terminals for continuity in the up and down positions and shorting in the middle position.

2. Replace switch if it fails tests in step 1.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install the switch and carefully tighten the hex nut.
4. Connect negative (–) cable (2, Fig. 10.16) to the batteries.
5. Test switch for proper operation:
 - UP for 4 wheel steer
 - CENTER for 2 wheel steer
 - DOWN for crab steer

If operation is not correct rotate switch or reconnect wires.

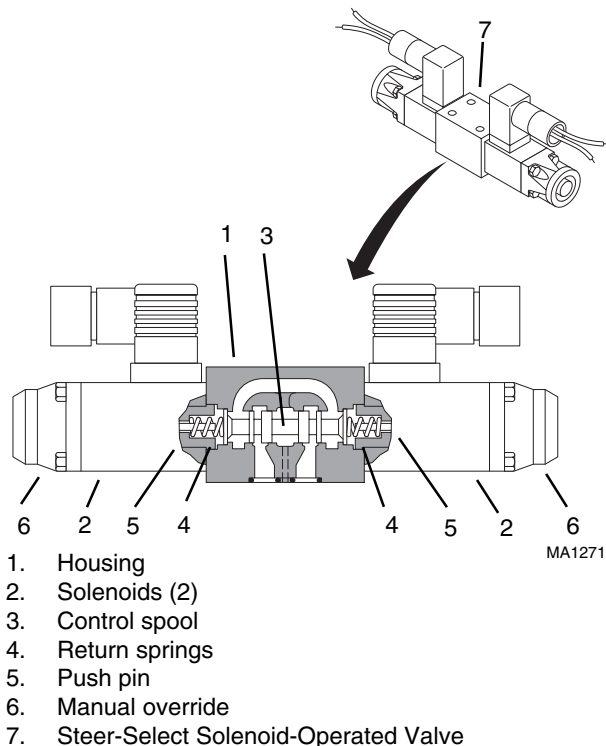


Fig. 10.23 Typical Steer-Select Solenoid-Operated Valve

10.7.7 Steer Select Solenoid

The steer select valve is a direct solenoid-operated spool-type directional control valve. It controls the start, stop and direction of fluid flow to the steering cylinders. It is located on the valve plate assembly which is mounted under the operator's cab.

The valve consists of a housing (1, Fig. 10.23), two solenoids (2), a control spool (3) and two return springs (4).

In the de-energized condition, the spool (3) is held by the return springs (4) in the center position. The spool is shifted by energizing wet pin solenoids (2).

The force of the solenoid (2) pushes against push pin (5) on the end of spool (3). The spool is shifted from its normal position to the desired end position. This selects the desired flow pattern of P to A and B to T, or P to B and A to T. When the solenoid (2) is de-energized, the control spool (3) is returned to its normal condition by the centering springs (4).

10.8 GAUGES AND INDICATOR LIGHTS

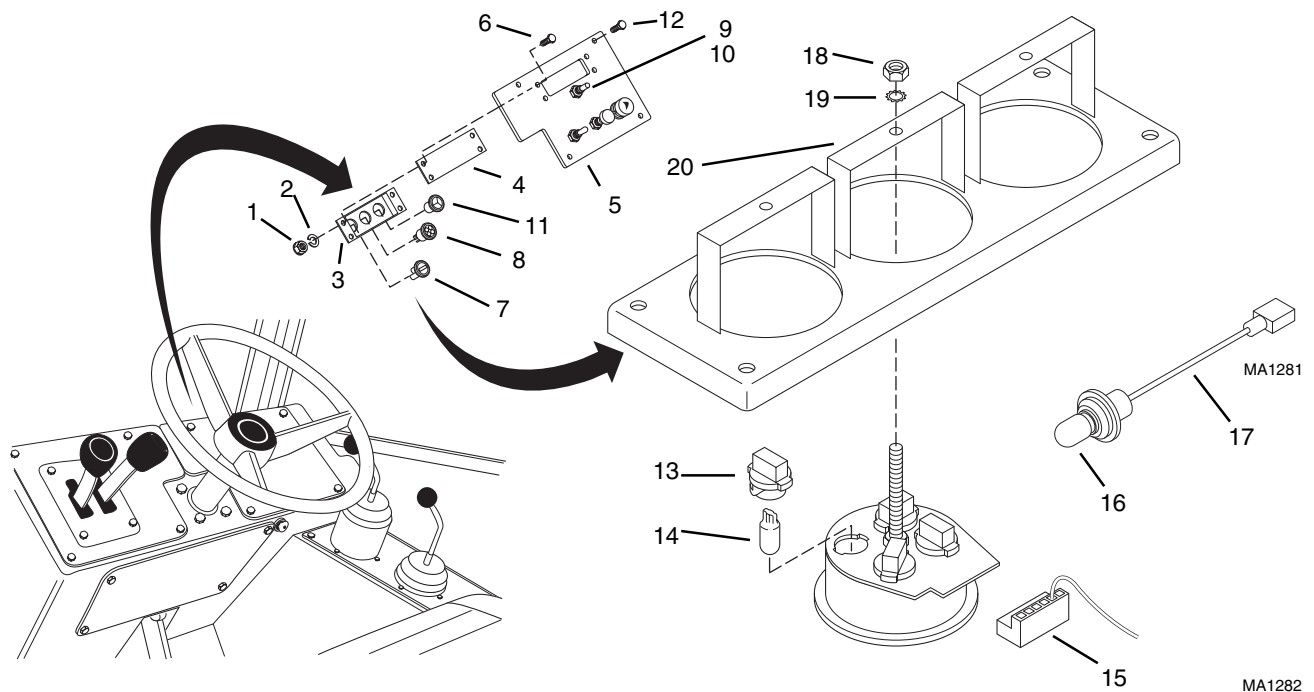
The gauge cluster contains an hourmeter, warning lights and a fuel level gauge. Removal and installation instructions for the gauge cluster are provided in paragraphs 10.8.1 and 10.8.2.

10.8.1 Removal of the Gauge Cluster

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Remove four hex nuts (1, Fig. 10.24) and lock washers (2) which secure gauge mounting plate (3) and gauge cover (4) to right console panel (5) and remove the four hex head screws (6) from the panel. Carefully break the rubber seal around the gauge mounting plate and cover and separate the plate and cover.
3. Service the gauge cluster as described in the following procedures for servicing of a specific component in the gauge cluster (refer to paragraphs 10.8.3, 10.8.4, 10.8.7 and 10.8.8.
4. Temporarily insulate all exposed wiring if it becomes necessary for you to connect the battery ground cable before you complete the removal and installation procedures.

10.8.2 Installation of Gauge Cluster

1. Clean gauge cover (4, Fig. 10.24).
2. Remove all old rubber sealant from gauge mounting plate (3) and gauge cover (4).
3. Position cover over gauge mounting plate. Examine the assembly for alignment and the cover for cleanliness. Apply a bead of silicon rubber sealing compound along the top and bottom surface of the gauge mounting plate (3) to minimize the entry of dust between the plate and the gauge cover (4). Leave the ends open to provide some ventilation.



- | | | | |
|-------------------------|------------------------------|----------------------|-------------------------------|
| 1. Nut, hex, 1/4" | 6. Screw, hex hd 1/4 by 3/4" | 11. Fuel Gauge | 16. Bulb |
| 2. Lock Washer, 1/4" | 7. Hourmeter | 12. Flange Head Bolt | 17. Fuel gauge light assembly |
| 3. Gauge Mounting Plate | 8. Warning Lights Gauge | 13. Bulb socket | 18. Hex nut |
| 4. Gauge Cover | 9. Seal Cap | 14. Bulb | 19. Tooth type lock washer |
| 5. Right Console Panel | 10. Bulb Test Switch | 15. Connector | 20. Clip |

Fig. 10.24 Gauges and Indicator Lights

4. Position the plate and cover under the right console panel (5) and secure with four hex head screws (6), lock washers (2) and hex nuts (1).
5. Connect any wiring removed in previous steps.
6. Position right console panel (5) and overlay on control console and secure with four screws (12).
2. Disconnect spade connector at hourmeter (7, Fig. 10.24).
3. To remove hourmeter, loosen nut on clip which secures hourmeter to gauge mounting plate (3).
4. Lift hourmeter from gauge mounting plate.

b. Cleaning and Drying

Clean the hourmeter with a clean lint-free cloth.

c. Inspection and Replacement

Inspect the hourmeter and replace if defective. To check operation observe the indicator flag wheel.

d. Installation of the Hourmeter

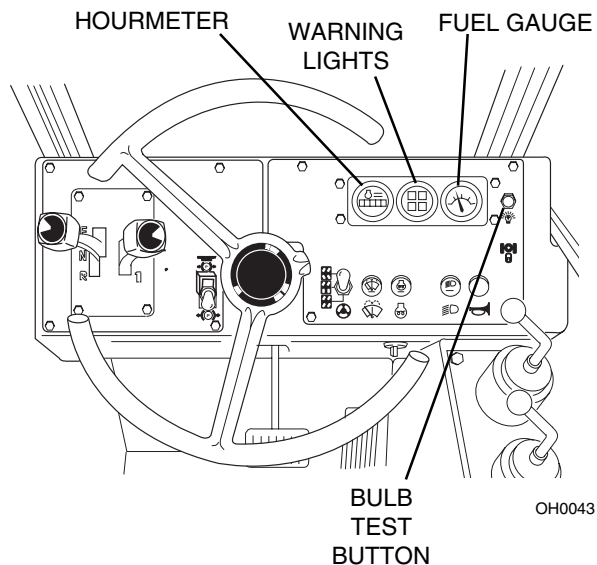
1. Position hourmeter (7, Fig. 10.24) in gauge mounting plate
2. Install clip and nut which secures hourmeter to gauge mounting plate.
3. Refer to paragraph 10.8.2 for installation of the gauge cluster.

10.8.3 Hourmeter

The hourmeter (7, Fig. 10.24) indicates the total elapsed hours of forklift operation. It is a solid state electronic piece of equipment except for the number wheels, rotor and reduction gears. The hourmeter should operate whenever the engine is running. If the hourmeter is intermittent or fails to operate, check for faulty wiring or connections. Check for proper voltage at meter terminal (8 to 32 Vdc). To check accuracy observe the running indicator flag wheel. The gauge is accurate to ± 1 percent at 75 °F (24 °C).

a. Removal of the Hourmeter

1. Refer to paragraph 10.8.1 for removal of gauge cluster.



Engine Oil Pressure—Indicates low engine oil pressure.



Engine Water Temperature—Indicates high coolant temperature.



Alternator Charging—Indicates alternator is not charging.



Transmission Oil Temperature—Indicates high transmission Oil Temperature.

OA0751

Fig. 10.25 Warning Lights Signal Dangerous Operating Conditions

10.8.4 Warning Lights

Warning lamps indicate:

- low engine oil pressure,
- high engine coolant temperature,
- alternator is not charging,
- and high transmission oil temperature.

When ignition key is turned to RUN, engine low oil pressure and alternator charge lamps will light. This is normal. When engine is running all lights should be OFF. If a lamp lights, an emergency condition exists; stop forklift as soon as possible and correct the indicated condition.

At the right of the gauges is a warning bulb test button. With ignition key in RUN position and engine OFF, press this button to test all four warning lights. If a bulb fails to light, replace it immediately. You will find the bulb number in the Specifications Table at the end of this section.

a. How to Test the Warning Light Gauge Bulb Test Switch

1. Prepare to test the bulb test switch (10, Fig. 10.24) by disconnecting the wiring at switch.

2. Use an ohmmeter or a continuity tester to test switch for continuity in the depressed TEST position and for a short in the released OFF position.

3. Replace the switch if it fails the test in step 2.

b. How to Replace Bulbs in Warning Light Gauge

1. Turn ignition key to RUN and press bulb test button, Fig. 10.25. Note which bulbs fail to light.

NOTE: If forklift has an optional lighting system, turn on headlights momentarily to see if bulb (16, Fig. 10.24) in fuel level gauge lights. You may have to move the forklift to a dark environment to observe if this bulb lights. If it doesn't light, refer to paragraph 10.8.9 for fuel level gauge instructions. Then continue with step 4 of this procedure.

2. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
3. Remove the four bolts (12, Fig. 10.24) which secure the right console panel and overlay to the cab and lift and tilt the panel to gain access to the back side of the panel.
4. Grasp and turn the appropriate bulb socket (13) a few degrees counterclockwise and remove socket from gauge.
5. Press and turn bulb counterclockwise to release it from socket.
6. Inspect socket contact areas for corrosion and clean and brighten any corroded areas; replace components as required.
7. To install a new bulb, align pins on bulb with channels in socket, push bulb into socket, turn it clockwise to lock pins in detents, and release it; bulb should be securely anchored in socket.
8. Position socket in gauge and turn socket a few degrees clockwise to lock in place.
9. Lower the right console panel into position and install the four bolts (12) which secure the panel to the cab.
10. Connect negative (–) cable to the batteries.
11. Turn ignition key to RUN and press TEST button (10). All four warning bulbs should light.
12. Turn ignition key to OFF and remove key from switch.

c. Removal of Warning Lights Gauge

1. Refer to paragraph 10.8.1 for removal of gauge cluster.
2. Tag and disconnect connector from warning lights gauge.
3. To remove warning lights gauge, remove nut (18, Fig. 10.24), lock washer (19) and clip (20) and remove warning lights gauge from gauge mounting plate (3).

d. Cleaning and Drying

Clean warning lights gauge with a clean lint-free cloth.

e. Inspection and Replacement

Inspect warning lights gauge; replace if required.

f. Installation of Warning Lights Gauge

1. Position warning lights gauge (8, Fig. 10.24) in gauge mounting plate (3).
2. Install clip (20), lock washer (19) and nut (18) to secure gauge (8) to gauge mounting plate (3).
3. Install connector (15) on gauge (8).
4. Refer to paragraph 10.8.2 for the installation of the gauge cluster.

10.8.5 Engine Low Oil Pressure Sender

The engine low oil pressure light warns the operator to discontinue forklift operation immediately because engine oil pressure is too low.

The engine low oil pressure light in the warning lights gauge is described in paragraph 10.8.5.

The oil pressure warning bulb lights to warn the operator to discontinue forklift operation immediately when engine oil pressure falls below 8.7 psi (0,6 bar). The bulb will also light momentarily due to low oil pressure when the ignition key is turned to start the engine. After the engine starts and builds normal oil pressure, the sender opens and the light goes out.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Unlock and open right engine access door.

3. Tag and disconnect wire from terminal of low oil pressure sender.
4. Remove low oil pressure sender.

b. Disassembly

Do not disassemble the engine low oil pressure sender.

c. Cleaning and Drying

Without submerging sender, clean sender as required by using a fiber bristle brush and an approved solvent.

d. Inspection and Replacement

1. Check engine oil level before testing sender. Correct low oil level condition.
2. Test the sender for continuity while installed on engine. With wire disconnected from sender terminal, connect an ohmmeter or continuity tester between the sender terminal and a ground point. Continuity should be present. Connect wire to terminal on sender and start the forklift. If warning light remains ON after pressure has built up in the engine, the sender is defective.
3. Replace the sender if it fails to pass the tests in step 2.

e. Installation

1. Install low oil pressure sender.
2. Connect wire to terminal of low oil pressure sender.
3. Connect negative (–) cable (2, Fig. 10.16) to batteries.
4. Start engine and inspect installation for oil leaks.
5. Close and lock right engine access door.

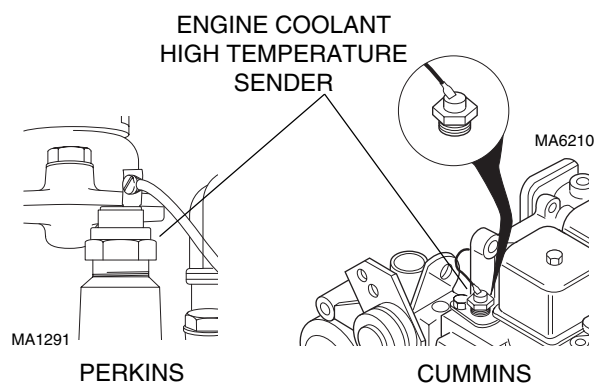


Fig. 10.26 Engine Coolant High Temperature Sender

10.8.6 Engine Coolant High Temperature Sender

The engine coolant temperature light warns the operator to discontinue forklift operation immediately when engine coolant is too hot.

When ignition switch is in RUN position, current through the bulb can be grounded through the coolant high temperature sender. The sender closes when the coolant temperature exceeds 210 °F (99 °C) and the bulb lights.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Unlock and open right engine access door.

IMPORTANT: Drain engine coolant below the level of the high temperature sender, Fig. 10.26.

3. Tag and disconnect wire from high temperature sender terminal, Fig. 10.26.
4. Remove high temperature sender.

b. Disassembly

Do not disassemble high temperature sender.

c. Cleaning and Drying

Without submerging the sender, clean the sender as required by using a fiber bristle brush and an approved cooling system cleaner.

d. Inspection and Replacement

Test the sender by connecting a low voltage dc power supply and a test lamp to the sender and suspending its probe in engine coolant which is several degrees below 210 °F (99 °C). The sender should remain open. It should close when coolant exceeds this temperature.

e. Installation

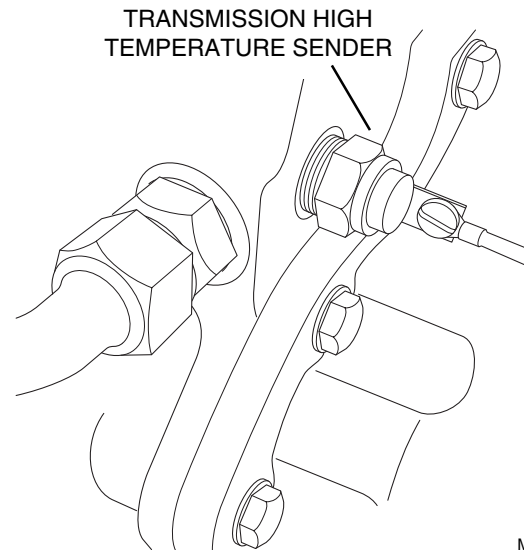
1. Install high temperature sender.
2. Connect wire to terminal of engine coolant high temperature sender.
3. Add engine coolant to normal operating level.
4. Connect negative (–) cable (2, Fig. 10.16) to the batteries.
4. Operate engine and check for coolant leaks.
5. Close and lock right engine access door.

10.8.7 Alternator Not Charging Light

The alternator not charging light warns the operator to discontinue forklift operation immediately due to a malfunction in the battery charging circuit.

Wire number 6 from the alternator is energized and lights the alternator not charging bulb if the alternator stops supplying current upon demand by the charging circuit.

Refer to paragraph 10.8.4 for procedure for replacing indicator lamp.



MA1301

Fig. 10.27 Transmission High Temperature Sender

10.8.8 Transmission High Temperature Sender

The transmission high temperature light warns the operator to discontinue forklift operation immediately because the fluid in the transmission is too hot.

When the ignition key is in RUN, current through the bulb can be grounded through the transmission high temperature sender. The sender closes when the fluid temperature exceeds 250 ± 5 °F (122 ± 3 °C) and the bulb lights.

a. Removal

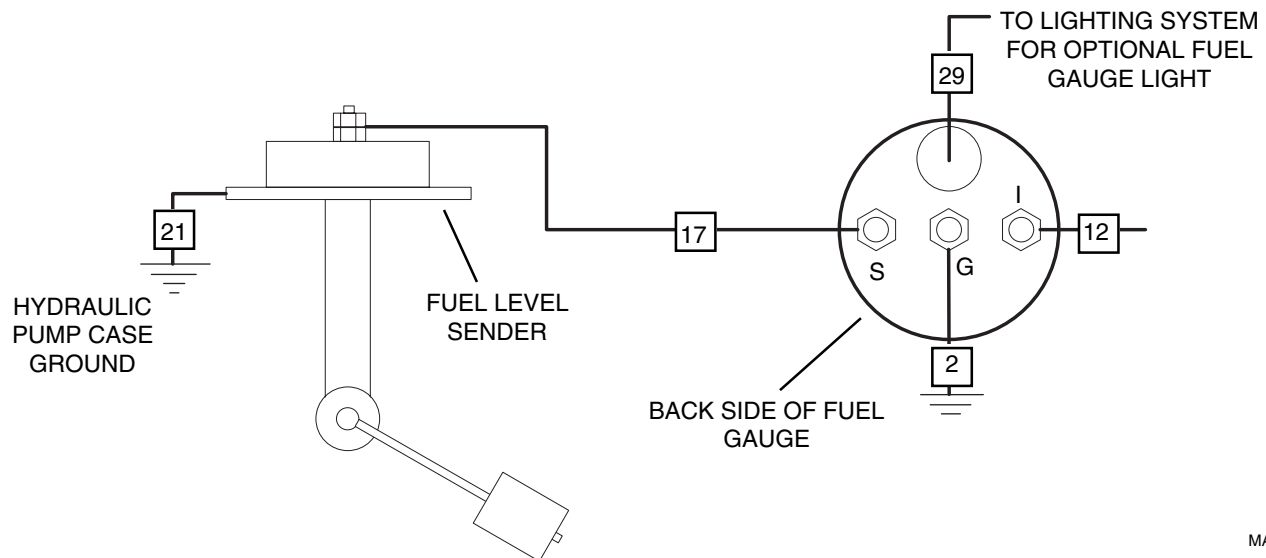
1. Disconnect negative (–) cable (2, Fig. 10.16) from batteries.
2. Remove transmission cover.
3. Tag and disconnect wire from high temperature sender terminal, Fig. 10.27.
4. Remove high temperature sender.

b. Disassembly

Do not disassemble the transmission high temperature sender.

c. Cleaning and Drying

Without submerging the sender, clean the sender as required by using a fiber bristle brush and an approved solvent.



MA1312

Fig. 10.28 Fuel Lever Sender and Fuel Gauge Schematic

d. Inspection and Replacement

Test the sender by suspending its probe in hydraulic fluid which is at least 10 °F (5 °C) below 250 °F (122 °C). The sender should remain open. Increase the temperature of the fluid until it exceeds this temperature by 10 °F (5 °C). The sender should close.

e. Installation

1. Install the transmission high temperature sender.
2. Connect wire to terminal of transmission high temperature sender.
3. Connect negative (–) cable (2, Fig. 10.16) to batteries.
4. Operate engine and check transmission for fluid leaks.
5. Install transmission cover.

10.8.9 Fuel Gauge

The fuel gauge indicates the liquid level in the fuel tank. It consists of a resistance, float type fuel level sender, Fig. 10.28, mounted in the top of the fuel tank and a fuel level gauge in the control console. The resistance range of the submerged coil type fuel sender is 0-30 ohms.

The pointer of the fuel gauge is moved by the magnetic field of two coils. The coils are at right angles to each other. Battery voltage is applied to the “E” coil and the circuit divides at the opposite end of this coil. One path continues to ground through the “F” coil. Another goes to ground through the variable resistor of the fuel level sender.

When the tank is low, the resistance of the sender is low. A large flow of current passes through the “E” coil and the fuel level sender resistor. This moves the pointer toward “E” on the scale. When the tank is full the sender resistance is high. More current flows through the “F” coil, moving the pointer toward “F” on the scale.

With two coils operating the pointer, the gauge is not affected by changes in the voltage of the system.

a. Fuel Gauge Testing

1. With five gallons of fuel in the fuel tank, fuel gauge needle must be at approximately 1/4 full.
2. Use a jumper wire to jump across the two wires at the fuel level sender on the fuel tank. Fuel gauge needle must be at FULL mark.
3. Switch ignition key OFF; needle must drop below EMPTY.

If a fuel gauge malfunctions, perform the following checks:

1. Check for loose gauge mounting screws, defective wiring, faulty grounds, and corrosion on fuel tank ground connection.
2. If pointer in gauge does not move when ignition key is turned ON, use a test lamp to see if current is flowing from the ignition switch to the terminal on the gauge. Also, be sure paint or corrosion doesn't prevent proper ground. If pointer still doesn't move, gauge is defective and must be replaced.
3. If gauge doesn't indicate fuel level in tank, be sure gauge is 0-30 ohm, 12 V.

4. If gauge shows no indication, look for an empty fuel tank, no current to ignition terminal because of broken or disconnected lead, grounded wire between sender and gauge, gauge not grounded, or sender defective.
5. Excessive pointer fluctuation may be caused by loose wire connections or defective sender.
6. "Full" scale reading at all times may occur if wire to sender is broken, sender is not properly grounded, or if sender is defective.
7. If gauge indicates inaccurately, sender may be defective or there may be low voltage at gauge terminals.
8. If the pointer fluctuates when optional head lights are turned on, the engine is not properly grounded.

b. Fuel Gauge Bulb Replacement

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Remove four bolts (12, Fig. 10.24) which secure the right console panel (5) and overlay to the cab and lift and tilt panel to gain access to the back side of the fuel gauge.
3. Tilt and lift the socket from the fuel gauge.
4. Press and turn bulb (16) counterclockwise to release it from socket.
5. To install a new bulb, align pins on bulb with channels in socket, push bulb into socket, turn it clockwise to lock pins in detents, and release it; bulb should be securely anchored in socket.
6. Position and push socket until it seats in gauge.
7. Lower right console panel (5) into position and secure the panel with four bolts (12).

c. Removal of Fuel Gauge and Sender

Removal of Fuel Gauge

1. Refer to paragraph 10.8.1 for the removal of the gauge cluster.
2. Remove the nut and wire from the right (IGN) terminal post, Fig. 10.29.

IMPORTANT: Do not touch this wire to the left (SEND) terminal post on the fuel gauge or the sender capsule will be damaged.

3. Remove the nut and wire from the left (SEND) terminal post of the fuel gauge.
4. Remove the nut and ground wires from the center (GND) terminal post of the fuel gauge.

5. Loosen the nuts on the clip which secures the gauge to the gauge mounting plate.
6. Lift the gauge from the gauge mounting plate.
7. Connect negative (–) cable to batteries.

Removal of Sender

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Remove the nut and wire from the center terminal on the sender.
3. Remove the screw which secures the ground wire and sender to the fuel tank and remove the ground wire.
4. Remove the other four screws which secure the sender to the fuel tank.
5. Carefully remove the sender from the fuel tank by lifting and tilting the assembly so the float and lever clears the opening in the fuel tank.
6. Remove and discard the gasket.

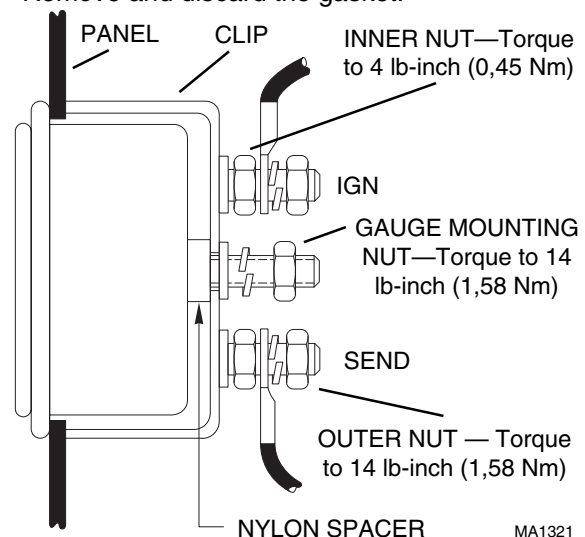


Fig. 10.29 Top View of Fuel Level Gauge

d. Installation of Fuel Gauge and Sender

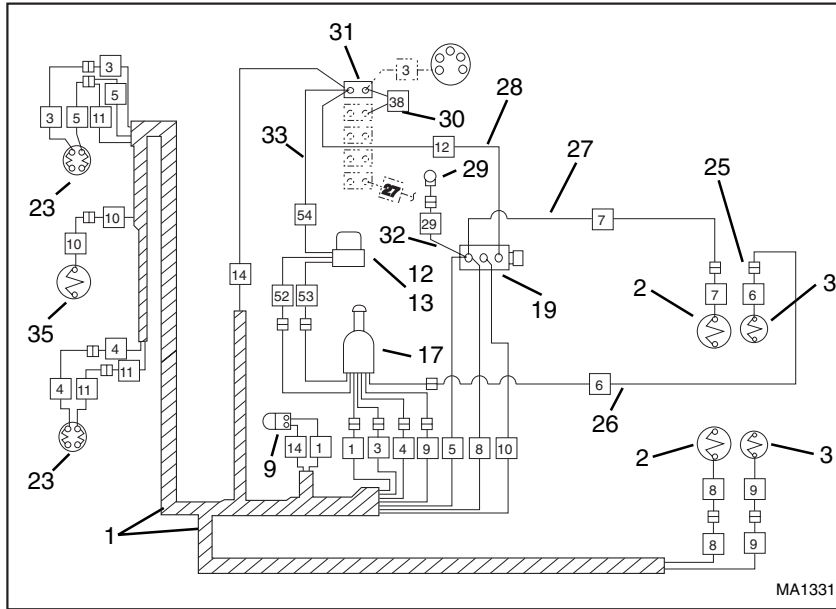
Installation of Fuel Gauge

1. Position fuel gauge in gauge mounting plate (3, Fig. 10.24).
2. Install clip and nuts which secure gauge to gauge mounting plate.
3. Install the nut and ground wires on the center (GND) terminal post of the gauge.

IMPORTANT: Torque inner nuts to 4 lb-inch (0,45 Nm) and outer nuts to 14 lb-inch (1,6 Nm) on the terminal posts of the fuel gauge.

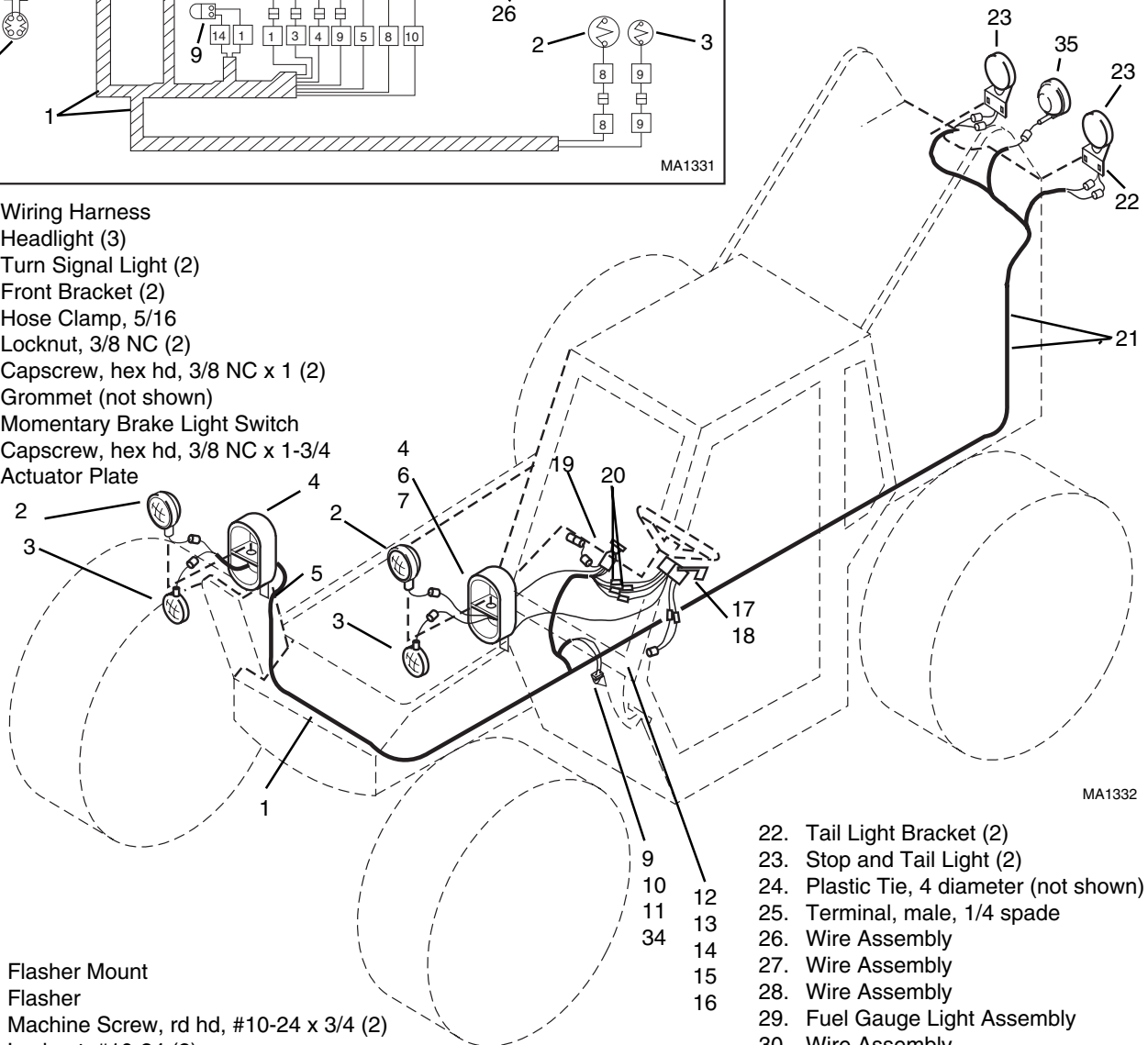
4. Install the nut and wire on the left (SEND) terminal post of the gauge.

LIGHTING SYSTEM - EARLY VERSION



8 IS A GROMMET (NOT SHOWN)
24 IDENTIFIES FOUR PLASTIC TIES (NOT SHOWN)

1. Wiring Harness
2. Headlight (3)
3. Turn Signal Light (2)
4. Front Bracket (2)
5. Hose Clamp, 5/16
6. Locknut, 3/8 NC (2)
7. Capscrew, hex hd, 3/8 NC x 1 (2)
8. Grommet (not shown)
9. Momentary Brake Light Switch
10. Capscrew, hex hd, 3/8 NC x 1-3/4
11. Actuator Plate



12. Flasher Mount
13. Flasher
14. Machine Screw, rd hd, #10-24 x 3/4 (2)
15. Locknut, #10-24 (2)
16. Flat Washer, #10 (2)
17. Turn Signal Switch
18. Conduit, 1/2 ID x 12 (not shown)
19. Head Light Switch
20. Terminal, female, 1/4 spade (7)
21. Hose Clamp, 3/8 (2)

22. Tail Light Bracket (2)
23. Stop and Tail Light (2)
24. Plastic Tie, 4 diameter (not shown)
25. Terminal, male, 1/4 spade
26. Wire Assembly
27. Wire Assembly
28. Wire Assembly
29. Fuel Gauge Light Assembly
30. Wire Assembly
31. Circuit Breaker, 15 A
32. Wire Assembly
33. Wire Assembly
34. Jam Nut 3/8 NC
35. Rear Work Light

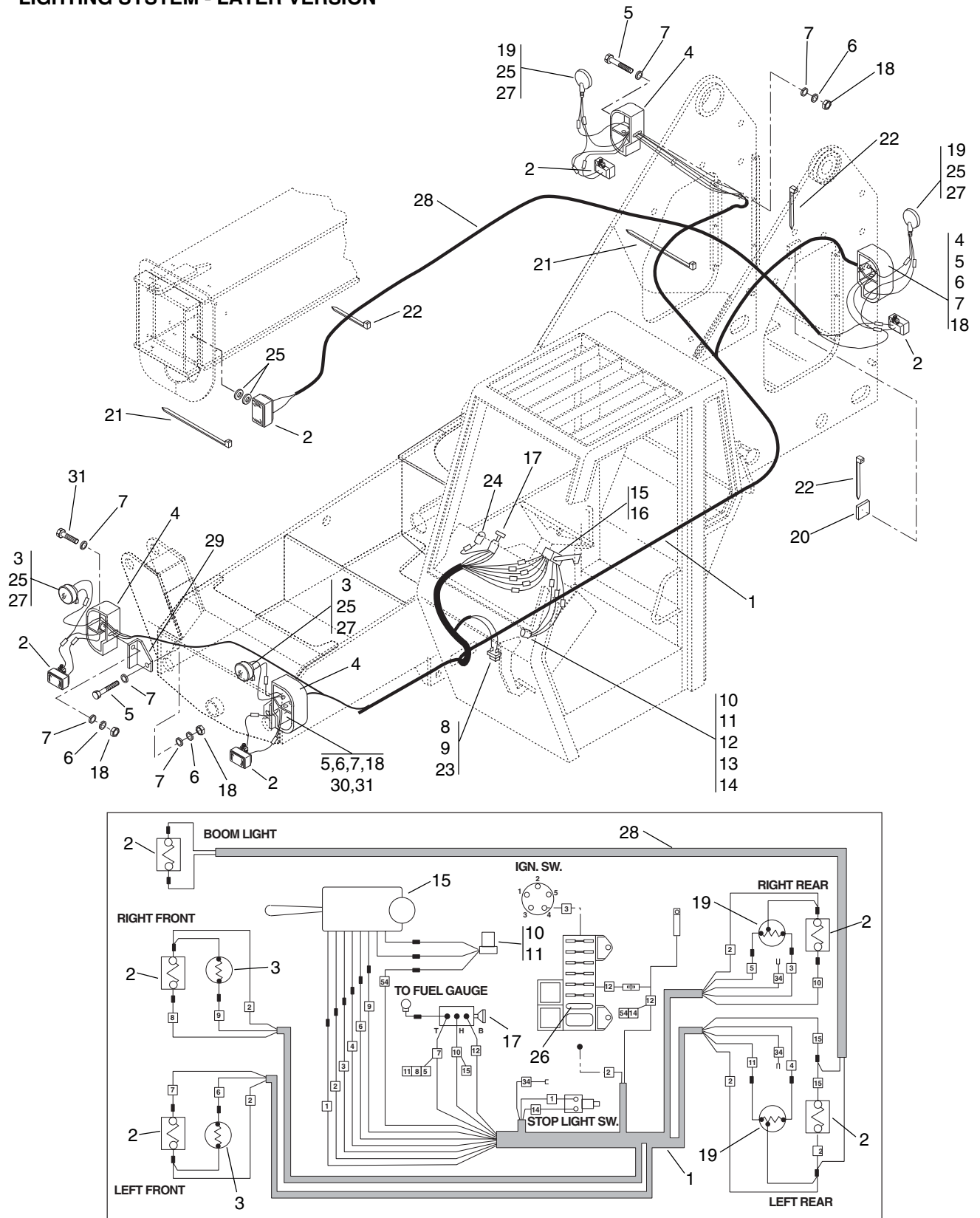
Fig. 10.30 Schematic of Lighting System

Lighting System Circuits - Early Version

Use with Fig. 10.30 Lighting System

Wire No.	Color	Gauge	From	To
1	Black	14	Turn Signal Switch (17)	Momentary Brake Switch (9)
2	Black	14	Not Used	
3	Black	14	Turn Signal Switch (17)	Stop and Tail Light (23)
4	Black	14	Turn Signal Switch (17)	Stop and Tail Light (23)
5	Black	14	Headlight Switch (19)	Stop and Tail Light (23)
6	Black	14	Turn Signal Switch (17)	Turn Signal Light (3)
7	Black	14	Headlight Switch (19)	Headlight (2)
8	Black	14	Headlight Switch (19)	Headlight (2)
9	Black	14	Turn Signal Switch (17)	Turn Signal Light (3)
10	Black	14	Headlight Switch (19)	Headlight (2)
11	Black	14	Stop and Tail Light (23)	Stop and Tail Light (23)
12	Black	14	15 A Circuit Breaker (31)	Headlight Switch (19)
13	Not Used			
14	Black	14	15 A Circuit Breaker (31)	Momentary Brake Light Switch (9)
29	Black	14	Headlight Switch (19)	Fuel Gauge Light Assembly (29)
38	Black	14	15 A Circuit Breaker	6 A Circuit Breaker
52	Black	14	Turn Signal Switch (17)	Flasher (13)
53	Black	14	Turn Signal Switch (17)	Flasher (13)
54	Black	14	15 A Circuit Breaker (31)	Flasher (13)

LIGHTING SYSTEM - LATER VERSION



PA1840

Fig. 10.30A Schematic of Lighting System

Section 10. Electrical System

1 Harness, Wiring	12 Screw, Round Hd Mach, #10-24 x 3/4	22 Tie, Plastic, 6.7"
2 Light, Head and Work Lamp	13 Nut, Hex Lock, #10-24	23 Nut, Hex Jam. 3/8
3 Light, Turn Signal	14 Washer, Flat, #10	24 Fuel Gage Light Assembly
4 Bracket, Mounting	15 Switch, Turn Signal	25 Washer, Flat, 1/2 Heavy
5 Screw, Hex Hd Cap, 5/8-11 x 2-1/2	16 Conduit, (Not Shown)	26 Fuse, 20 Amp
6 Lockwasher, 5/8	17 Switch, Head and Tail Lights	27 Terminal, Blade Male, 1/4
7 Washer, Flat, 5/8 Heavy	18 Nut, Hex, 5/8-11	28 Cord, Boom Work Light
8 Switch, Momentary Brake Light	19 Stop/Turn Signal Light	29 Bracket, Mounting, RH
9 Plate, Actuator	20 Mount, Tie	30 Bracket, Mounting, LH
10 Mount, Flasher	21 Tie, Plastic, 14.8"	31 Screw, Hex Hd Cap, 5/8-11 x 1-1/2
11 Flasher		

Fig. 10.30A Schematic of Lighting System

Lighting System Circuits - Later Version

Use with Fig. 10.30A Lighting System

Wire No.	Color	Gauge	Function
1	Tan	16	Turn Signal Switch to Brake Light Switch
2	White	16/14	All Grounds
3	dark Green	16	Turn Signal Switch to Right Rear Turn Signal Light
4	Yellow	16	Turn Signal Switch to Left Rear Turn Signal Light
5	Light Blue	16	Light Switch to Right Rear Tail Light (Spliced to #7)
6	Orange	16	Turn Signal Switch to Left Front Turn Signal Light
7	Light Blue	16/14	Light Switch to Left Front Headlight
8	Light Blue	16	Light Switch to Right Front Headlight (Spliced to #7)
9	Light Green	16	Turn Signal Switch to Right Front Turn Signal Light
10	Dark Blue	16/14	Light Switch to Right Rear Flood Light
11	Light Blue	16	Light Switch to Left Rear Tail Light (Spliced to #7)
12	Red	14	Power From Fuse Block to Light Switch
14	Red	16	Power From Fuse Block to Brake Light Switch (Spliced to #12)
15	Dark Blue	16	Light Switch to Left Rear Flood Light (Spliced to #10)
34	Brown	16	Brake Light Switch to Left and Right Rear Brake Lights
54	Red	16	Power From Fuse Block to Flasher (Spliced to # 12)

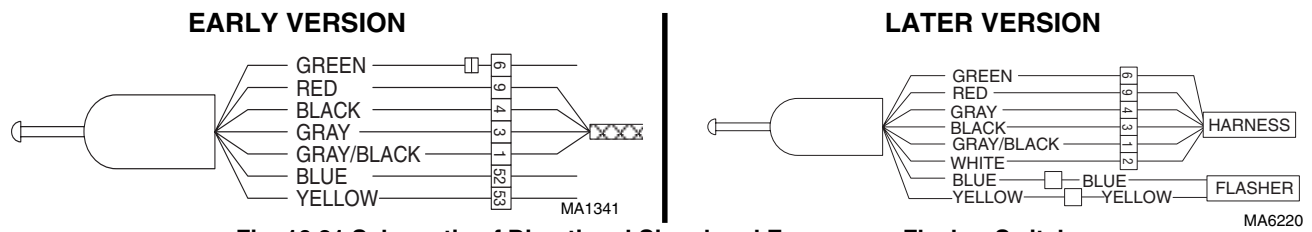


Fig. 10.31 Schematic of Directional Signal and Emergency Flasher Switch

5. Install nut and wire on the right (IGN) terminal post.

IMPORTANT: Do not touch this wire to the left (SEND) terminal post on the gauge or the sender capsule will be damaged.

6. Refer to paragraph 10.8.2 for the installation of the gauge cluster.

Installation of the Sender

1. Install a new gasket in the tank opening.
2. Carefully tilt and lower the sender assembly into the fuel tank.
3. Loosely install the screw which secures the ground wire to the sender and fuel tank.
4. Install the other four screws and alternately torque the five screws which secure the sender to the fuel tank from 10 to 14 lb-inch (1,13 to 1,58 Nm). Use No. 10-24 screws.
5. Install the wire and nut on the center terminal of the sender.
6. Connect negative (–) cable to the batteries.

10.9 OPTIONAL LIGHTING SYSTEM

The optional lighting, Fig. 10.30/10.30A provides:

- headlights, directional signal and hazard warning lights at the front of the forklift;
- directional signal, hazard warning, stop and tail lights and rear work lights at the rear of the forklift;
- boom work light (later version only) and,
- an illuminated fuel level gauge.

The stop lights glow when the brake pedal is pressed. The stoplights are combined with the directional signal lights, emergency flasher lights and tail lights.

Occasionally check to be sure:

- all wiring connections are tight and clean;
- that each lighting unit is tightly mounted to provide a good ground, and
- that the headlights are properly adjusted.

Loose or corroded connections may cause a discharged battery, difficult starting, dim lights, and possible damage to the alternator and charging circuit.

10.9.1 Directional and Emergency Flasher Switch

The directional signal lever and the hazard (emergency flasher) slide controls, Fig. 10.32, are located directly below the steering wheel.

The ignition switch must be in the RUN position for directional signal lights to be operated with the directional signal switch lever.

With the directional signal switch in the neutral position, stepping on the brake pedal will illuminate the rear stop lights on both sides. If directional signals are operating on either side, stepping on the brake pedal will turn on the stop light only on the side which is not flashing.

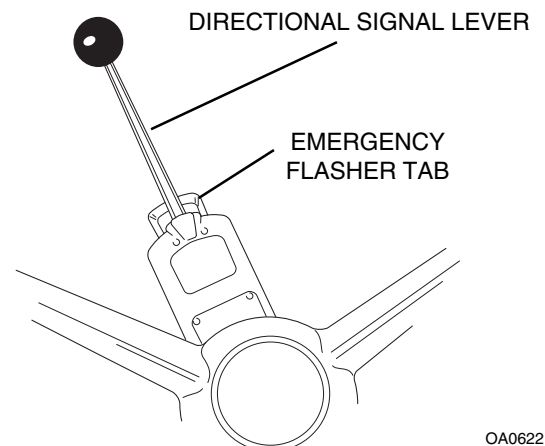


Fig. 10.32 Directional Signal Switch Lever and Emergency Flasher Control Tab

Push the lever of the directional signal switch to the left and down to signal a left turn; to the right and up for a right turn. A green pilot light will flash to indicate proper functioning. If pilot light doesn't flash, check for defective lamp or pilot bulb before checking flasher.

The signals are not self-cancelling; the lever must be moved to the center OFF position after the indicated turn is negotiated.

a. How to Operate the Emergency Flashers

To operate the emergency flashers, pull flasher tab out. All signal lamps and red pilot light will flash. To cancel the emergency flashers, move the directional signal lever momentarily in either direction.

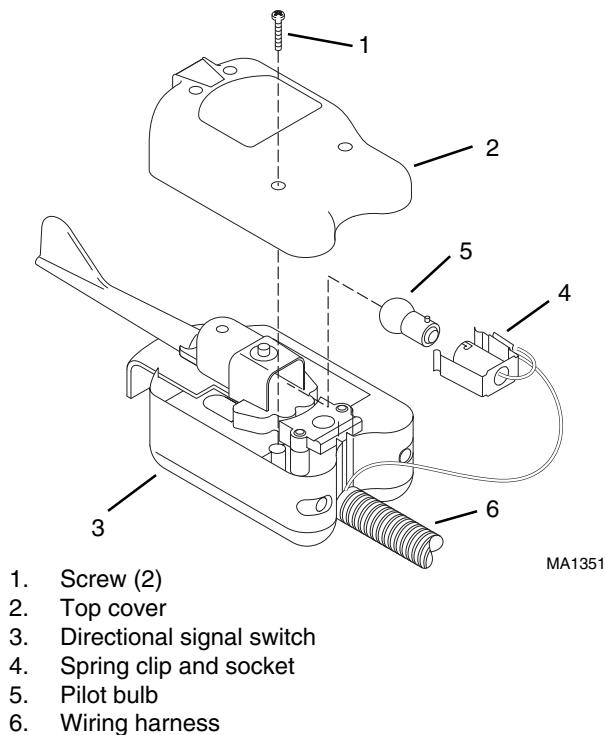


Fig. 10.33 Pilot Bulb Replacement

b. Flasher and Pilot Bulb Replacement

To replace the pilot bulb, remove two screws (1, Fig. 10.33) and lift top cover (2) of directional signal switch (3). When cover is removed, pull spring clip (4) away from handle. Remove old pilot bulb (5) and install a new No. 53 bulb for 12 volt service. Engage the spring clip into the handle. Do not try to test pilot bulb until switch is reassembled and grounded.

The flasher mount (12, Fig. 10.30 or 10, Fig. 10.30A) is located above and to the right of the brake pedal. When replacing a flasher, use Flasher No. 180 for this 12 V system.

c. Switch Removal

1. Remove console cover below steering wheel.
2. Disconnect negative cable (2, Fig. 10.16) from the batteries.
3. Disconnect wiring.
4. Remove screws, anchors, clips, strap and switch.

d. Switch Disassembly

There are no serviceable parts in the switch except the bulbs.

e. Switch Inspection and Replacement

1. If the switch has been in service for a long period of time, prepare to remove the top cover of the switch by removing two screws.
2. Apply silicon lubricant to the switch lever pivot and mechanical contact areas.
3. Replace top cover and two screws.

f. Switch Installation

1. Make sure you disconnect the ground cable (2, Fig. 10.16) from the negative terminals of the batteries and remove the flasher during installation and wiring.
2. Refer to schematic Fig. 10.31 and reconnect the wires.
3. Tape ends of unused wires to prevent shorts.
4. Mount switch on steering column as shown in Fig. 10.34.
5. Insert screws into anchors.

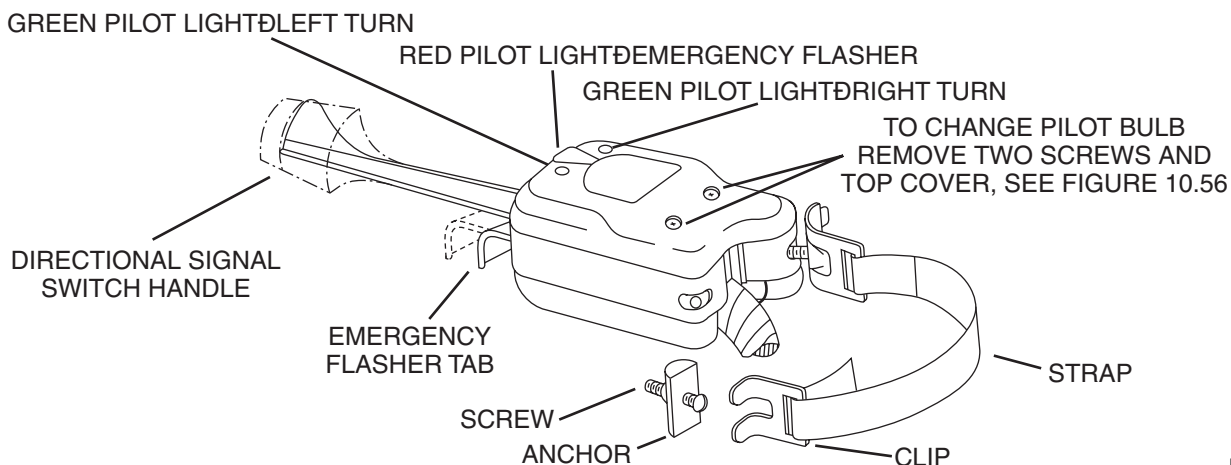


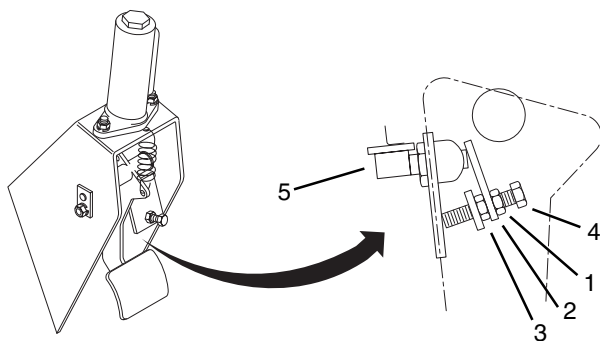
Fig. 10.34 Directional and Emergency Flasher Switch Removal

6. Insert assembled anchor screws into slots in switch. Do not tighten.
7. Bend strap end through and around clip. Engage clip between anchor and switch housing.
8. Hold switch against steering column in desired position and bend strap around column. Scrape paint from column under strap to make ground contact.
9. Estimate strap length required and cut if necessary. Insert unbent portion of strap through other clip and assemble as in step 7.
10. Catch clip under anchor and tighten screws equally until switch is clamped firmly to steering column.
11. Replace flasher and connect negative (–) cable to the batteries.

10.9.2 Momentary Brake Light (Stop Light)

Two stop/tail lights (23, Fig. 10.30 or 19, Fig. 10.30A) at the rear of the forklift have dual filament bulbs. The brake filament lights as long as the service brake pedal is pressed; it goes out when the pedal is released completely.

Inspect the operation of the stop/tail light daily and replace the bulb whenever either filament fails to light. You will find the number of the bulb in the Electrical Specifications Table at the end of this section.



MA1371

1. Jam Nut
2. Actuator Plate
3. Jam Nut
4. Capscrew
5. Momentary Brake Light Switch

Fig. 10.35 Momentary Brake Light Switch

10.9.3 Momentary Brake Light Switch

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Loosen jam nut (1, Fig. 10.35) which secures actuator plate (2) to the brake pedal
3. Loosen jam nut (3) which bears against the plate which is welded to the brake pedal.
4. Remove capscrew (4) and actuator plate (2).
5. Prepare to remove the rubber capped mounting nut, hereafter referred to as the “boot,” from the switch (5) by loosening the switch jam nut on the back side of the brake pedal.
6. Remove the boot from the switch by manually turning the boot counterclockwise. Pull and tilt the boot as required to release the boot from the groove in the plunger and remove the boot from the switch.
7. Remove the switch from the brake pedal and carefully lower it to the cab floor without disconnecting the wires.
8. Tag and disconnect the wires.

b. Disassembly

Do not disassemble the momentary brake light switch.

c. Cleaning and Drying

If the switch is to be reinstalled, without submerging the switch clean the switch in an approved solvent and dry it using clean, lint-free cloths.

d. Inspection and Replacement

1. Inspect the switch plunger for freedom of movement.
2. Inspect the boot for pliability and for cracks.
3. The switch is normally ON, push to OFF, release and switch will spring return to ON. Test continuity across the switch terminals with the switch released in the ON position.

e. Installation

1. Refer to the tags attached in paragraph “a” and connect the wires to the switch.
2. Remove the boot from the switch and insert the switch (5, Fig. 10.35) through mounting hole in the brake pedal and secure switch by tightening switch jam nut on the back side of the brake pedal.

3. Work the opening in the boot into the groove of the plunger so the metal of the plunger bears against the actuator plate, not the boot. Proper installation of the boot protects the sliding plunger from contamination.
4. Install jam nut (1) on capscrew (4) and actuator plate (2) on capscrew.
5. Install jam nut (3) on capscrew and then install capscrew in brake pedal.
6. Readjust brake pedal stop position as described in paragraph 4.3.1.
7. With brake pedal in its normal adjusted position the plunger must be depressed approximately 0.12" (3 mm). Adjust the plunger by loosening the switch jam nut and adjust by turning the boot as required to obtain this dimension.
8. Tighten the switch jam nut to maintain this adjustment.
9. Reconnect negative (–) cable to the batteries.

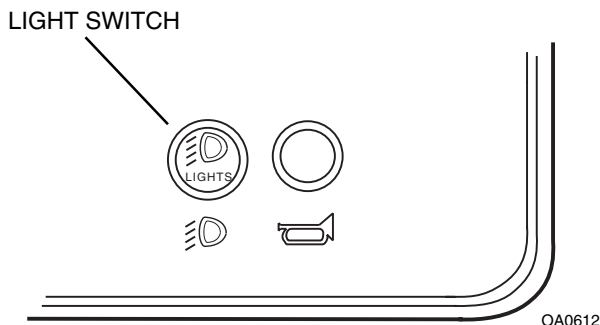


Fig. 10.36 Headlight and Work Light Switch

10.9.4 Headlight and Rear Work Light Switch

The headlights and rear work light are controlled by a three position push-pull switch, Fig. 10.36, on the instrument panel. This switch also controls the headlights, directional signal lights, tail lights and a light in the fuel gauge.

- Switch In: Lights OFF
- Switch Halfway Out: Headlights, Tail Lights and Panel Lights ON
- Switch Fully Out: Headlights, Tail Lights, Panel Lights, Rear Work Lights and Boom Work Light (if so equipped) ON

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Prepare to remove the light switch by removing the lower panel which is located below the steering wheel.

3. Tag and disconnect the wires from the switch.
4. Remove the hex nut which secures the switch to the right front console panel.

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity in the switch halfway out and fully out positions and shorting in the switch in position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install switch and hex nut.
4. Install lower console panel.
5. Connect negative (–) cable to the batteries.
6. Test switch in all three positions.

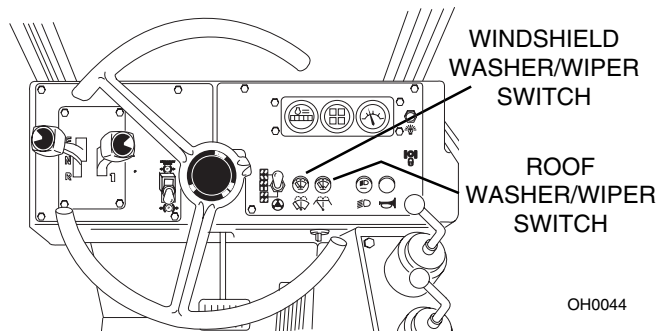


Fig. 10.37 Windshield Washer/Wiper Switch

10.10 WINDSHIELD WASHER/WIPER

10.10.1 Windshield Washer/Wiper Switch (Enclosed Cab Only)

The windshield washer/wiper switch, Fig. 10.37, is supplied on a forklift with an enclosed cab. Turn knob to left to operate wiper at low speed; to right to operate wiper at high speed. Press and hold knob to activate windshield washer. The windshield washer fluid tank is located at the right side of the seat.

The 6 A rated switch has a built-in circuit breaker.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Prepare to remove the windshield washer/wiper switch by removing the lower panel which is located below the steering wheel.
3. Tag and disconnect the wires from the switch.
4. Remove the knob by pulling directly upward on the knob.
5. Remove the hex nuts which secure the switch to the panel.

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity with the switch in the right, left and depressed positions and shorting in the center position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

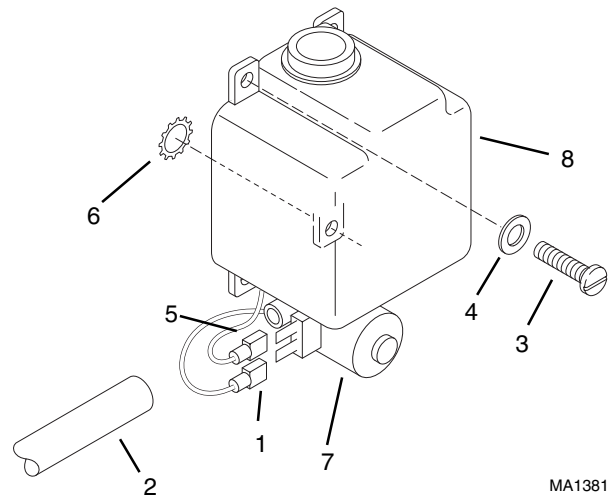
1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install the switch and tighten the hex nut.
4. Replace the knob and lower console panel.
5. Connect negative (–) cable to the batteries.

10.10.2 Windshield Washer Motor and Reservoir (Enclosed Cab Only)

The windshield washer motor and reservoir are a unit and cannot be serviced separately.

a. Removal

1. Disconnect the negative (–) cable at the batteries (2, Fig. 10.16).
2. Disconnect the positive wire (1, Fig. 10.38) at the motor (7).
3. Disconnect the hose (2).
4. Remove three bolts (3), three flat washers (4) and the ground wire (5).



1. Positive Wire
2. Hose
3. Bolt (3)
4. Flat Washers
5. Ground Wire
6. Tooth-Type Lock Washer
7. Motor
8. Washer Reservoir Assembly

Fig. 10.38 Windshield Washer Motor Removal

IMPORTANT: Be careful to save the tooth type lock washer (6) at the lower right corner of the reservoir between the reservoir and the cab wall.

5. Lift the washer reservoir assembly (8) from the forklift.

b. Disassembly

Do not disassemble; the reservoir and motor are not available separately.

c. Cleaning and Drying

Without submerging the motor or pump, rinse out the reservoir and allow it to air dry.

d. Inspection and Replacement

1. Prepare to test the motor by filling the reservoir with water.
2. Test the motor by connecting a 12 Vdc source to the motor terminals. If motor doesn't run, replace reservoir and motor assembly.
3. Inspect the condition of the reservoir; if cracked, brittle, or leaking at the joint between the reservoir and pump, replace the reservoir and motor assembly.
4. Check hose from pump to washer nozzle for proper connection and deterioration.
5. Be sure passage through nozzle is open and is not clogged.

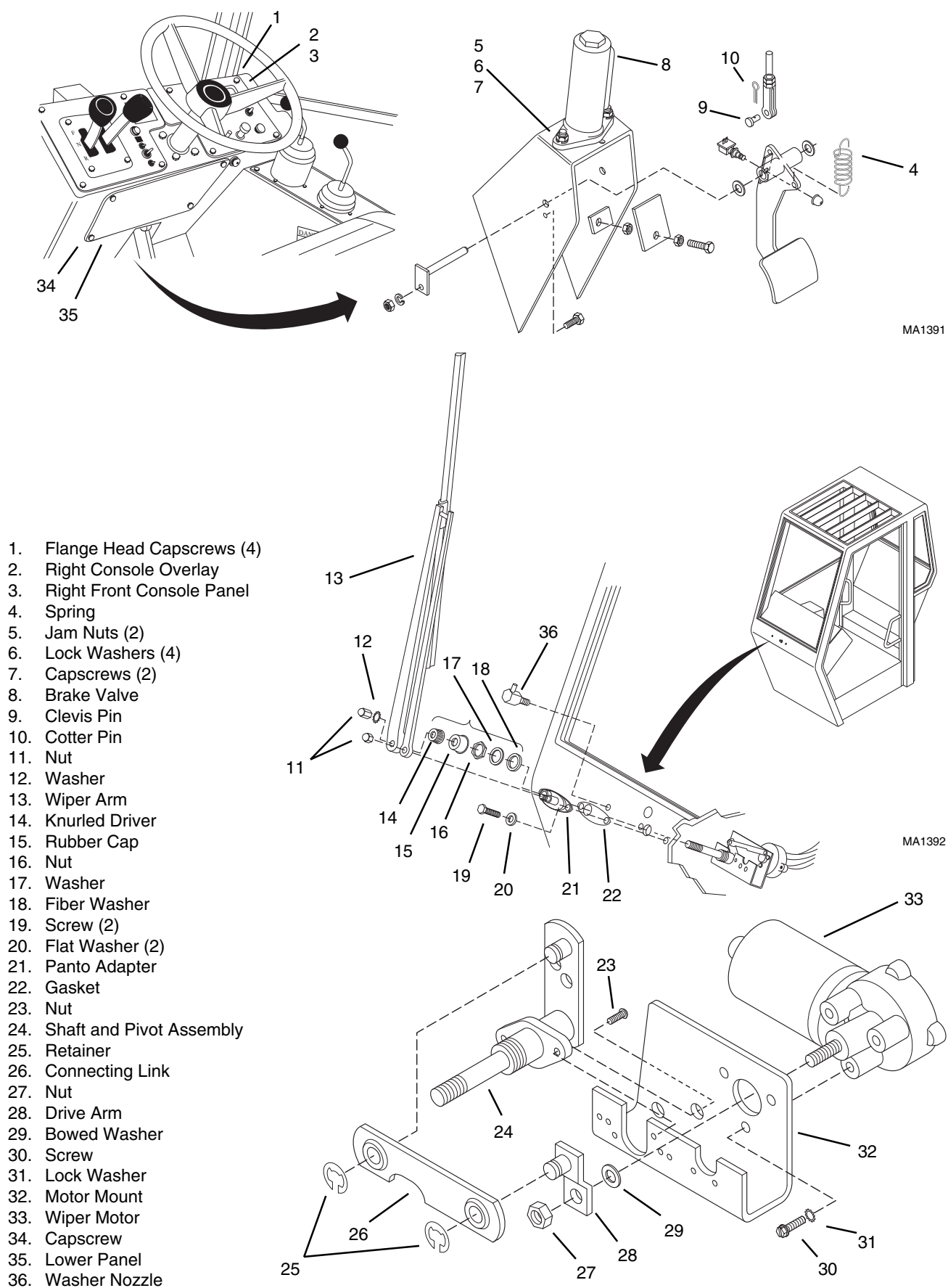


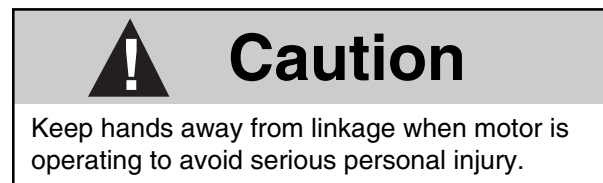
Fig. 10.39 Windshield Wiper Motor Removal and Disassembly

e. Installation

1. Prepare to install washer reservoir assembly by taping a tooth-type lock washer (4, Fig. 10.38) to back side of the lower right corner of reservoir. Use a thin transparent tape.
2. Position reservoir assembly (8) in the forklift.
3. Install two flat washers (4) and two bolts (3) through the holes in the top of the reservoir.
4. Install the ground wire (5), flat washer (4), bolt (3) through the hold in the lower right corner of the reservoir. The bolt will pass through the tooth-type lock washer (4) which was taped to the reservoir in step 1.
5. Connect the hose (2).
6. Connect the positive wire (1) to the motor.
7. Connect negative (–) cable to the batteries.

10.10.3 Windshield Wiper Motor (Enclosed Cab Only)

The windshield wiper motor is located behind the steering column and brake valve.

**a. Initial Testing**

1. If the motor fails to operate, prepare to test the motor by disconnecting the negative (–) cable from the batteries.
2. Disconnect the wiring to the motor and test the motor using an independent 12 Vdc power source which supplies at least 6 A.
3. Reconnect the negative (–) cable to the batteries.
3. If the motor fails to operate, remove and replace the motor as follows.

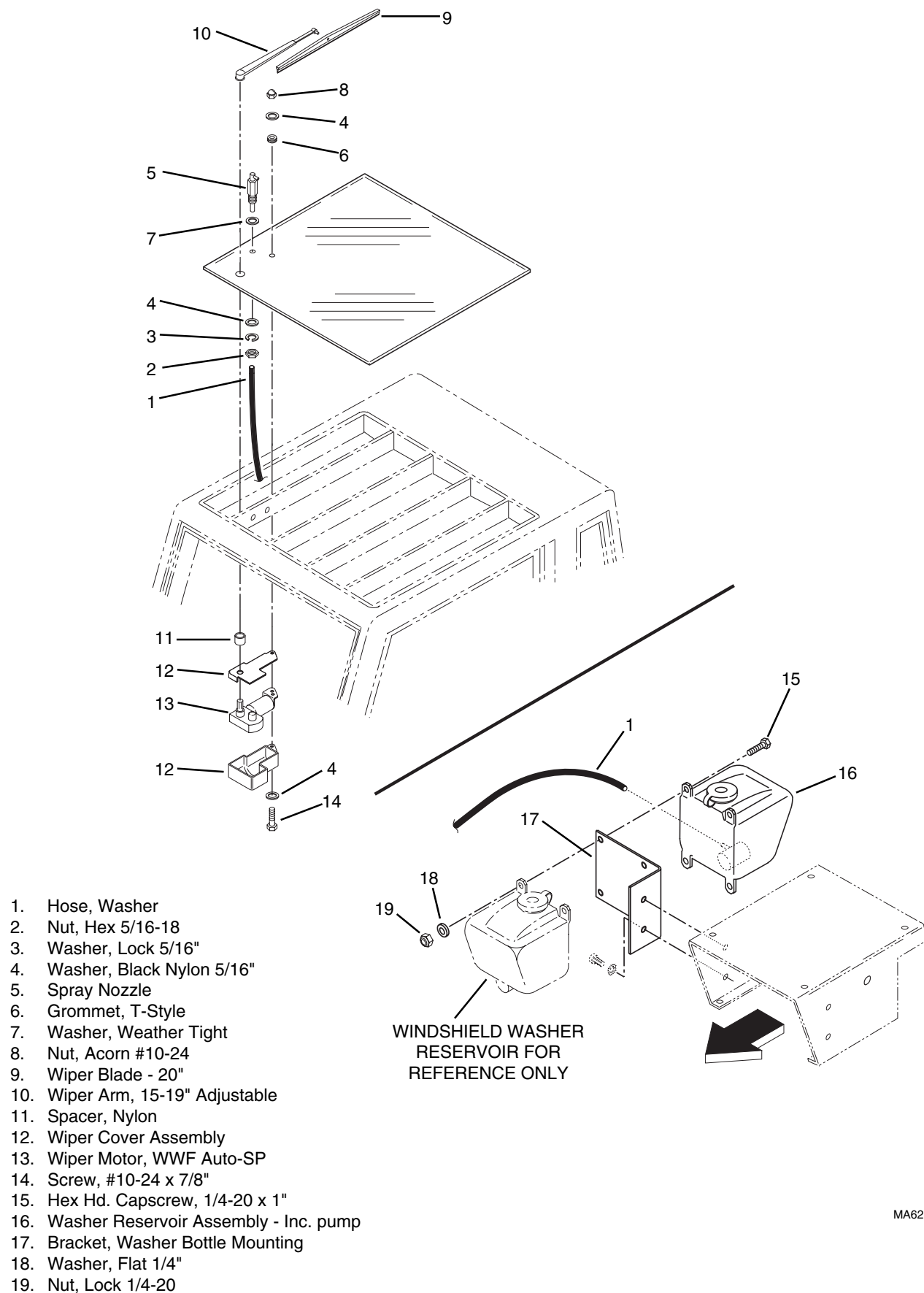
b. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Prepare to remove the windshield wiper motor by removing four flange head capscrews (1, Fig. 10.39) and lifting and positioning the right console overlay (2) and right front console panel (3) to one side to provide access to the windshield wiper motor.
3. Tag and disconnect wiring from wiper motor.

4. Prepare to position the brake valve (8, Fig. 10.39) to one side by disconnecting spring (4).
5. Remove two jam nuts (5), four lock washers (6) two capscrews (7) and position the brake valve (8) out of the way to provide access to the windshield wiper motor.
6. Remove nuts (11) and washer (12).
7. If necessary, use a gear puller to separate wiper arm (13) from knurled driver (14). Then remove knurled driver.
8. Remove rubber cap (15), nut (16), washer (17) and fiber washer (18).
9. While an assistant supports the windshield wiper motor from within the cab, remove the screw (19), flat washer (20), panto adapter (21), and gasket (22); your assistant can now lift the motor and attached parts from the cab.
10. Place motor and attached parts on a bench and remove nut (27), drive arm (28) and washer (29) from wiper motor assembly (33).

c. Installation

1. Attach the motor (33, Fig. 10.39) to the motor mount (32) using three lock washers (31) and capscrews (30).
2. Install the drive arm (28) and nut (27) on the gear and shaft assembly.
3. While an assistant supports the windshield wiper motor from within the cab, install the gasket (22, Fig. 10.39), panto adapter (21), flat washer (20) and screw (19).
4. Connect the wiring to the wiper motor.
5. Install the fiber washer (18), washer (17), nut (16), and rubber cap (15).
6. Install wiper arm (13) on knurled driver (14).
7. Install washer (12) and nut (11).
8. Connect wiring to wiper motor.
9. Position the brake valve (8) and install two capscrews (7), four lock washers (6) and two jam nuts (5).
10. Install clevis pin (9) and cotter pin (10).
11. Connect spring (4).
12. Position the right front console panel (3) and right console overlay (2) and install four flange head capscrews (1).
13. Connect the negative (–) cable (2, Fig. 10.16) to the batteries.



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Fig. 10.40 Roof Wiper Motor Removal and Disassembly

10.10.4 Roof Washer/Wiper Switch (Enclosed Cab Only) - Later Models

The roof washer/wiper switch, Fig. 10.37, is supplied on a forklift with an enclosed cab. Turn knob to left to operate wiper at low speed; to right to operate wiper at high speed. Press and hold knob to activate roof washer. The roof washer fluid tank is located at the right side of the seat behind the fluid tank for the windshield washer (Fig. 10.40).

The 6 A rated switch has a built-in circuit breaker.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Prepare to remove the roof washer/wiper switch by removing the lower panel which is located below the steering wheel.
3. Tag and disconnect the wires from the switch.
4. Remove the knob by pulling directly upward on the knob.
5. Remove the hex nuts which secure the switch to the panel.

b. Disassembly

Do not disassemble the switch.

c. Cleaning and Drying

Without submerging the switch, clean the switch with an approved solvent and dry with a clean lint-free cloth.

d. Inspection and Replacement

1. Inspect the switch terminals for continuity with the switch in the right, left and depressed positions and shorting in the center position.
2. Replace the switch if it fails the tests in step 1.

e. Installation

1. Connect the wires as they were tagged during switch removal.
2. Position the switch from under the right front console panel.
3. Install the switch and tighten the hex nut.
4. Replace the knob and lower console panel.
5. Connect negative (–) cable to the batteries.

10.10.5 Roof Washer Motor and Reservoir - Later Models

The roof washer motor and reservoir are a unit and cannot be serviced separately.

a. Removal

1. Disconnect the negative (–) cable at the batteries (2, Fig. 10.16).
2. Tag and disconnect the wires at the motor.
3. Disconnect the hose (1, Fig. 10.40).
4. Remove three bolts (15), three flat washers (18) and three locknuts (19) holding the reservoir to the bracket (17).

IMPORTANT: When the bolts are removed the front reservoir will also become loose from the bracket.

5. Lift the washer reservoir assembly (16) from the forklift.

b. Disassembly

Do not disassemble; the reservoir and motor are not available separately.

c. Cleaning and Drying

Without submerging the motor or pump, rinse out the reservoir and allow it to air dry.

d. Inspection and Replacement

1. Prepare to test the motor by filling the reservoir with water.
2. Test the motor by connecting a 12 Vdc source to the motor terminals. If motor doesn't run, replace reservoir and motor assembly.
3. Inspect the condition of the reservoir; if cracked, brittle, or leaking at the joint between the reservoir and pump, replace the reservoir and motor assembly.
4. Check hose from pump to washer nozzle for proper connection and deterioration.
5. Be sure passage through nozzle is open and is not clogged.

e. Installation

1. Prepare to install the roof washer reservoir assembly (16, Fig. 10.40)
2. Position reservoir assembly (16) in the forklift and to the rear of the bracket (17).
3. Install two bolts (15) through the holes in the top of the reservoir and through the bracket and front reservoir.
4. Install a flat washer (18) and locknut (19) onto each bolt and tighten. Install the third bolt through the bottom hole and secure in place.
5. Connect the hose (1).
6. Connect the wires to the motor.
7. Connect negative (–) cable to the batteries.

10.10.6 Roof Wiper Motor (Enclosed Cab Only) - Later Models

The roof wiper motor is located above the fan in the front right corner of the cab (Fig. 10.40)



Caution

Keep hands away from linkage when motor is operating to avoid serious personal injury.

a. Initial Testing

1. If the motor fails to operate, prepare to test the motor by disconnecting the negative (–) cable from the batteries.
2. Disconnect the wiring to the motor and test the motor using an independent 12 Vdc power source which supplies at least 6 A.
3. Reconnect the negative (–) cable to the batteries.
3. If the motor fails to operate, remove and replace the motor as follows.

b. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Remove the wiper arm (10, Fig. 10.40) from the motor shaft.
3. Remove the acorn nut (8).
4. From inside the cab remove the #10 screw (14) and nylon washer (4).

5. Remove the upper nylon washer (4) from the topside of the glass.
6. Pull the wiper cover assembly (12) with motor (13) from the upper glass. It may be necessary to remove the fan bracket to remove the wiper motor.
7. Remove the nylon spacer (11) from the shaft.
8. Open the wiper cover assembly and tag and remove the wires from the motor.

c. Installation

1. Place the motor (13, Fig. 10.40) inside the wiper cover assembly (12).
2. Connect wiring to wiper motor.
3. Place the two halves of the wiper cover (12) together and reassemble the nylon spacer (11) to the motor shaft.
4. Assemble the motor to the upper glass and secure in place with the #10 screw (14) and nylon washer (4) inserted from the inside of the cab up through the grommet (6).
5. Assemble the other nylon washer (4) and the acorn nut (8). Tighten securely.
6. Reassemble the wiper arm assembly (10) to the motor shaft.
7. Reassemble the fan mount if it was removed to the cab.
8. Connect the negative (–) cable (2, Fig. 10.16) to the batteries.

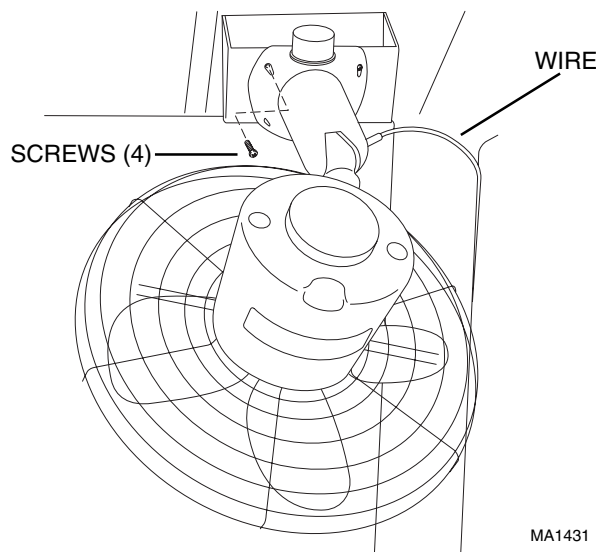


Fig. 10.41 Air Circulation Fan Removal

10.11 FAN SWITCH AND FAN MOTOR (OPTIONAL)

The circulation fan is only operable when the ignition switch is in the RUN position. The fan switch is located at the base of the fan mount.

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16), from the batteries.
2. Disconnect wire, Fig. 10.41, from fan at terminals.
3. Support the fan with one hand and remove four screws with the other hand.

b. Disassembly

Do not disassemble; there are no serviceable parts in the fan.

c. Cleaning and Drying

Without submerging motor or bearings, clean fan with a nonmetallic bristle brush using an approved solvent and dry with a clean cloth.

d. Inspection and Replacement

Test fan using a 12 Vdc source which supplies at least 4 A; replace if defective.

e. Installation

1. Position the fan and install four screws, Fig. 10.41.
2. Connect wire at terminal.
3. Connect negative (–) cable to the batteries.
4. Test fan operation.

10.12 CAB HEATER (ENCLOSED CAB ONLY)

10.12.1 Cab Heater Switch (Enclosed Cab Only)

The cab heater fan is only operable when the ignition switch is in the RUN position. The heater fan switch (11, Fig. 10.42) is located on the left side of the seat base.

NOTE: During summer operation, close the heater line shut-off valve (13) at the left corner of the engine.

a. Removal

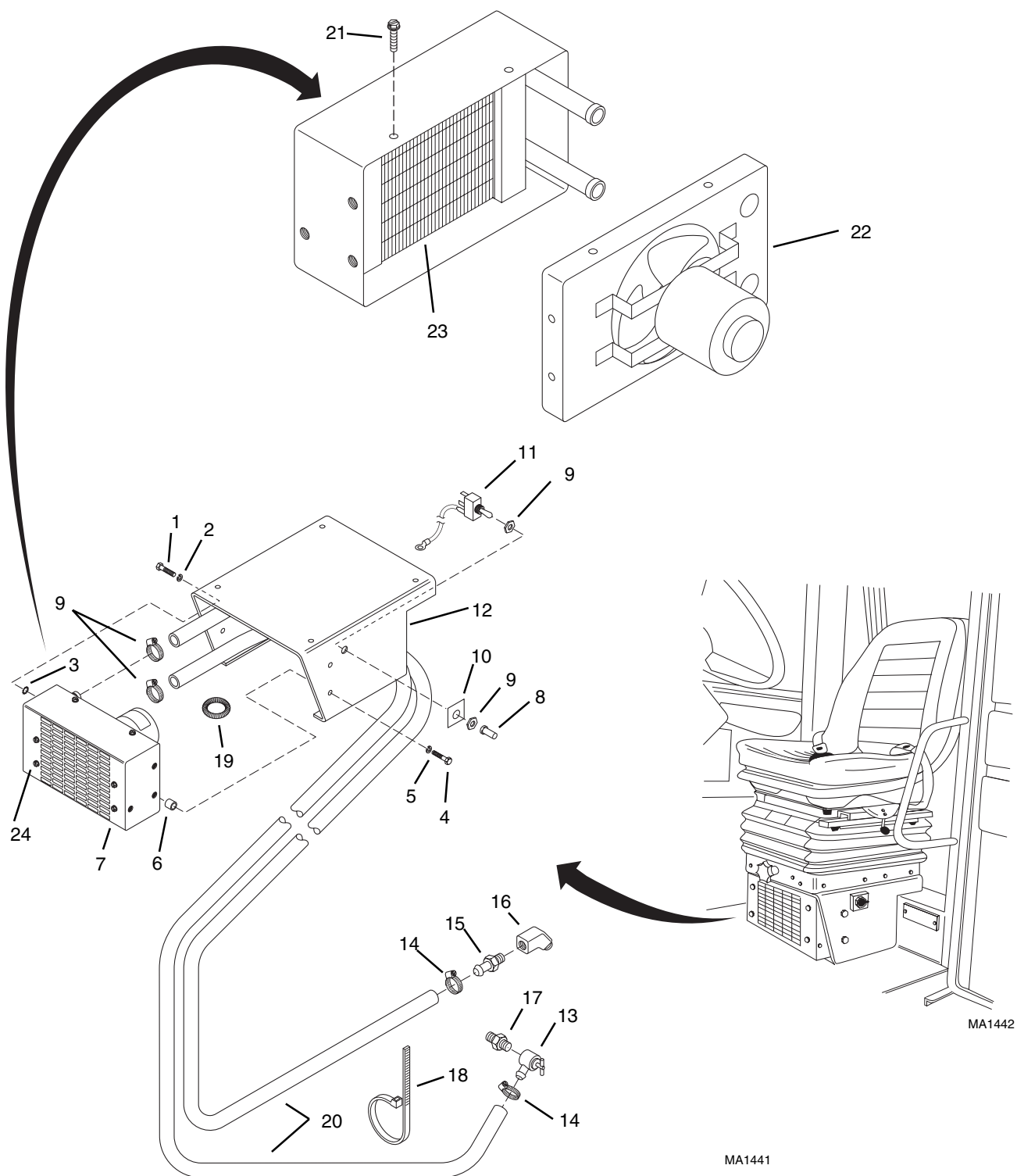
1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Remove two capscrews (1, Fig. 10.42) and lock washers (2) and tooth-type grounding washers (3).
3. Remove two capscrews (4), lock washers (5) and spacers (6).
4. Slide heater and fan unit (7) forward to provide access to the cab heater switch (11).
5. Tag and disconnect wiring from switch.
6. Remove hex nut with cap (8), knurled nut (9), decal (10), and heater switch (11) from suspension support (12).

b. Inspection and Replacement

1. Test the mechanical operation of the switch toggle; switch positions are HI, LOW and OFF.
2. Test switch for continuity in the HI and LO positions and for a short in the OFF position.
3. Replace switch if it fails to pass the tests in steps 1 and 2.

c. Installation

1. If negative (–) cable (2, Fig. 10.16) had been reconnected to the batteries, disconnect this cable.
2. Position heater fan switch (11, Fig. 10.42) in suspension support (12) and adjust knurled nut (9) to provide the desired projection of the switch stem through the suspension support. Install decal (10), knurled nut (9), heater switch (11), and hex nut with cap (8).



- | | | | |
|---------------------------------|------------------------|--------------------|--------------------------|
| 1. Capscrew | 7. Heater and Fan Unit | 13. Valve | 19. Grommet |
| 2. Lock Washer | 8. Hex Nut with Cap | 14. Clamps | 20. Hoses |
| 3. Tooth-Type Grounding Washers | 9. Knurled Nut | 15. Hose Connector | 21. Sheet Metal Screws |
| 4. Capscrew | 10. Decal | 16. Elbow, 45° | 22. Fan Mounting Bracket |
| 5. Lock Washer | 11. Heater Fan Switch | 17. Reducer | 23. Core |
| 6. Spacer | 12. Suspension Support | 18. Tie Wrap | 24. Sheet Metal Screws |

Fig. 10.42 Removal of Optional Cab Heater Switch and Heater Fan Motor

3. Connect wiring to switch (11).
4. Slide heater and fan unit (7) into position.
5. Install two spacers (6), lock washers (5) and capscrews (4).
6. Install two tooth-type grounding lock washers (3), lock washers (2) and capscrews (1).
7. Connect negative (–) cable (2, Fig. 10.16) to the batteries.
8. Test heater fan motor operation.

10.12.2 Heater Fan Motor and Coil (Enclosed Cab Only)

a. Removal

1. Disconnect negative (–) cable (2, Fig. 10.16) from the batteries.
2. Remove two capscrews (1, Fig. 10.42), lock washers (2), and tooth-type grounding washers (3).
3. Remove two capscrews (4), lock washers (5) and spacers (6).
4. Slide heater and fan unit (7) forward to provide access to the cab heater motor and hose connections.
5. Tag and disconnect wiring from motor.
6. Open valve (13) at the left corner of the engine.
7. Place a clean container under the engine drain plug. Drain the coolant by venting the radiator and removing the engine drain plug.
8. At the cab heater loosen clamps (14) and disconnect hoses (20).
9. Remove heater and fan unit (7) from forklift and place it on a clean bench.

b. Disassembly

1. Disassembly of the heater unit is not required. However, if you intend to clean the heater core, remove four sheet metal screws (21, Fig. 10.42) and the fan mounting bracket (22).

IMPORTANT: Handle core (23) with care to avoid damaging the delicate fins.

2. Remove four sheet metal screws (21) from the front of the heater and lift the heater core from the heater.

c. Cleaning and Drying

1. Clean the interior of the heater core by connecting a hose to the inlet and flushing the core with water.
2. Soak the exterior of the heater core in a detergent solution and then flush the coil with water from a hose.
3. Allow the core to air dry.
4. Clean all parts of the heater housing with detergent in water, rinse and dry using a clean lint-free cloth.

d. Inspection and Replacement

1. Straighten bent fins using a duckbill pliers.
2. Test the heater fan motor for free rotation of the shaft. If the shaft is binding, lubricate bushing area using a few drops of an approved oil for small electric motors. Manually turn the shaft to work the oil into the bushings.
3. Test the motor by connecting a fused or protected 6 A minimum output, 12 Vdc power supply to the motor terminals using short heavy gauge wires.
4. If the motor doesn't run prepare to replace it by removing the nuts and lock washers which secure the motor to the heater.
5. Position the new motor on the heater and install the lock washers and nuts which secure it to the heater.
6. Pressure test the heater core for leakage and replace core if defective or in marginal condition.

e. Assembly

1. Position core (23, Fig. 10.42) in the heater and install four sheet metal screws (24).
2. Position fan mounting bracket (22) on heater and install four sheet metal screws (21).

f. Installation

1. If negative (–) cable (2, Fig. 10.16) had been reconnected to the batteries, disconnect this cable.
2. Position the heater and fan unit in the forklift.
3. Connect hoses (20, Fig. 10.42) and install and tighten clamps (14).
4. Open valve (13).

5. Replace coolant in engine and heater lines, connect the ground cable (2, Fig. 10.16) to the negative terminals of the batteries, start the engine, allow engine to idle for several minutes, and check for leakage at the heater connections.
6. Disconnect battery ground cable (2, Fig. 10.16) from the negative terminals of the batteries.
7. Connect wiring to motor.
8. Prepare to electrically ground the heater unit by positioning tooth type ground washers (3, Fig 10.42) over the tapped holes in the coolant inlet/outlet side of the heater. Use a thin, transparent tape to temporarily secure the washers to the heater unit.
9. Slide heater and fan unit (7) into position under suspension support (12) without disturbing the ground washers (3) which were taped into position during the previous step.
10. Install two lock washers (5), capscrews (4) and spacers (6) at the other side of the suspension support (12).
11. Install two lock washers (2) and capscrews (1) through the holes in the suspension support (12) and through the tooth type grounding washers (3) into the tapped holes in the heater.
12. Connect negative (–) cable (2, Fig. 10.16) to the batteries.
13. Test heater fan motor operation.

10.14 TROUBLESHOOTING

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<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
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Warning Devices—HORN

Horn doesn't sound when horn button is pressed.	1. No voltage at horn; broken wire or circuit breaker doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.2.1
	2. Corroded electrical ground at horn mounting.	Repair electrical ground.	See para. 10.2.1
	3. Loose or broken wiring.	Repair or replace wiring.	See para. 10.2.1
	4. Defective horn switch.	Test horn switch for continuity with horn button pressed; replace switch if open.	See para. 10.2.1
	5. Defective horn.	Remove horn from forklift and test horn using short heavy gauge wires connected to a fused or protected 6 A minimum output, 12 Vdc power supply.	See para. 10.2.1
Horn sounds continuously without horn button pressed.	1. Defective horn switch.	Test horn switch for continuity without horn button pressed; replace switch if closed.	See para. 10.2.1
	2. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.2.1

Warning Devices—BACKUP ALARM AND REVERSE SWITCH

Backup alarm doesn't sound with travel select lever in REVERSE.	1. No voltage at backup alarm; broken wire or circuit breaker doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.2.2 and 10.4
	2. Defective reverse switch.	Replace reverse switch.	See para. 10.2.2
Backup alarm sounds with travel select lever in NEUTRAL AND FORWARD.	1. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.3
	2. Defective reverse switch.	Test and replace reverse switch as required	See para. 10.7.5

Trouble**Probable Cause****Remedy****Reference****Warning Devices—WARNING LIGHTS**

Bulbs in warning lights gauge don't light when test button is pressed.	<ol style="list-style-type: none"> 1. Bulbs are burned out. 2. No voltage at warning lights gauge; loose or broken wiring or circuit breaker doesn't reset. 3. Defective sender switches. 	<p>Replace bulbs.</p> <p>Replace wiring and circuit breaker as required.</p> <p>Test switches for continuity under the appropriate conditions and replace as required.</p>	<p>See para. 10.8.4</p> <p>See para. 10.4</p> <p>See para. 10.8.5 thru 10.8.8</p>
Bulbs in warning lights gauge light continuously when ignition key switch is in the RUN position.	<ol style="list-style-type: none"> 1. Defective test switch. 2. Short circuit in wiring. 3. Defective sender switches. 	<p>Check test switch for continuity and replace switch if closed in the released position.</p> <p>Determine and repair the cause of the short circuit.</p> <p>Test switches for continuity under the appropriate conditions and replace as required.</p>	<p>See para. 10.8.4</p> <p>See para. 10.8.4</p> <p>See para. 10.8.5 thru 10.8.8</p>

CIRCUIT BREAKERS/FUSES

Loss of electrical power for some but not all forklift operations.	No voltage at these operations caused by a broken wire or switch, or a circuit breaker which doesn't reset to its closed position.	Replace wiring, switch and circuit breaker as required.	See para. 10.4
Circuit breaker continuously trips.	Check the system for shorts, grounds or defective electrical components.	Repair or replace as required.	See para. 10.4
Overheating and burnout of wiring and forklift electrical components.	<p>Circuit breaker remains closed during an overload condition or is illegally bypassed with a jumper.</p> <p>Important: <i>Never jumper a circuit breaker without providing an equivalent protective device in the jumper.</i></p>	Correct the cause of the overload and replace damaged wiring, components and circuit breaker	See para. 10.4

<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
<u>Starting System—GENERAL</u>			
Engine will not crank and starting motor relay or solenoid does not engage.	1. Battery is discharged. 2. Ignition switch, relay or solenoid inoperative. 3. Starting circuit is open or has high resistance.	Check battery and charge or replace battery. Check circuitry and repair or renew faulty components. Check circuit connections and repair or renew faulty wiring.	See para. 10.6.2 See para. 10.7.1 See para. 10.5.1
Starter relay closes and solenoid engages but engine will not crank.	1. Battery is discharged. 2. Defective starting motor connections or loose battery connections. 3. Starting motor faulty. 4. Relay or solenoid contacts are burned. 5. Engine is seized; crankshaft cannot rotate.	Check battery and charge or renew. Check, clean and tighten connections. Inspect, repair or renew. Renew relay or solenoid. Repair or replace engine and transmission as required.	See para. 10.6.2 See para. 10.5.1 and 10.6.2 See para. 10.5.2 See para. 10.5.2 and 10.5.4 Section 8
Starting motor turns but does not crank engine.	1. Defective starting motor drive assembly. 2. Defective solenoid or pinion engagement levers. 3. Defective flywheel ring gear.	Inspect and repair or renew. Inspect and repair or renew. Inspect and renew.	See para. 10.5.2 See para. 10.5.2 See para. 10.5.2
Engine cranks slowly.	1. Discharged battery. 2. Excessive resistance in starting circuit. 3. Defective starting motor. 4. Excessively tight engine.	Check battery and charge or renew. Check circuit connections and repair or renew faulty wiring. Inspect and repair or renew. Investigate cause and repair or replace engine.	See para. 10.6.2 See para. 10.5.2 Section 8
Engine turns over but fails to start.	1. Fuel tank is empty. 2. Engine is malfunctioning.	Fill fuel tank. Contact authorized engine dealer.	See para. 8.4.2 See para. 8.7

Trouble

Probable Cause

Remedy

Reference

Starting System—STARTER

Starter doesn't run or doesn't run correctly.	1. Discharged batteries.	See corrections for problem of discharged batteries.	See para. 10.6.2
	2. Bad connections, wires, cables or other parts in the starting circuit.	See troubleshooting the "Starting system—General".	
	3. Using the wrong engine oil for cold weather operation.	Refer to paragraph 8.1, Engine Lubrication instructions.	See para. 8.1
	4. Worn teeth on the starter drive pinion or the flywheel ring gear.	Remove the starter to check the teeth. Repair as necessary.	See para. 10.5.2
	5. Hex nuts that fasten the starter to the flywheel housing are loose.	Tighten the hex nuts.	See para. 10.5.2

Starting System—STARTING MOTOR RELAY

No voltage at starter solenoid when ignition key switch is in the START position.	Starter relay (36, Fig 10.7) is not energized due to broken wiring or a defective circuit breaker (10).	Replace wiring or circuit breaker.	See para. 10.5.3
Starter operates continuously without ignition key in the START position.	Starter relay (36, Fig 10.7) is "frozen" in the closed position.	Temporarily disconnect wiring to starter relay and replace starter relay.	See para. 10.5.3

<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
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Starting System—THERMO START PLUG FOR COLD WEATHER STARTING

Intake manifold remains cold after ignition key switch is momentarily turned to THERMO START position.	1. Discharged batteries.	Charge batteries only if electrolyte is not frozen; if frozen, remove batteries from forklift, completely thaw and then charge.	See para. 10.6.2
	2. Broken wiring or circuit breaker.	Replace wiring or circuit breaker.	See para. 10.4
	3. Loose connections.	Tighten connections.	See para. 10.5.4
	4. Clogged or bent fuel line to Thermo Start plug.	Clean or replace fuel line.	See para. 10.5.4
	5. Defective plug.	Replace Thermo Start plug.	See para. 10.5.4
	6. Broken ignition switch.	Remove and test ignition switch in all positions; replace if defective.	See para. 10.7.1
Intake manifold remains abnormally hot during normal engine operation.	Thermo Start plug is ON continuously due to broken ignition switch or a short circuit in the wiring.	Remove and test ignition switch in all positions; replace if defective.	See para. 10.7.1

Charging System—GENERAL

Visual Check	1. Check for loose or corroded connections.	Repair as necessary.	See para. 10.6
	2. Check the condition and adjustment of the alternator belts.	Install a new set of drive belts if necessary; refer to paragraph 8.1.2 for belt adjustment instructions.	See para. 8.1.2 and 10.6.1
	3. Check the condition of the batteries.	Refer to "Charging System—Batteries".	See para. 10.6.2

Charging System—ALTERNATOR

Noise coming from the alternator.	1. Damaged or worn drive belt.	Install new drive belt.	See para. 8.1.2 and 10.6.1
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Trouble **Probable Cause** **Remedy** **Reference**

Charging System—BATTERIES

Warning

- Wear safety glasses when working near batteries.
- Keep batteries out of the reach of children.
- Never wear rings, metal watch bands or other items that may ground a live circuit.
- All lead-acid batteries generate hydrogen gas which is highly explosive and flammable. If ignited by a spark or flame, the gas may explode violently causing spraying of acid, fragmentation of the battery, and possible severe personal injuries, particularly to the eyes.
- Never cause sparks to occur or smoke near batteries that are charging or have been recently charged. Keep sparks, flame and smoking materials away. Ventilate when charging or using in enclosed area. Always shield eyes when working near a battery.
- Avoid battery acid. Batteries contain sulfuric acid. Antidote: EXTERNAL—In case of contact with acid, flush immediately with water. INTERNAL—drink large quantities of water or milk. Follow with milk of magnesia, beaten egg, or vegetable oil. Call physician immediately. DO NOT give fluids that would induce vomiting. EYES—Flush with water for 15 minutes and get prompt medical attention.
- Never use booster batteries to start the engine or try to charge the battery if the electrolyte in the battery is frozen.
- Charge batteries only in a well-ventilated area. Always be sure battery chargers are OFF when connecting to or disconnecting from batteries.
- See Delco Remy Service Bulletin 1B115 and 1B-116 for additional safety information and procedures.

IMPORTANT: *The diodes in the alternator function as one-way valves and the transistors in the voltage regulator operate as fast switches. Both are accurate and sensitive. They do not wear out and cannot be adjusted, but because they are sensitive to voltage changes and high temperature, the following precautions are vital to prevent them from being destroyed:*

- Disconnect the ground cable first when you disconnect the battery cables from the battery; connect the ground cable last when you connect the battery cables to the battery.
- Always connect POSITIVE TO POSITIVE, NEGATIVE TO NEGATIVE.
- DO NOT disconnect the battery while the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.
- DO NOT disconnect a lead without first stopping the engine and turning all electrical switches to the OFF position.
- DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors and diodes.
- DO NOT connect a battery into the system without checking for correct polarity and voltage.
- DO NOT “flash” connections to check for current flow. No matter how brief the contact the transistors may be ruined.
- If a battery-caused cranking complaint exists with a clear or light yellow indication, replace the battery. In this case the charging system should be checked; refer to charging system instructions in this manual. Excessive over-charging, broken case or tipping the battery over 45° on its side will result in loss of electrolyte level.

Batteries test good but don't perform satisfactorily in service.	Refer to possible causes in paragraph 10.6.2.f.	Provide a remedy for the cause of the trouble.	See para. 10.6.2.f
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<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
Charging System—BATTERIES (cont'd)			
Discharged batteries.	1. Short circuit in battery cell or cells.	Refer to paragraph 10.6.2.d and perform battery load test.	See para. 10.6.2.d
	2. Loose or dirty battery cable connections.	Clean the clamp on the battery cables and the battery posts.	See para. 10.6.2.i
	3. Dirty battery top.	Refer to paragraph 10.6.2.i and clean the top of the battery.	See para. 10.6.2.i
	4. Low output or no output from alternator.	Refer to paragraph 10.6.1 and test alternator.	See para. 10.6.1
	5. High resistance in the positive battery cable.	Refer to paragraph 10.6.2 and check the positive battery cable.	See para. 10.6.2
	6. High resistance in the negative battery cable.	Refer to paragraph 10.6.2 and check the negative battery cable.	See para. 10.6.2

Switches and Solenoids—IGNITION (KEY) SWITCH

Key binds in ignition switch lock.	Sticky, painted or bent key.	Clean, remove paint and straighten, remove any burrs from surface of key and sprinkle powdered graphite on working surfaces of key as described in paragraph 10.7.1 IMPORTANT: Use only graphite or a liquid lock deicer within the lock. Severe lock malfunctions may require the services of a locksmith.	See para. 10.7.1
Key cannot enter ignition switch or cannot be turned inside lock.	Moisture within ignition switch is frozen.	Warm the ignition switch using a hair dryer or use a liquid lock deicer to lower the freezing point and evaporate the moisture within the lock.	See para. 10.7.1
Ignition switch fails to function in one or more positions.	1. Loose or broken wiring or circuit breaker doesn't reset and remains open.	Replace wiring and circuit breaker.	See para. 10.7.1
	2. Trouble in the starting circuit.	Refer to starting circuit troubleshooting.	
	3. Trouble in the THERMO START circuit.	Refer to Thermo Start plug troubleshooting.	
	4. Defective ignition switch.	Repair or replace ignition switch.	
Ignition switch doesn't crank engine in START position.	Travel select lever is in FORWARD or REVERSE.	Move travel select lever to NEUTRAL position.	See para. 4.2.2

Trouble**Probable Cause****Remedy****Reference****Switches and Solenoids—IGNITION (KEY) SWITCH (cont'd)**

Ignition switch causes starter to crank engine but doesn't maintain engine operation in RUN position.	1. Fuel run solenoid fails to admit fuel to fuel injection pump.	Refer to fuel run solenoid troubleshooting.	See para. 10.7.3
	2. Fuel tank is empty.	Fill fuel tank.	See para. 8.4.2

Switches and Solenoids—NEUTRAL START SWITCH

Starter fails to crank engine with travel select lever in NEUTRAL, the park lock switch DISENGAGED and ignition key switch in START.	1. Check for problems in the shift lever linkage.	Refer to shift lever linkage adjustment instructions in paragraph 4.2.2.	See para. 4.2.2
	2. Be sure the neutral start switch is closing.	The switch closes when a switch actuating pin presses against a spring-loaded ball in the neutral start switch. Remove switch from the control valve assembly and check actuator pin for free movement in the control valve assembly. Also check for continuity with the pin pressing against the ball. If open install new switch.	See para. 10.7.2

Switches and Solenoids—FUEL RUN SOLENOID

Ignition switch cranks engine in START but engine doesn't operate in RUN.	1. Fuel run solenoid fails to admit fuel to fuel injection pump due to loose connections or broken wiring.	Tighten connections and install new wiring as required.	See para. 10.7.3
	2. Fuel tank is empty.	Fill fuel tank.	See para. 8.4.2
	3. Fuel run solenoid is stuck in the OPEN position.	Install new fuel run solenoid.	See para. 10.7.3

Switches and Solenoids—PARK LOCK SWITCH

Park lock switch fails to disengage park lock brake in disengaged position.	1. Loose connections or broken wiring.	Tighten connections and install new wiring as required.	See para. 10.7.4
	2. Park lock switch isn't closed in the disengaged position.	Repair or replace park lock switch if it isn't closed in the disengaged position.	See para. 10.7.4
Park lock switch fails to engage park lock brake in engaged position	1. Park lock switch should be open in the engaged position.	Repair or replace park lock switch if it isn't open in the engaged position.	See para. 10.7.4

<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
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Switches and Solenoids—REVERSE SWITCH AND BACKUP ALARM

Backup alarm doesn't sound with travel select lever in REVERSE.	1. No voltage at backup alarm; broken wire or circuit breaker (11) doesn't reset.	Replace wiring and circuit breaker as required.	See para. 10.4
	2. Defective reverse switch.	Replace reverse switch.	See para. 10.7.5
Backup alarm sounds with travel select lever in NEUTRAL AND FORWARD	1. Short circuit in wiring.	Determine and repair cause of short circuit.	See para. 10.2.2
	2. Defective reverse switch.	Test and replace reverse switch as required.	See para. 10.7.5

Switches and Solenoids—STEERING SELECT SWITCH AND SOLENOID

Steering select switch fails to select mode or selects incorrect steering mode.	1. Short circuit or broken wire.	Eliminate short or repair or replace wire.	See para. 10.7.6
	2. Circuit breaker stuck in open position.	Replace circuit breaker.	See para. 10.4
	3. Steering select switch is defective.	Remove steering select switch and check for continuity in each position and replace switch if defective.	See para. 10.7.6
	4. Steering select solenoid is defective.	Remove steering select solenoid and test for correct operation.	See para. 10.7.7

Gauges and Indicator Lights—HOURMETER

Hourmeter Doesn't Operate.	1. Defective wiring and ground.	Renew wiring and correct ground.	See para. 10.8.3
	2. Incorrect voltage at meter terminals.	Required voltage is 9 to 36 Vdc.	See para. 10.8.3
Hourmeter is Inaccurate.	Check running indicator flag wheel.	Replace hourmeter if defective.	See para. 10.8.3

Trouble

Probable Cause

Remedy

Reference

Gauges and Indicator Lights—WARNING LIGHTS

Bulbs in warning lights gauge fail to light when test button is pressed.	1. Bulbs are burned out.	Replace bulbs.	See para. 10.8.4
	2. No voltage at warning lights gauge; loose or broken wiring or circuit breaker doesn't reset.	Test switches for continuity under the appropriate conditions and replace as required.	See para. 10.8.4 thru 10.8.8
	3. Defective sender switches.	Replace switches.	See para. 10.8.5 thru 10.8.8
Bulbs in warning lights gauge light continuously when ignition key switch is in RUN position.	1. Defective test switch.	Check test switch for continuity and replace switch if closed in the released position.	See para. 10.8.4
	2. Short circuit in wiring.	Determine and repair the cause of the short circuit.	
	3. Defective sender switches.	Test switches for continuity under the appropriate conditions and replace as required.	See para. 10.8.5 thru 10.8.8

Gauges and Indicator Lights—ENGINE LOW OIL PRESSURE SWITCH

Oil Pressure Indicator does not go out when the engine is running.	If the oil level and oil pressure are good and voltage is zero, check for shorts to ground.	If there are no shorts to ground, install a new oil pressure switch.	See para. 10.8.5
With a good oil pressure indicator bulb and the ignition key in RUN, oil pressure indicator does not light before engine is started.	1. Oil pressure switch should be closed.	If open, replace oil pressure switch.	See para. 10.8.5
	2. There is battery voltage with the ignition key in RUN and the engine not running.	Install a new oil pressure switch.	See para. 10.8.5

Trouble Probable Cause Remedy Reference

Gauges and Indicator Lights—ENGINE COOLANT HIGH TEMPERATURE SWITCH

Coolant high temperature indicator bulb fails to light when the test switch is pressed or the engine is overheated.	Coolant high temperature indicator bulb is burned out.	Replace bulb.	See para. 10.8.4
Coolant temperature warning bulb lights when the engine is running but not overheated.	<ol style="list-style-type: none"> 1. Remove the terminal at the coolant temperature switch 2. If the indicator remains on, check wire 15 and the ignition switch for a short to ground. 	<p>If the indicator bulb goes out, install a new coolant temperature switch.</p> <p>If there is a short to ground, remedy the cause of the short.</p>	<p>See para. 10.8.6</p> <p>See para. 10.8.6</p>

Gauges and Indicator Lights—ALTERNATOR WARNING LIGHT

Alternator warning bulb doesn't light when alternator isn't producing voltage.	<ol style="list-style-type: none"> 1. Alternator not producing voltage or warning bulb is burned out. 2. Battery is discharged. 3. Circuit breaker is stuck in open position. 4. Resistor R6 in alternator is open. 	<p>Replace bulb.</p> <p>Charge battery.</p> <p>Replace circuit breaker.</p> <p>Replace resistor R6.</p>	<p>See para. 10.8.4</p> <p>See para. 10.6.2</p> <p>See para. 10.4</p> <p>See para. 10.6.1</p>
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Gauges and Indicator Lights—TRANSMISSION HIGH OIL TEMPERATURE SWITCH

Transmission high temperature indicator bulb fails to light when the test switch is pressed or the engine is overheated.	Transmission high temperature indicator bulb is burned out.	Replace bulb.	See para. 10.8.4
Transmission temperature warning bulb lights with the engine running but not overheated.	<ol style="list-style-type: none"> 1. Remove the connector to the transmission temperature switch. 2. If the indicator remains on, check wire 18 and the ignition switch for a short to ground. 	<p>If the indicator bulb goes out, install a new transmission high temperature sender.</p> <p>If there is a short to ground, remedy the cause of the short.</p>	See para. 10.8.8

Trouble**Probable Cause****Remedy****Reference****Gauges and Indicator Lights—FUEL LEVEL GAUGE**

No indication.	1. Empty fuel tank.	Fill fuel tank.	See para. 8.4.2
	2. No current to ignition terminal because of broken or disconnected lead.	Connect lead.	See para. 10.8.9
	3. Grounded wire between sender and fuel level gauge.	Insulate wire.	See para. 10.8.9
	4. Fuel level gauge isn't grounded.	Ground receiver.	See para. 10.8.9
	5. Sender defective.	Replace sender.	See para. 10.8.9
Excessive pointer fluctuation.	1. Loose wire connections.	Tighten connectors.	See para. 10.8.9
	2. Defective sender.	Replace sender.	See para. 10.8.9
FULL reading at all times.	1. Wire to sender is broken.	Replace wire.	See para. 10.8.9
	2. Sender is not properly grounded.	Ground sender.	See para. 10.8.9
	3. Defective sender.	Replace sender.	See para. 10.8.9
Gauge indicates inaccurately.	1. Incorrect sender.	Replace sender.	See para. 10.8.9
	2. Defective sender.	Replace sender.	See para. 10.8.9
	3. Low voltage at receiver terminals.	Determine and correct cause of low voltage.	See para. 10.8.9
Pointer fluctuates when headlights are turned ON.	Engine not properly grounded.	Improve engine ground.	See para. 8.3

Optional Light Circuit—DIRECTIONAL AND EMERGENCY FLASHER SWITCH

Turn signals operative on one side.	1. Bulb(s) burned out (flasher cannot be heard). One or more bulbs are inoperative with hazard warning system ON.	Replace bulbs.	See para. 10.9.1
	2. Open wiring or ground connector. One or more bulbs are inoperative with hazard warning system ON. Use test light and check circuit at bulb socket.	If test bulb lights, repair open ground connection; if not, repair open wiring between bulb socket and turn signal switch.	See para. 10.9.1
	3. Short to ground (flasher can be heard but no bulbs operate).	Locate and repair short to ground by disconnecting front and rear circuits separately.	See para. 10.9.1
Turn signals inoperative.	Defective flasher (located below instrument panel near brake pedal).	Replace flasher.	See para. 10.9.1

<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
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Optional Light Circuit—MOMENTARY BRAKE LIGHT (STOP LIGHT) AND SWITCH

Stop and tail light bulbs fail to light when brake pedal is pressed.	1. Stop and tail light bulb(s) are burned out.	Replace stop and tail light bulb(s).	See para. 10.9.2
	2. Momentary brake switch is open when brake pedal is pressed.	Replace momentary brake switch.	See para. 10.9.2
Momentary brake bulbs remain ON when brake pedal is released.	1. Momentary brake switch is closed when brake pedal is released.	Replace momentary brake switch.	See para. 10.9.3
	2. Short in wiring.	Remedy cause of short.	See para. 10.9.3

Optional Light Circuit—HEADLIGHT AND REAR WORK LIGHT SWITCH

One headlight or rear work light is inoperative or intermittent.	1. Loose connection.	Secure connections to headlight including ground wire (black wire).	See para. 10.9.4
	2. Defective sealed beam unit.	Replace sealed beam unit.	See para. 10.9.4
One or more headlights are dim.	1. Open ground connection at headlight.	Repair black wire connection between sealed beam and body ground.	See para. 10.9.4
	2. Black wire mislocated in headlight connector (three wire, hi-lo connector only).	Relocate black wire in connector.	See para. 10.9.4
One or more headlights have a short life.	Charge circuit problem.	Refer to charge circuit troubleshooting.	See para. 10.6

Trouble Probable Cause Remedy Reference

Optional Light Circuit—HEADLIGHT AND REAR WORK LIGHT SWITCH (cont'd)

All lights are inoperative or intermittent.	1. Tripped circuit breaker or blown fuse.	Determine cause of overload and reset circuit breaker or replace fuse	See para. 10.4
	2. Loose connection.	Check and secure connections at light switch.	See para. 10.9.4
	3. Open wiring from light switch to battery.	Check red wire terminal at light switch with test light; if bulb doesn't light, repair open wire circuit to battery.	See para. 10.4 and 10.9.4
	4. Short to ground in circuit between light switch and lights.	If after a few minutes operation, lights flicker ON and OFF and a thumping noise can be heard from the circuit breaker, repair short to ground between light switch and headlights. After repairing short, check for flickering lights after one minute of operation. If flickering occurs, replace circuit breaker.	See para. 10.9.4
	5. Defective light switch.	Check red and yellow wire terminals at light switch with test light. If bulb lights at red wire terminal but not at yellow terminal, replace light switch.	See para. 10.9.4

Windshield Washer/Wiper for Enclosed Cab—GENERAL

Windshield wiper Inoperative.	1. Turn ignition switch to RUN and wiper switch clockwise to HIGH SPEED. Ground a 12 Vdc test lamp and touch probe to wiper or switch terminal H.	If lamp lights, continue with step 2; if lamp doesn't light, continue with step 3.	See para. 10.10.1
	2. If lamp lights, turn wiper switch to LOW, leave wiring connected to wiper motor, and connect jumper wire from motor to ground.	If wiper runs, repair open in ground strap; if wiper doesn't run, problem is in motor (refer to paragraph 10.10.3).	See para. 10.10.1 and 10.10.3
	3. If lamp doesn't light, circuit breaker may be stuck in the open position, it may be oscillating between open and closed due to a short in the circuit, or it may be in its normally closed condition.	If open, replace circuit breaker. If oscillating, check for high amperage draw due to a short in wiring or motor. If circuit breaker is closed, repair open in line 32 between circuit breaker and wiper motor or repair or replace wiper motor.	See para. 10.4

Trouble**Probable Cause****Remedy****Reference****Windshield Washer/Wiper for Enclosed Cab—GENERAL (cont'd)**

Windshield wiper has low speed only and is inoperative in high speed.	<ol style="list-style-type: none"> 1. Remove connector from terminal H of wiper motor and connect a 12 Vdc source to this terminal. 2. If wiper runs in high, check for open in red wire from switch to motor. 3. If wiper is inoperative, look for a hung or grounded high speed brush in the wiper motor. 	<p>If the wiper runs in high, proceed to step 2; if the wiper is inoperative, proceed to step 3.</p> <p>Repair or replace as required; if red wire provided continuity, replace wiper switch.</p> <p>Repair or replace as required.</p>	<p>See para. 10.10.3</p> <p>See para. 10.10.1</p> <p>See para. 10.10.3</p>
Windshield wiper has high speed only and is inoperative in low speed.	<ol style="list-style-type: none"> 1. Remove connector from terminal L of wiper motor and connect a 12 Vdc source to this terminal. 2. If wiper runs in low, check for open in black wire from switch to motor. 3. If wiper is inoperative, look for a hung or grounded low speed brush in the wiper motor. 	<p>If the wiper runs in low, proceed to step 2. If the wiper is inoperative, proceed to step 3.</p> <p>Repair or replace as required; if black wire provided continuity, replace wiper switch.</p> <p>Repair or replace as required.</p>	<p>See para. 10.10.3</p> <p>See para. 10.10.1</p> <p>See para. 10.10.3</p>
Wiper has one speed which is the same in both low and high.	<ol style="list-style-type: none"> 1. Remove connectors from terminals H and L of wiper motor and connect a 12 Vdc source first to one terminal and then the other terminal. 2. If wiper runs in high and low, check for an open in wires from wiper terminals H and L to the wiper switch. 3. If wiper runs at one speed, check for low and high speed brush leads shorting together internally. 	<p>Repair or replace as required.</p> <p>If the wiper runs in high and low proceed to step 2; if wiper runs at one speed proceed to step 3.</p> <p>Repair or replace as required.</p>	<p>See para. 10.10.3</p> <p>See para. 10.10.3</p> <p>See para. 10.10.3</p>

Trouble**Probable Cause****Remedy****Reference****Windshield Washer/Wiper for Enclosed Cab—GENERAL (cont'd)**

Wiper shuts off but blades do not return to park position.	1. Remove connector from terminal P of wiper motor and connect a jumper from terminal L to P and a 12 Vdc source to terminal P.	If wiper is inoperative or doesn't park proceed to step 2; if wiper runs and parks proceed to step 3.	See para. 10.10.3
	2. If wiper is inoperative or doesn't park, check park switch actuator and brush holder assembly in wiper motor.	Repair or replace as required.	See para. 10.10.3
	3. If wiper runs and parks, use a test lamp to check for current flow between terminals P and L.	If lamp doesn't light, proceed to step 4; if lamp lights, proceed to step 5.	See para. 10.10.3
	4. If lamp doesn't light, check for open in green wire from wiper switch to wiper motor.	Repair or replace green wire as required; if green wire provided continuity, replace wiper switch.	See para. 10.10.1
	5. If lamp lights, check for open in wire to circuit breaker.	Repair or replace as required.	See para. 10.3
Wiper will not shut off.	Remove connectors from wiper terminals P and L. Connect a jumper from terminal P to L and a 12 Vdc source to terminal P.	If the wiper parks, replace the wiper switch; if the wiper still runs, repair wiper motor by checking the park switch actuator and the brush holder assembly.	See para. 10.10.3
Wiper runs but blades do not move.	1. Check wiper linkage connection to wiper crank arm.	If the linkage is connected, refer to step 2; if linkage is disconnected, refer to step 3.	See para. 10.10.3
	2. Wiper linkage is connected but wiper gear is stripped.	Repair wiper motor.	See para. 10.10.3
	3. Linkage is disconnected.	Connect linkage and check system.	See para. 10.10.3

<u>Trouble</u>	<u>Probable Cause</u>	<u>Remedy</u>	<u>Reference</u>
Windshield Washer/Wiper for Enclosed Cab—GENERAL (cont'd)			
Wiper motor parks but above the normal position.	1. With the ignition switch in RUN and the wiper switch in PARK, remove connector from wiper motor terminal P. Use a test lamp to check for an OPEN between terminal P to ground.	If the lamp lights, proceed to step 2; if the lamp doesn't light, proceed to step 3.	See para. 10.10.3
	2. If the lamp lights repair open in motor or replace holder assembly.	Repair or replace as required.	See para. 10.10.3
	3. If the lamp doesn't light, check arm and blade location and transmission linkage.	Repair or replace as required.	See para. 10.10.3
Windshield washer pump runs but doesn't spray fluid on windshield.	1. Reservoir is empty.	Fill reservoir.	See para. 10.10.2
	2. Washer fluid is frozen.	Use windshield washer fluid with a low freeze point for low temperature operations.	See para. 10.10.2
	3. Washer nozzle or hoses are clogged.	Clean or replace nozzle and hoses.	See para. 10.10.2
	4. Broken, kinked, or disconnected hoses.	Repair, replace, or connect hoses.	See para. 10.10.2
Windshield washer pump doesn't run.	1. Broken washer/wiper switch.	Test switch for continuity in the washer, depressed position; if switch is open, replace switch.	See para. 10.10.1
	2. Wire between switch and washer pump motor is broken.	Repair or replace wire.	See para. 10.3
	3. Broken washer pump motor.	Replace washer reservoir assembly.	See para. 10.10.2

Air Circulation Fan Switch and Fan Motor for Enclosed Cab—GENERAL

Air Circulation Fan Doesn't Run.	1. Wire from circuit breaker is broken.	Repair or replace wire.	See para. 10.11
	2. Fan switch or motor is broken.	Replace air circulation fan assembly.	See para. 10.11

Cab Heater for Enclosed Cab—GENERAL

Heater doesn't produce heat with coolant at operating temperature and heater fan running.	1. Coolant shut off valve in the OFF position.	Turn shut off valve to the ON position.	
	2. Heater hoses clogged, kinked or crushed.	Repair or replace heater hoses.	See para. 10.12.2
	3. Dirty heater core.	Disassemble heater and clean heater core as described in paragraph 10.12.1 & 10.12.2.	See para. 10.12.1 and 10.12.2

Trouble

Probable Cause

Remedy

Reference

Cab Heater for Enclosed Cab—CAB HEATER SWITCH

Blower fan motor doesn't run.	1. Check circuit breaker/fuses.	Replace circuit breaker if open.	See para. 10.4
	2. Check continuity through blower switch in high and low positions.	Replace switch if defective.	See para. 10.12.1
	3. Check motor and fan for mechanical binding.	Realign motor and fan as required to relieve binding.	See para. 10.12.2
	4. Open heater ground at mechanical support.	Check ground at mechanical support for presence of tooth-type washer.	See para. 10.12.2

Cab Heater for Enclosed Cab—HEATER FAN MOTOR AND COIL

Blower fan motor doesn't run.	1. Check circuit breaker.	Replace circuit breaker if open.	See para. 10.4
	2. Check motor and fan for mechanical binding.	Realign motor and fan as required to relieve binding.	See para. 10.12.2
	3. Check continuity through blower switch in high and low positions.	Replace switch if defective.	See para. 10.12.1
	4. Open heater ground at mechanical support.	Check ground at mechanical support for presence of tooth-type washer.	See para. 10.12.2

10.15 SPECIFICATIONS

RATING 12 Vdc Negative Ground

NUMBER AND TYPE OF BATTERIES 2 in parallel, Maintenance Free Lead Acid

CIRCUIT BREAKER RATINGS

Steering Select Valve 6 A

Horn and Backup Alarm (Optional - Heater Fan) 10 A

Instrument Panel, Park Lock Switch 6 A

Ignition Switch Feed for entire Electrical System 40 A

(Optional - Enclosed Cab) 6 A

(Optional - Lighting Package) 15 A

FUSE RATINGS

Steering Select Valve 7.5 A

Horn and Backup Alarm (Optional - Heater Fan) 10 A

Instrument Panel, Park Lock Switch 7.5 A

Ignition Switch Feed for entire Electrical System 40 A

(Optional - Enclosed Cab) 7.5 A

(Optional - Lighting Package) 20 A

BULB QUANTITIES AND BULB NUMBERS FOR FORKLIFT:

Warning Light Gauge Bulbs 4 (GE 161)

BULB QUANTITY AND BULB NUMBERS FOR OPTIONAL LIGHTING SYSTEM (Early Version)

Headlight and Backup Light Bulbs 3 (4411)

Turn Signal Switch Bulb 1 (53)

Turn Signal Bulbs 2 (S1156)

Stop/Tail Bulbs 2 (1157)

Fuel Level Indicator Bulb 1 (GE 1893 or 53X)

BULB QUANTITY AND BULB NUMBERS FOR OPTIONAL LIGHTING SYSTEM (Later Version)

Headlights, Rear Worklights & Boom Light Bulbs 5 (GE894)

Turn Signal Switch Bulb 1 (53)

Turn Signal Bulbs 2 (S1156)

Stop/Tail Bulbs 2 (1157)

Fuel Level Indicator Bulb 1 (GE 1893 or 53X)

Notes

Notes

Notes

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