SECTION 00 – GENERAL INFORMATION

CONTENTS

INTRODUCTION

This service manual provides the technical information needed to properly service and maintain the Models LS180 and LS190 skid steers. Use it in conjunction with the operator's manual which is supplied with the skid steer. Keep both manuals available for ready reference.

The LS180 and LS190 have many similarities with the major difference being a two-speed hydrostatic motor system, which is a factory option on the LS180 and standard on the LS190.

The LS180 skid steers are equipped with the 332T non-emissionized or the 332T/JF emissionized three-cylinder 60 net horsepower turbocharged engine.

The LS190 is equipped with the 450/NC emissionized four cylinder 75 net horsepower naturally aspirated engine.

Whenever working on New Holland equipment, left and right sides of the machine are determined by standing behind the unit, looking in the direction of travel.

The easiest and least time-consuming removal, disassembly, and reassembly procedure are detailed in the manual. Modifying these procedures is not recommended.

New Holland skid steers are designed with emphasis on safety for operator protection. However, careless and negligent operation can still result in serious injury to persons or property. Be sure to read and follow all safety instructions in this manual.

Your New Holland dealer is interested in your obtaining the most from your investment and will be glad to answer any questions you may have about your skid steer. When major service is required, your dealer's staff of trained service technicians is ready to serve you.

When in need of parts, always order genuine New Holland service parts from your New Holland dealer. Be prepared to give your dealer the model and serial number of the engine and skid steer (the location of these numbers is described later in this section). Record the serial numbers here.

Skid Steer Model____________________________

Skid Steer Serial Number_____________________

Engine Model_______________________________

Engine Serial Number________________________

⚠ CAUTION ⚠

This symbol is used throughout this book whenever your own personal safety is involved. Take time to be careful!

ABOUT IMPROVEMENTS

New Holland is continually striving to improve its products. We must, therefore, reserve the right to make improvements or changes when it becomes practical and possible to do so, without incurring any obligation to make changes or additions to the equipment sold previously.

ALL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

COMPANY POLICY

Company policy, which is one of continuous improvement, reserves the right to make changes in design and specifications at any time without notice and without obligation to modify units previously built.

All data given in this book is subject to production variations. Dimensions and weights are approximate only and the illustrations do not necessarily show skid steers in standard condition.

PARTS AND ACCESSORIES

Genuine NEW HOLLAND parts and accessories have been specifically designed for HEW HOLLAND MACHINES.

We would like to point out that “NON GENUINE” parts and accessories have not been examined and released by NEW HOLLAND. The installation and or use of such products could have negative effects upon the design characteristics of your machine and thereby affect its safety. NEW HOLLAND is not liable for any damage caused by the use of “NON GENUINE” NEW HOLLAND parts and accessories.

MODEL CODES

The range of Skid Steers described in this manual is identified in the text by the engine horsepower Pferdestarke. (PS). The skid steers listed below may not be available in all countries or markets.

ENGINE	PS	MODEL
332T/JF	60	LS180
4501NC	75	LS190

PRECAUTIONARY STATEMENTS

PERSONAL SAFETY

Throughout this manual and on machine decals, you will find precautionary statements (“**CAUTION**”, “**WARNING**”, and “**DANDER**”) followed by specific instructions. These precautions are intended for the personal safety of you and those working with you. Please take the time to read them.

⚠ CAUTION ⚠

The word “CAUTION” is used where a safe behavioral practice according to operating and maintenance instructions and common safety practices will protect the operator and others from accident involvement.

⚠ WARNING ⚠

The word “WARNING” denotes a potential or hidden hazard which has a potential for serious injury. It is used to warn operators and others to exercise every appropriate means to avoid a surprise involvement with machinery.

⚠ DANGER ⚠

The word “DANGER” denotes a forbidden practice in connection with a serious hazard.

Failure to follow the “**CAUTION**”, “**WARNING**”, and “**DANGER**” instructions may result in serious bodily injury or death.

MACHINE SAFETY

Additional precautionary statement “**IMPORTANT**” is followed by specific instructions. This statement is intended for machine safety.

IMPORTANT: *The word “**IMPORTANT**” is used to inform the reader of something he needs to know to prevent minor machine damage if a certain procedure is not followed.*

SAFETY PRECAUTION INFORMATION

CAUTION

Unsafe operating practices and improper use of the skid steer and its attachments on the part of the operator can result in injuries. Observe the following safety precautions at all times:

1. **For servicing, the skid steer should be on level terrain, engine stopped with the wheels blocked or the entire skid steer solidly supported with the wheels off the ground before servicing any component of the drivetrain.**
2. **For servicing under the operator's seat, raise the seat and pan assembly up to the raised latched position and securely latch.**
3. **Do not operate the skid steer unless the seat is latched in the operate position.**
4. **Do not service the skid steer with a raised boom unless the boom is resting on the boom lock pins.**
5. **Do not service the skid steer with the engine running unless the skid steer is properly and securely supported with all four wheels off the ground.**
6. **Use caution when servicing the unit around moving parts.**
7. **Do not tilt the boom and cab without proper instruction.**
8. **Do not tilt the boom and cab without using the proper cab tilting tool.**
9. **Reinstall all shields removed for service.**
10. **Never loosen any hydraulic connections before relieving the pressure in the hydraulic system.**
11. **Wear eye protection such as goggles, etc.**
12. **Wear ear protection such as ear plugs, etc. When you feel the noise level is uncomfortable.**
13. **If any servicing or adjustments require the battery to be disconnected, disconnect the (-) negative ground cable.**
14. **When servicing electrical components, disconnect the (-) negative ground cable.**
15. **If the electronic instrument cluster (EIC) requires removal from the dash area or the skid steer disconnect the (-) negative ground battery cable. This will shut off power to the EIC and prevent damage to the EIC board or blowing the 5-amp fuses if the board is accidentally grounded.**
16. **If welding is required on the skid steer, disconnect the (-) negative ground cable. failure to disconnect the battery may result in damage to the EIC (Electronic Instrument Cluster) monitoring system and other electrical components.**
17. **If welding is required on an attachment, remove the attachment from the skid steer.**
18. **Give complete and undivided attention to the job at hand so that complete control of the skid steer is maintained at all times.**
19. **Drive slowly over rough ground and on slopes; keep alert for holes, ditches and other irregularities that may cause the skid steer to overturn.**
20. **Avoid steep hillside operation which could cause the skid steer to overturn.**
21. **Never transport a loaded bucket at full height. Operate the skid steer with the load as low as possible until it becomes necessary to raise the boom to discharge the load into a truck, container, etc.**
22. **Reduce speed when turning so there is no danger of the skid steer overturning.**
23. **Never drive up or back up a hill or incline with a raised boom or the skid steer could over turn.**
24. **Always look behind you before backing the skid steer.**
25. **Maintain proper transmission oil level to prevent loss of hydrostatic braking.**
26. **Do not allow passengers to ride on the skid steer at any time.**
27. **Do not allow children to operate the skid steer or ride on the skid steer at any time.**
28. **Do not allow anyone to operate the skid steer without proper instruction. OSHA requires that all operators be instructed on the proper operation of the machine before they operate the unit.**
29. **Do not operate the skid steer in any position other than while in the operator's seat with the seat belt securely fastened.**

30. Before starting the engine, be sure that all operating controls are in neutral and the parking brake is engaged.

31. Never operate the skid steer engine in a closed building without adequate ventilation.

32. Refuel the skid steer outdoors with the engine shut off. Replace the fuel cap securely. Use an approved fuel container. Do not smoke when handling fuel. Avoid spilling fuel.

33. After operating the engine, never touch the muffler, exhaust pipe, engine or radiator until they have had time to cool.

34. Dress appropriately - wear relatively tight-fitting clothing when operating the skid steer. Loose or torn clothing can catch in moving parts or controls.

35. Before servicing the skid steer or any of its attached equipment, be sure that the attachments are lowered to the ground or that the boom arms are supported by the boom lock pins.

36. Do not work under overhangs, electric wires, or where there is danger of a slide.

37. Wear an approved safety hat when operating the machine and while in any work area.

38. When driving the skid steer on a road or highway, use warning lights or warning devices as may be required by local or state government regulations. Headlights, warning lights and smv signs are available through your new holland dealer.

39. Keep the skid steer clean. do not allow trash, debris or other articles to accumulate in the cab, floor or foot control pedal area that may hinder safe machine operation.

40. Never operate the skid steer with any of the shielding removed.

41. Never operate the skid steer without windows and/or screens in place.

42. Never extend any part of the body outside of the operator's area.

43. Always properly tie down the skid steer to a truck or trailer before transport.

44. Make sure all bystanders are at a safe distance away from the skid steer before starting the engine.

45. Do not allow anyone near the skid steer while the engine is running and the skid steer is operational.

46. When using the skid steer to crane objects, do not allow any person to ride on objects being craned.

47. Do not use the skid steer as a work platform for supporting materials.

48. Do not lift personnel or allow personnel to work while standing in the bucket or on other attachments. This is not a man-lift.

OSHA requirements now make it the employer's responsibility to fully instruct each operator in the proper and safe operation of all operative equipment. Both employer and employee should thoroughly familiarize themselves with the following sections.

CAUTION

Some pictures in this manual show safety shields removed or open to show parts being serviced or for clarity. All shields should be closed or replaced prior to operating the machine.

DANGER

Fasten seat belt before starting engine!

This skid steer is a very stable unit but it can be upset if stopped suddenly when the bucket is raised and loaded.

Therefore, do not start the engine before securely fastening the seat belt, and carry the load low.

GENERAL SAFETY INFORMATION

HANDLE FLUIDS SAFELY

When you work around fuel or other flammable material, do not smoke, work near heaters or other fire hazards.

Do not store flammable material in open containers.

Store flammable fluids away from fire hazards.

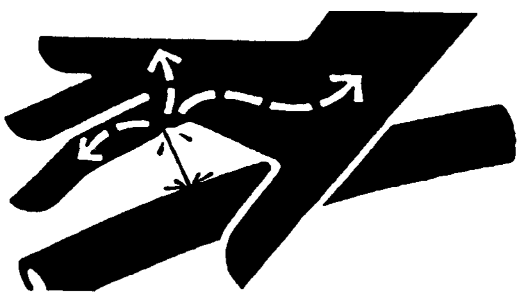
Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, oil, and debris.

Do not store oily rags; they can ignite and burn spontaneously.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



USE CARE AROUND HIGH-PRESSURE FLUID LINES

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines.

Tighten all line connections before applying pressure.

Check for leaks with a piece of cardboard.

Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.

AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders.

Do not heat by welding, soldering, or using a torch near pressurized fluid lines.

Pressurized lines can be accidentally cut or damaged when heat goes beyond the immediate flame area.

USE CARE IN HANDLING AND SERVICING BATTERIES

Prevent Battery Explosions

Keep sparks, lighted matches, and open flame away from the top of the battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Do not charge a frozen battery; it may explode. Warm the battery to 60° F (16° C).

WARNING

If any servicing or adjustments require the battery to be disconnected, or welding is required on the skid steer, disconnect the (-) negative ground cable. Failure to disconnect the battery may result in damage to the EIC (electronic instrument cluster) monitoring system and other electrical components.

WARNING

If welding on an attachment is required, first remove the attachment from the skid steer boom attaching plate.

WARNING

Engine starting with a booster battery requires extreme care as batteries produce explosive gases. The slightest spark can cause an explosion.

Follow these safety tips:

1. **Always shield your eyes when charging or working near a battery. Always provide good ventilation.**
2. **Cover the battery with a piece of carpet or other heavy material. Do not remove the battery vent caps.**
3. **Connect one cable to the (+) positive terminal of the weak battery. Connect the other end of the cable to the (+) positive terminal of the stronger battery.**
4. **Connect the second cable to the (–) negative terminal of the stronger battery.**
5. **Connect the remaining (–) negative cable end to the engine block or starter ground terminal.**
6. **Reverse this procedure when disconnecting the booster.**

USE SAFE SERVICE PROCEDURES

Wear Protective Clothing

Do not wear loose clothing.

Wear close-fitting clothing.

Wear safety glasses or face shield as required.

Wear other safety equipment appropriate to the job.

Wear earplugs or earmuffs as required.

SERVICE MACHINES SAFELY

Use caution when working around moving parts.

If servicing requires the boom to be in the raised position, support the boom on the boom locks and remove any attachment from the boom mounting plate. If servicing requires the complete skid steer to be in the supported position, support all four wheels off the ground using adequate jack stands or blocks.

If servicing requires the engine to be operated, raise the machine and properly support the unit with adequate jack stands or blocking with all four wheels off the ground.

CAUTION

Before servicing the skid steer or any of its attached equipment, be sure that the attachments are lowered to the ground or the boom arms are supported by the boom lock pins.

USE PROPER TOOLS

Use tools appropriate for the job.

If tilting of the cab is required, use the proper tools and follow the procedure for tilting the cab in Section 1 of this manual.

REVIEW SAFETY EQUIPMENT, SIGNS AND SHIELDS

Replace missing or damaged safety decals.

Reinstall all shielding removed for servicing.

Replace any damaged or missing shielding.

CONTROLS

Operate unit and check machine functions for proper operation.

Check seat belt for proper operation, wear, and damage - Replace as needed.

Check operator restraint system - EIC for proper operation.

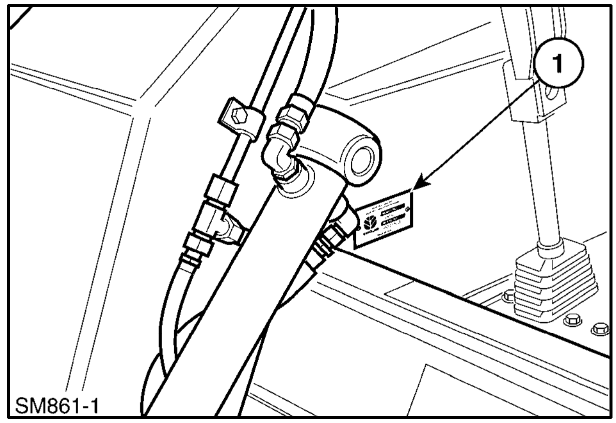
Check boom and bucket spool locks for proper operation.

Check mechanical boom locks for proper operation.

Check parking brake for proper operation and adjustment.

MACHINE MODEL AND SERIAL NUMBER LOCATION

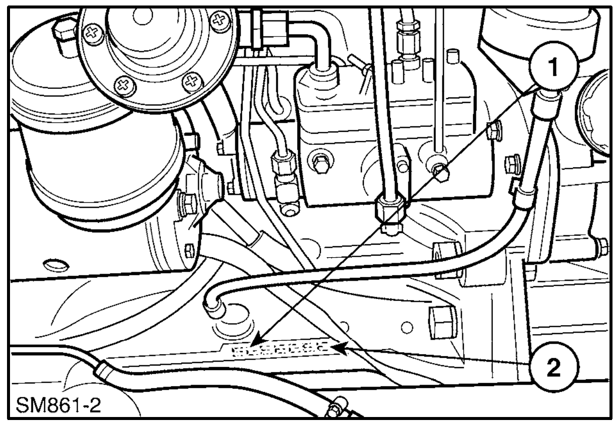
The skid steer model and serial number tag is located on the right front interior of the operator's cab at 1.



1

ENGINE MODEL AND SERIAL NUMBER LOCATION

The engine model is located on the left side of the block at 1, and the engine serial number is located at 2.



2

For the tightening torques for reassembly, use the following hardware torque charts unless the torque is specified in the instructions.

MINIMUM HARDWARE TIGHTENING TORQUES

IN FOOT POUNDS (NEWTON-METERS) FOR NORMAL ASSEMBLY APPLICATIONS

INCH HARDWARE AND LOCKNUTS

NOMINAL SIZE	SAE GRADE 2		SAE GRADE 5		SAE GRADE 8		LOCKNUTS		NOMINAL SIZE
	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	GR.B w/GR5 BOLT	GR.C w/GR8 BOLT	
1/4	55* (6.2)	72* (8.1)	86* (9.7)	112* (13)	121* (14)	157* (18)	61* (6.9)	86* (9.8)	1/4
5/16	115* (13)	149* (17)	178* (20)	229* (26)	250* (28)	324* (37)	125* (14)	176* (20)	5/16
3/8	17 (23)	22 (30)	26 (35)	34 (46)	37 (50)	48 (65)	19 (26)	26 (35)	3/8
7/16	27 (37)	35 (47)	42 (57)	54 (73)	59 (80)	77 (104)	30 (41)	42 (57)	7/16
1/2	42 (57)	54 (73)	64 (87)	83 (113)	91 (123)	117 (159)	45 (61)	64 (88)	1/2
9/16	60 (81)	77 (104)	92 (125)	120 (163)	130 (176)	169 (229)	65 (88)	92 (125)	9/16
5/8	83 (112)	107 (145)	128 (174)	165 (224)	180 (244)	233 (316)	90 (122)	127 (172)	5/8
3/4	146 (198)	189 (256)	226 (306)	293 (397)	319 (432)	413 (560)	160 (217)	226 (306)	3/4
7/8	142 (193)	183 (248)	365 (495)	473 (641)	515 (698)	667 (904)	258 (350)	364 (494)	7/8
1	213 (289)	275 (373)	547 (742)	708 (960)	773 (1048)	1000 (1356)	386 (523)	545 (739)	1

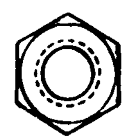
NOTE: Torque values shown with * are inch pounds.

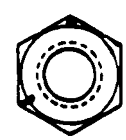
IDENTIFICATION
CAP SCREWS AND CARRIAGE BOLTS

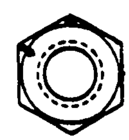

SAE GRADE 2


SAE GRADE 5

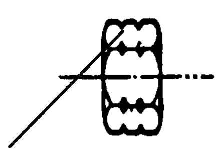

SAE GRADE 8


REGULAR NUTS


SAE GRADE 5 HEX NUTS


SAE GRADE 8 HEX NUTS

LOCKNUTS

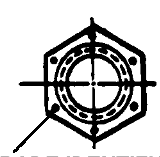


GRADE IDENTIFICATION

GRADE A NO NOTCHES

GRADE B ONE CIRCUMFERENTIAL NOTCH

GRADE C TWO CIRCUMFERENTIAL NOTCHES



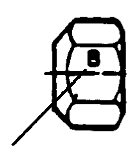
GRADE IDENTIFICATION

GRADE A NO MARKS

GRADE B THREE MARKS

GRADE C SIX MARKS

MARKS NEED NOT BE LOCATED AT CORNERS



GRADE A NO MARK
GRADE B LETTER B
GRADE C LETTER C

GRADE IDENTIFICATION

MINIMUM HARDWARE TIGHTENING TORQUES

IN FOOT POUNDS (NEWTON-METERS) FOR NORMAL ASSEMBLY APPLICATIONS

METRIC HARDWARE AND LOCKNUTS

NOMINAL SIZE	CLASS 5.8		CLASS 8.8		CLASS 10.9		LOCKNUT CL.8 W/CL8.8 BOLT
	UNPLATED	PLATED W/ZnCr	UNPLATED	PLATED W/ZnCr	UNPLATED	PLATED W/ZnCr	
M4	15* (1.7)	19* (2.2)	23* (2.6)	30* (3.4)	33* (3.7)	42* (4.8)	16* (1.8)
M6	51* (5.8)	67* (7.6)	79* (8.9)	102* (12)	115* (13)	150* (17)	56* (6.3)
M8	124* (14)	159* (18)	195* (22)	248* (28)	274* (31)	354* (40)	133* (15)
M10	21 (28)	27 (36)	32 (43)	41 (56)	45 (61)	58 (79)	22 (30)
M12	36 (49)	46 (63)	55 (75)	72 (97)	79 (107)	102 (138)	39 (53)
M16	89 (121)	117 (158)	137 (186)	177 (240)	196 (266)	254 (344)	97 (131)
M20	175 (237)	226 (307)	277 (375)	358 (485)	383 (519)	495 (671)	195 (265)
M24	303 (411)	392 (531)	478 (648)	619 (839)	662 (897)	855 (1160)	338 (458)

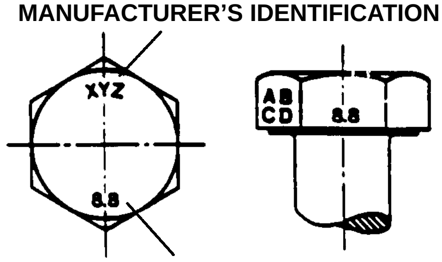
NOTE: Torque values shown with * are inch pounds.

IDENTIFICATION

HEX CAP SCREW AND CARRIAGE BOLTS

CLASSES 5.6 AND UP

MANUFACTURER'S IDENTIFICATION

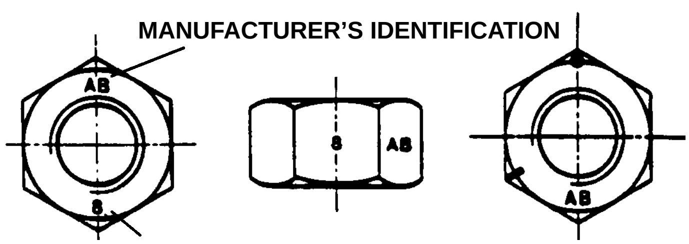


PROPERTY CLASS

HEX NUTS AND LOCKNUTS

CLASSES 05 AND UP

MANUFACTURER'S IDENTIFICATION



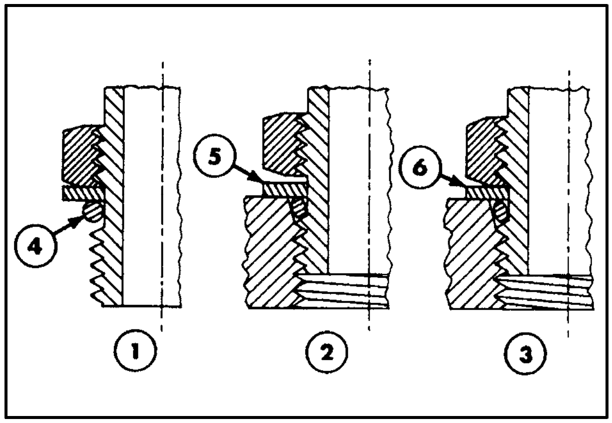
PROPERTY CLASS CLOCK MARKING

INSTALLATION OF ADJUSTABLE FITTINGS IN STRAIGHT THREAD O RING BOSSES

1. Lubricate the O ring by coating it with a light oil or petroleum. Install the O ring in the groove adjacent to the metal backup washer which is assembled at the extreme end of the groove, 4.
2. Install the fitting into the SAE straight thread boss until the metal backup washer contacts the face of the boss, 5.

NOTE: *Do not over tighten and distort the metal backup washer.*

3. Position the fitting by turning out (counterclockwise) up to a maximum of one turn. Holding the pad of the fitting with a wrench, tighten the locknut and washer against the face of the boss, 6.



3

STANDARD TORQUE DATA FOR HYDRAULIC TUBES AND FITTINGS

SIZE	TUBE NUTS FOR 37° FLARED FITTINGS – TUBING OD In.	mm	THREAD SIZE	TORQUE – FOOT POUNDS Min.	Max.	NEWTON METERS Min.	Max.	O RING BOSS PLUGS ADJUSTABLE FITTING LOCKNUTS, SWIVEL JIC - 37° SEATS – TORQUE – FOOT POUNDS Min.	Max.	NEWTON METERS Min.	Max.
4	1/4	6.4	7/16-20	9	12	12	16	6	10	8	14
5	5/16	7.9	1/2-20	12	15	16	20	10	15	14	20
6	3/8	9.5	9/16-18	21	24	29	33	15	20	20	27
8	1/2	12.7	3/4-18	35	40	47	54	25	30	34	41
10	5/8	15.9	7/8-14	53	53	72	79	35	40	47	54
12	3/4	19.1	1-1/16-12	77	82	104	111	60	70	81	95
14	7/8	22.2	1-3/16-12	90	100	122	136	70	80	95	109
16	1	25.4	1-5/16-12	110	120	149	163	80	90	108	122
20	1-1/4	31.8	1-5/8-12	140	150	190	204	95	115	129	158
24	1-1/2	38.1	1-7/8-12	160	175	217	237	120	140	163	190
32	2	50.8	2-1/2-12	225	240	305	325	250	300	339	407

These torques are not recommended for tubes of 1/2″ (12.7 mm) OD and larger with wall thickness of 0.035″ (0.889 mm) or less. The torque is specified for 0.035″ (0.889 mm) wall tubes on each application individually.

Before installing and torquing 37° flared fittings, clean the face of the flare and threads with a clean solvent or Loctite cleaner and apply hydraulic sealant Loctite no. 569 to the 37° flare and the threads.

Install fitting and torque to specified torque, loosen fitting and retorque to specifications.

PIPE THREAD FITTING TORQUE

Thread Size	Torque (Maximum)
1/8″ – 27	13 N·m (10 ft. lbs.)
1/4″ – 18	16 N·m (12 ft. lbs.)
3/8″ – 14	22 N·m (16 ft. lbs.)
1/2″ – 14	41 N·m (30 ft. lbs.)
3/4″ – 14	54 N·m (40 ft. lbs.)

Before installing and tightening pipe fittings, clean the threads with a clean solvent or Loctite cleaner and apply sealant Loctite no. 567 for all fittings including stainless steel or no. 565 for most metal fittings. For high filtration/zero contamination systems use no. 545.

LUBRICANTS AND COOLANTS

Application	New Holland Part Number	Specification
Gearboxes, Final Drive chain case	1 qt – #9613295 2.5 gal – #9613294 4 L – #9613375	SAE 80W 90
Hydraulic/Transmission	1 qt – #9613313 2.5 gal – #9613314 1 L – #9613358 20 L – #9613360	API Service SH–CG4 10W-30
All lubrication fittings	Tube – #9613310	High viscosity lithium base grease
Engine	1 qt – #9613313 2.5 gal – #9613314 1 L – #9613358 20 L – #9613360	API Service SH-CG4 10W-30 Refer to Operator’s Manual for Temperature/Oil usage Chart
Cooling System	1 gal – #FGCC2701DS	Antitreeze/Water 50/50 Mixture (Ethylene Glycol)

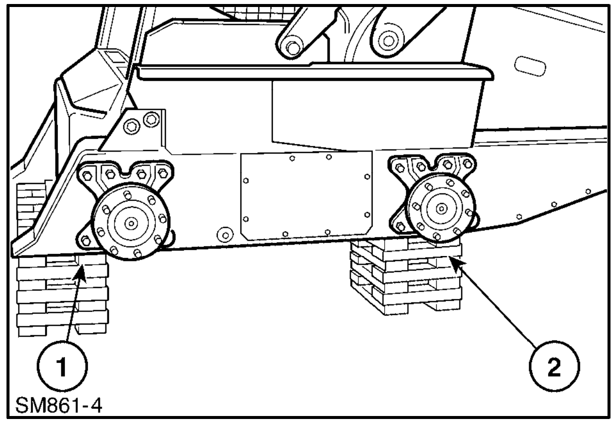
SEALANTS

Description	New Holland Part Number	Typical Applications	Strength	Color
Thread Lock	L22200 (222) L24231 (242) L29000 (290) L26231 (262)	Small screws/hardware Wicking Type Nuts & Bolts	Low Medium Medium High	Purple Blue Green Red
Thread Sealants	L54531 (545) L56531 (565) L56747 (567)	Hydraulic/Pneumatic Pipe Sealant Pipe Sealant	Non fouling Controlled strength High Temperature	
Silicones	L81724 (3.5 oz tube) L58775 (10.2 oz. cartridge) L82180 (3.35 oz. tube) L59875 (10.2 oz. cartridge)	Ultra Blue RTV Gasket Ultra Blue RTV Gasket Ultra Blue RTV Gasket Ultra Blue RTV Gasket	Non-corrosive Non-corrosive Non-corrosive Non-corrosive	Blue Blue Black Black

PROPERLY SUPPORT A RAISED MACHINE

If servicing, neutral adjustment, final drive adjustment or repairs require the machine to be raised, securely support the machine with adequate jack stands or blocks as shown.

Support the machine at 1, to the front of the final drive cases and the rear at 2, making sure the supports are on the flat area of the final drive cases.

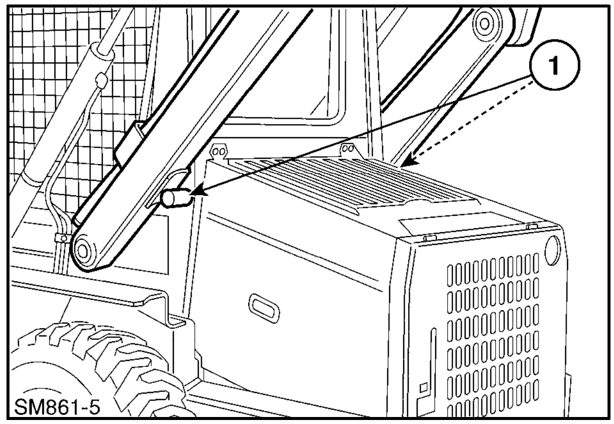


4

PROPERLY SUPPORT BOOM ON BOOM LOCK PINS

Before servicing the machine or any of its attached equipment, be sure that the attachments are lowered to the ground or the boom arms are supported by the boom lock pins, 1.

If the boom is to be raised on boom lock pins, remove any attachment. Opening a hydraulic line could cause a mounted attachment to dump over unexpectedly.

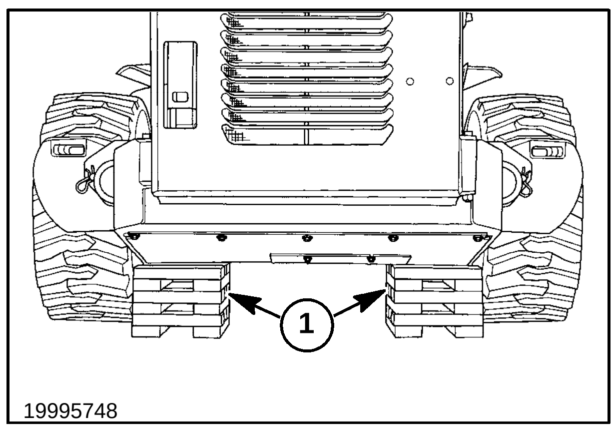


5

RAISING BOOM WITHOUT HYDRAULIC OIL FLOW

(Engine or Hydraulic System not functioning)

1. Remove any attachment from the boom mounting plate.
2. Block the rear of the skid steer under the rear of the final drive cases, 1, as shown. This will prevent the front wheels from raising during boom lifting.

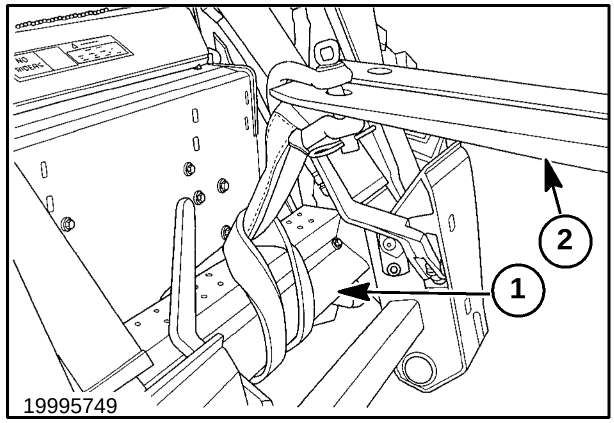


6

3. Attach a fork lift or overhead hoist to the main boom, 1, and lifting device, 2. Attach chain or strap securely to prevent unhooking during boom lifting.

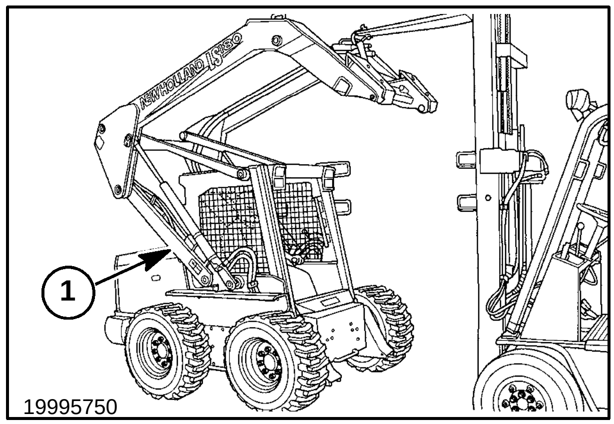
CAUTION

Attach suitable chains or straps capable of handling the weight of the boom, about 450 kg (1000 lbs.). Attach chains securely to prevent them from coming loose during lifting of the boom.



7

4. With an Operator sitting in the Operator's seat with the seat belt buckled.
5. Turn the ignition key to the "ON" position. Foot controls, press the toe of the left foot pedal, boom control, or hand controls, pivot the left hand control lever down, into the boom float position.
6. Slowly raise the boom above the boom lock pins, 1.
7. Operator sitting in seat, engage the boom lock pins, 1.
8. Lower the boom and rest on the boom lock pins, 1.
9. Return the boom control to the "NEUTRAL" position.
10. Turn the ignition key to the "OFF" position.



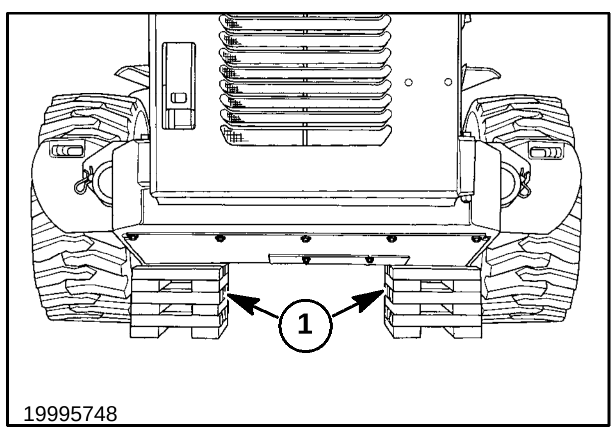
8

CAUTION

The operator must not leave the operator's seat until the boom is resting solidly on the boom lock pins. The boom could drop suddenly if lifting devices should fail.

RAISING BOOM WITHOUT BATTERY VOLTAGE (12 VOLTS)

1. Remove any attachment from the boom mounting plate.
2. Block the rear of the skid steer under the rear of the final drive cases, 1, as shown. This will prevent the front wheels from raising during boom lifting.

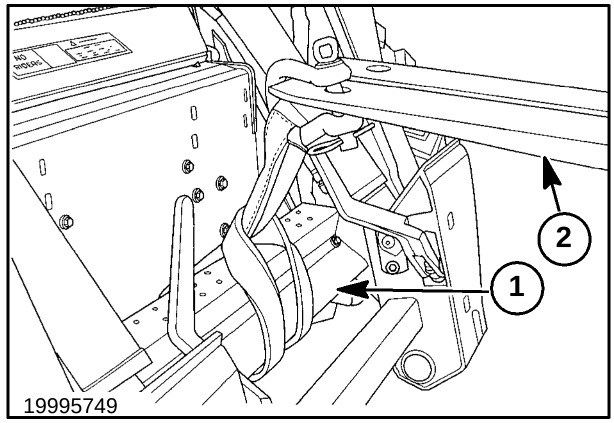


9

3. Attach a fork lift or overhead hoist to the main boom, 1, and lifting device, 2. Attach chain or strap securely to prevent unhooking during boom lifting.

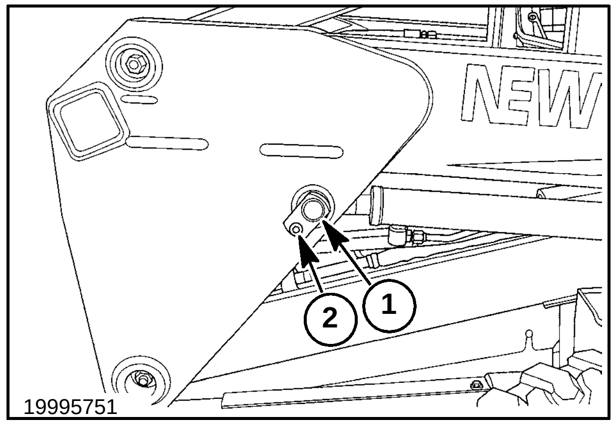
CAUTION

Attach suitable chains or straps capable of handling the weight of the boom, about 450 kg (1000 lbs.). Attach chains securely to prevent them from coming loose during lifting of the boom.



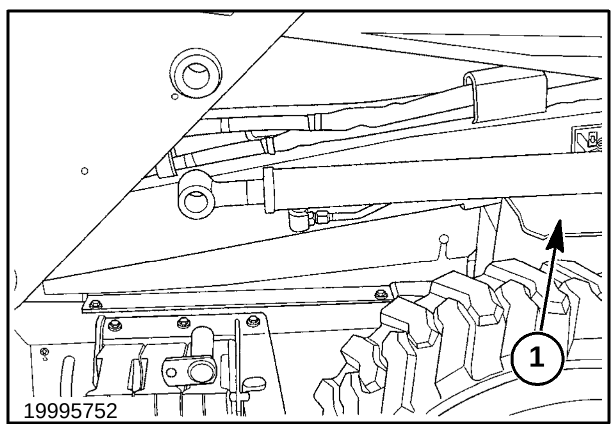
10

4. Remove the rod end (top) pivot pins, 1, from both cylinders. Remove retaining hardware, 2, from pivot pin and boom.



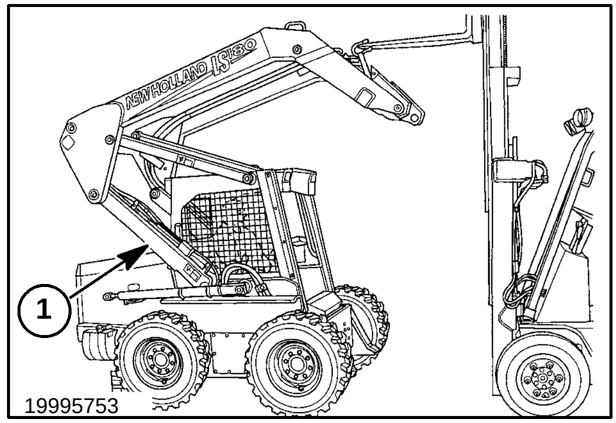
11

5. Support the cylinders on the fenders, 1, as shown.



12

6. With an Operator sitting in the Operator's seat with the seat belt buckled.
7. Slowly raise the boom above the boom lock pins, 1.
8. Operator sitting in seat, engage the boom lock pins, 1.
9. Lower the boom and rest on the boom lock pins, 1.



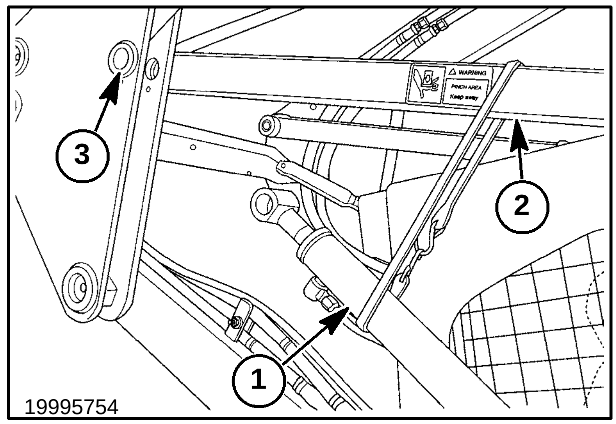
13

CAUTION

The operator must not leave the operator's seat until the boom is resting solidly on the boom lock pins. The boom could drop suddenly if lifting devices should fail.

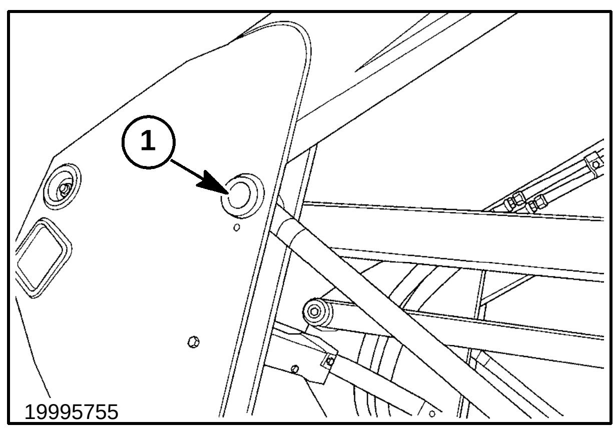
REATTACHING CYLINDERS AFTER REPAIR WITH BOOM RESTING ON BOOM LOCK PINS

1. Support the rod end of cylinders, 1, off the boom upper links, 2, to align with main boom cylinder pivot pin holes, 3.



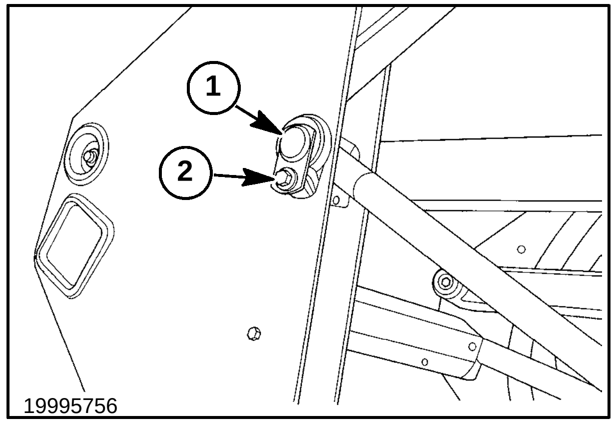
14

2. Operator sitting in the Operator's seat with seat belt buckled.
3. Start the engine and hydraulically extend cylinder rods to align cylinder with pivot pin, 1. Stop engine.
4. Turn the ignition key to the "ON" position. Foot controls, press the toe of the left foot pedal, boom control, or hand controls, pivot the left hand control lever down, into the boom float position, turn the ignition key to the "OFF" position.
5. If cylinder and boom are not properly aligned, use a pry bar to align cylinder and boom.



15

6. Install pivot pin, 1, and secure with retaining hardware, 2. Torque bolts to 38 Nm (28 ft. lbs.).
7. Start the engine and hydraulically extend the second cylinder rod to align cylinder with pivot pin. Stop engine.
8. If cylinder and boom are not properly aligned, sit in the operator’s seat with seat buckled, turn the ignition key to the “ON” position.
9. Move the boom control to the “DETENT (float) position and turn the ignition key to the “OFF” position.
10. Use a pry bar and align cylinder with boom and install pivot pin, 1, and retaining hardware, 2, and torque to 38 Nm (28 ft. lbs.).



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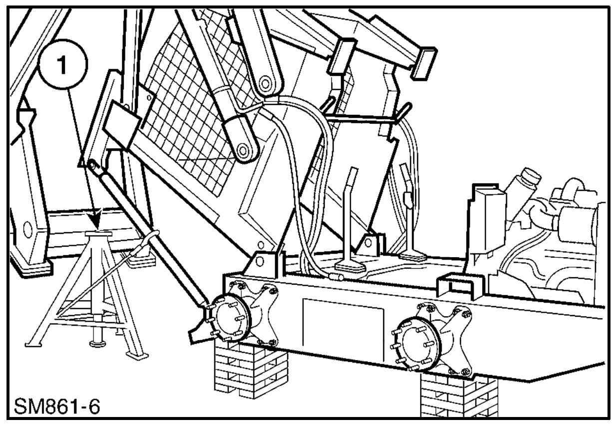
MAJOR UNIT OVERHAUL

For a major hydrostatic component or engine repair, the skid steer cab and boom assembly can be tilted forward for easier access to the components area. The skid steer is shown properly supported at 1, and the cab tilted forward.



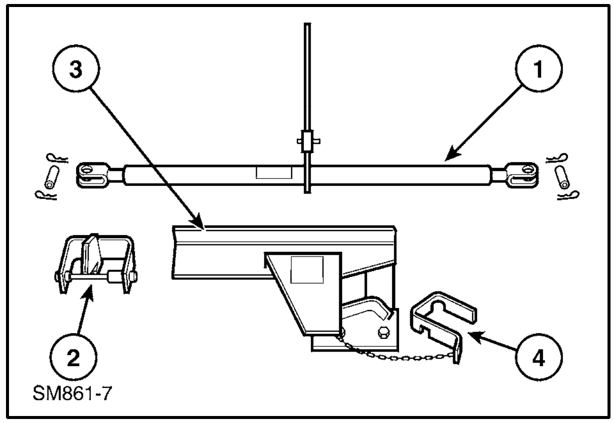
17

WARNING

Never attempt to tilt the skid steer cab without using the proper tool and instructions. See more detail later in this section of the manual and/or contact your New Holland dealer.

CAB AND BOOM TILT PROCEDURE

The cab and boom assembly can be tilted forward for easier access to the major skid steer hydrostatic transmission or engine components. To tilt the cab, the proper cab tilting tool must be used to insure a safe operation and to prevent damage to theskid steer frame, cab, and boom structure. Contact your New Holland dealer for major service or repairs of the skid steer. Using the proper cab tilting tool and following these steps, the cab and boom can be tilted forward.

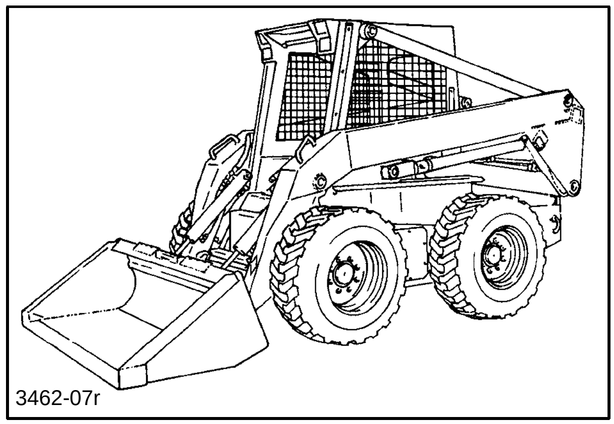


18

Cab Tilting Jack and Support Bracket

1 Jack and screw assembly
2 Lower jack support
3 Upper jack support
4 Spacer plate (not required)

1. Remove any attachment, bucket etc. from the boom quick-attach plate.



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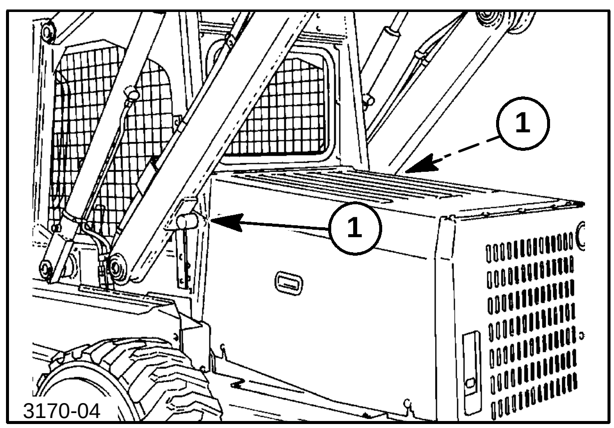
2. Raise the boom and lower onto boom lockpins, 1.
   - Raise boom above boom lockpins.
   - Engage boom lockpins.
   - Stop engine, turn ignition key to “OFF” position.
   - Turn ignition key to the “ON” position.
   - Lower boom onto boom lockpins.
   - Turn the ignition key to the “OFF” position.



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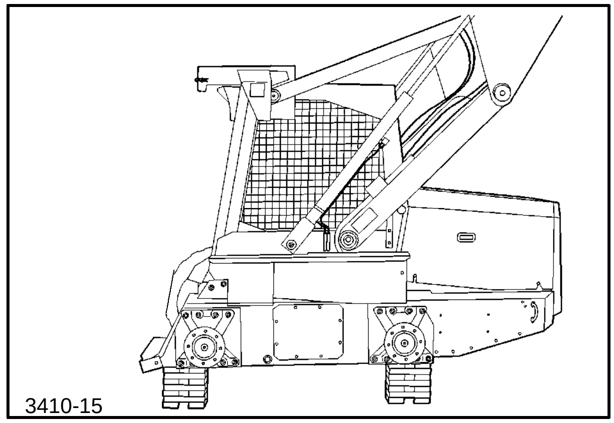
3. Jack up the skid steer and block it securely with all four wheels off the ground, as shown. Position the front blocks to the front of the final drive housings and the rear blocks to the rear of the flat area of the final drive housing

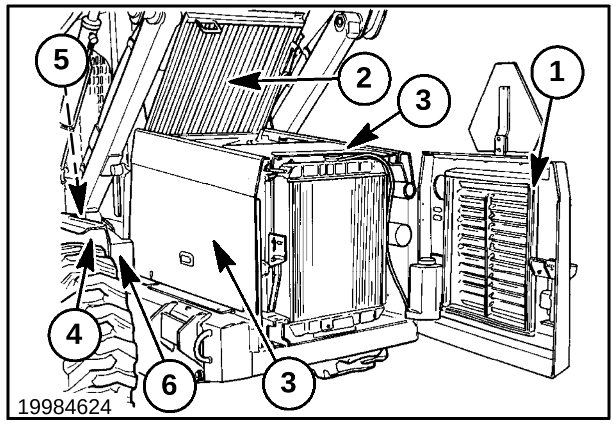
WARNING

Never attempt to tilt the skid steer cab over unless the skid steer is securely supported.



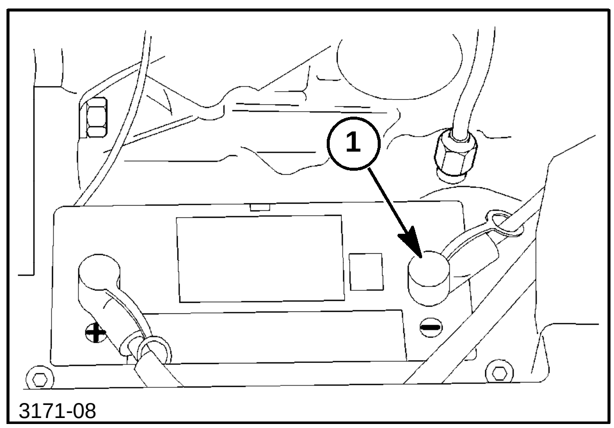
21

4. Open the rear door, 1, raise and latch the top engine shield, 2, in the raised position.
5. Remove engine side covers, 3.
6. Remove fenders, 4, rear fender supports, 6, right and left sides.
7. Remove foam material, 5, from both sides.



22

8. Disconnect the battery, negative(-) cable, 1.



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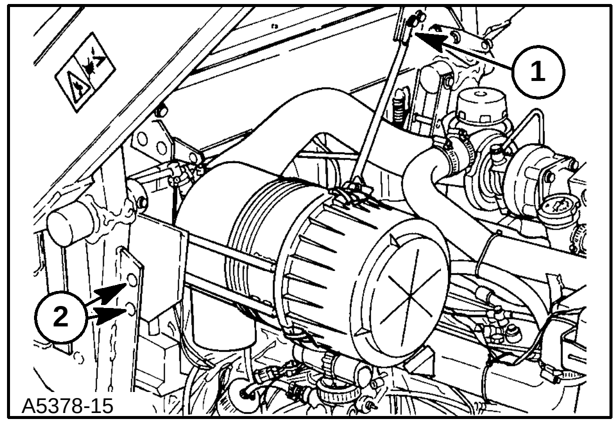
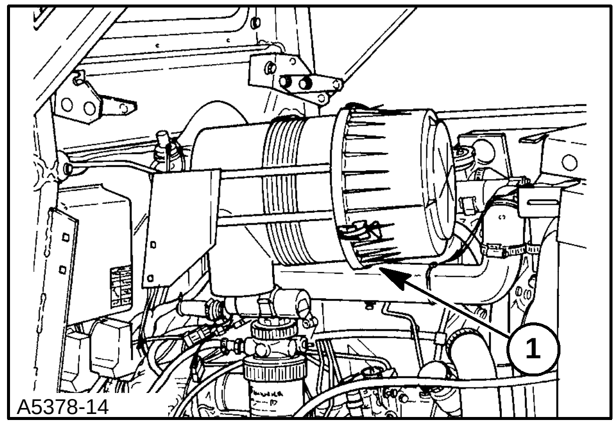
9. Remove support rod hardware at 1. Remove air cleaner canister support hardware at 2.



24

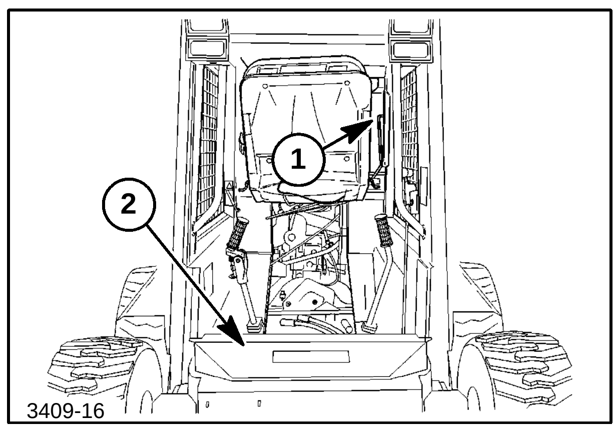
10. Allow the air cleaner canister assembly to rest on the engine as shown at 1.

NOTE: *If the unit is equipped with the cab heater, the water supply lines to the heater core must be disconnected and capped.*



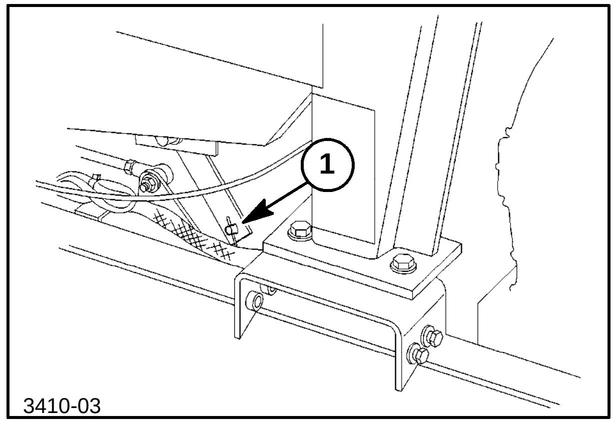
25

11. Raise the seat and lock in the up position, 1. Make sure the seat pan assembly is latched securely.
12. Remove the front step shield, 2.



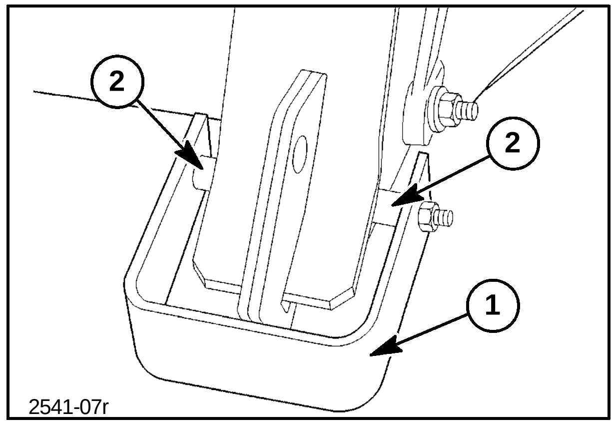
26

13. Remove the cotter pins from the parking brake linkage, unhook link rod, 1, and raise the parking brake lever to the engaged position.



27

14. Install the lower cab jack support, 1. Hook the support over the end of the front left final drive housing at and attach with a 1/2″ x 8″ cap screw, 2.



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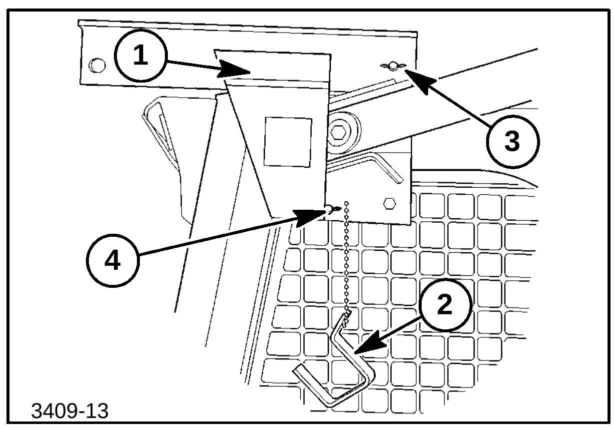
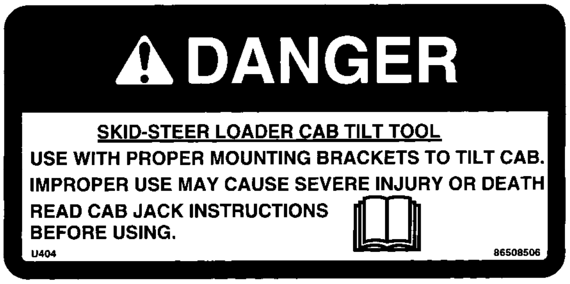
15. Install the upper cab jack support, 1. Pivot the retaining plate, 3, up behind the boom top link and secure with 1/2″ x 1-1/4″ carriage bolt and 1/2″ wing nut. Install retaining bolt, 4, 1/2″ x 2-1/2″ cap screw through side of cab with a large 1/2″ flat washer, 1/2″ wing nut to the inside of cab and tighten.

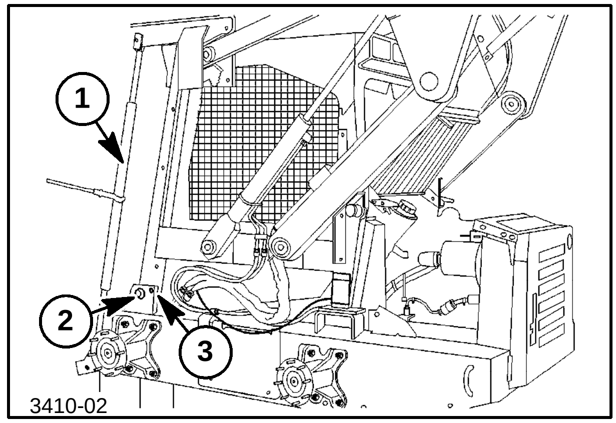
NOTE: *Spacer, 2, is not required for the LS180 and LS190 skid steers.*



29

16. Install the jack assembly, 1, between the upper and lower supports using two pins and retaining clips.





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17. Loosen the front cab mounting bolts, 2, (one each side) **only** enough to allow the bolt to rotate in post and remove the rear front cab bolts, 3, one each side.

CAUTION

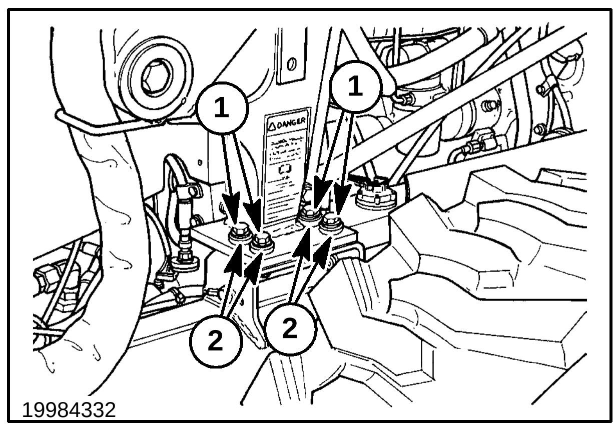
Never remove the front cab bolts, 2, as these are the pivot bolts during the cab tilting procedure. Removal of these bolts could cause cab to fall, and may cause injury and machine damage.

18. Remove the rear cab post bolts, 1, four each side.

NOTE: *If the rear bolts, 1, have spacers under the bolt heads at 2, they must be reinstalled during reassembly for proper bolt torquing.*

CAUTION

Never loosen or remove any cab retaining hardware before the jack assembly is installed.



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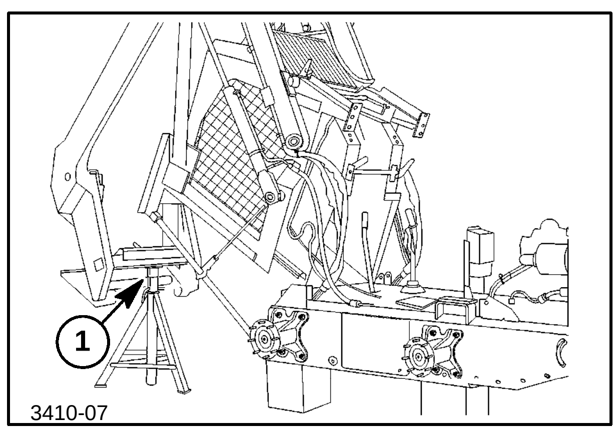
19. Jack cab and boom assembly over with the loader properly supported off the ground. Support the boom at 1, to support the boom and cab to prevent tipping of the skid steer when heavy components, engine, hydrostatic pumps etc. are removed from the lower frame. Jack travel will limit the travel of the cab assembly to prevent over travel. Be sure all wire harnesses, hydraulic hoses, and throttle cable clear any obstructions during cab tilting.



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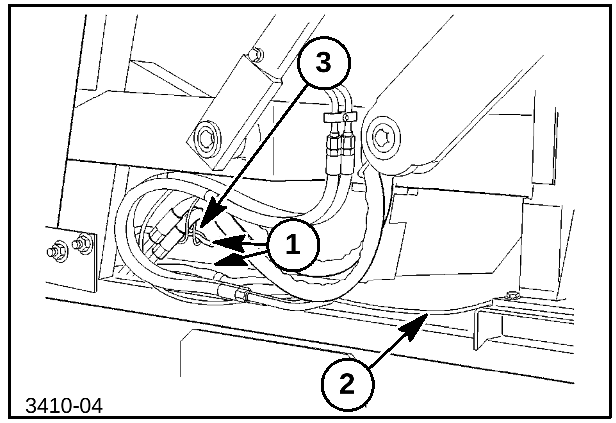
To return and secure the cab and boom assembly safely, do the following:

1. Pull the hydrostat control handles forward and hold in this position with rubber tie straps from the handle to the front cab post.
2. Jack the cab and boom back into position.
3. Keep the wire harness, 1, and throttle cable, 2, in position to prevent damage from setting the cab on them.



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CAUTION

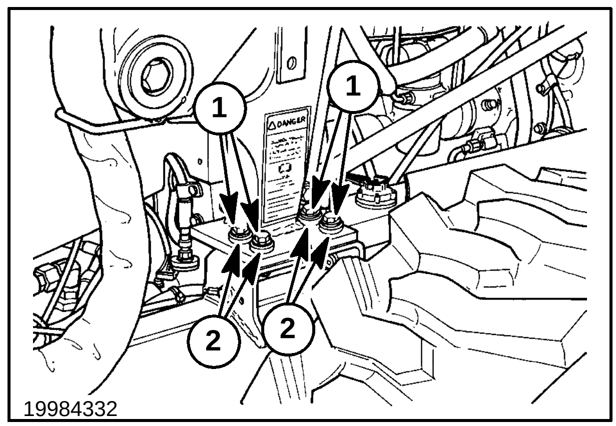
Keep the wire harness from being damaged. A Damaged wire harness could result in damage to the skid steer electrical components.

4. Pull the wire harness through the loop, 3.
5. Remove rubber tie straps from the hydrostatic control handles.
6. Reinstall all cab support bolts front and rear.

NOTE: *If spacers were installed under the rear cab support bolts, 1, the spacers, 2, must be reinstalled for proper torquing.*

- Torque the rear bolts, 1, to 80 ft. lbs. (108 N·m), four bolts each side.

7. Reinstall the parking brake linkage, 2.
8. Position the throttle cable, 3, inside frame.



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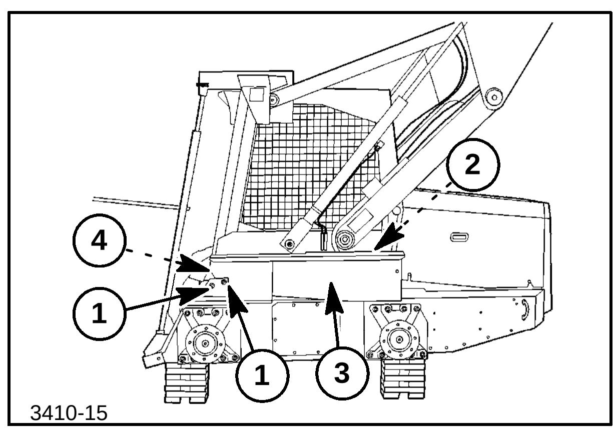
9. Torque the front bolts, 1, to 160 ft. lbs. (217 N·m).
10. Reinstall the foam, 2, fenders, 3, and front step shield, 4.



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WARNING

Never attempt to tilt the skid steer cab without proper instructions and using the proper tool. See the service manual and/or your new holland dealer.

Never attempt to operate or move the skid steer without first installing and properly tightening all cab retaining hardware.

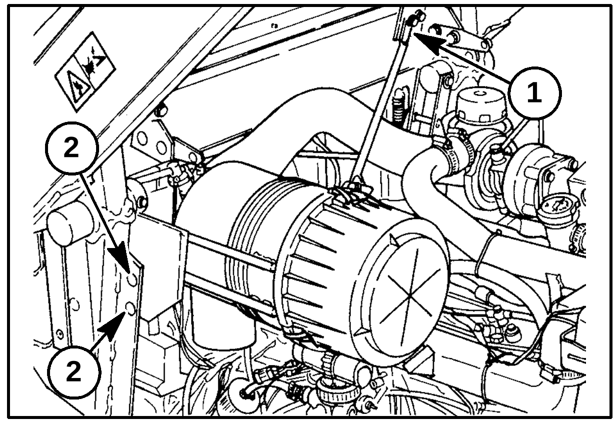
CAUTION

Reinstall all shields that were removed for servicing and adjustment procedures.

11. Reattach the air cleaner canister to the ROPS post at 2, and the support rod at 1.

IMPORTANT: *Support the air cleaner assembly level and tighten all attaching hardware.*

12. Remove jack and supports.
13. Reconnect the battery cable.



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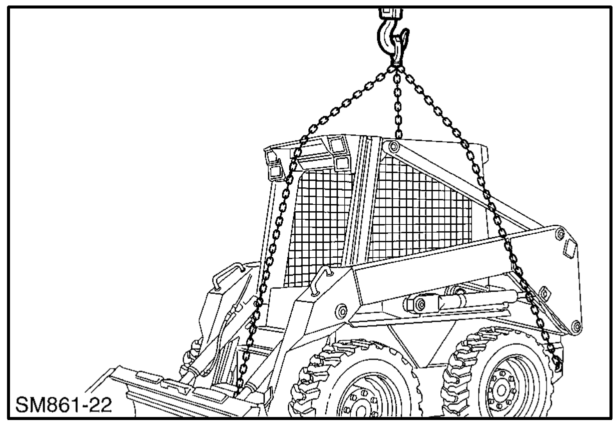
CRANING THE SKID STEER

If the skid steer is inoperative and located in an area where it cannot be loaded onto a truck or trailer, the unit may be craned to load the unit.

To crane the loader, only use chain or cable with a rated capacity to handle the weight of the model skid steer being craned. Refer to the “Specifications” section of the operator’s manual for the operating weight of the model loader being craned. Use three chains, minimum of 12′ (3.66 m) long for the models LS180, and 14′ (4.27 m) long for the LS190, to prevent sharp angles and damage to the loader cab, boom, and lifting chains.



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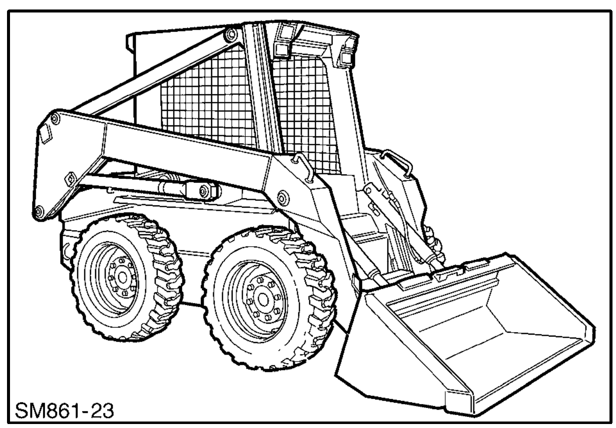
Remove any attachment except a standard bucket from the loader boom attaching plate.

CAUTION

Do not lift any attachments on the loader mounting plate that weigh 600 lbs. (272 kg) or more. lift such attachments separately.



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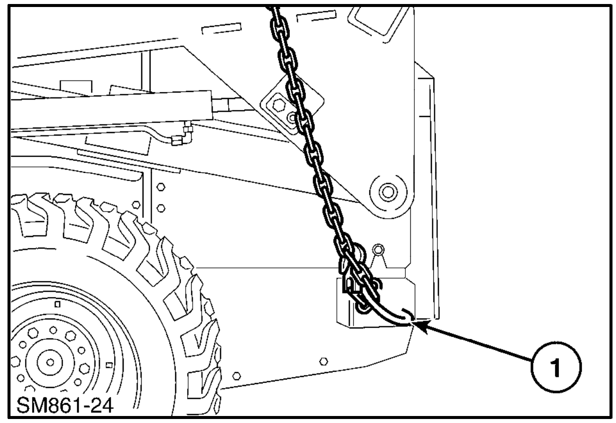
The rear lifting points are at the outside corners of the loader, 1.



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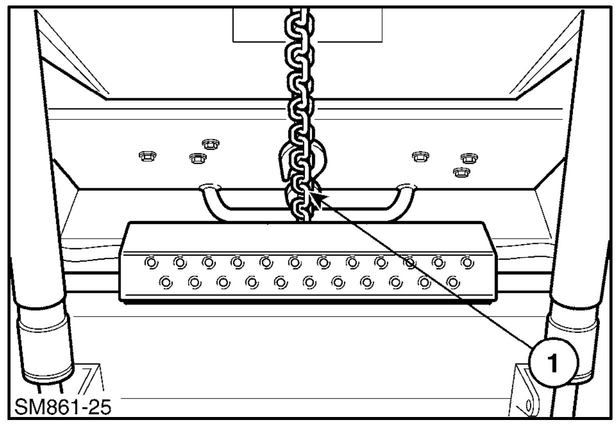
The front lifting point is located in the center of the main frame, 1.



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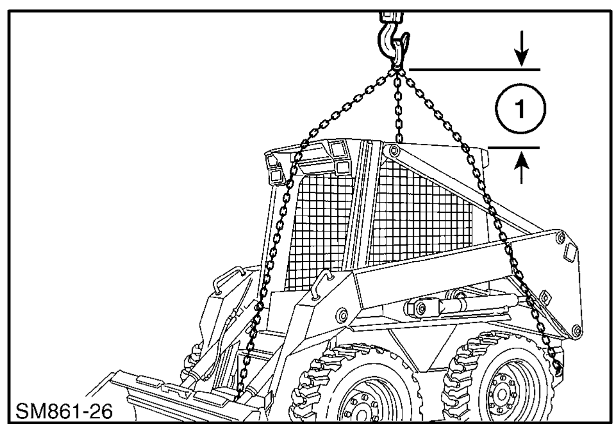
The lifting chains or cables must be minimum, 12′ (3.66 m). The lifting hook point must be minimum of 75″ (1.9 m) above the cab, 1, to prevent the chains or cables from damaging the loader frame or cab.



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WARNING

Always use properly rated lifting devices to prevent personal injury or damage to the loader.

CAUTION

When craning (lifting or lowering) a skid steer, follow these precautions:

1. **No riders (including the operator) in or on the machine while lifting or lowering.**
2. **Do not lift any attachments on the loader boom mounting plate that weigh 600 lbs. (272 kg) or more. Lift such attachments separately.**
3. **Always use a chain, cable, etc. capable of safely hoisting the weight of the skid steer.**
4. **Before hoisting the skid steer, always inspect the lifting chain, cable, etc. and the lifting points on the main frame, to insure they are in good condition. if worn or damaged, do not use.**
5. **Do not lift the skid steer with any frame-mounted attachments such as a backhoe or rear stabilizers.**
6. **Do not attach lifting devices to the loader boom or attachments attached to the boom mounting plate.**
7. **Make sure the loader boom is in the completely lowered position.**
8. **Make sure that any attachment to be lifted on the skid steer is securely fastened to the loader boom mounting plate with the over-center handles and pins fully engaged. Pivot the attachment fully back.**
9. **Make sure that the engine is off and the parking brake is engaged before lifting.**
10. **Keep bystanders away from the machine a safe distance while lifting.**

SPECIAL TOOLS

Tool Number	Order From	Description	LS180	LS190
86590084	New Holland	Cab Tilting Tool	***	***

Engine				
FNH02136	OTC	Valve Guide Ream kit	*	*
FNH01301	OTC	Rear Crank Shaft Seal Installer	***	***
FNH01442 FNH01255	OTC	Cam Shaft Bearing Installation Tool and Handle	*	*
FNH09539 FNH09212	OTC OTC	Cam Shaft pulley, puller and shaft protector FNH09539 is also used to remove water pump pulley	*	*
FNH02134 FNH01237	OTC OTC	Crank shaft timing gear puller and adapter	*	*
FNH09210	OTC	Front timing cover seal installer	***	***
FNH04572	OTC	Water pump seal installation tool	*	*
FNH08124	OTC	Injector cleaner	*	*

Hydraulic System				
238 Bar (3500 Psi) Test Gauge	OTC	Main system pressure	***	***
Flow meter	OTC	Main system/Hydrostatic pumps	***	***
3/4″ –16 UNF Oring fitting	Local	Main system at Boom cylinder	***	***
1/2″ Quick coupler	New Holland	Main system at Auxiliary boom couplers	*	*
FNH22ESS95	OTC	Hydraulic tank pressuring tool	*	*

*Recommend Tool

***Essential Tool

SPECIFICATIONS

MODEL	LS180
MANUFACTURER	NEW HOLLAND
MODEL	332T/JF Emissionized
CYLINDERS	3
ASPIRATION	TURBOCHARGED
CYCLE	4 Stroke
BORE AND STROKE	4.4″ X 4.2″(112x106.7)
DISPLACEMENT	192 cu.in. (3.15L)
COMPRESSION RATIO	17.5 to 1
SPEEDS	
-FAST (no load)	2350 to 2400 RPM
-IDLE (no load)	1000 to 1050 RPM
HORSEPOWER	
(GROSS) MFG rating	67 @ 2200 RPM
(SAE NET)	60 @ 2200 RPM
TORQUE (Mfg, rating) Gross	187 ft. lbs. (253 N·m)@1400RPM
VALVE CLEARANCE	
Intake (cold).	0.016″ (0.40 mm)
Exhaust (cold).	0.017″ - 0.021″(0.43 - 0.53mm)
FIRING ORDER	1-2-3
FUEL CONSUMPTION	
(approximate at continuous full load)	3.7 GPH (14 LPH)
IGNITION TYPE	Compression
GRADEABILITY (Intermittent duty)	
Left	30°
Right	30°
Front	20°
Rear	28°
AIR CLEANER	
Dry type dual element with plastic air cleaner canister	
(Primary element)	NH #86555826
(Safety element)	NH #86555827
FUEL SYSTEM	
Type of fuel	Diesel
Injector type	Direct
Cleaning system	
Filter with water trap (DIESEL)	NH#87801434
OIL TYPES - ENGINE	API SH/CG-4 SAE 10W-30

MODEL	**LS180**
OIL FILTER - ENGINE	NH#87800083
CAPACITIES	
Cooling system	15.5 qt. (14.7 L)
Cooling system pressure	radiator cap 13 psi (89.5 kpa)
Engine crankcase w/filter	7 qt. (6.6L)
Fuel tank	18 Gal. (68 L)
Hydraulic system	11.3 Gal. (42.6 L)
Engine gearbox	1.4 qt. (1.32 L)
Common gearbox and final drive chain case (ea.)	9.6 qt. (9.1 L)
ELECTRICAL SYSTEM	
Battery	BCI PC31 - 12V 925 amps @ 0° F (-18° C)
Alternator capacity	45 amps
Starter switch	Key start and relay
Ignition system protection	Fuse 15 amps
Headlights (work)	NH #86533429
Taillights (work)	NH #86533429
Taillights (road)	NH #86505510
Amber flasher	NH #529068
HYDRAULIC SYSTEM	
Pump - Make or type	Gear pump
Output	18.5 GPM (70 LPM) @2350 RPM @1000 PSI (68 bar)
Optional high flow	32.3 GPM (122.8 LPM) @ 2350 RPM @ 1000 PSI (68 bar)
Hydraulic system	11.3 gal. (42.6 L)
Hydraulic fluid	API Service SH/CG4 10W-30
Control valve	3 Spool Open Center
Main system relief	2500 PSI - 2600 PSI (170 - 176 bar)
Circuit relief - boom	3500 PSI (238 bar)
Filter - Spin-on canister	NH #9842392
BOOM CYLINDERS	
Double-acting	2.5″(6.4cm) Bore; 24.06″(61.1cm) Stroke
Raise	3.6 seconds
Lower	1.5 seconds
BUCKET CYLINDERS	
Double-acting	2.5″ (6.4 cm) Bore
Cycle time	17.6″(44.7cm) Stroke
Dump	2.4 seconds
Curl	1.8 seconds
HYDROSTATIC TRANSMISSIONS	
Pump	Variable displacement piston type
Motor (with single speed)	Fixed displacement piston type
Motor (with 2-speed)	Variable displacement piston type
Charge pressure	250 - 300 PSI (17 - 20.4 bar)
Relief pressure (transmission)	5000 PSI (344.7 bar)
Oil type	SAE 10W-30 API SH/CG4
TRAVEL SPEEDS - 12.00 X 16.5 Tires	
Low range - MAX	7.2 MPH (11.6 KPH)
LS180 equipped with factory 2-speed	
High range - MAX	11.4 MPH (18.3 KPH)

MODEL	**LS180**

TIRE SIZES AND INFLATION

Tire	**Tire Pressure**
8.25 X 15 - CHEVRON TREAD	50 PSI (345 kPa)
8.25 X 15 - HST-HOLLOW SEGMENTED TIRES	N/A
12.00 X 16.5 - R4 CLEAT TREAD	50 PSI (345 kPa)
12.00 X 16.5 HD 2000	50 PSI (345 kPa)
12.00 X 16.5 - HST-HOLLOW SEGMENTED	N/A

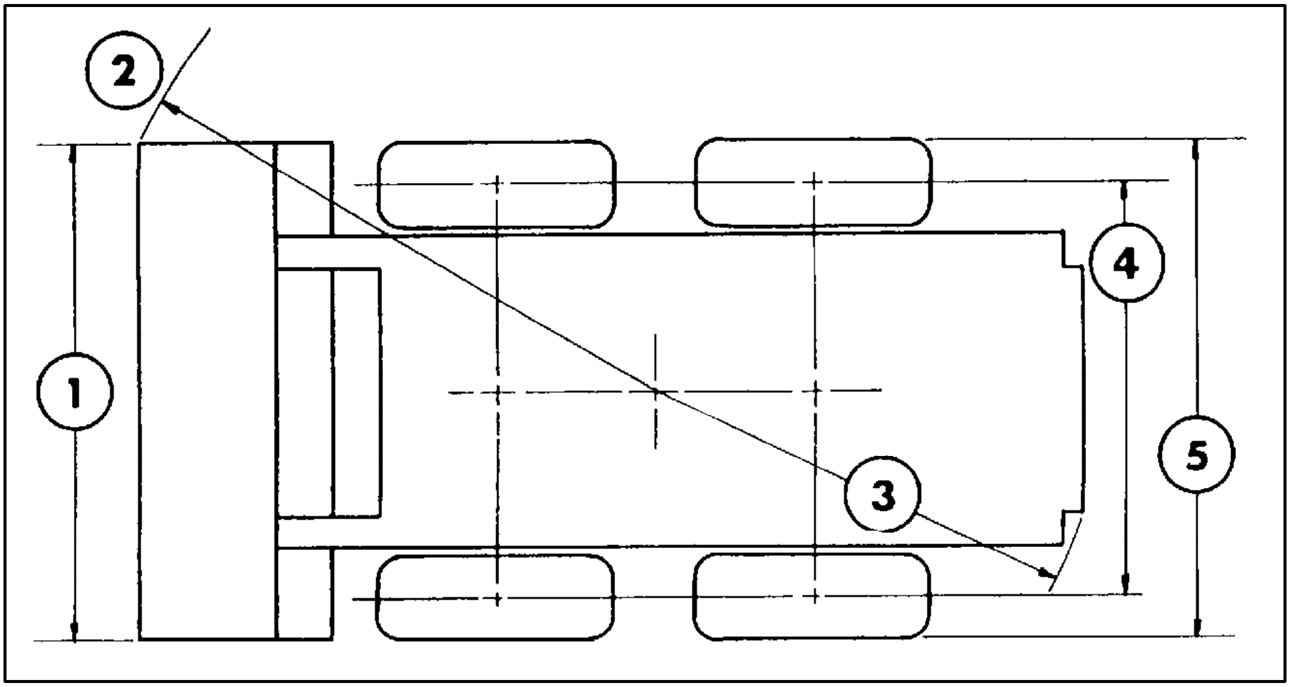
BASIC WEIGHT
With 72″ (cm) Dirt & Foundry bucket, 175-lb. (79kg) operator, full fuel tank, battery, and 12.00 X 16.5 tires

LS180 single speed	7193 lbs. (3263 kg)
LS180 2-speed	7223 lbs. (3276 kg)

OPERATING CAPACITY
SAE Operating load capacity per SAE J732, J818, J742 Standard.

LS180	2200 lbs. (999.9 kg) (Mfg. Rating) 2555 lbs. (1158.9 kg) (SAE Rating)*

*SAE Operating load rating Per J818 Specifications.



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DIMENSIONS - LS180 WITH 72″ DIRT AND FOUNDRY BUCKET AND 12 X 16.5 TIRES - IN. (CM)

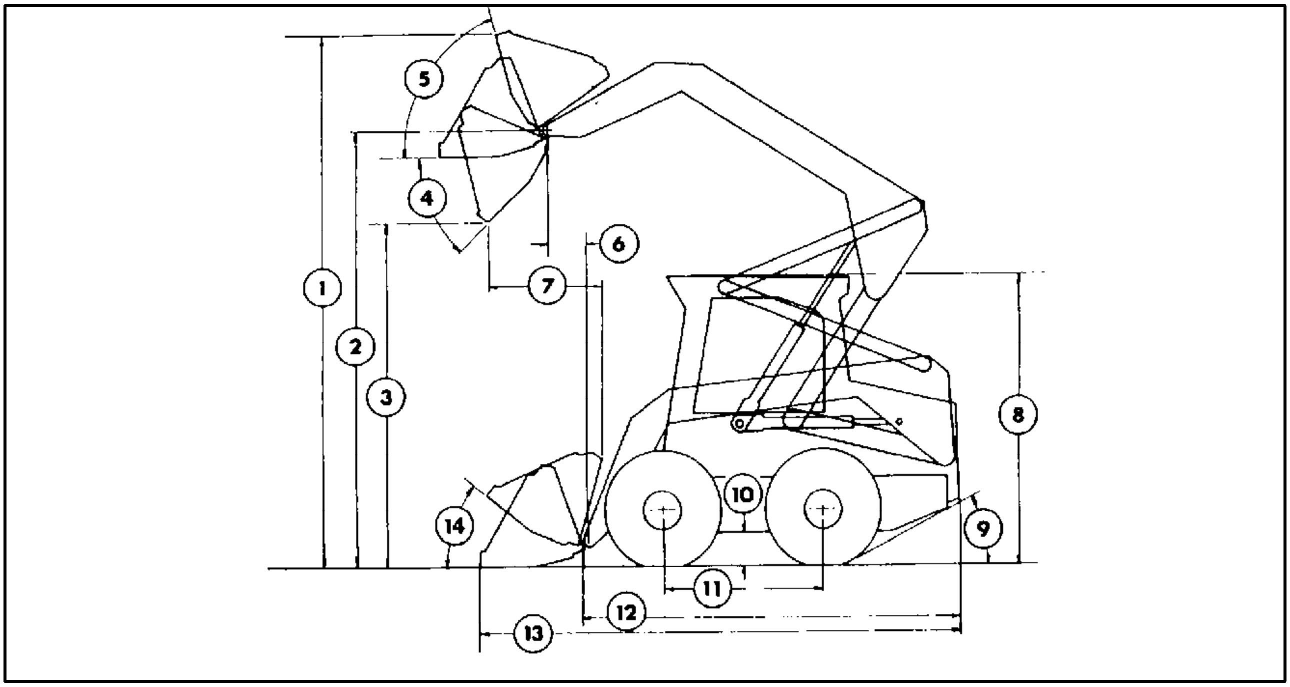
1 - OVERALL WIDTH w/BUCKET . . . . 71.7″ (182.1 cm)

2 - TURNING RADIUS - FRONT . . . . 82.75″ (210.2 cm)

3 - TURNING RADIUS - REAR . . . . 69.25″ (175.9 cm)

4 - WHEEL TREAD w/12 X 16.5 TIRES . . . . 58.3″ (148.1 cm)

5 - OVERALL WIDTH w/12 X 16.5 TIRES . . . . 73.2″ (185.9 cm)



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DIMENSIONS - LS180 WITH 72″ DIRT AND FOUNDRY BUCKET AND12 X 16.5 TIRES - IN. (CM)

1 - MAXIMUM OPERATING HEIGHT . . . . 150.9″ (3083.3 cm)

2 - HEIGHT TO HINGE PIN . . . . 124.6″ (316.5 cm)

3 - DUMP HEIGHT . . . . 99.9″ (253.8 cm)

4 - DUMP ANGLE (MAX.) . . . . 45.2°

5 - ROLLBACK FULLY RAISED . . . . 74.5°

6 - BOOM REACH TO PIVOT PIN (At max. reach) . . . . 17.75″ (45.09 cm)

7 - DUMP REACH @ MAXIMUM HEIGHT @ 45 ANGLE . . . . 32.5″ (82.6 cm)
DUMP REACH @ MAXIMUM REACH @ 45 ANGLE . . . . 32.5″ (82.6 cm)

8 - OVERALL HEIGHT . . . . 77″ (195.6 cm)

9 - ANGLE OF DEPARTURE . . . . 28.4°

10- GROUND CLEARANCE
(CHAIN CASE) . . . . 8″ (20.3 cm)
(BELLY PAN) . . . . 9.4″ (23.9 cm)

11- WHEELBASE . . . . 47.8″ (121.4 cm)

12- OVERALL LENGTH LESS BUCKET . . . . 116.1″ (294.9 cm)

13- OVERALL LENGTH w/BUCKET . . . . 141″ (358.1 cm)

14- ROLL BACK ANGLE (BOOM DOWN) . . . . 37.4°

SPECIFICATIONS

MODEL	LS190
MANUFACTURER	NEW HOLLAND
MODEL	450/NC Emissionized
CYLINDERS	4
ASPIRATION	NATURAL
CYCLE	4 Stroke
BORE AND STROKE	4.4″ X 5.0″(112x127)
DISPLACEMENT	304 cu.in. (5L)
COMPRESSION RATIO	17.5 to 1
SPEEDS	
-FAST (no load)	2325 to 2375 RPM
-IDLE (no load)	1000 to 1050 RPM
HORSEPOWER	
(GROSS)MFG rating	83 @ 2200 RPM
(SAE NET)	75 @ 2200 RPM
TORQUE (Mfg, rating) Gross	240 ft. lbs. (325 N·m) @1300 RPM
VALVE CLEARANCE	
Intake(cold).	0.016″ (0.406 mm)
Exhaust (cold).	0.019″ (0.483 mm)
FIRING ORDER	1-3-4-2
FUEL CONSUMPTION	
(approximate at continuous full load)	4.4 GPH (16.6 LPH)
IGNITION TYPE	Compression
GRADEABILITY (Intermittent duty)	
Left	30°
Right	30°
Front	20°
Rear	28°
AIR CLEANER	
Dry type dual element	
(Primary element)	NH #86555826
(Safety element)	NH #86555827
FUEL SYSTEM	
Type of fuel	Diesel
Injection type	Direct
Cleaning system	
Filter (DIESEL)	NH#87801434
Water separator	F0NN9B328AE

MODEL	**LS190**
OIL TYPES - ENGINE	API SH/CG4 SAE 10W-30
OIL FILTER - ENGINE	NH#87800083
CAPACITIES	
Cooling system	16 qt.(15.1 L)
Cooling system pressure	Radiator cap 13 psi (89.5 kpa)
Engine crankcase w/filter	4 gal. (10.9 L)
Fuel tank	21.5 gal. (81.4 L)
Hydraulic system	11.3 gal. (42.6 L)
Engine gearbox	1.4 qt. (1.32 L)
Common gearbox and final drive chain case (ea.)	12 qt. (11.4 L)
ELECTRICAL SYSTEM	
Battery	(2) BCI 35/75 - 12V, 650 cca @ 0° F (-18° C)
Alternator capacity	45 amps
Starter switch	Key start and relay
Ignition system protection	Fuse 15 amps
Headlights (work)	NH #86533429
Taillights (work)	NH #86533429
Taillights (road)	NH #86505510
Amber flasher	NH #529068
HYDRAULIC SYSTEM	
Pump - Make or type	Gear pump
Output	20 GPM (75.7 LPM) @2350 RPM @1000 PSI (68 bar)
Optional high flow	33.8 GPM (127.9 LPM) @ 2350 RPM @ 1000 PSI (68 bar)
Hydraulic system	11.3 gal. (42.6 L)
Hydraulic fluid	API Service SH/CG4 10W-30
Control valve	3 Spool Open Center
Main system relief	2500 - 2600 PSI (170 - 176 bar)
Circuit relief - boom	3500 PSI (238 bar)
Filter - Spin-on canister	NH #9842392
BOOM CYLINDERS	
Double-acting	2.75″ (7.0 cm) Bore; 24.06″ (61.1 cm) Stroke
Raise	3.9 seconds
Lower	2.8 seconds
BUCKET CYLINDERS	
Double-acting	2.5″ (6.4 cm) Bore
Cycle time	17.6″ (44.7 cm) Stroke
Dump	2.2 seconds
Curl	2.5 seconds
HYDROSTATIC TRANSMISSIONS	
Pump	Variable displacement piston type
Motor	Variable displacement piston type
Charge pressure	250 - 300 PSI (17 - 20.4 bar)
Relief pressure (transmission)	5000 PSI (344.7 bar)
Oil type	SAE 10W-30 API SH/CG-4
TRAVEL SPEEDS - 14.00 X 17.5 Tires	
Low range - MAX	7.6 MPH (12.2 KPH)
High range - MAX	12.1 MPH (19.3 KPH)

MODEL **LS190**

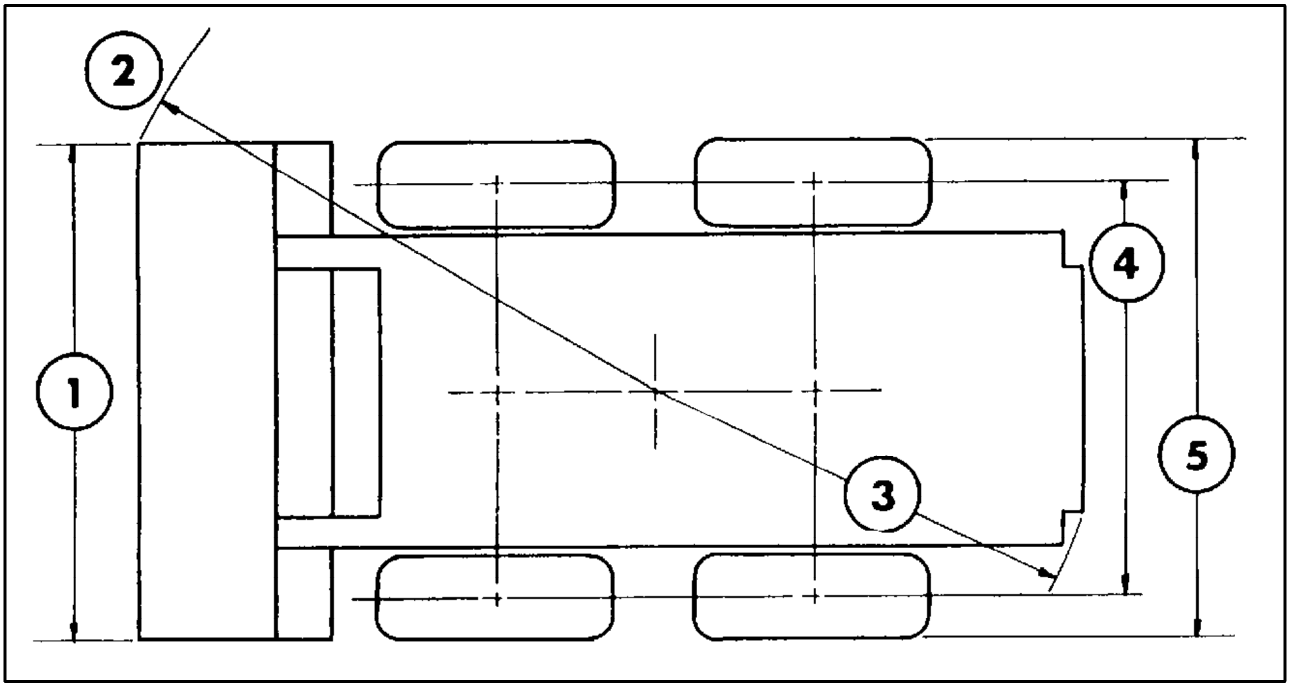
TIRE SIZES AND INFLATION

Tire . . . . Tire Pressure
8.25 X 15 - CHEVRON TREAD . . . . 50 PSI (345 kPa)
8.25 X 15 - HST-HOLLOW SEGMENTED TIRES . . . . N/A
12.00 X 16.5 - R4 CLEAT TREAD . . . . 50 PSI (345 kPa)
12.00 X 16.5 HD 2000 . . . . 50 PSI (345 kPa)
12.00 X 16.5 - HST-HOLLOW SEGMENTED . . . . N/A
14.00 X 17.5 - CLEAT TREAD . . . . 60 PSI (410 kPa)

BASIC WEIGHT
With 78″ (cm) Dirt & Foundry bucket, 175 lb. (79 kg) operator, full fuel tank, battery,
and 14.00 X 17.5 tires . . . . 7860 lbs. (3565 kg)

OPERATING CAPACITY
SAE Operating load capacity per SAE J732, J818, J742 Standard
. . . . 2800 lbs. (1270 kg) (Mfg. Rating)
. . . . 2842 lbs. (1289.1 kg) (SAE Rating)*

*SAE Operating load rating Per J818 Specifications.



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DIMENSIONS - LS190 WITH 78″ DIRT AND FOUNDRY BUCKET AND 14 X 17.5 TIRES - IN. (CM)

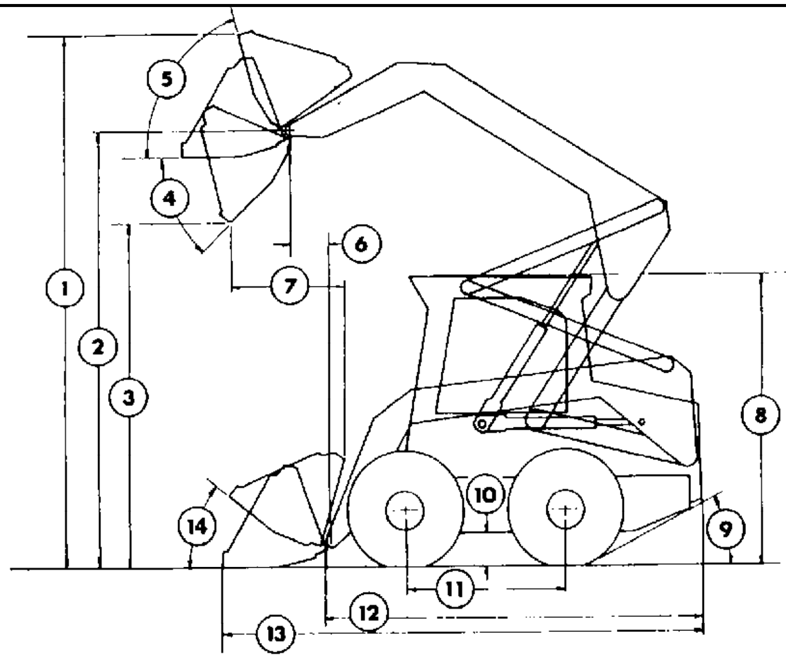
1 - OVERALL WIDTH w/72″ D & F BUCKET . . . . 78″ (198.1 cm)

2 - TURNING RADIUS - FRONT . . . . 83.7″ (212.6 cm)

3 - TURNING RADIUS - REAR . . . . 73.4″ (186.4 cm)

4 - WHEEL TREAD w/12 X 16.5 TIRES . . . . 62.3″ (158 cm)

5 - OVERALL WIDTH w/14 X 17.5 TIRES . . . . 76.1″ (193.4 cm)



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DIMENSIONS - LS190 WITH 72″ DIRT AND FOUNDRY BUCKET AND14 X 17.5 TIRES - IN. (CM)

1 - MAXIMUM OPERATING HEIGHT . . . . 150.6″ (382.5 cm)

2 - HEIGHT TO HINGE PIN . . . . 124.1″ (315.2 cm)

3 - DUMP HEIGHT . . . . 100.6″ (255.3 cm)

4 - DUMP ANGLE (MAX.) . . . . 46.7°

5 - ROLLBACK FULLY RAISED . . . . 74.2°

6 - BOOM REACH TO PIVOT PIN (At max. reach) . . . . 17.75″ (45.09 cm)

7 - DUMP REACH @ MAXIMUM HEIGHT @ 45 ANGLE . . . . 31.5″ (80 cm)
DUMP REACH @ MAXIMUM REACH @ 45 ANGLE . . . . 31.5″ (80 cm)

8 - OVERALL HEIGHT . . . . 79.4″ (201.7 cm)

9 - ANGLE OF DEPARTURE . . . . 27°

10- GROUND CLEARANCE
(CHAIN CASE) . . . . 9.9″ (25.1 cm)
(BELLY PAN) . . . . 11.2″ (28.4 cm)

11- WHEELBASE . . . . 51.4″ (130.6 cm)

12- OVERALL LENGTH LESS BUCKET . . . . 123.63″ (313.9 cm)

13- OVERALL LENGTH w/BUCKET . . . . 147.3″ (374.1 cm)

14- ROLL BACK ANGLE (BOOM DOWN) . . . . 37.2°

SECTION 10 – ENGINE

Chapter 1 – LS180 - 332T/JF

CONTENTS

Chapter 1 – LS180 - 332T/JF

Op. 10 000

INTRODUCTION

This engine section has two parts to cover the two engines. Refer to the chapter that pertains to the engine being serviced.

Chapter 1 - LS180, 332T/JF engine (3-cylinder, turbocharged)

Chapter 2 – LS190, 450/NC engine (4-cylinder, naturally aspirated)

SAFETY PRECAUTIONS

CAUTION

Do not change the specification of the engine.

Do not smoke when you put fuel in the tank.

Clean away any fuel which has spilled and move material which has fuel contamination to a safe place.

Do not put fuel in the tank during engine operation (unless absolutely necessary).

Never clean, lubricate, or adjust the engine during operation (unless you have had the correct training when extreme caution must be used to prevent injury).

Do not make any adjustments you do not understand.

Ensure the engine is not in a position to cause a concentration of toxic emissions.

Persons in the area must be kept clear during engine and equipment or vehicle operation.

Do not permit loose clothing or long hair near parts which move.

Keep away from parts which turn during operation. Note that fans cannot be seen clearly while the engine is running.

Do not run the engine with any safety guards removed.

Do not remove the radiator cap while the engine is hot and the coolant is under pressure, as dangerous hot coolant can be discharged.

Do not use salt water in the fresh water cooling system or any other coolant which can cause corrosion.

Keep sparks or fire away from batteries (especially during charge) or combustion can occur. The battery fluid can burn and is also dangerous to the skin and especially the eyes.

Disconnect the battery terminals before you make a repair to the electrical system.

Only one person must be in control of the engine.

Ensure the engine is only operated from the control panel or operator’s position.

If your skin comes into contact with high-pressure fuel, get medical assistance immediately.

Diesel fuel and used engine oils can cause skin damage to some persons. Use protection on the hands (gloves or special skin protection solutions).

Do not move equipment unless the brakes are in good condition.

Ensure that the transmission drive control is in neutral position before the engine is started.

Do not use ether to start the engine.

LS180 ENGINE SERVICE

GENERAL ENGINE INFORMATION

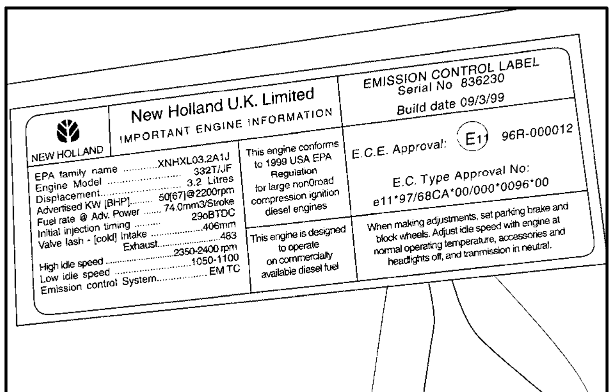
ENGINE DESCRIPTION

The LS180 skid steer is equipped with a 332T/JF, turbocharged diesel engine, 60 SAE net HP, 192 cubic inch displacement.

The 332T/JF series is a three-cylinder, four-stroke, liquid-cooled and turbocharged diesel engine, designed to provide fuel efficiency, quiet operation, and durable performance. The engine features cross flow cylinder heads with the inlet and exhaust manifolds on opposite sides of the head. The combustion chamber is formed in the crown of the piston. The piston has three compression rings and one oil control ring, all located above the piston pin. The cylinder head assembly incorporates the valves, valve springs, and spring retainers. Valve guides are an integral part of the cylinder head with replaceable valve seats pressed into the valve ports.

ENGINE MODEL AND SERIAL NUMBER LOCATION

The engine model number, serial number, date of manufacture, and other important information are located on the nameplate on the rear of the engine valve cover.



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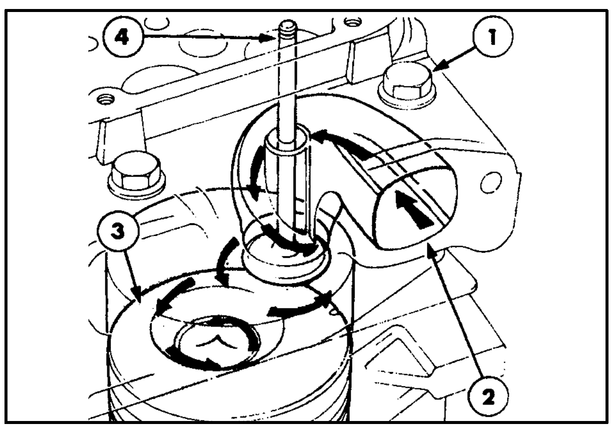
CYLINDER HEAD AND VALVES

The cylinder head casting contains the following detail:

Larger inlet ports, 2, feature a snail shell form which swirls inducted air, improving the air/fuel mixing and the resultant quality of combustion. This design contributes to performance and fuel efficiency.

The inlet valves, 4, and valve seats have a 29.5° face angle and a 30° seat angle, respectively. The exhaust valves and valve seats have a 44.5° face angle and a 45° seat angle, respectively.

The turbocharged engine incorporates heavy-duty rocker shafts.



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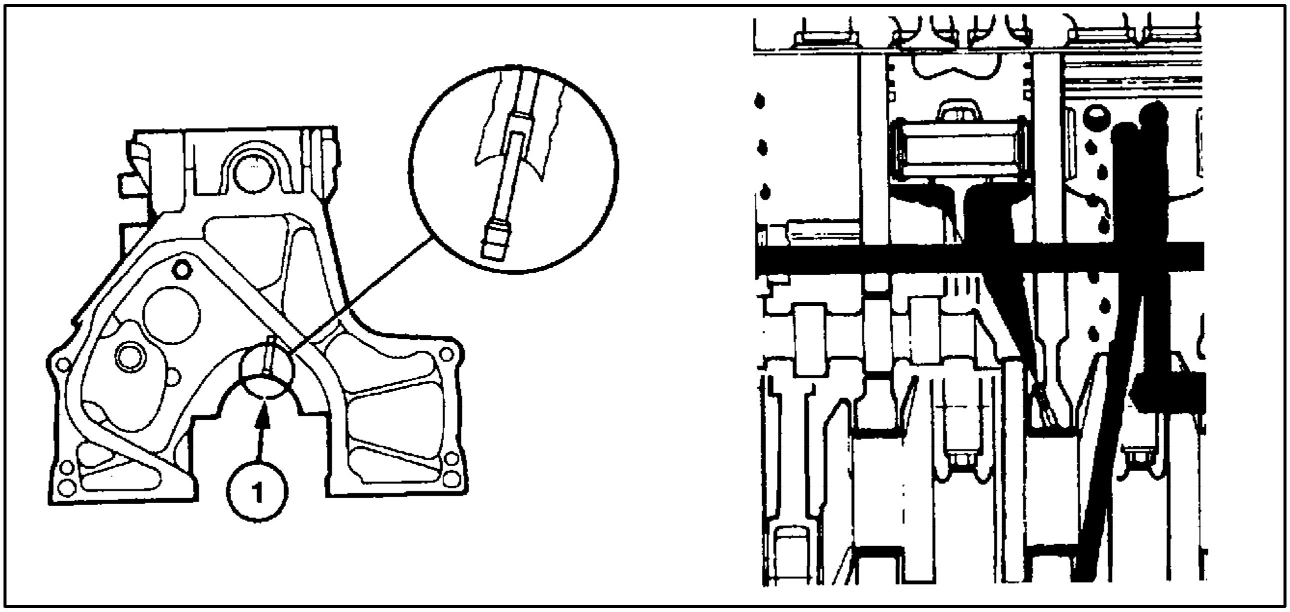

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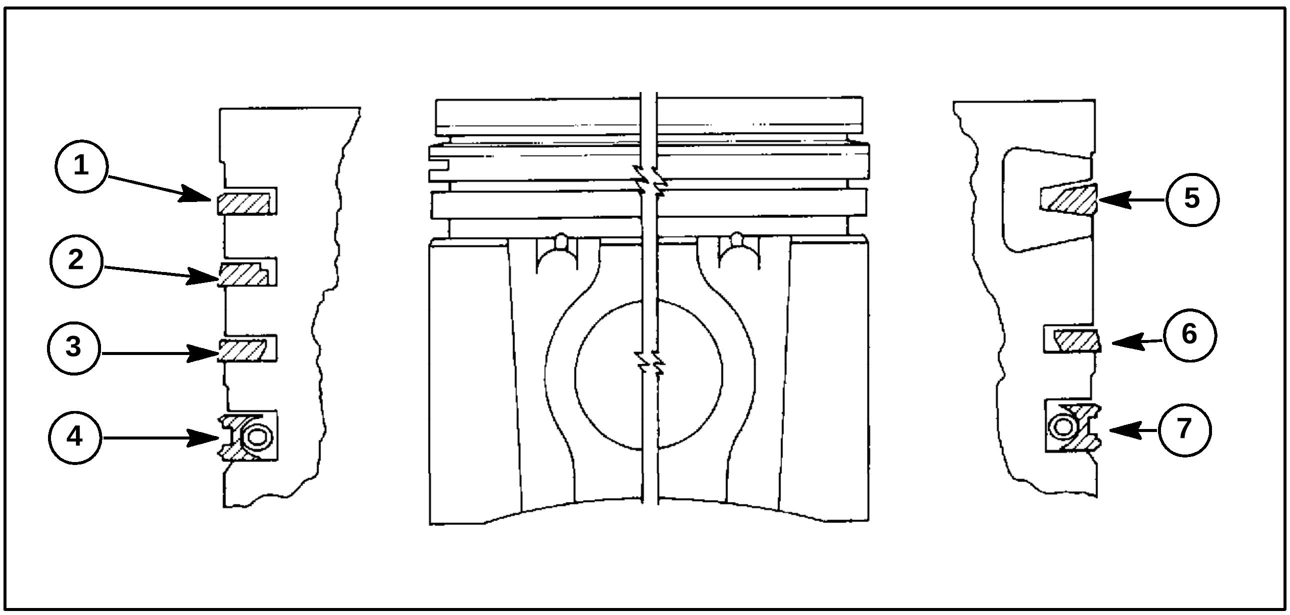
CYLINDER BLOCK

The cylinder block of the turbocharged engine contains oil jets, 1, fed from the main bearing journals to provide under piston cooling and additional lubrication.



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PISTONS AND CONNECTING RODS

Effective with engine serial number 532563, a piston change was made. The early piston is fitted with three compression rings, 1, 2, and 3, and oil control ring, 4, with expander. The later piston is fitted with a keystone top compression ring, 5; a second compression ring, 6; and an oil control ring, 7, with expander. Both pistons are of the “Mexican Hat” type, so called because of the raised section in the middle of the combustion bowl. This configuration aids the swirl of the incoming air from the cylinder head, improving fuel/air mixing.

The connecting rods are machined from high-strength forged steel. The big end bearings are renewable, steel-backed, copper/lead alloy overlay with tin plating. The small end bearings are a press fit plain bush of tin-backed lead/bronze.

CRANKSHAFT AND MAIN BEARINGS

The crankshaft is a chrome-molybdenum steel forging, fully machined, static, and dynamically balanced with integral counterweights. All bearing surfaces are induction hardened. Axial location is maintained by thrust washers. The main journals run in replaceable steel-backed cast copper/lead alloy bearings. The front of the crankshaft is keyed.

CAMSHAFT AND TIMING GEAR TRAIN

The camshaft is made of forged steel and is induction hardened. Friction bearings support the camshaft. The camshaft is lubricated by oil pressure from the main oil gallery.

The timing gear train consists of three helical gears; the crankshaft gear (located by a woodruff key), the idler gear, and the camshaft gear.

LUBRICATION SYSTEM

Lubrication of the engine is maintained by a rotor-type oil pump mounted at the base of the engine block. The oil pump is driven from the camshaft and draws oil from the engine sump through a wire mesh screen.

A spring-loaded relief valve in the pump body limits the pressure in the system by directing excess oil back to the intake side of the pump.

Oil passes from the pump to an external, throw-away, spin on type filter incorporating a relief valve which permits oil to be bypassed if filter blockage occurs; therefore ensuring engine lubrication at all times.

Oil flows from the filter to the main oil gallery which runs the length of the cylinder block and intersects the camshaft follower chambers.

The main gallery also supplies oil to the crankshaft main bearings and to the connecting rod journals via drillings in the crankshaft. Drilled passages from each main bearing direct oil to the camshaft bearings.

The camshaft drive gear bushing is pressure lubricated through a drilled passage from the front main bearing. The gear has small oil passages machined on both sides which allow the oil to escape.

The timing gears are lubricated by oil from the cam follower chamber and the pressure lubricated camshaft drive gear bushing.

Cylinder walls, pistons, and piston pins are splash lubricated by the connecting rods and rotating crankshaft as well as by oil jets fed from the main bearing journals.

An intermittent flow of oil is directed to the valve rocker arm shaft assembly via a drilled passage in the cylinder block located vertically above the No. 1 camshaft bearing. This drilling aligns with a corresponding hole in the cylinder head. As the camshaft turns, holes in the camshaft and camshaft bearing align and a regulated stream of oil is directed to the cylinder head and on up the rocker arm shaft support bolt to the rocker shaft. The oil flows from the shaft through drilled holes in each rocker arm bushing to lubricate both ends of the arms. Excess oil flows down the pushrods and assists in lubricating the cam followers before draining back into the pan through cored openings in the block.

COOLING SYSTEM

A belt-driven centrifugal water pump circulates coolant via the internal water passages. The coolant is radiator-cooled and temperature controlled by a conventional thermostat.

AIR INTAKE AND EXHAUST SYSTEM

The air intake manifold is located on the left side of the engine. Its unique design provides accurate alignment with the cylinder head ports, resulting in maximum engine performance. The exhaust manifold, located on the right side of the engine, houses the turbocharger and muffler system.

FUEL SYSTEM

A flange-mounted, Lucas CAV DP200 Series (emmissionized) fuel injection pump is mounted to the cylinder block front thrust plate. The pump is operated by three helical gears; the crankshaft gear, idler gear, and the injection pump drive gear.

TURBOCHARGER

A turbocharged engine requires careful attention for proper operation.

Normal everyday start-up and shutdown of a turbocharged engine:

1. Set engine speed control at 1/3 to 1/2 position.
2. Start the engine and allow the engine to warm up for one minute at approximately 1,000 RPM.

NOTE: *When temperatures are below freezing (32°F, 0°C), do not exceed 1,500 RPM during the first three minutes after starting.*

3. After full-speed operation, run the engine at low idle speed for one minute before shutdown.

Starting a turbocharged engine after an extensive period of non-use (four weeks or more).

1. Disconnect the electrical wire at the fuel injection pump fuel shut off solenoid. Crank the engine until oil pressure rises. Do not operate the starter motor continuously more than 30 seconds. Allow it to cool two minutes between attempts.
2. Reconnect the wire at the fuel shut off solenoid. Start the engine and allow it to idle for one minute (three minutes in freezing weather).

IMPORTANT: *On every start-up, allow the engine to idle at approximately 1,000 RPM (1500 RPM max.) for 60 seconds before operating at full load. After full-load operation, operate the engine at low idle speed for one minute (minimum) before shutdown.*

GENERAL ENGINE SPECIFICATIONS - LS180

Model	LS180
Engine Model	332T/JF
Type	3-cylinder, 4-stroke, turbocharged diesel
Bore	111.8 mm (4.40″)
Stroke	106.7 mm (4.20″)
Displacement	3.2 L (192 cu. in.)
Compression Ratio	17.5:1
Firing Order	1 - 2 - 3
Horsepower	
(Gross) MFG rating	67 @ 2200 RPM
(SAE NET)	60 @ 2200 RPM
Torque	
(Gross) MFG rating	253 N·m (187 ft. lbs.) @1400 RPM
Ignition Type	Compression
Injection Pump	Distributor Type
Injection Pressure	4235 - 4350 psi (292 - 300 bar)
Speeds	
Fast (no load)	2350 to 2400 RPM
Idle (no load)	1050 to 1100 RPM
Cooling System	Liquid with water pump and radiator
Capacity	14.7 L (15.5 qt.)
Lubricating System	
Oil Capacity (including filter)	5.7 L (6 qt.)
Electrical System	
Starter	12V
Alternator	12V, 45 amps
Battery	12V, 925 amps @ - 18°C (0°F)

Model	**LS180**
Thermostat	
Opening Temperature	76°C (168°F)
Recommended Engine Fluids	
Lubricating Oil	SAE 10W - 30 API SH/CG4
Fuel	Use clean, quality No. 1-D or No. 2-D fuel (ASTM D975). Use No. 1-D if the ambient temperature is expected to be less than 4°C (40°F) or if the loader is to be used at an altitude exceeding 1524 m (5000′). The sulfur content of the fuel should be no more than 0.5%. The sediment and water content should not exceed 0.5%. To prevent fuel flow problems in cold weather, use No. 1 - 2 diesel fuel with a pour point of at least 10°F below the expected ambient temperature. Minimum cetane number is 40. Lower temperature or high altitude operation may require the use of fuel with a higher cetane number.
Coolant	Clean soft water. Maximum antifreeze concentration 50% with 5% corrosion inhibitor

TROUBLESHOOTING - LS180

ENGINE SYSTEM

PROBLEM	POSSIBLE CAUSES	CORRECTION
Engine will crank but does not start	Faulty key switch	Correct the connection and/or replace switch
	Blown 5-amp electronic ignition fuse (cab fuse panel)	Replace fuse
	Fuel solenoid not operating	Check solenoid for battery voltage and correct
	Insufficient charging or complete discharging of the battery	Charge or replace battery
	Lack of fuel	Supply fuel
	Air mixed in the fuel system	Bleed the air
	Clogged fuel filter	Replace
	Irregular and faulty fuel supply (injection pump trouble)	Repair in an authorized service shop
	Improper viscosity of the lubricating oil	Inspect and replace
	Clogged air cleaner	Clean or replace
	No compression	Overhaul engine
Engine will not crank or start	Seat belt not fastened	Buckle seat belt
	Faulty key switch	Correct the connection or replace the switch
	Insufficient charging or complete discharging of the battery	Charge or replace battery
	Blown 5-amp electronic battery fuse (engine fuse panel)	Replace fuse
	Blown 15-amp key main fuse (engine fuse panel)	Replace fuse
Engine runs erratically	Air mixed in the fuel system	Bleed the air from the system
	Uneven fuel injection (faulty fuel injection pump)	Repair at authorized shop
	Clogged fuel filter	Replace
	Defective governor	Check and correct

PROBLEM	POSSIBLE CAUSES	CORRECTION
Engine stops during operation	EIC (Electronic Instrument Cluster) shows fault with hydrostatic charge pressure	Check and repair hydrostatic charge pressure
	EIC (Electronic Instrument Cluster) shows fault with engine crankcase oil pressure	Check oil level and/or repair engine crankcase oil pressure
	Lack of fuel in the tank	Supply fuel and bleed air
	Clogged fuel filter	Replace
	Air mixed in the fuel system	Bleed the air
	Faulty function of the engine	Repair in a service shop
Engine overheats	Lack of cooling water	Supply water, inspect for leakage and correct
	Loose or slipping fan belt	Remove oil, dust, etc. and tighten
	Damaged fan belt	Replace
	Clogged radiator	Flush the radiator
	Clogged radiator fins	Clean
	Dust or scale clogged in the cooling water passage	Flush the system
	Faulty thermostat	Inspect or replace thermostat
	Lack of lubricating oil	Add oil
	Overloading	Decrease the load
Exhaust (white or blue) smoke	Excess engine oil	Inspect and correct the level
	Engine oil viscosity too low	Inspect and replace the oil to correct one
	Faulty injection timing	Too late: correct
Exhaust dark grey smoke	Incorrect fuel grade	Inspect and replace to correct grade
	Excessive injection	Inspect and adjust (in a service shop)
	Overloading	Reduce the load
	Clogged air cleaner	Clean
Oil pressure lamp not turned on (key switch “ON” with engine not started)	Broken lamp	Replace lamp
	Broken wire between battery to the lamp	Correct it

PROBLEM	POSSIBLE CAUSES	CORRECTION
Oil pressure lamp not turned off	Lack of engine oil	Supply oil up to the specified level
	Fault in the pressure switch	Replace the switch
	Oil leakage from the lubricating system	Inspect and retighten
	Short-circuit between oil pressure lamp and pressure switch	Repair
Engine knocks	Diluted or thin oil	Drain and refill with specified oil and replace filter. Determine cause of dilution
	Insufficient oil supply	Check oil level and replenish as necessary. Overhaul or replace pump as necessary. Check that oil pump filter is not clogged
	Low engine oil pressure	Overhaul pump or relief valve as necessary
	Excessive crankshaft end play	Install new thrust bearing liner
	Excessive flywheel or ring gear run-out	Skim flywheel or fit new ring gear
	Excessive connecting rod or main bearing clearance	Install new bearing inserts
	Bent or twisted connecting rods	Replace connecting rods
	Crankshaft journals out-of-round	Grind crankshaft and fit undersize bearing inserts
	Excessive piston-to-cylinder bore clearance	Bore engine block and fit new pistons
	Excessive piston ring clearance	Fit new piston rings
	Broken rings	Fit new rings. Check bores and pistons for damage
	Excessive piston pin clearance	Fit new piston pin and bushing
	Piston pin retainer loose or missing	Install new retainer. Check bore and pistons for damage
	Excessive camshaft end play	Install new thrust plate
	Imperfections on timing gear teeth	Replace timing gear
	Excessive timing gear backlash	Replace timing gear

AIR INTAKE SYSTEM - TURBOCHARGER

PROBLEM	POSSIBLE CAUSES	CORRECTION
Turbocharger is sluggish in picking up speed	The sealed part of turbine wheel is heavily carboned, causing the rotor to resist turning.	Change oil (engine oil) Disassemble and clean
	Incomplete fuel combustion due to a faulty condition in the fuel injection system.	Disassemble and clean Check the injection system for cause, and repair.
Excessive or abnormal vibration	A loose pipe connection at the turbine or blower side or at the bearing	Tighten and repair
	Bearing failure causing the rotor to run rough.	Disassemble and repair
	Turbine wheel or blower wheel has broken vanes caused by entry of foreign objects	Disassemble and repair damaged parts
	Loss of dynamic balance in the rotor	Disassemble and repair damaged parts
Dirty exhaust smoke	Not enough intake air	A clogged element in the air cleaner, clean or replace element Restricted air intake inlet. Open inlet Air leakage from a connection, between turbocharger and intake manifold. Check and repair
	The turbocharger is not running freely	Gum or sludge formation in the turbine-side seal, causing the turbocharger to resist turning, Check the oil quality and change Disassemble and clean Seized bearings, disassemble and clean Disassemble and repair Oil temperature too high, change engine oil Dynamic imbalance in the rotor, clean and/or replace rotor parts Turbine wheel or blower wheel rubbing or broken. Disassemble and repair (remove foreign matter, if any, and check air cleaner and engine to locate the cause).

PROBLEM	POSSIBLE CAUSES	CORRECTION
Dirty exhaust smoke, (Cont.)	Not enough exhaust gas pressure	Gas leakage through a connection on upstream side of turbine. Check and repair A large constriction in the exhaust line, due to distorted gas passages. Check and repair
White exhaust smoke	Oil return pipe is clogged or distorted, causing the lube oil to leak into turbine and blower Seal rings are abnormally worn or broken due to worn-down bearings	Repair or replace the pipe Disassemble and repair
Abnormally high oil consumption	Seal rings worn or broken due to worn bearings	Disassemble and repair
Engine lacks output power	Gas leakage in the exhaust line Air leakage in the blower outlet side, resulting in reduced boost pressure A clogged element in the air cleaner The turbocharger is internally fouled with foreign matter or its running parts are damaged	Check and repair Check and repair Clean or replace Disassemble and repair or replace damaged parts
Abnormal running noise	Restrictions in exhaust gas passage, particularly due to the nozzle ring approaching a clogged condition Restrictions in the air outlet side of the blower, causing the air to surge at blower wheel when the engine accelerates The casing is being rubbed by turbine wheel or blower wheel	Disassemble and clean Disassemble and clean Disassemble and repair or replace damaged parts
Repeated turbocharger bearing failure	Improper operation Frequent stalling	Refer to “Important” decal to right of ignition switch Change operating practices or adjust engine idle RPM

PROBLEM	POSSIBLE CAUSES	CORRECTION
Worn turbocharger bearings, bores or journals	Inadequate pre-oiling following turbocharger installation or engine lubrication or engine lubrication servicing	Pre oil turbocharger components
	Contaminated or improper grade of engine oil used in engine	Inspect and replace with proper grade engine oil
	Insufficient oil supplied to turbocharger due to oil lag	Inspect and clean oil feed lines
	Restricted turbocharger oil feed line	Clean or replace
	Plugged engine oil filter	Replace
	Abrasive wear due to material lodged in turbocharger	Disassemble, inspect and clean parts
Seal leak at compressor end of turbocharger	Dirty air cleaner	Clean or replace
	Restricted duct between air cleaner and turbocharger	Inspect and retighten
	Leaks at engine intake manifold	Inspect and retighten
	Restricted turbocharger oil drain line	Remove and clean line
	Plugged engine crankcase breather	Clean
	Worn or damaged compressor wheel (worn bearings, bores or journals)	Inspect parts, replace as necessary
	Excessive piston blowby or high internal crankcase pressure	Inspect piston rings. Replace as necessary
Seal leaks at turbine end of turbocharger	Excessive pre-oiling	Reduce oiling
	Plugged engine crankcase breather	Repair or replace line
	Restricted turbocharger oil drain line	Disassemble and clean
	Worn turbocharger bearings, bearing bores, or shaft journals	Inspect and replace parts as necessary.

ELECTRICAL SYSTEM - STARTER MOTOR

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
Loader will not start (Starter will not rotate)	Starter circuit	Inoperative seat switch or operator not sitting in seat	Check seat switch, sit in seat
		Seat belt not buckled	Buckle seat belt
		No power to ignition switch	Check battery Check 5 amp fuse in engine fuse panel
		No power to EIC	Check seat switch, check battery Check 5amp fuse in engine fuse panel
		No power to starter	Check ignition switch, EIC, seat switch, seat belt, start relay, battery Check 15amp fuse in engine fuse panel
Pinion fails to advance when key switch is closed	Wiring	Open circuit, battery and switch terminal connections	Repair or replace
		Open circuit, fuse	Replace fuse
	Key switch	No contact	Repair or replace
	Starter motor	Sleeve bearing burnt out	Repair or replace
		Lever spring or shaft lever broken	Replace
	Magnetic switch	Magnetic switch plunger movement defective or coil open or shorted.	Repair or replace
Starter motor rotates but no rotation transmitted to engine	Starting motor	Starter drive defective	Replace
		Reduction gear damaged	Replace
Motor rotates before pinion meshes with ring gear	Starting motor	Lever spring weak, shift lever damaged	Replace
		Slip ring defective	Replace
		Pinion teeth worn	Replace
		Pinion push out position defective	Replace
	Engine	Ring gear worn	Replace
	Starter solenoid	Starter solenoid defective	Replace

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
Pinion meshes with ring gear but starting motor fails to turn	Battery	In discharged state	Recharge or replace
	Wiring	Line connecting starter solenoid switch to battery broken or defective ground.	Repair or replace
		Lead wire connecting starter solenoid to motor tightened improperly.	Repair or replace
	Starting motor	Ball bearing locked	Replace
		Installation defective	Reinstall
		Brush worn	Replace
		Brush spring defective	Replace
		Commutator dirty	Clean
		Armature or field coil defective	Repair or replace
		Field coil to brush connection defective	Repair
	Starter solenoid	Contact not touching properly	Replace
		Contact contacting surface roughened	Replace
Starter motor fails to stop after engine starts and key switch is turned off	Key switch	Switch defective	Replace
	Starter solenoid	Starter solenoid defective	Replace

ELECTRICAL SYSTEM - ALTERNATOR

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
No charging	Wiring	Loose connection, short circuit	Repair
	Alternator	Loose connection, no ground, short circuit	Repair or replace
		Defective rectifier	Replace
		Loose connection of RF resistor	Replace
	Regulator	Defective regulator	Replace
		Loose connection of alternator or regulator	Repair or replace

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
Insufficient charging	Wiring	Loose connection or short circuit	Repair
	Alternator	Loose drive belt	Repair
		Short in rotor coil	Replace
		Short in stator coil	Replace
		Defective rectifier	Replace
		Insufficient brush contact	Repair or replace
	Regulator	Defective regulator	Replace
		Loose connection at alternator and regulator	Repair
Overcharge	Battery	Internal short	Replace
	Regulator	Defective regulator	Replace
Unstable charging circuit	Wiring	Loose connection or open wire	Repair or replace
	Alternator	Loose drive belt	Repair
		Short in rotor coil	Replace
		Short in stator coil	Replace
		Insufficient brush contact	Repair or replace
		Broken brush or spring	Replace
		Loose connections	Repair
	Regulator	Defective regulator	Replace
		Loose connection at alternator and regulator	Repair or replace
Abnormal noise of alternator	Alternator	Loose mounting hardware	Repair
		Defective bearings	Repair or replace
		Rotor core and stator in contact	Replace
		Defective diode	Replace
		Short in stator coil	Replace

SPECIFICATIONS

SERVICE STANDARDS - LS180

CYLINDER BLOCK

Taper of Cylinder Bore . . . . 0.025 mm (0.001″) repair limit
0.127 mm (0.005″) wear limit

Cylinder Bore Out-of-Round . . . . 0.03 mm (0.0015″) repair limit
0.127 mm (0.005″) wear limit

Cylinder Bore Diameters . . . . 111.778 - 111.841 mm (4.4007″ - 4.4032″)

Rear Oil Seal Bore Diameter . . . . 140.77 - 140.87 mm (5.542″ - 5.546″)

Block-to-Head Surface Flatness . . . . 0.08 mm (0.003″) in any 152 mm (6″)
or 0.15 mm (0.006″) overall limit

CYLINDER HEAD

Valve Guide Bore Diameter . . . . 9.469 - 9.487 mm (0.3728″ - 0.3735″)

Head-to-Block Surface Flatness . . . . 0.08 mm (0.003″) in any 152 mm (6″)
or 0.15 mm (0.006″) overall limit

EXHAUST VALVES

Face Angle . . . . 44.15° - 44.30° Relative to Head of Valve

Stem Diameter
Standard: . . . . 9.401 - 9.418 mm (0.3701″ - 0.3708″)
Oversize 0.076 mm (0.003″): . . . . 9.477 - 9.495 mm (0.3731″ - 0.3738″)
Oversize 0.38 mm (0.015″): . . . . 9.781 - 9.799 mm (0.3851″ - 0.3858″)
Oversize 0.76 mm (0.030″): . . . . 10.163 - 10.180 mm (0.4001″ - 0.4008″)

Head Diameter . . . . 38.23 - 38.48 mm (1.505″ - 1.515″)

Seat Width (minimum) . . . . 0.79 mm (0.031″)

Stem-to-Guide Clearance . . . . 0.051 - 0.094 mm (0.0020″ - 0.0037″)

Lash Clearance (Cold) . . . . 0.43 - 0.53 mm (0.017″ - 0.021″)

INTAKE VALVES

Face Angle . . . . 29.15° - 29.30° Relative to Head of Valve

Stem Diameter
Standard: . . . . 9.426 - 9.444 mm (0.3711″ - 0.3718″)
Oversize 0.076 mm (0.003″): . . . . 9.502 - 9.520 mm (0.3741″ - 0.3748″)
Oversize 0.381 mm (0.01″): . . . . 9.807 - 9.825 mm (0.3861″ - 0.3868″)
Oversize 0.762 mm (0.030″): . . . . 10.188 - 10.206 mm (0.4011″ - 0.4018″)

Head Diameter . . . . 46.48 - 46.77 mm (1.832″ - 1.842″)

Seat Width (minimum) . . . . 1.58 mm (0.062″)

Stem-to-Guide Clearance . . . . 0.025 - 0.069 mm (0.0010″ - 0.0027″)

Lash Clearance . . . . 0.36 - 0.46 mm (0.014″ - 0.018″)

VALVE SPRINGS

Number per Valve 1

Free Length . . . . 54.6 mm (2.15″)

Load at 1.74″ Length (44.20 mm) . . . . 27.7 - 31.3 kg (61 - 69 lbs.)

Load at 1.32″ Length (33.53 mm) . . . . 57.8 - 63.1 kg (125 - 139 lbs.)

VALVE TIMING

Intake Opening . . . . 14° Before Top Dead Center

Intake Closing . . . . 38° After Bottom Dead Center

Exhaust Opening . . . . 41° Before Bottom Dead Center

Exhaust Closing . . . . 11° After Top Dead Center

VALVE INSERTS

Insert Oversize	Exhaust Valve Insert Counterbore Diameter in Cylinder Head	Intake Valve Seat Insert Counterbore Diameter in Cylinder Head
0.254 mm (0.010″)	40.82 - 40.84 mm (1.607″ - 1.608″)	43.44 - 43.46 mm (1.907″ - 1.908″)
0.508 mm (0.020″)	41.07 - 41.10 mm (1.617″ - 1.618″)	43.69 - 43.72 mm (1.917″ - 1.918″)
0.762 mm (0.030″)	41.33 - 41.36 mm (1.627″ - 1.628″)	43.95 - 43.97 mm (1.927″ - 1.928″)

VALVE SEATS

Exhaust Valve Seat Angle . . . . 45.0° - 45.3°

Intake Valve Seat Angle . . . . 30.0° - 30.3°

Interference Angle Valve . . . . 0.30° - 1.15°

Face to Valve Seat Seat Runout . . . . 0.038 mm (0.0015″) Total Indicator Reading Max.

Seat Width
- Exhaust . . . . 2.13 - 2.69 mm (0.084″ - 0.106″)
- Intake . . . . 2.03 - 2.59 mm (0.080″ - 0.102″)

CAMSHAFT DRIVE GEAR

Number of Teeth 47

End Play . . . . 0.025 - 0.28 mm (0.001″ - 0.011″)

Bushing Inside Diameter . . . . 50.813 - 50.838 mm (2.005″ - 2.0015″)

Adapter Outside Diameter . . . . 50.762 - 50.775 mm (1.9985″ - 1.9990″)

Backlash with Crankshaft Gear . . . . 0.025 - 0.23 mm (0.001″ - 0.009″)

Backlash with Camshaft Gear . . . . 0.025 - 0.23 mm (0.001″ - 0.009″)

Backlash with Fuel Injection Pump Drive Gear . . . . 0.025 - 0.30 mm (0.001″ - 0.012″)

CAMSHAFT GEAR

Number of Teeth 52

Timing Gear Backlash . . . . 0.08 - 0.20 mm (0.003″ - 0.008″)

ROCKER ARM SHAFT

Shaft Diameter . . . . 25.40 - 25.43 mm (1.000″ - 1.001″)

Support Diameter
(Internal Diameter) . . . . 25.45 - 25.50 mm (1.002″ - 1.004″)

ROCKER ARM

Inside Diameter . . . . 25.48 - 25.50 mm (1.003″ - 1.004″)

TAPPETS

Clearance to Bore . . . . 0.015 - 0.053 mm (0.0006″ - 0.0021″)

Tappet Diameter . . . . 25.118 - 25.130 mm (0.9889″ - 0.9894″)

Tappet Bore Diameter . . . . 25.15 - 25.17 mm (0.990″ - 0.991″)

CAMSHAFT

Bearing Journal Diameter . . . . 60.693 - 60.719 mm (2.3895″ - 2.3905″)

Bearing Clearance . . . . 0.025 - 0.076 mm (0.001″ - 0.003″)

End Play . . . . 0.025 - 0.18 mm (0.001″ - 0.007″)

CONNECTING RODS

Small End Bushing (Internal Diameter) . . . . 38.108 - 38.115 mm (1.5003″ - 1.5006″)

Clearance Bushing-to-Piston Pin . . . . 0.013 - 0.018 mm (0.0005″ - 0.0007″)

Side Float . . . . 0.18 - 0.33 mm (0.007″ - 0.013″)

Maximum Twist . . . . 0.30 mm (0.012″)

Maximum Bend . . . . 0.10 mm (0.004″)

PISTON PIN

Outside Diameter . . . . 38.092 - 38.100 mm (1.4997″ - 1.5001″)

PISTONS

Skirt-to-Cylinder Clearance . . . . 0.162 - 0.196 mm (0.0064″ - 0.0077″)

Taper (Out-of-Round) . . . . 0.063 - 0.127 mm (0.0025″ - 0.0050″)

Piston Pin Clearance at 21°C (70°F) . . . . 0.0076 - 0.0127 mm (0.0003″ - 0.0005″)

Piston Crown to Block Face Height . . . . 0.288 - 0.58 mm (0.011″ - 0.023″)

PISTON RINGS

Type
- Top Compression . . . . Keystone Tapered Sides-Barrel Faced
- Second Compression . . . . Lower Side Internal Chamfer-Tapered Face
- Oil Control Ring . . . . Slotted with Expander Ring

Side Face Clearance to Ring Groove . . . . 0.075 - 0.125 mm (0.00295″ - 0.00485″)

Ring Gap Width . . . . 0.40 - 0.90 mm (0.016″ - 0.036″)

CRANKSHAFT

Main Journal Diameter
- Blue . . . . 85.631 - 85.644 mm (3.3713″ - 3.3718″)
- Red . . . . 85.644 - 85.656 mm (3.3718″ - 3.3723″)

Main Journal Length . . . . 36.96 - 37.21 mm (1.455″ - 1.465″)

Main Journal Wear Limits . . . . 0.127 mm (0.005″) maximum

Main and Crankpin Fillet Radius . . . . 3.048 - 3.556 mm (0.12″ - 0.14″)

Thrust Bearing Journal Length . . . . 37.06 - 37.11 mm (1.459″ - 1.461″)

Intermediate Bearing Journal Length . . . . 36.96 - 37.21 mm (1.455″ - 1.465″)

Rear Bearing Journal Length . . . . 37.97 - 38.48 mm1 (.495″ - 1.515″)

Crankpin Journal Length . . . . 42.62 - 42.72 mm (1.678″ - 1.682″)

Crankpin Diameter
- Blue . . . . 69.840 - 69.850 mm (2.7496″ - 2.7500″)
- Red . . . . 69.850 - 69.860 mm (2.7500″ - 2.7504″)

End Play . . . . 0.10 - 0.20 mm (0.004″ - 0.008″)

Crankpin Out-of-Round . . . . 0.005 mm (0.0002″) Total Indicator Reading

Taper-Surface Parallel to Center Line of Main Journal . . . . 0.005 mm (0.0002″)

Crankshaft Rear Oil Seal Journal Diameter . . . . 122.12 - 122.28 mm (4.808″ - 4.814″)

Crankshaft Pulley Journal Diameter . . . . 44.45 - 44.48 mm (1.750″ - 1.751″)

Crankshaft Timing Gear Journal Diameter . . . . 46.23 - 46.25 mm (1.820″ - 1.821″)

Crankshaft Flange Runout . . . . 0.038 mm (0.0015″) Max

CRANKSHAFT DRIVE GEAR

Number of Teeth 26

MAIN BEARING

Bearing Length (except thrust bearing) . . . . 27.94 - 28.19 mm (1.10″ - 1.11″)

Bearing Length (thrust bearing) . . . . 39.91 - 39.96 mm (1.453″ - 1.455″)

MAIN BEARING IDENTIFICATION

Identifying Mark	Color Code	Material	Wall Thickness	Specified Clearance
PV or G	Red	Copper Lead	3.162 - 3.175 mm (0.1245″ - 0.1250″)	0.056 - 0.114 mm (0.0022″ - 0.0045″)
PV or G	Blue	Copper Lead	3.172 - 3.185 mm (0.1249″ - 0.1254″)	0.056 - 0.114 mm (0.0022″ - 0.0045″)
G and AL	Red	Aluminum Tin Alloy	3.162 - 3.175 mm (0.1245″ - 0.1250″)	0.056 - 0.114 mm (0.0022″ - 0.0045″)
G and AL	Blue	Aluminum Tin Alloy	3.172 - 3.185 mm (0.1249″ - 0.1254″)	0.056 - 0.114 mm (0.0022″ - 0.0045″)

CRANKPIN BEARINGS

Bearing Length . . . . 35.56 - 35.81 mm (1.40″ - 1.41″)

BEARING IDENTIFICATION

Identifying Mark	Color Code	Material	Wall Thickness	Specified Clearance
PV or G	Red	Copper Lead	2.395 - 2.408 mm (0.0943″ - 0.0948″)	0.043 - 0.096 mm (0.0017″ - 0.0038″)
PV or G	Blue	Copper Lead	2.405 - 2.418 mm (0.0947″ - 0.0952″)	0.043 - 0.096 mm (0.0017″ - 0.0038″)
G and AL	Red	Aluminum Tin Alloy	2.390 - 2.403 mm (0.0941″ - 0.0946″)	0.053 - 0.107 mm (0.0021″ - 0.0042″)
G and AL	Blue	Aluminum Tin Alloy	2.400 - 2.413 mm (0.0945″ - 0.0950″)	0.053 - 0.107 mm (0.0021″ - 0.0042″)

CRANKSHAFT GRINDING

When grinding a crankshaft, the main and crankpin journal diameters should be reduced the same amount as the undersize bearings used. The following dimensions apply. The rear end of the crankshaft should be located on the 60° chamfer of the pilot bearing bore.

Undersize Bearing

Available — **Main Journal Diameters**

0.051 mm (0.002″) . . . . 85.580 - 85.583 mm (3.3693″ - 3.3698″)

0.254 mm (0.010″) . . . . 85.390 - 85.402 mm (3.3618″ - 3.3623″)

0.508 mm (0.020″) . . . . 85.136 - 85.148 mm (3.3518″ - 3.3523″)

0.762 mm (0.030″) . . . . 84.882 - 84.894 mm (3.3418″ - 3.3423″)

1.016 mm (0.040″) . . . . 84.628 - 84.640 mm (3.3318″ - 3.3323″)

Crankpin Journal Diameters

0.051 mm (0.002″) . . . . 69.789 - 69.799 mm (2.7476″ - 2.7480″)

0.254 mm (0.010″) . . . . 69.956 - 69.606 mm (2.7400″ - 2.7404″)

0.508 mm (0.020″) . . . . 69.342 - 69.352 mm (2.7300″ - 2.7304″)

0.762 mm (0.030″) . . . . 69.088 - 69.098 mm (2.7200″ - 2.7204″)

1.016 mm (0.040″) . . . . 68.834 - 68.844 mm (2.7100″ - 2.7104″)

FLYWHEEL

Runout of Clutch Face . . . . 0.127 mm (0.005″)

Ring Gear Runout . . . . 0.64 mm (0.025″)

OIL PUMP

Rotor Clearance . . . . 0.025 - 0.15 mm (0.001″ - 0.006″)

Rotor-to-Pump Housing Clearance . . . . 0.15 - 0.28 mm (0.006″ - 0.011″)

Rotor End Play . . . . 0.025 - 0.089 mm (0.001″ - 0.0035″)

Relief Valve Pressure . . . . 4.1 - 4.8 bar (60 - 70 PSI)
(4.2 - 4.9 kg/cm^2) at 2000 RPM

Relief Valve Spring Tension . . . . 27.2 mm (1.07″) under 4.85 kg - 5.4 kg (10.7 lb. - 11.9 lb.) load

ENGINE OIL SPECIFICATIONS

Temperature	Oil Viscosity and Type	API Classification	Engine Oil & Filter Change Period (hours)
- 40°F - +30°F	SAE 5W	SH-CG4	100
- 20°F - +60°F	SAE 5W - 30	SH-CG4	100
- 10°F - +120°F	SAE 10W - 30	SH-CG4	100

When using diesel fuel with sulphur content between 0.5% and 1.0% use only oils listed above but reduce the oil and filter change period to every 50 hours.

When using diesel fuel with sulphur content between 1.0% and 1.3% use only oils listed above but reduce the oil and filter change period to every 25 hours.

Use of diesel fuel with a sulphur content above 1.3% is not recommended.

THERMOSTAT

Opening Temperature . . . . 76°C (168°F)

WATER PUMP

Type . . . . Centrifugal

Drive . . . . V-belt

Drive Belt Deflection . . . . 3 mm (0.375″) midway between pulleys with a force of 1 kg (2 lbs.) applied

COOLING FLUID

Use an antifreeze that meets ESE-M97B - 18C/D or SSM - 97B - 9101A specifications. Mix with an equal amount of clean water. Add Inhibitor, FW - 15, to the mixture to yield a 5% concentration.

FUEL INJECTOR SPECIFICATIONS

Needle valve opening pressure	227 bar (3381 PSI)
Nozzle retaining nut	48 N·m (35 ft. lbs.)

FUEL INJECTION PUMP SPECIFICATIONS

Rotation (looking on drive end)	Clockwise
Governor type	Mechanical all - speed
Governor link length	54 mm ± 0.3 mm
Governor link length	41.5 mm ± 0.5 mm
Governor arm	Outer hole
Diameter and no. of plungers	4 x 7.0 mm
Drive arrangement	Standard with supported shaft
Advance type	Automatic speed
Solenoid shutoff device	12 volts

MINIMUM HARDWARE TIGHTENING TORQUES

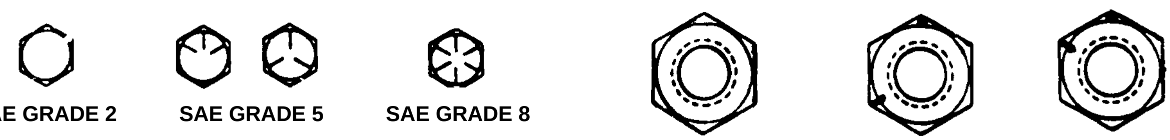
IN FOOT POUNDS (NEWTON-METERS) FOR NORMAL ASSEMBLY APPLICATIONS

INCH HARDWARE AND LOCKNUTS

	SAE GRADE 2		SAE GRADE 5		SAE GRADE 8		LOCKNUTS		
NOMINAL SIZE	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	GR.B w/GR5 BOLT	GR.C w/GR8 BOLT	NOMINAL SIZE
1/4	55* (6.2)	72* (8.1)	86* (9.7)	112* (13)	121* (14)	157* (18)	61* (6.9)	86* (9.8)	1/4
5/16	115* (13)	149* (17)	178* (20)	229* (26)	250* (28)	324* (37)	125* (14)	176* (20)	5/16
3/8	17 (23)	22 (30)	26 (35)	34 (46)	37 (50)	48 (65)	19 (26)	26 (35)	3/8
7/16	27 (37)	35 (47)	42 (57)	54 (73)	59 (80)	77 (104)	30 (41)	42 (57)	7/16
1/2	42 (57)	54 (73)	64 (87)	83 (113)	91 (123)	117 (159)	45 (61)	64 (88)	1/2
9/16	60 (81)	77 (104)	92 (125)	120 (163)	130 (176)	169 (229)	65 (88)	92 (125)	9/16
5/8	83 (112)	107 (145)	128 (174)	165 (224)	180 (244)	233 (316)	90 (122)	127 (172)	5/8
3/4	146 (198)	189 (256)	226 (306)	293 (397)	319 (432)	413 (560)	160 (217)	226 (306)	3/4
7/8	142 (193)	183 (248)	365 (495)	473 (641)	515 (698)	667 (904)	258 (350)	364 (494)	7/8
1	213 (289)	275 (373)	547 (742)	708 (960)	773 (1048)	1000 (1356)	386 (523)	545 (739)	1

NOTE: Torque values shown with * are inch pounds.

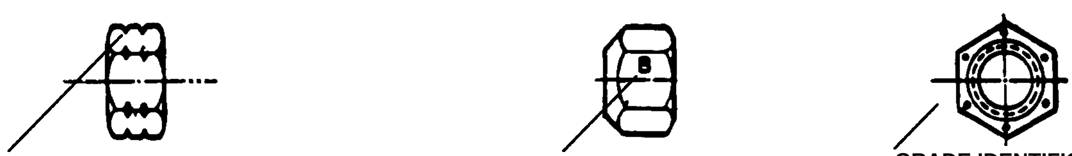
IDENTIFICATION
CAP SCREWS AND CARRIAGE BOLTS



SAE GRADE 2 **SAE GRADE 5** **SAE GRADE 8**

REGULAR NUTS **SAE GRADE 5 HEX NUTS** **SAE GRADE 8 HEX NUTS**

LOCKNUTS



GRADE IDENTIFICATION
GRADE A NO NOTCHES
GRADE B ONE CIRCUMFERENTIAL NOTCH
GRADE C TWO CIRCUMFERENTIAL NOTCHES

GRADE IDENTIFICATION
GRADE A NO MARKS
GRADE B LETTER B
GRADE C LETTER C

GRADE IDENTIFICATION
GRADE A NO MARKS
GRADE B THREE MARKS
GRADE C SIX MARKS
MARKS NEED NOT BE LOCATED AT CORNERS

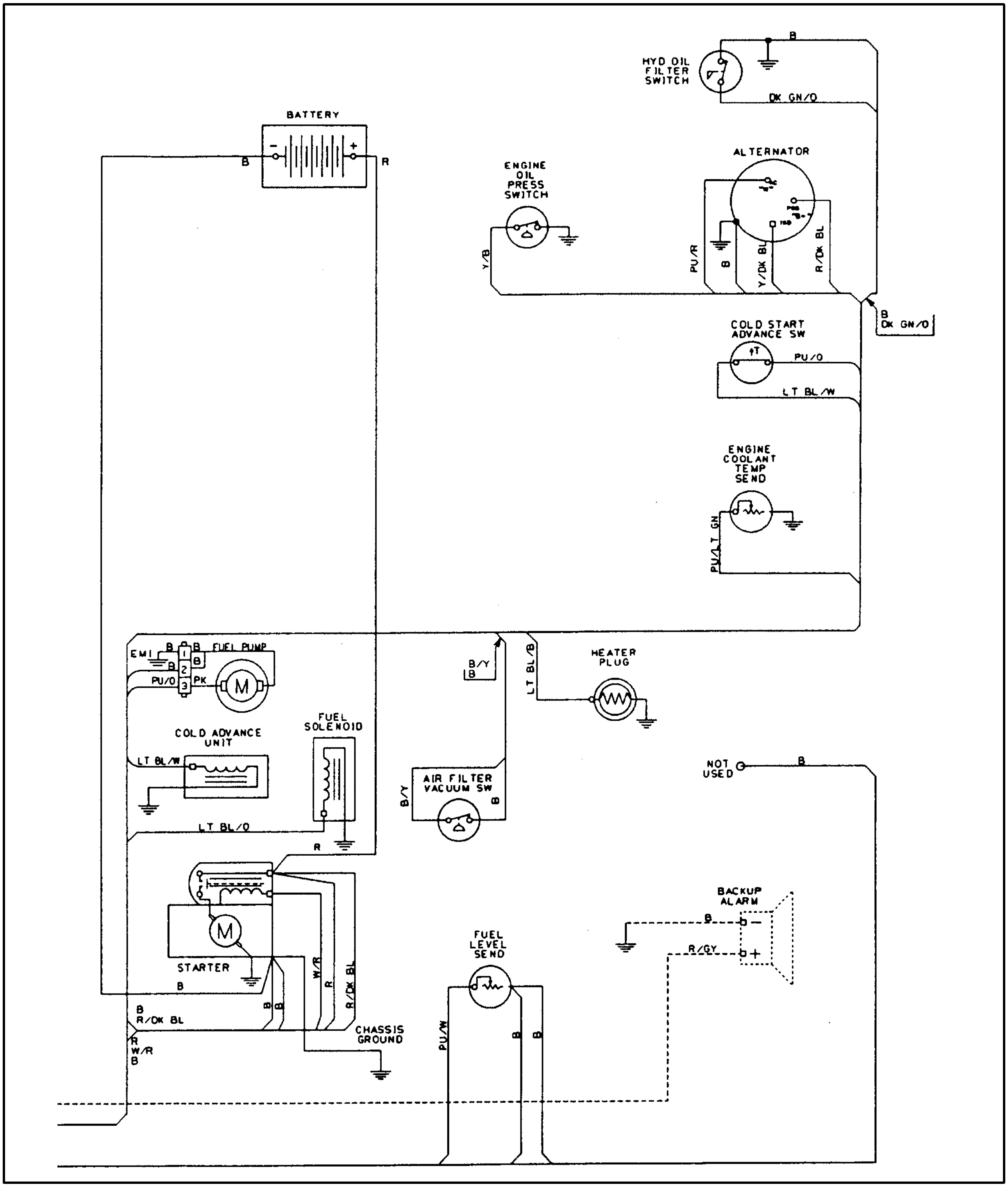
TORQUE SPECIFICATIONS

	N·m	kgm	ft. lbs.
Main Bearing Bolts	163	14	120
Connecting Rod Nuts	85	9	63
Cylinder Head Bolts (with Engine Cold)	150	15	110
Intake Manifold-to-Cylinder Head	35	4	26
Exhaust Manifold-to-Cylinder Head	38	4	28
Exhaust Pipe-to-Flange	31	4	23
Flywheel-to-Crankshaft	217	22	160
Oil Pan Drain Plug	41	4	30
Valve Rocker Cover Bolts	18	2	13
Crankshaft Pulley-to-Crankshaft	224	23	165
Self-Locking Screw-Valve Rocker Arm	24	3	18
Injector Attachment Bolts	23	2	17
Oil Pump-to-Block	49	5	36
Water Pump-to-Cylinder Block	35	4	26
Water Pump Cover-to-Pump	27	3	20
Oil Pan-to-Cylinder Block (Stamped)	30	3	22
Injector Line Nuts	27	3	20
Leak-off Tube Banjo Fitting Bolts	8	1	6
Injection Pump-to-Front Adapter Plate	24	3	18
Camshaft Drive Gear-to-Block	140	14	103
Front Adapter Plate-to-Cylinder Block	19	2	14
Front Cover-to-Front Adapter Plate	22	2	16
Camshaft Gear Bolts	58	6	43
Oil Filter Retaining Bolts	65	7	48
Oil Filter Mounting Bolt Insert	34	4	25
Starting Motor-to-Rear Adapter Plate	31	3	23
Governor Drive Gear Nut	122	13	90
Oil Pump Gear Stop	95	10	70
Oil Pressure Switch Assembly	31	3	23
Turbocharger-to-Exhaust Manifold	44	5	33
Fan-to-Pulley Bolts	22	2	16

TURBOCHARGER TORQUE SPECIFICATIONS

	N·m	kgf.m	ft. lbs.
Turbine Housing Bolts	20 - 25	2.0 - 2.5	15 - 18
Turbocharger to Manifold	41 - 47	4.1 - 4.7	30 - 35
Oil Feed Tube to Turbocharger (Banjo Bolt)	30 - 40	3.0 - 4.0	22 - 30
Oil Feed Tube to Filter Head Connector	18 - 20	1.8 - 2.0	13 - 15
Connector to Filter Head	54 - 81	5.4 - 8.1	40 - 60
Oil Return Tube Bolts from Turbocharger	20 - 25	2.0 - 2.5	15 - 18
Oil Return Tube to Block Connector	60 - 70	6.0 - 7.0	45 - 50
Oil Return Connector to Block	27	2.7	20
Inlet Hose Clamps	1.7 - 2.3		15 - 20 in. lbs
SEALER Type ESE-M4G194-B	Sealer Anaerobic Low Strength		

ENGINE ELECTRICAL COMPONENTS - LS180



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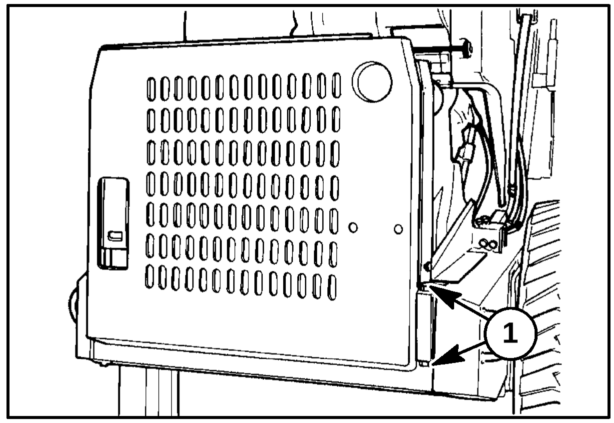
Op. 10 001 10

ENGINE REMOVAL BY TILTING THE CAB AND BOOM FORWARD - LS180

1. Securely block the skid steer loader with all four wheels off the ground. Refer to Section 00 for more detailed information on properly supporting the skid steer loader.

CAUTION

Failure to securely support the skid steer loader could result in movement of the loader causing serious injury or damage to the equipment.



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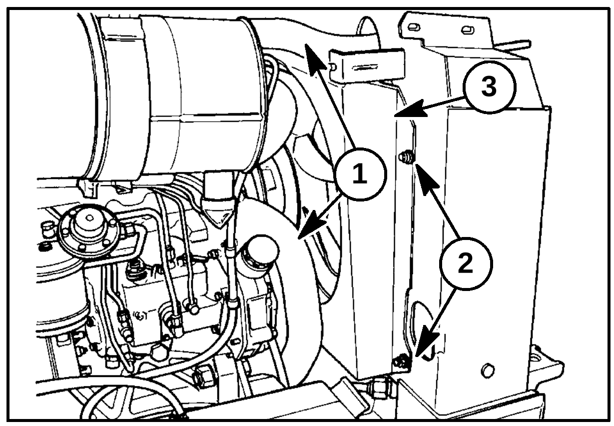
2. Tilt cab and boom forward. Refer to Section 00 for more detailed information on this procedure.
3. Remove the battery. Refer to Section 55 for the battery removal procedure.
4. Open the rear door and disconnect the radiator overflow hose at the overflow tank. Remove the cap screw and nut, 1. Remove the rear door.
5. Drain the engine cooling system.
6. Remove the upper and lower radiator hoses, 1, from the engine block and plug the hoses with plastic plugs.
7. Remove cap screws and nuts, 2. Slide fan shroud, 3, forward to access the oil cooler line connection.
8. Disconnect the oil cooler bottom left line and cap to prevent loss of oil.



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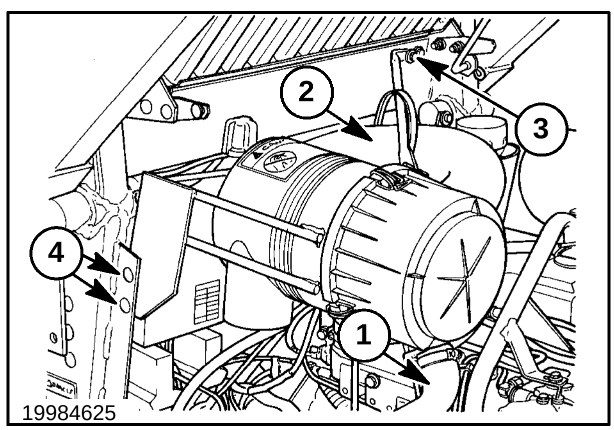
9. Disconnect the air hoses, 1 and 2. Remove support rod hardware at 3. Remove air cleaner canister support hardware at 4.



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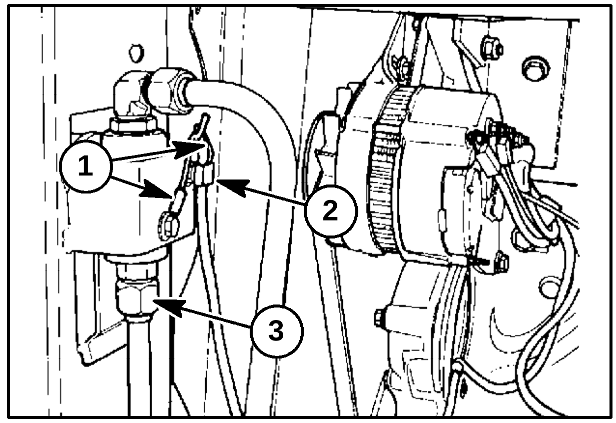
10. Remove the hydraulic oil filter restriction switch wires, 1, and harness clamps, 2.
11. Disconnect hydraulic line, 3, from the oil filter base.

NOTE: *Figure illustrates original configuration without any kit installation. With kits installed there may be additional wiring and hydraulic hoses to disconnect.*



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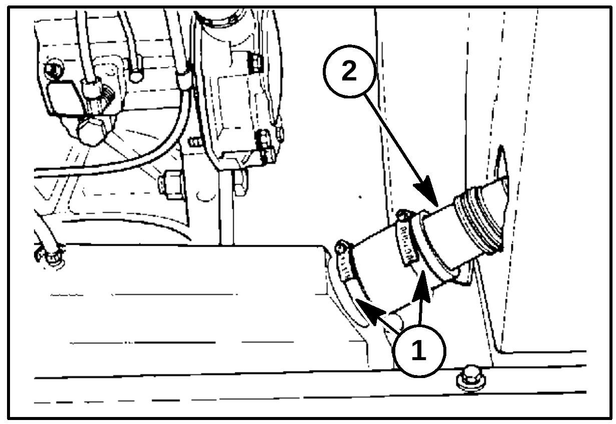
12. Loosen clamps, 1, and remove the fuel tank filler neck, 2.



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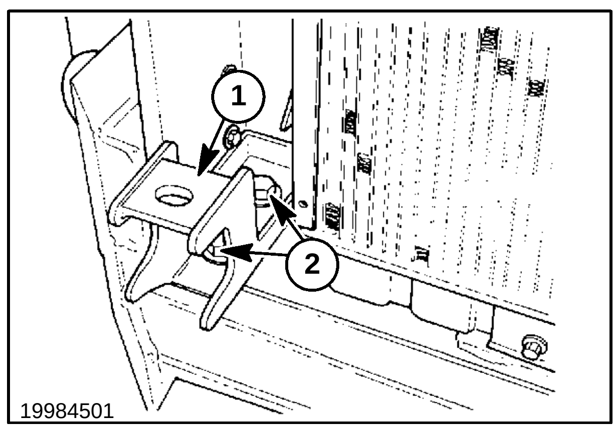
13. Remove the rear door latch bracket, 1, by removing the two capscrews, 2.



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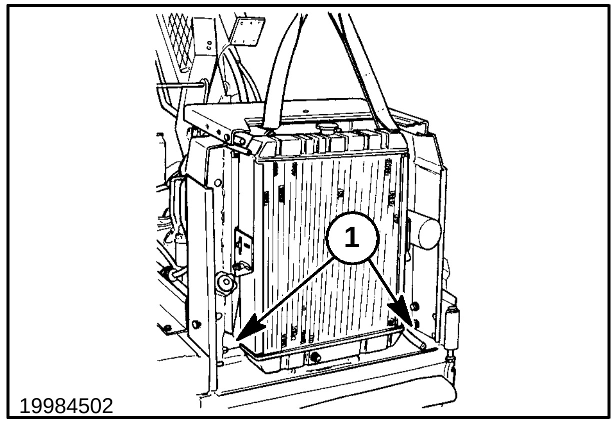
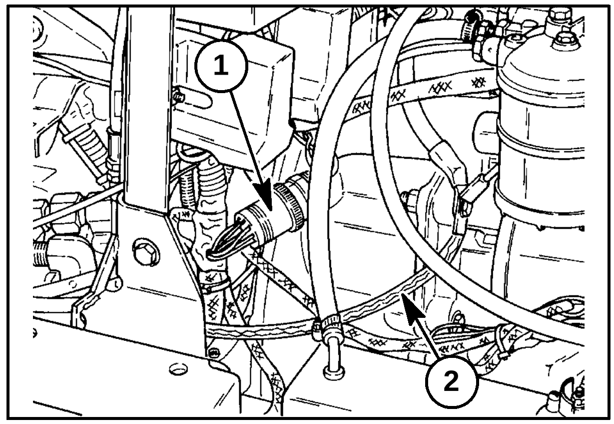
14. Remove eight mounting cap screws, 1 (four cap screws on each side). Remove the radiator/oil cooler assembly from the skid steer.

NOTE: *The radiator/oil cooler assembly is heavy and may require a lifting device to remove.*



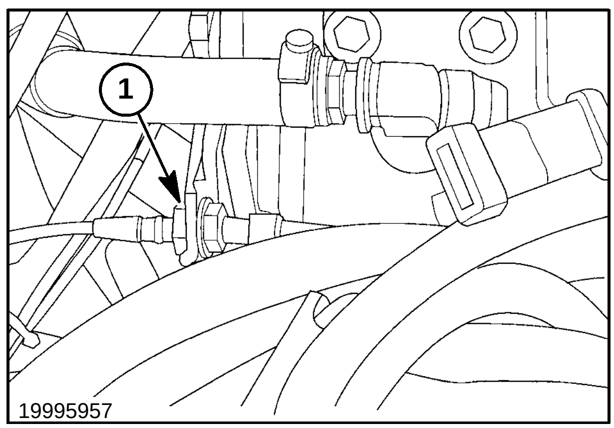
12

15. Disconnect the engine main harness connector, 1. Remove ground strap, 2.



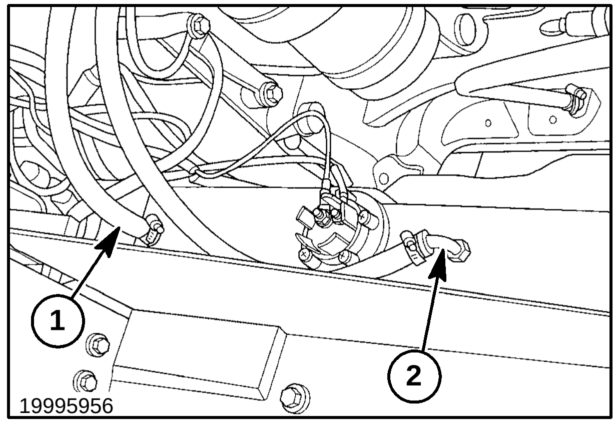
13

16. Disconnect throttle cable, 1.



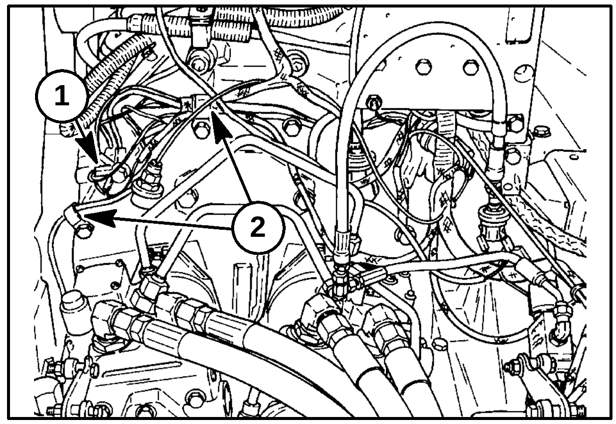
14

17. Remove fuel supply line, 1, and return line, 2.



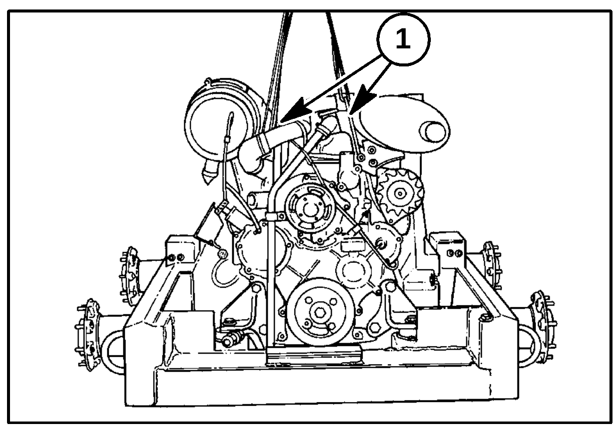
15

18. Remove the fan from the water pump shaft to prevent damage during the removal process.
19. Remove the hydrostatic pumps from the transmission gearbox. Refer to Section 5 for the hydrostatic pump removal procedure.
20. Remove ground wire connections, 1, and wire harness clamps, 2, from the transmission gearbox.



16

21. Attach a chain or cable to the engine lift eyes at 1, and hook to a suitable lifting device to support the engine.



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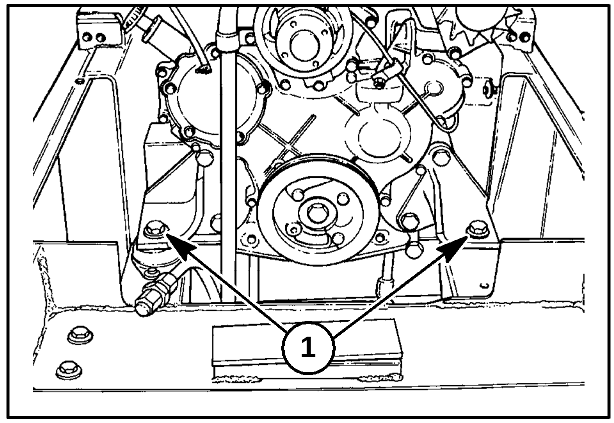
22. Remove the engine motor mount and splitter drive mount hardware, 1. Slide the engine to the rear to clear the hydrostatic pumps. Lift the engine assembly from the skid steer.



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Op. 10 001 20

MOUNTING THE ENGINE FOR MAINTENANCE - LS180

The approximate weight of the engine is 363 kg (800 lbs.). Use an engine repair stand with a minimum capacity of 363 kg (800 lbs.).

The engine repair stand should be used only by qualified service technicians familiar with the equipment.

To maintain shear strength specifications, alloy steel SAE Grade 8 or higher bolts must be used to mount the engine.

For full thread engagement, check that tapped mounting holes in the engine blocks are clean and not damaged. A thread engagement equal to 1 - 1/2 screw diameters minimum is required to maintain strength requirements.

To avoid structural or personal injury, do not exceed the maximum capacity rating of the engine stand.

To avoid an unsafe off-balance load condition, the center of balance of an engine must be located near the engine stand rotating shaft. The engine center of balance is generally located a few millimeters above the crankshaft. Adjust engine mounting to avoid an off-balance condition.

To prevent possible personal injury due to engine slippage, recheck to make sure the engine is solidly mounted while releasing support from the engine lifting device.

Never permit any part of the body to be positioned under an engine or component being lifted or suspended. Accidental slippage may result in personal injury.

Op. 10 001 53

ENGINE DISASSEMBLY SEQUENCE - LS180

The following preliminary disassembly procedure is suggested to remove external components when complete disassembly for overhaul is required. Refer to the appropriate section when removing individual engine components.

1. Drain all coolant and engine oil. Check engine oil for metal contaminates.
2. Remove fan, fan belts, and alternator.
3. Remove turbocharger and exhaust manifold.
4. Remove rocker arm cover with vent tube.
5. Remove coolant outlet connection with thermostats and gasket.
6. Remove dipstick, oil filter, engine oil cooler, and hoses.
7. Remove fuel filter, fuel supply pump, and fuel line.
8. Remove water pump.
9. Remove starting motor.
10. Remove transmission housing and flywheel. (See Section 27)
11. Remove oil pan.
12. Remove crankshaft pulley.

ENGINE COMPONENT MAINTENANCE - LS180

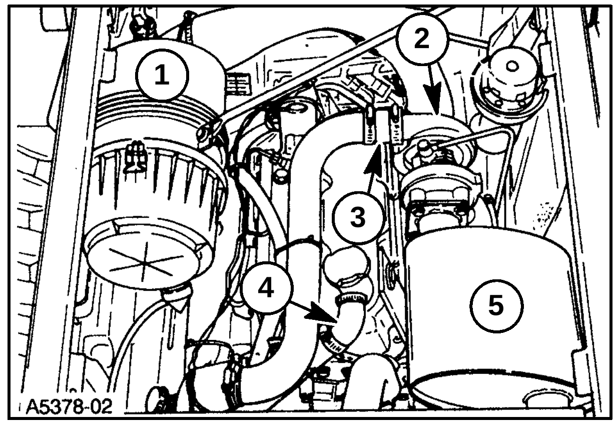
CYLINDER HEAD AND VALVES

Op. 10 101 20

Removal

NOTE: *The cylinder head can be removed with the engine installed in the machine.*

1. Disconnect the battery.
2. Remove the hood and side panel assemblies.
3. Drain the radiator and cylinder block. Remove the upper radiator hose.
4. Remove the air cleaner and bracket assembly, 1, disconnecting the outlet hose at the turbocharger, 2, and the air cleaner restriction indicator switch electrical connections. Remove the hose from the turbocharger outlet to the inlet to the intake manifold, 3.
5. Disconnect and remove the valve rocker cover ventilation tube, 4.
6. Remove the muffler, 5.



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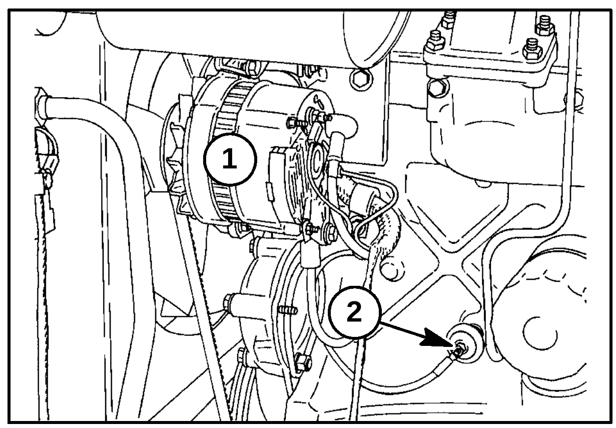
7. Remove the alternator, 1, and oil pressure sender switch electrical connection, 2.



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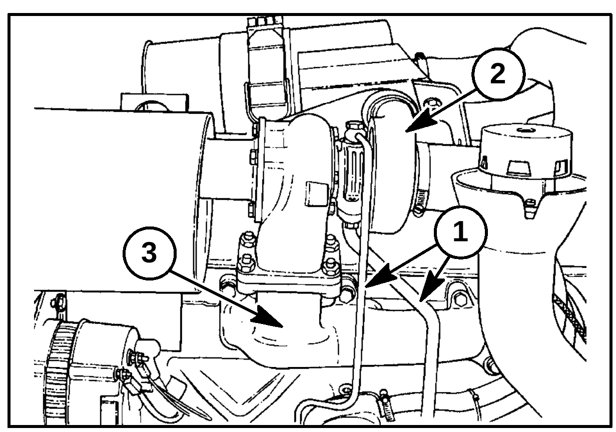
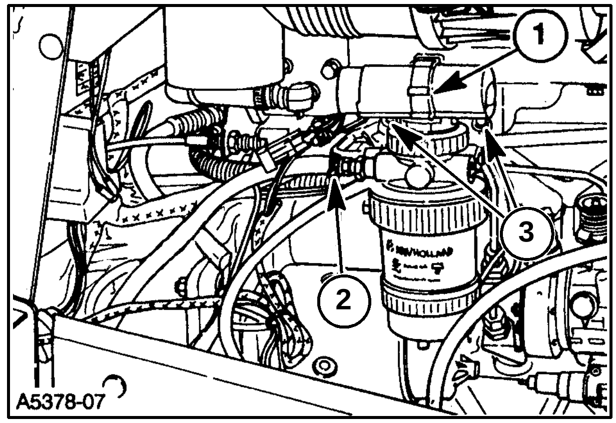
8. Remove the turbocharger oil supply and return lines, 1. Remove the turbocharger, 2.
9. Remove the exhaust manifold, 3, and gasket.



21

10. Disconnect the electrical connectors from the fuel electric lift pump, 1.
11. Disconnect the filter inlet and outlet fuel lines, 2.
12. Remove the two socket head capscrews, 3, and remove the filter and pump assembly.



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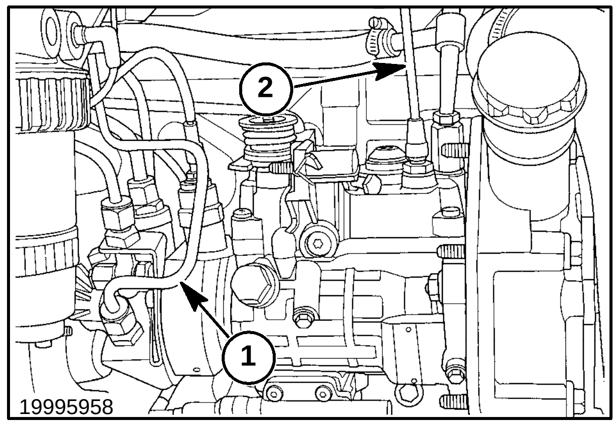
13. Remove the injector lines, 1, from the injection pump and the injectors. Remove the fuel leakoff line from the injection pump, 2. Cap all openings to prevent dirt entry.
14. Disconnect the fuel and electrical connections at the intake manifold heater located at the inlet to the manifold.
15. Disconnect and plug the heater hoses.
16. Remove the retaining bolts and lock washers. Remove the intake manifold and gasket.
17. Remove the rocker arm cover from the engine.



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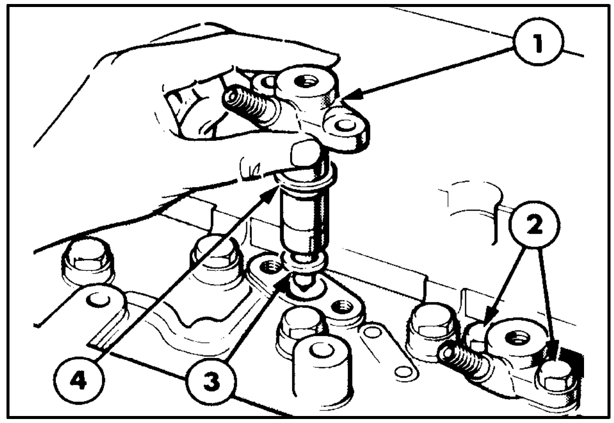
18. Hold the leak-off pipe at each injector and carefully disconnect the fuel injector leak-off pipes. Clean the area surrounding the fuel injectors, then remove the bolts, 2, and carefully withdraw the fuel injectors, 1, and washers, 3 and 4.
19. Check the pushrods for straightness by rotating the rods with the valve closed and identify any bent rods.
20. Loosen the rocker shaft retaining bolts, which also serve as cylinder head bolts, evenly and alternately. Remove the rocker shaft assembly.

NOTE: *Leave the bolts in the rocker shaft supports during removal as they retain the supports on the shaft.*



24

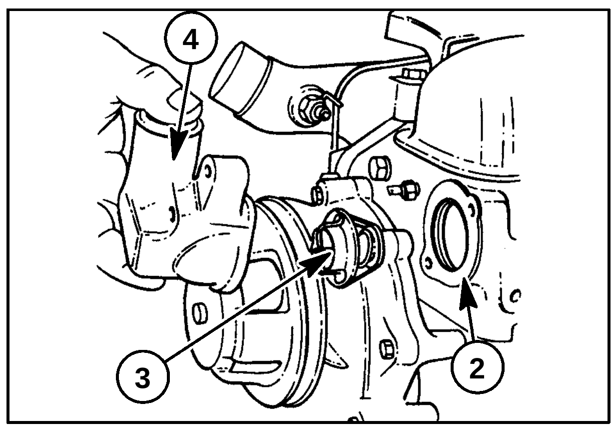
21. Remove the pushrods and place in a numbered rack.
22. Remove the remaining cylinder head bolts and washers working inward from the ends to the center of the head.
23. Lift the cylinder head from the block. If necessary, lever the head off on the pads provided, taking care not to damage the cylinder head or block faces.

DISASSEMBLY

Op. 10 402 30

Thermostat Removal

1. Remove the coolant outlet connection, 4; the thermostat, 3; and gasket, 2.



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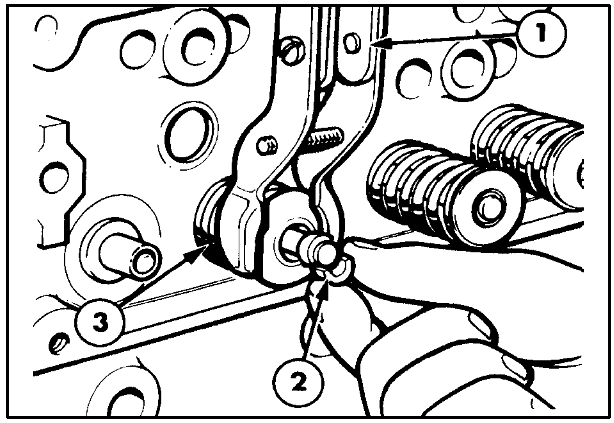
Op. 10 121 21

Cylinder Head

2. Clean the head and remove carbon deposits from around the valve heads.
3. Using a valve spring compressor, 1, remove the retainer locks, 2; spring retainers/ rotators; springs, 3; and seals from each valve.
4. Withdraw the valves and place in a numbered rack together with the valve rotators.



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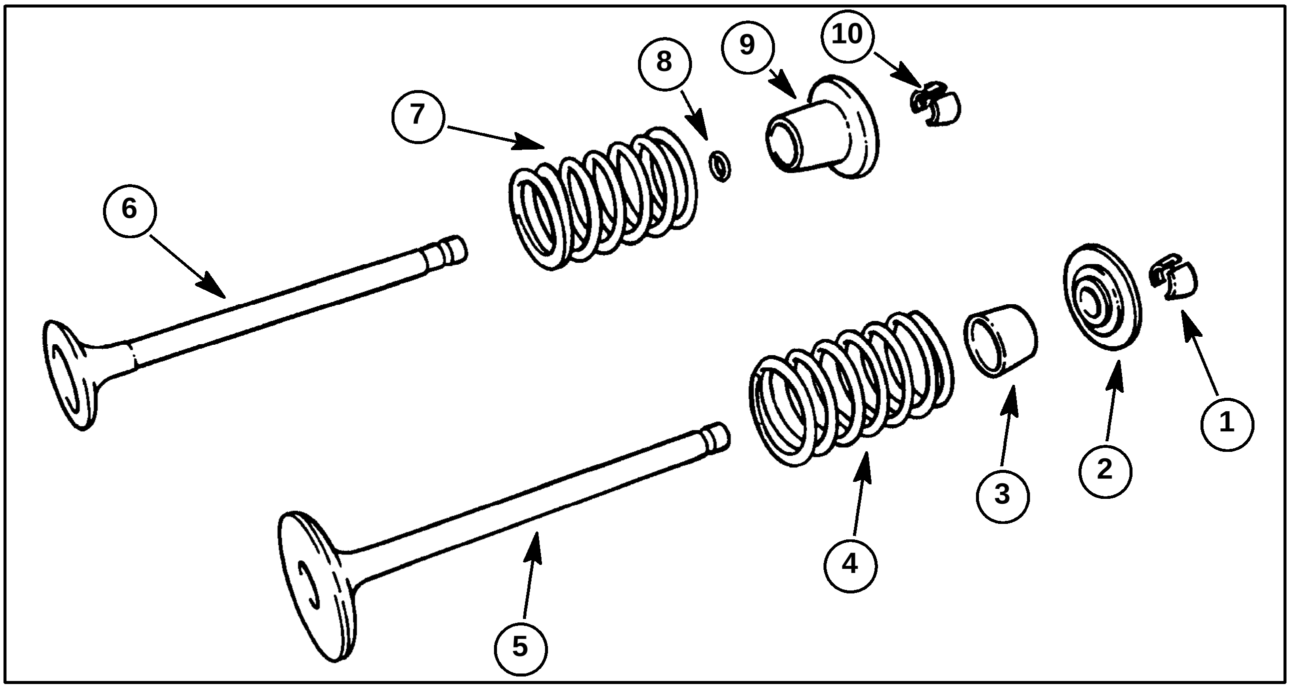

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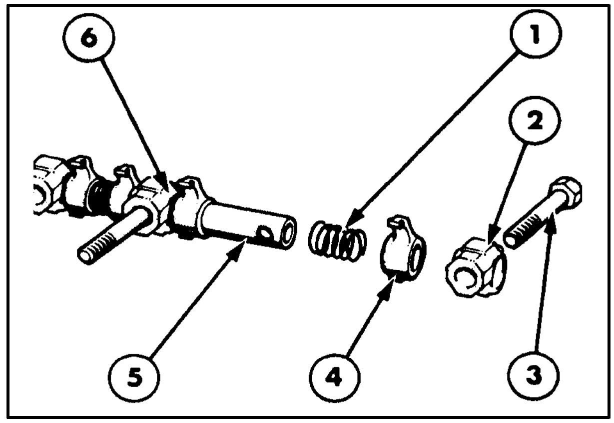
1. Intake valve spring retainer lock
2. Intake valve spring retainer
3. Intake valve seal
4. Intake valve spring
5. Intake valve
6. Exhaust valve
7. Exhaust valve spring
8. Exhaust valve seal
9. Exhaust valve spring retainer
10. Exhaust valve spring retainer locks

Op. 10 106 20

Rocker Shaft Assembly

5. Remove the cylinder head bolts, 3, which pass through the rocker shaft supports, 2, and slide the spring, 1; rocker arm, 4; and spacer, 6, from the shaft.



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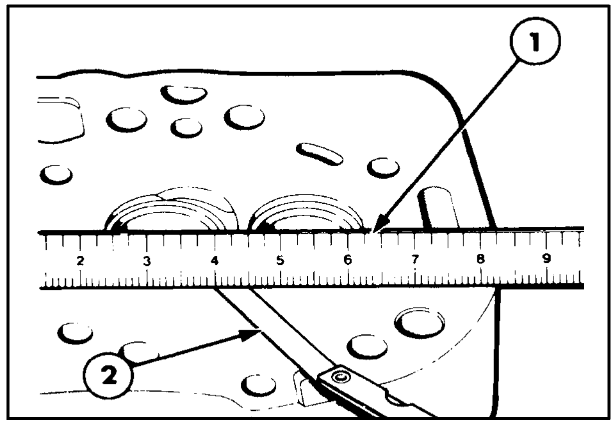
INSPECTION AND REPAIR

Op. 10 101 21

Cylinder Head

1. Scrape all gasket surfaces clean, then wash the cylinder head in a suitable solvent and thoroughly dry with a lint-free cloth or compressed air.
2. Inspect the cylinder head for damage and, if necessary, remove nicks and burrs from the gasket faces using a suitable abrasive. Ensure all traces of abrasive material are removed after repair.
3. Use a straightedge, 1, to check the flatness of the cylinder head in all directions. Resurface or replace if found warped beyond 0.08 mm (0.003 in.) in any area.
4. After skimming the head, check whether any cylinder head bolts are bottoming by mounting the cylinder head on the block without a gasket and without any of the pistons at T.D.C. Install all the bolts finger tight and ensure the rocker shaft supports and flat washers are fitted with the long bolts. If a 0.25 mm (0.010″) feeler gauge can be inserted under the bolt head, then the bolts are bottoming and the cylinder block thread must be increased in depth. Use a 1/2″ x 13 UNC - 2A thread tap.



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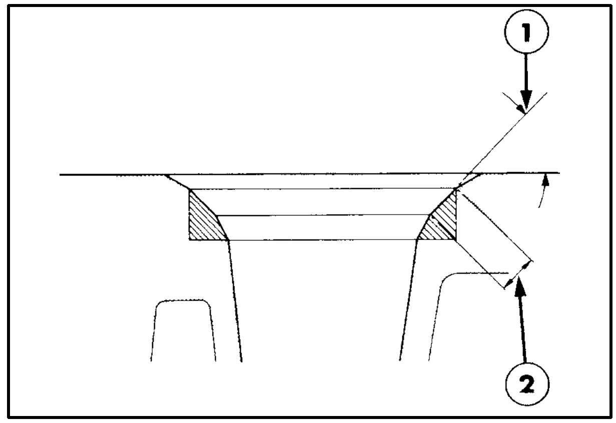
Op. 10 101 55
Valve Seats

5. Examine the valve seat inserts and reface if pitted. Replace damaged inserts. If necessary, install an oversize insert by machining the seat counterbore in the cylinder head. Inserts are available in 0.254 mm (0.010 in.), 0.508 mm (0.020 in.) and 0.762 mm (0.030 in.) oversize. The insert must be chilled in dry ice prior to installation.

***NOTE:** Valve seat inserts of 0.25 mm (0.010″) and 0.5 mm (0.020″) oversize on diameter are sometimes installed in cylinder heads in production. Heads fitted with oversize inserts are stamped S010 or S020 on the exhaust manifold side in line with the valve seat concerned.*

When replacing exhaust valve seat inserts, ensure the replacement inserts are of the correct type as the size and material specification varies for the different engine types.



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6. Check the width of the valve seat inserts and, if necessary, reface by grinding to the dimensions shown.

   Valve Seat Angle: 45.0° - 45.3° for exhaust valve seats. Intake valve seat to be 30.0° - 30.3°

   Valve Seat Width: Intake 2.032 - 2.590 mm (0.080″ - 0.102″) Exhaust 2.133 - 2.692 mm (0.084″ - 0.106″)

***NOTE:** Refacing of the valve seat should always be coordinated with refacing of the valve to ensure a compression tight fit.*

Op. 10 101 32
Valves

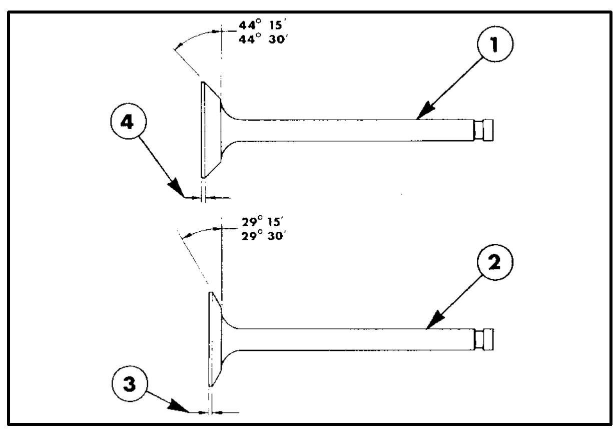
7. Examine the valve face and, if pitted, replace or reface by grinding to the dimension shown. Before refacing the valve, ensure the valve stem is not bent or worn and check that the valve seat runout, measured at right angles to the seat, does not exceed a total of 0.038 mm (0.0015″).

   1 Exhaust valves

   2 Intake valves

   3 Dimension after Refacing: 1.58 mm (0.062″) Minimum

   4 Dimension after Refacing: 0.79 mm (0.031″) minimum



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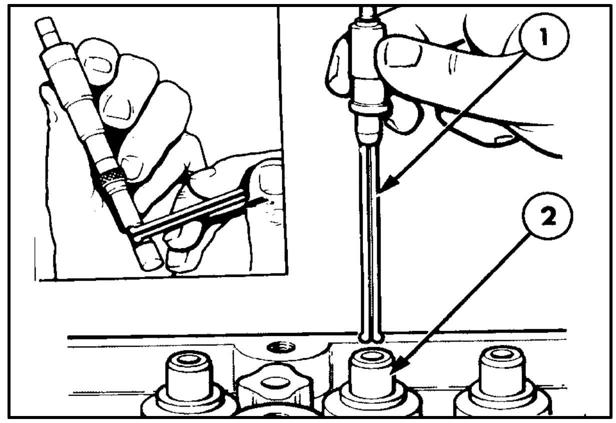
***IMPORTANT:** The finished valve seat should contact the center of the valve face. Using the refaced or new valve, check the seat using Prussian blue. Rotate the valve with a light pressure. If the blue is transferred to the middle of the valve face, the contact is correct.*

Valve Guides

8. Using a telescopic gauge, 1, and micrometer, measure the valve-to-guide clearance. If the intake side clearance exceeds 0.069 mm (0.0027 in.) or the exhaust side clearance exceeds 0.094 mm (0.0037 in.), ream the valve guide, 2, to fit the next oversize valve.

NOTE: *Production cylinder heads may have one or more 0.38 mm (0.015″) oversize valve guides and valves installed. Such cylinder heads have 15 or V015/OS stamped on the exhaust manifold side of the head opposite the valve(s) concerned.*



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9. Use Kit No. FNH02136 to ream out the valve guide to accept an oversize valve. The kit contains three reamer and pilot combinations as follows:

   0.076 mm (0.003″) Oversize Reamer and Standard Diameter Pilot

   0.38 mm (0.015″) Oversize Reamer and 0.076 mm (0.003″) Oversize Pilot

   0.76 mm (0.030″) Oversize Reamer and 0.38 mm (0.015″) Oversize Pilot

   When going from a standard valve stem to an oversize, always use the reamers in sequence. After reaming a valve guide, always check the valve seating and reface if necessary.

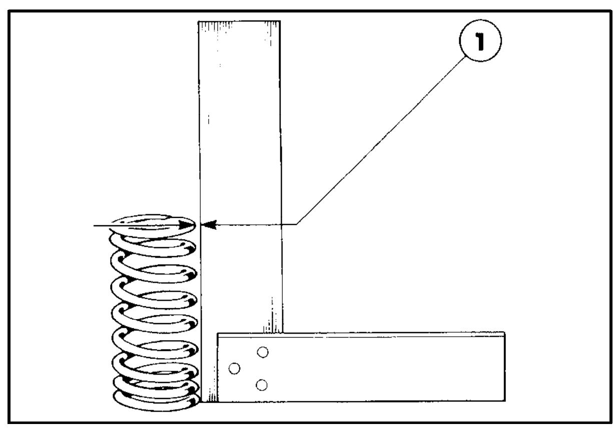
Valve Springs

10. Replace worn or damaged valve springs. Check for squareness and reject if out-of-squareness, 1, exceeds 1.5 mm (0.06″).
11. Place the valve springs on a flat surface. Measure the free-length of the spring. Replace the spring if less than 54.6 mm (2.15 in.).
12. Place the springs in a suitable spring load tester and measure the spring load rating. Replace springs that do not meet the following specifications.

    Load at 1.74 in. length (44.2 mm) 27.7 - 31.3 kg (61 - 69 lbs).

    Load at 1.32 in. length (33.53 mm) 57.8 - 63.1 kg (125 - 139 lbs).

13. Check that the valve spring retainer locks are in good condition and the exhaust valve rotators are not binding or worn.



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Rocker Shaft Assembly

14. Examine the rocker arm for wear or damage. Check the adjusting screw threads and replace if damaged. Inspect the rocker arm locating springs and spacers for damage. Check the rocker arm-to-shaft clearances and replace if beyond specified limits. See “Specifications Service Standards” in this section.
15. Clean the shaft in a suitable solvent and thoroughly dry with compressed air ensuring the oil passages are free from obstruction.

REASSEMBLY

CYLINDER HEAD

1. Insert each valve in the guide bore from which it was removed and lap in position to ensure an even seat around the valve. Withdraw the valve and ensure removal of all traces of lapping compound.
2. Use a valve spring compressor to reassemble the valves, valve springs, retainers, and retainer locks. For the exhaust valves install a new sealing ring in the second groove from the top of the valve stem.

NOTE: *Turbocharged engines have no seals fitted to the intake valves.*

Thermostat

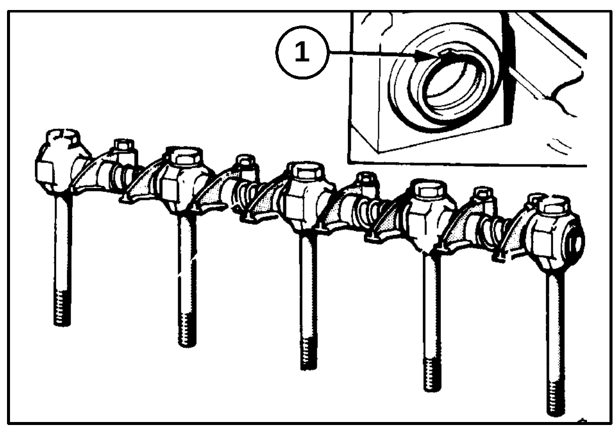
3. Install the thermostat (spring end toward the head), coolant outlet, and a new gasket.

Rocker Shaft Assembly

4. Coat all components with engine oil and position the notch, 1, on the front of the rocker shaft upwards to correctly locate the oil holes.

Rocker Shaft Installation

5. Start the assembly from the shaft rear end by securing a rocker arm support with a long bolt. Ensure the notch, 1, on the support is positioned to the right of the shaft when looking forward. Proceed to install a spacer, rocker arm, spring, rocker arm, and support. Repeat the procedure until complete.



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INSTALLATION

Installation of the cylinder head and related components follows the removal procedure in reverse. On installation observe the following requirements:

Install new cylinder head, intake, and exhaust manifold gaskets.

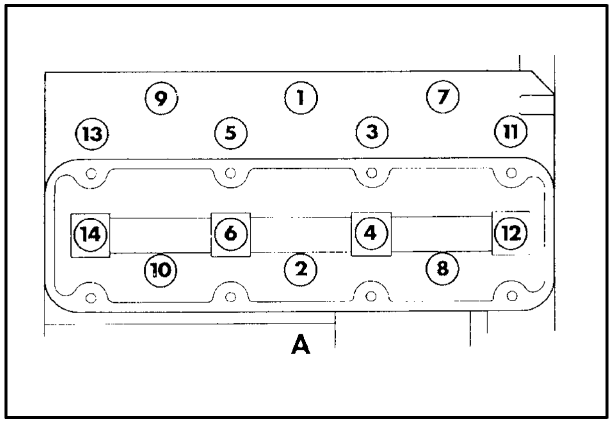
Ensure washers are installed under the heads of the cylinder head retaining bolts. Tighten the cylinder head bolts in the sequence shown and progressively in three steps as follows:

1) Torque to 122 N·m (90 ft. lbs.).

2) Torque to 135 N·m (100 ft. lbs.).

3) Torque to 149 N·m (110 ft. lbs.).

NOTE: *The cylinder head bolts should be torqued only when the engine is cold.*



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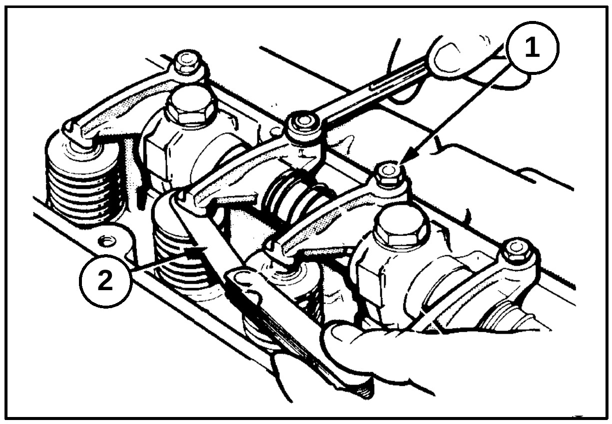
Rotate the engine and set the valve lash on the exhaust side to 0.43 - 0.53 mm (0.017 - 0.021 in.), and on the intake side to 0.36 - 0.46 mm (0.014 - 0.018 in.), using the adjuster screw, 1, and a feeler gauge, 2.



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Install the injectors with new seat washers and cork seals. Tighten the attaching bolts to 23 N·m (17 ft. lbs.).

Install the injector lines and leak-off pipe with new washers. Tighten the lines to 27 N·m (20 ft. lbs.). Tighten the leak-off pipe to 8 N·m (6 ft. lbs.).

NOTE: *Hold the leak-off plastic tube securely to prevent pivoting when tightening the banjo fitting bolts to the correct torque. See "Specifications Service Standards" in this section.*

Use new lock tabs for the exhaust manifold retaining bolts and bend the tabs to effect retention. Tighten the attaching bolts to 38 N·m (28 ft. lbs.).

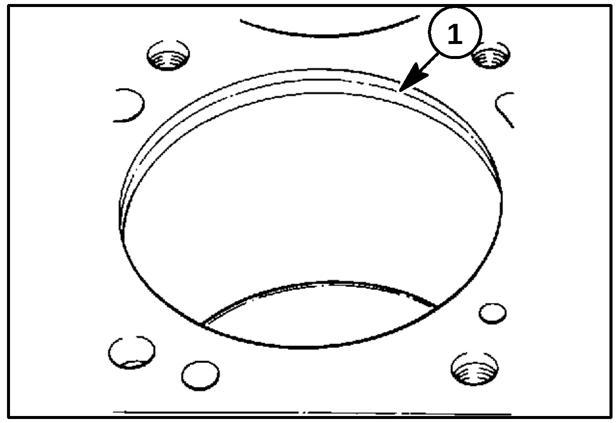
CYLINDER BLOCK, PISTONS, RINGS, RODS AND BEARINGS

Op. 10 105 10

Removal

NOTE: *The connecting rods and pistons can only be removed after prior removal of the engine cylinder head, oil pan and oil pump assembly as described in this section.*

1. If necessary, remove any ridge from the top of the cylinder bores with a cylinder ridge, 1, reamer or hand scraper. Do not cut down into the piston ring travel area.



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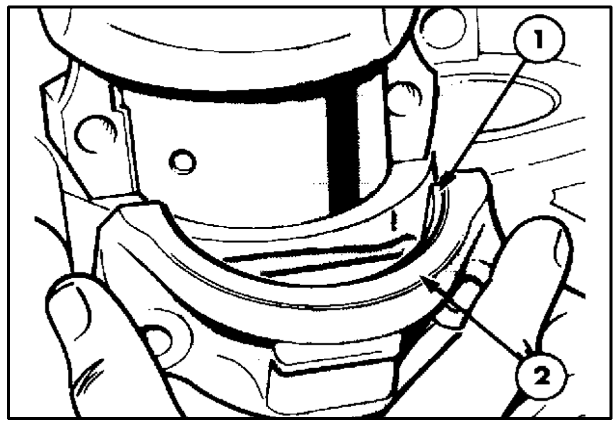
2. With the piston at the bottom of its stroke, remove the nuts from the bearing cap bolts and remove the bearing cap, 2, and liner, 1.
3. Use the handle end of a hammer to push the piston and rod assembly out of the top of the block. Remove the bearing liner from the connecting rod.
4. Turn the crankshaft to bring each piston to the bottom of its stroke and repeat this procedure. Keep the bearing caps and liners with their respective connecting rods.



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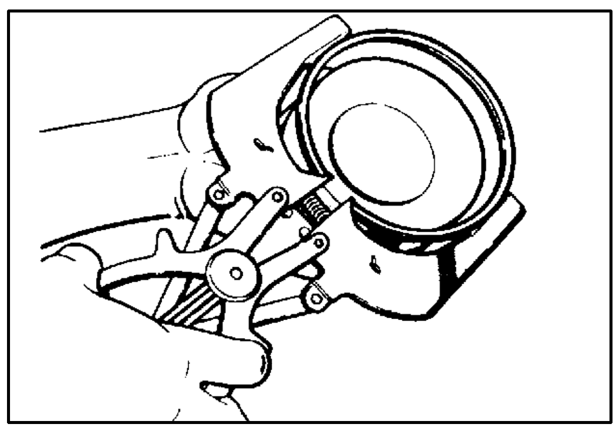
Disassembly

1. Remove the piston pin retainer (snap ring) from each side of the piston and remove the pin.
2. Use an expander to remove the piston rings.



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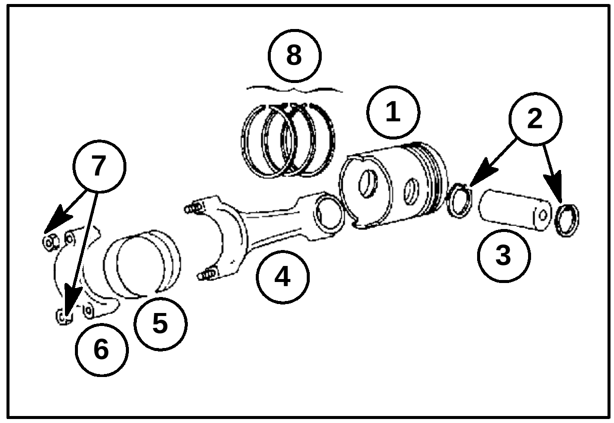
3. Identify each piston and rod for reassembly.
   1 Piston
   2 Pin retainers
   3 Piston pin
   4 Connecting rod
   5 Bearing liners
   6 Bearing cap
   7 Retaining nuts
   8 Piston rings



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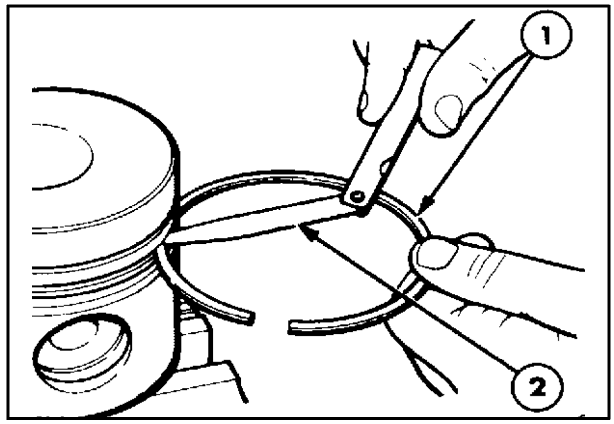
Inspection And Wear

1. Wash the piston and connecting rod assembly in a suitable solvent and dry with a clean lint-free cloth or compressed air.
2. Inspect the piston ring lands, skirts, and pin bosses for damage. Check for separation of the top ring insert from the piston.
3. Clean the ring grooves and using a new ring, 1, and feeler gauge, 2, check the piston ring lands for wear. Replace rings if the clearance is not within 0.075 - 0.125 mm (0.00295 - 0.00485 in.).



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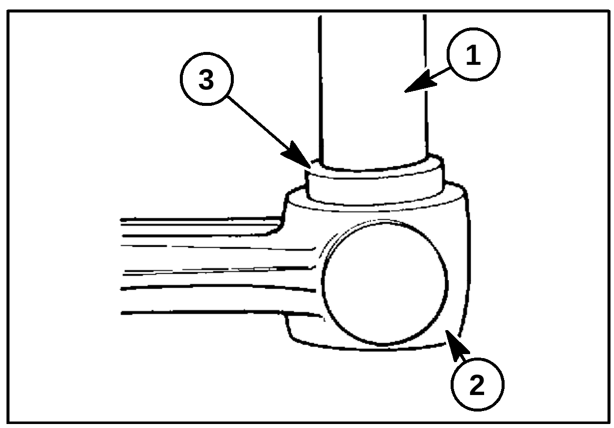
4. Check the connecting rod components for damage and place each connecting rod, 2, in an alignment fixture to check for distortion. Replace if distorted beyond the following: Max. twist – 0.30 mm (0.012 in.), Max. bend – 0.10 mm (0.004 in.)
5. Measure the outside diameter of the piston pin and the inside diameter of the connecting rod bushing. If the clearance is not within 0.013 - 0.018 mm (0.0005 - 0.0007 in.), press out the connecting rod bushing and install a new bushing using a press, 1, and a suitable adapter, 3.



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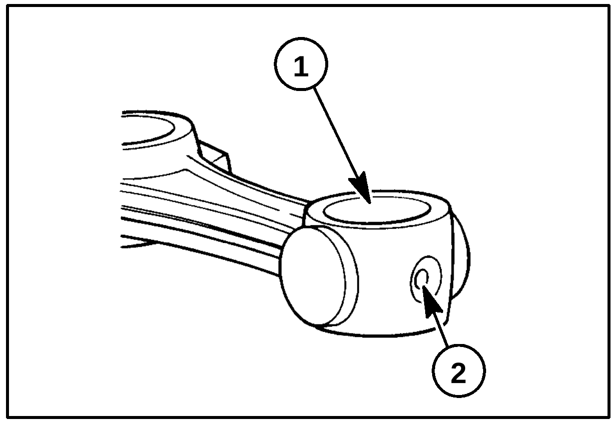
6. After installation of a new connecting rod bushing, 1, use the hole in the top of the rod as a guide and drill a 6 mm (0.25″) diameter hole, 2, into the bushing.
7. Use an expansion reamer to ream the bushing to obtain the specified bushing-to-piston pin clearance.
8. Check the connecting rod and main bearing clearances as described in this section. If the bearing clearances exceed 0.127 mm (0.005 in.), install new bearings as described in the “Crankshaft” part of this section.
9. Clean and inspect the cylinder block. Rust around the core plugs indicates leakage, and new plugs should be fitted with suitable sealant.



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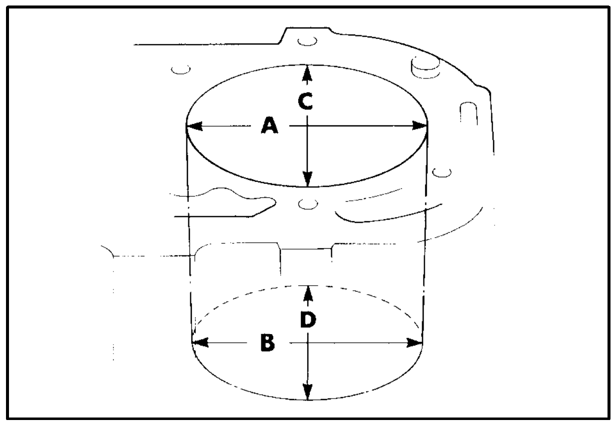
10. Inspect and measure the cylinder bores for waviness, scratches, scuffing, out-of-round, wear and taper. A wavy cylinder wall has a series of parallel lines or rings worn around the cylinder, within the ring travel area. These irregularities can be felt by running a finger over the surface. A scuffed cylinder can be identified by discolored areas. Out-of-roundness, wear and taper can only be detected with a cylinder bore gauge. Measure lengthwise and crosswise to obtain dimensions A, B, C, and D. Dimension A compared with B, and dimension C compared with D, indicates taper while the crosswise dimensions C and D compared to the lengthwise measurements A and B show if an out-of-round condition exists.

    Taper
    Repair Limit: 0.025 mm (0.001 in.)
    Wear Limit: 0.127 mm (0.005 in.)

    Out-of-Round
    Repair Limit: 0.03 mm (0.0015 in.)
    Wear Limit: 0.127 mm (0.005 in.)



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11. If the cylinders are outside specification or the walls are damaged, the cylinders should be honed or bored to fit the next oversize pistons. The finished bore size can be determined by measuring the piston diameter at right angles to the piston pin and adding the appropriate piston-to-bore clearance. See “Specifications Service Standards” in this section. Always bore the cylinder with the most wear first to determine the oversize pistons required. Oversize pistons are available as follows:

    0.10 mm (0.004″)
    0.51 mm (0.020″)
    0.76 mm (0.030″)
    1.0 mm (0.040″)

    Bores to take 0.10 mm (0.004″) oversize pistons need only be honed. All honing should be done with a rigid hone having a grit size of 150 - 220. After reboring and honing, thoroughly wash and dry the cylinder block and coat the walls with engine oil.

12. For cylinders with severely damaged walls or to which maximum oversize pistons have already been installed, cylinder liners are available for sleeving the bore. A lipped, thin wall sleeve is used in engines with a 111.8 mm (4.4″) bore.

Block boring procedure for 111.76 mm (4.4″) Bore Thin Walled Lipped Sleeve:

1) Measure the outside diameter of the sleeve in four places and find the average diameter. Bore the block to 0.00 - 0.05 mm (0.000 - 0.002″) less than this average diameter.

2) Machine the counterbore to the dimensions shown:

The counterbore depth is critical as the sleeve must be flush with the block surface when installed.

Dimensions for Machining Cylinder Bore for Thin Walled Sleeve

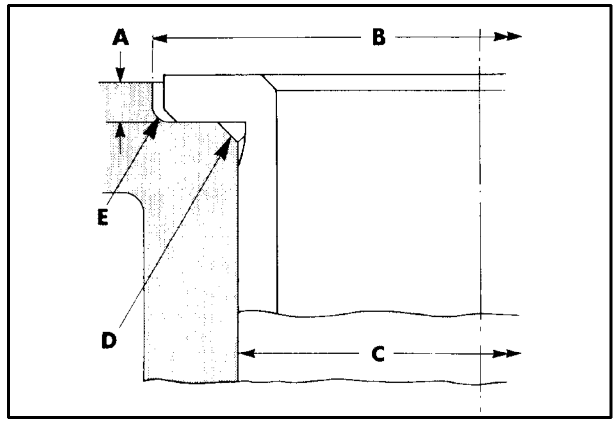
A 2.41 - 2.51 mm (0.095 - 0.099″)

B 120.55 - 120.73 mm (4.746 - 4.753″)

C Bore Cylinder to Average Diameter of Sleeve less 0.00 - 0.05 mm (0.000 - 0.002″)

D 0.50 - 0.75 mm (0.020 - 0.030″) x 45° Chamfer

E 0.381 mm (0.015″) Radius Maximum



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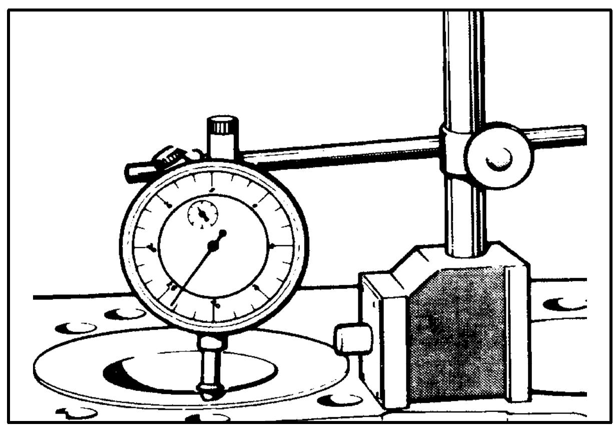
3) Thoroughly clean and dry the bore and the outside surface of the sleeve.

4) Chill the sleeve in liquid nitrogen or dry ice and assemble to the cylinder bore ensuring the lip is bottomed in the counterbore.

5) If necessary, the sleeve may be machined to bring it flush with the block face or, if necessary, the block face may be skimmed by up to 0.13 mm (0.005″) to achieve a flush condition. If the block is skimmed, ensure the piston-to-block height dimension is within 0.288 - 0.58 mm (0.011 - 0.023 in.).

6) Bore and hone the sleeve to the diameter required. Only standard and 0.10 mm (0.004″) oversize pistons can be used with the thin walled 111.76 mm (4.4″) bore lipped sleeve.

13. Check the flatness of the cylinder block-to-head surface. Resurface if not within 0.08 mm (0.003 in.) in any 152 mm (6 in.) or 0.15 mm (0.006 in.) overall limit.



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REASSEMBLY

NOTE: *Prior to reassembly, check the cylinder bores for taper and out-of-round as previously described in this section.*

1. Prior to reassembly, check the piston-to-bore clearance as follows:

   Measure the cylinder bore diameter in a crosswise direction, then measure the piston diameter at right angles to the piston pin.

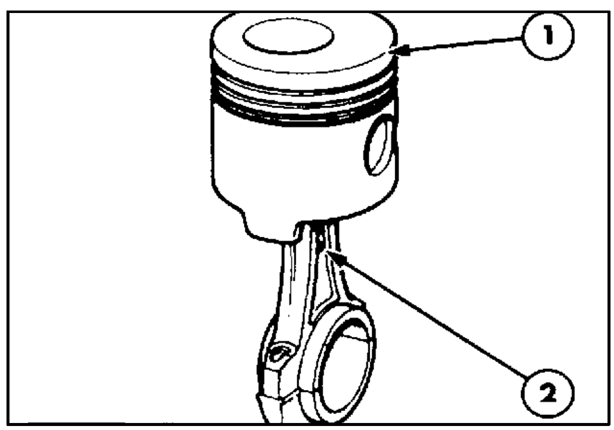
   Subtract the piston diameter from the bore diameter and the resultant figure should be within the 0.162 - 0.196 mm (0.0064 - 0.0072 in.).

NOTE: *Pistons are available in both standard and oversizes. New pistons should be installed if the clearance exceeds the specified limits.*

   If the clearance is **greater** than specified, try a similar new piston. If the clearance still exceeds the specified limit, measure the other cylinder bores and pistons and determine the cylinder with the greatest clearance. Based on the greatest clearance, rebore the cylinders to take the next oversize piston as previously described in this section.

   If the clearance is less than specified, hone the bore to obtain the desired clearance as previously described in this section.

2. Lubricate all components with engine oil, then assemble the piston to the connecting rod with the notch, 1, on the piston crown aligned with the pip, 2, on the connecting rod and install the piston pin and retainers (snap rings).



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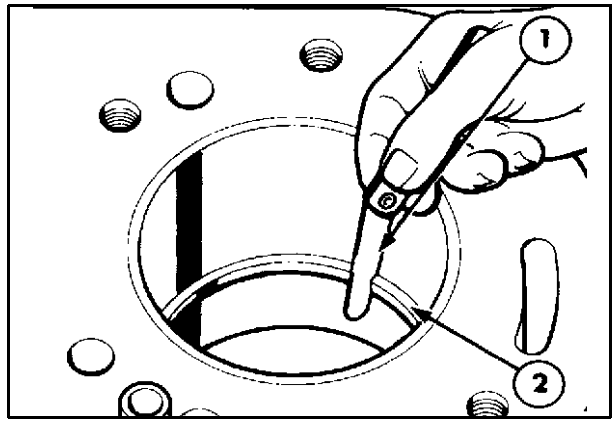
3. Check the piston rings, 2, for minimum gap using a feeler gauge, 1, prior to installation in the relevant cylinder. Use a piston crown to squarely locate the ring in the bore. New rings should be checked for side clearance in the piston as previously described in this section.



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4. Use an expander to install the piston rings, starting with the oil control ring in the bottom groove and working upwards.

   The service ring set comprises:

   1 coiled wire expander for oil control ring
   1 oil control ring
   3 compression rings

   Oil Control Ring

   Open the coiled wire expander to fully reveal the inner guide wire. Position the coiled expander in the oil groove and insert the inner guide wire into the open end of the coil. Close the coil until the ends abut.

   Install the cast iron ring (either side up) with the inside groove over the coiled expander. Position the ring gap diametrically opposite the coiled wire ends.

   3rd Compression Ring

   Dull finish with a step or chamfer on the inside diameter which must face upwards or a step on the outside diameter which must face downwards on assembly.

   2nd Compression Ring

   Bright chrome finish with a step on the inside diameter which must face upwards on assembly.

NOTE: *To facilitate assembly, the 2nd and 3rd compression rings are marked with a punched dot or the letters 'TOP ' engraved on their upper surfaces.*

   Top Compression Ring

   Bright chrome finish with a chamfer on the inside diameter which must face upwards on assembly.

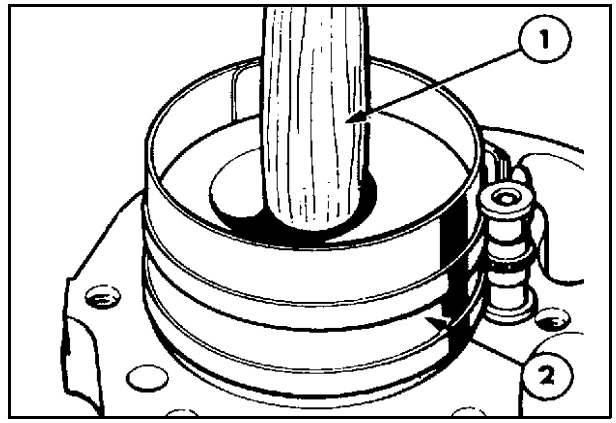
NOTE: *Some top compression rings do not have a chamfer and may be installed either side up.*

5. After installing the rings, stagger the ring gaps around the circumference of the piston.

INSTALLATION

NOTE: *Before installing a piston and new rings into a used cylinder bore, remove the high polish on the cylinder wall by passing a hone lightly through the cylinder or by making a figure-eight pattern with very fine emery cloth dipped in a mixture of fuel and lubricating oil. After honing, thoroughly wash and dry the bores and coat the walls with oil.*

1. Select the correct bearing liners, as described later in this section, and install in the connecting rod and cap. Ensure the bearing liner tang locates in the slots of the rod and cap.
2. Turn the crankshaft to position the No. 1 crankpin at the bottom of the stroke. Oil the pistons, rings, cylinder bore, and bearing liners. Use a compressor, 2, to install the piston into the cylinder. Ensure the notch on the top of the piston is toward the front of the engine.
3. Using a hammer handle, 1, push the piston into the bore until the connecting rod bearing liner seats on the crankpin. Install the connecting rod bearing cap with the number on the cap on the same side as the number on the rod. Install new nuts and tighten to 55 N·m (63 ft. lbs.).



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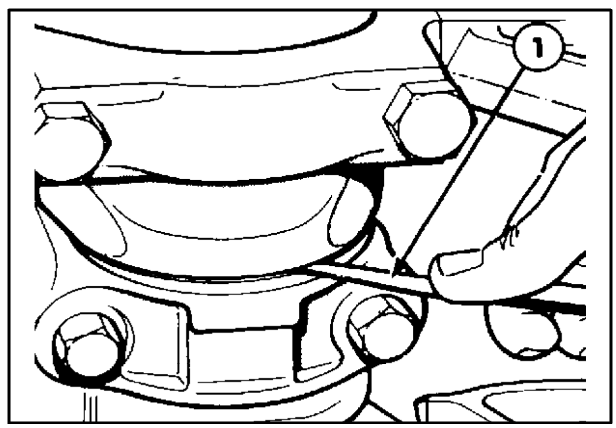
4. Use feeler gauges to check the side clearance of each connecting rod. Replace or repair if not within 0.18 - 0.33 mm (0.007 - 0.013 in.).
5. Install the remaining piston and rod assemblies in the same manner.
6. Install the oil pump, oil pan sump, and cylinder head as previously described in this section.
7. Fill the engine with the correct grade and quantity of oil and the radiator with coolant. See “Specifications Service Standards” in this section.
8. Start the engine and check for leaks.



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CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL

NOTE: *Replaceable bearing liners are installed in production to ensure the correct crankshaft journal-to-bearing clearance can be maintained in service. The main bearings and crankshaft can only be serviced after removal of the engine from the skid steer loader. See “Engine Removal” procedure in this section.*

1. Remove the transmission gearbox. See the procedure in Section 27.
2. Remove the flywheel.

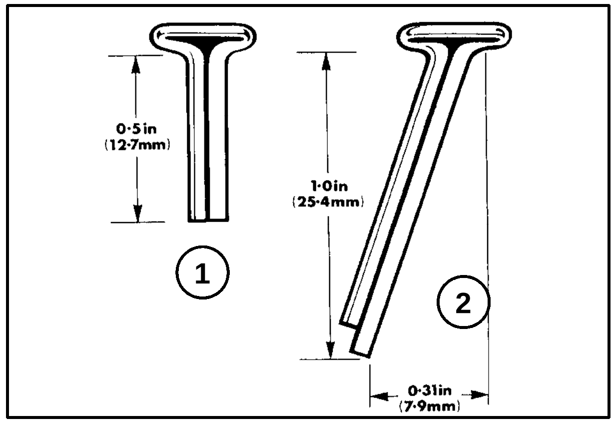
MAIN BEARINGS

Op. 10 103 10

Removal

1. Remove the oil pan, the oil pump and intermediate shaft as described earlier in this section.
2. Remove the main bearing cap from the journal to which the new bearing liners are to be installed. Always install one set of bearings at a time, leaving the other main bearing caps securely in place.
3. Install a bearing liner removal tool in the crankshaft journal oil passage. Slowly turn the crankshaft counterclockwise until the tool forces the bearing out of the cylinder block.

NOTE: *If a bearing liner removal tool, 2, is not available, a suitable tool may be fabricated from a 1″ (25 mm) x 1/8″(3 mm) split pin as shown. The shorter pin is used to remove the thrust bearing insert, 1.*



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Flatten and bend the head to 30° to conform to the angle of the oil passage in the crankshaft.

Inspection And Repair

1. Thoroughly clean the bearing liners, journals, and caps.
2. Bearing liners with scored, chipped or worn surfaces must be replaced. If new liners are to be installed, check the clearances as described later in this procedure.

Installation

1. Apply a light coat of engine oil to the journal and bearing liner.
2. Locate the liner installation tool in the crankshaft journal oil passage and position the liner on the journal with the plain end of the liner at the tang side of the cylinder block. Slowly turn the crankshaft clockwise until the bearing is fully located. Remove the installation tool.
3. Lubricate the bearing cap and liner and install the liner into the cap. Position the bearing cap with the locking tang toward the camshaft side of the engine and install the retaining bolts. Tighten the bolts to the correct torque. See “Specifications Service Standards” in this section.
4. If a new thrust bearing liner is installed, the bearing must be aligned as described later in this procedure.
5. Install the oil pump and intermediate shaft and the oil pan.

FLYWHEEL

Op. 10 103 70

Removal

The flywheel may be removed by performing one of the following procedures:

Remove the transmission gearbox with the engine installed in the skid steer. See “Engine To Transmission Gearbox Removal” procedure in Section 27.

Remove the transmission gearbox and engine as an assembly. See “Engine Removal” procedure in this section.

Withdraw the flywheel attaching bolts and carefully remove the flywheel.

Check the mating surfaces of the flywheel and the crankshaft for correct seating. See “Specifications Service Standards” in this section.

Inspection And Repair

1. Inspect the flywheel ring gear and replace if the teeth are damaged. Check the flywheel for damage due to a loosely or improperly fitted ring gear.
2. A damaged flywheel ring gear should be removed and replaced as follows:

   Cut the old ring gear free from the flywheel.

   Thoroughly clean the mating surfaces of the new ring gear and the flywheel.

   Use temperature-indicating crayons to mark the **side** face of the ring gear at six equally spaced locations. Mark with a 204°C (400°F) crayon at a point 13 mm (0.5″) below the root of the teeth and mark with a 212°C (450°F) crayon at a point just below the root of the teeth.

   Use an oxyacetylene torch with a tip size No. 2 maximum and direct the flame against the **internal** face of the gear.

   Stop applying heat when the 204°C (400°F) crayon marks melt and before the 212°C (450°F) crayon marks melt.

   Quickly place the hot gear on the flywheel with the flat face against the shoulder on the flywheel.

NOTE: *The flywheel is an unbalanced flywheel. Do not attempt to have the flywheel balanced to correct an engine vibration concern.*

Installation

1. Clean the crankshaft rear flange.
2. Establish the correct alignment of the flywheel-to-crankshaft mounting holes and install the flywheel. Tighten the attaching bolts to the correct torque and recheck the flywheel runout. See “Specifications Service Standards” in this section.
3. Install transmission gearbox. See “Engine to Transmission Gearbox Installation” procedure in Section 27.

CRANKSHAFT

Op. 10 103 10

Removal

1. Remove the engine from the skid steer. See "Engine Removal" procedure in this section. Place the engine on an engine stand.
2. Remove the flywheel and engine rear cover plates.
3. Remove the crankshaft pulley and engine front cover.

NOTE: *If the crankshaft is removed with the cylinder head in position, ensure all timing marks are realigned prior to reassembly. This action will prevent possible interference between the valves and pistons during reassembly.*

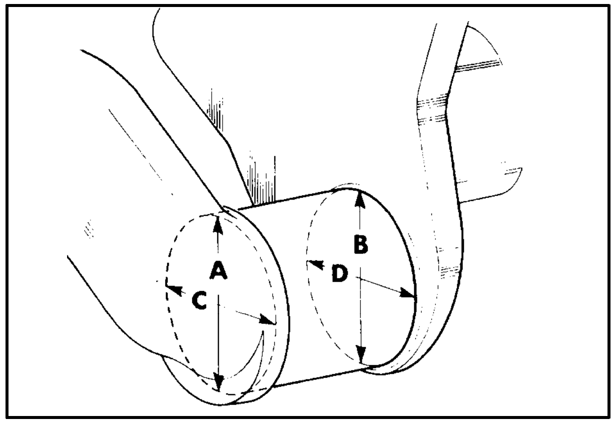
4. Remove the oil pan, the oil pump and intermediate shaft.
5. Remove the connecting rod and main bearing caps and liners and identify to facilitate reassembly.
6. Carefully lift the crankshaft out of the cylinder block.

Inspection And Repair

NOTE: *Current production engines may have a crankshaft with main or crankpin journals ground 0.25 mm (0.010″) undersize. These are identified with the letters 010 MUS and/or 010 PUS, respectively. The letters are stamped on one of the crankshaft counterbalance weights.*

1. If the crankshaft gear teeth are excessively worn or chipped, install a new crankshaft gear which must be fully located on the shoulder of the crankshaft.
2. Clean the crankshaft and drilled passages. Dress minor imperfections with an oil stone and refinish severely marked journals to the next undersize bearing.

3. Measure the diameter of each journal in four places to determine out-of-round taper or wear. Measurement A compared with B indicates vertical taper while measurement C compared with D indicates horizontal taper. Measurements A and B compared with C and D indicate journal out-of-round. If the journal exceeds the specified wear limit, refinish the journals to the next undersize bearing. See “Specifications Service Standards” in this section. Always reproduce the original journal side radii and after refinishing, chamfer the oil holes.
4. Examine the rear oil seal journal for score marks. Remove minor imperfections with fine emery cloth and, if severely damaged, replace the crankshaft.



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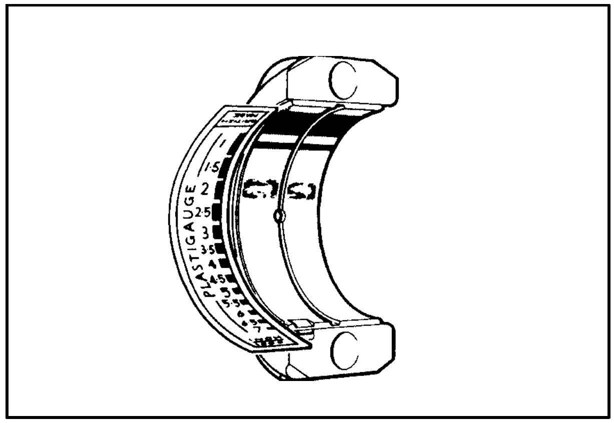
Reassembly

1. Check the crankshaft bearing clearance with micrometers or preferably using Plastigauge as follows:

   Position a piece of correct size Plastigauge across the full width of the bearing cap and approximately 6.0 mm (0.25″) off center.

   Install the cap and tighten the bolts to the specified torque.

   Remove the cap and use the scale to check the width of the flattened Plastigauge. The width of the Plastigauge at the widest point establishes the minimum clearance and, at the narrowest point, the maximum clearance. The difference between the two readings is the taper.



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NOTE: *Normally, main bearing journals wear evenly and will not be out-of-round. However, if a liner is fitted to an out-of-round journal which is within specifications, be sure to fit the bearing to the maximum diameter of the journal.*

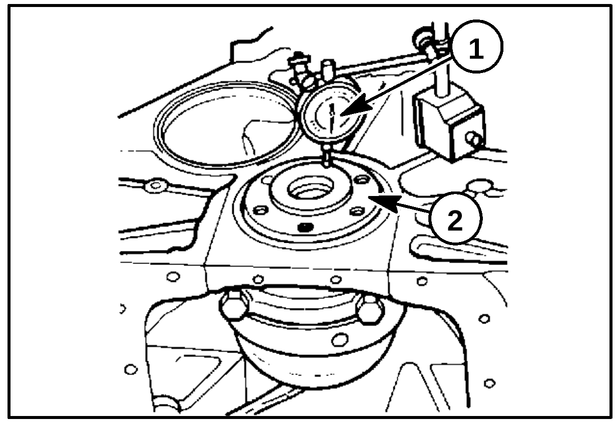
2. Standard size liners are color coded red or blue and are available in a copper lead or aluminum tin alloy. See “Specifications Service Standards” in this section.

IMPORTANT: *The engine may be assembled with liners of different material, but liners of the same material must be installed on the same journal.*

   The red liners have a thinner wall section than the blue liners and provide greater clearance. A combination of red and blue liners may be required to obtain the desired clearance. If the clearance is greater than specified when two blue liners are used, a 0.05 mm (0.002″) undersize liner with either red, blue or another 0.05 mm (0.002″) undersize liner should be installed. If any of these combinations of liners do not produce the specified clearance, refinish the crankshaft and fit undersize bearings. See “Specifications Service Standards” in this section.

3. Position the bearing liners in the block and caps and coat with oil. If the crankshaft has been refinished, fit the correct undersize main bearing liners. Ensure the bearing surfaces are clean and the bearing liner tangs align with the slots in the block and cap.
4. Align the timing mark on the crankshaft gear with that of the camshaft drive gear and install the crankshaft and all bearing caps except for the rear main bearing. Install the thrust bearing cap with the bolts finger tight. Pry the crankshaft forward and the thrust bearing cap rearward to align the thrust surfaces and tighten the bolts to the specified torque, keeping the bearing cap in the correct position.

5. Check the crankshaft, 2, end play with a dial indicator gauge, 1. Move the crankshaft rearward and set the dial indicator to zero. Pry the crankshaft forward and if the end play exceeds the limit, install new thrust bearing liners. (See “Specifications Service Standards” in this section.) If the end play is less than the specified limit, inspect the thrust bearing surfaces for burrs, scratches or dirt. If the thrust surfaces are not defective or dirty, realign the thrust bearings as detailed in step 4.



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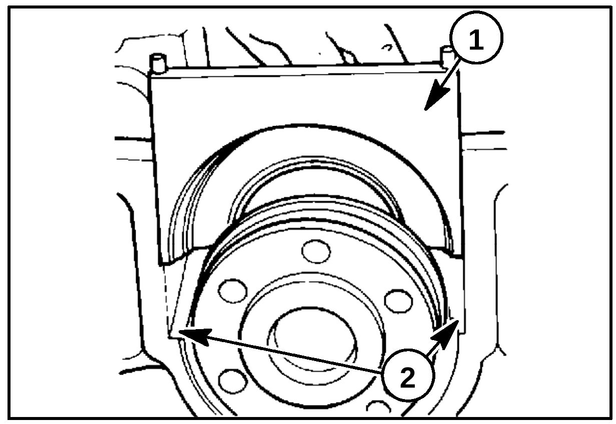
6. Wipe the mating surfaces of the block and rear main bearing cap, 1, and apply a light coat of sealing compound, 2, to both surfaces. Install new side seals in the rear main bearing cap to project slightly beyond the block face of the cap and assemble the cap to the block. Tighten the bearing cap bolts and cut the side seals to allow a projection of 0.4 mm (0.016″) above the sump pan flange.



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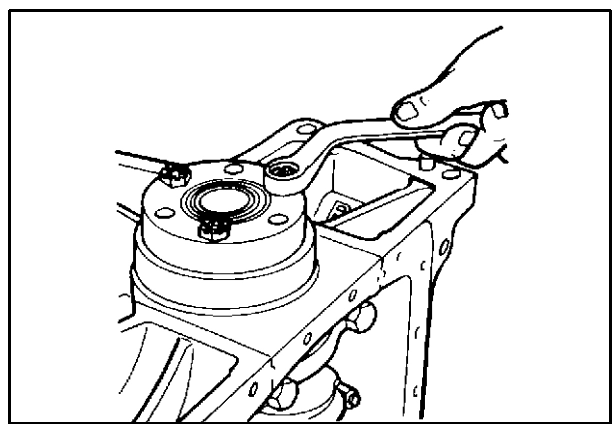
7. Apply a light coating of high-temperature grease to the rear oil seal bore, seal and journal. Use Tool No. FNH01301 and three flywheel retaining bolts to install the seal. Tighten the three bolts evenly and in sequence.



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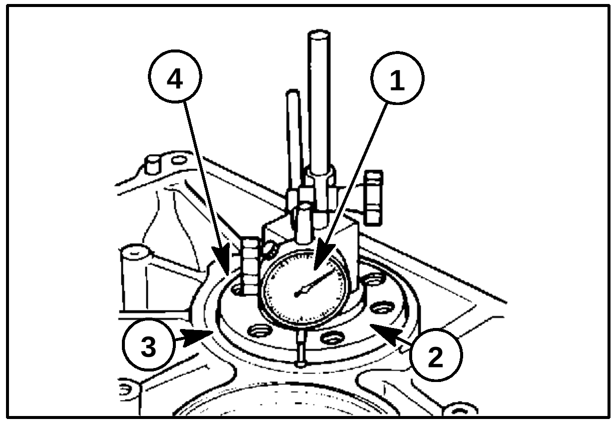
8. If the initial production seal is being replaced, install the service seal flush with the block face. Any second or subsequent service seal replacement must be fitted 1.5 mm (0.06″) below the face of the cylinder block, 4.

   Mount a dial indicator gauge, 1, on the end of the crankshaft. Rotate the crankshaft, 2, and check the runout of the seal, 3, does not exceed 0.38 mm (0.015″).

9. Apply a liberal amount of penetrating oil to the side seals to cause them to swell.
10. Install the correct bearing liners in the connecting rod and cap. If the journals are standard size, select the correct bearing liners as for main bearings in steps 1 and 2. Ensure the bearing liner tangs locate in the slots of the rod and cap.
11. Install the connecting rod bearing cap, as previously described in this section, with the number on the cap on the same side as the number on the rod. Install new nuts and tighten to the correct torque. See “Specifications Service Standards” in this section.



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Installation

1. Installation of the components to effect complete reassembly of the engine follows the removal procedure in reverse.

CAMSHAFT AND TIMING GEAR TRAIN

CAMSHAFT

Op. 10 106 40

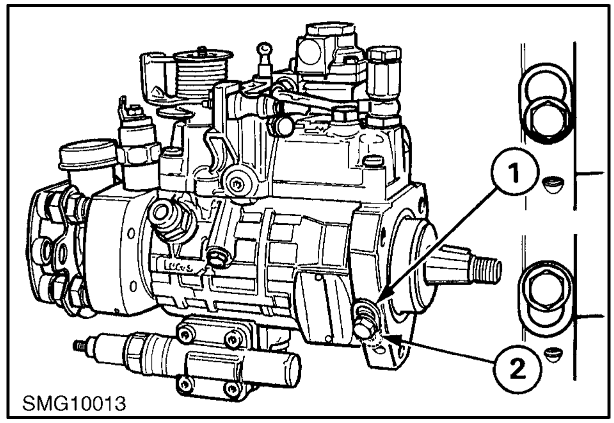
Removal

NOTE: *The camshaft bearings and/or tappets can only be serviced with the engine removed from the skid steer and mounted on an engine stand. See engine removal and engine mounting procedures in this section.*

1. Remove the engine front cover and cylinder head.
2. Remove the oil pump drive gear and shaft.
3. Check the camshaft end play as described later in this section. If the clearance exceeds the specified limit, see “Specifications Service Standards” in this section. Install a new thrust plate during reassembly.
4. Invert the engine on the stand and remove the oil pan if the camshaft bearings and/or the tappets are to be removed.

5. If the fuel pump will not be removed, rotate the engine in the normal direction of rotation to 29° BTDC compression stroke. Lock the pump locking tag using the bolt to 13 N·m (9.6 ft. lbs.). Locking tab location “1”, is unlocked, and location “2” is locked.

NOTE: *If the fuel pump will be disassembled, fuel pump timing adjustment will be necessary.*



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6. Withdraw the bolt and flat washer and remove the camshaft gear.
7. Withdraw the bolts and lock washers and remove the camshaft thrust plate.
8. Lift out the tappets and place in a numbered rack to facilitate reassembly.
9. Remove the camshaft.

Inspection and Repair

1. Inspect the camshaft journals and lobes for damage, pitting or heat discoloration.
2. Inspect the oil pump drive gear on the camshaft for broken or worn teeth. Check the mating gear on the oil pump drive shaft. If any damage is apparent, install a new camshaft and/or oil pump drive gear.
3. Measure the diameter and out-of-round of the bearing journals. If the journals exceed the specified limits, see “Specifications Service Standards” in this section. Install a new camshaft.

Camshaft Bearings

1. Inspect the camshaft bearings for pitting or scoring. Measure the clearance between the internal diameter of the bearings and the outside diameter of the respective camshaft journals.

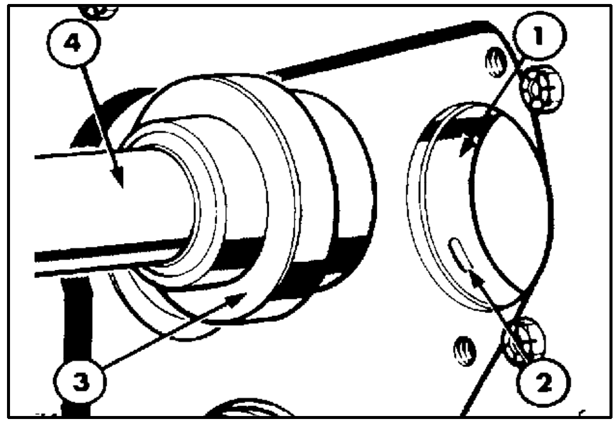
   If the clearance exceeds the specified limit, see “Specifications Service Standards” in this section, remove and install new bearings, 1, using Remover/Replacer Tool No. FNH01255, 3, and Handle, Tool No. FNH 01442, 4.

2. Camshaft Bearing Removal:

   Position Tool No. FNH01255 against the camshaft bearing to be removed and attach handle Tool No. FNH01442. Drive the camshaft bearing from the bearing bore.

3. Camshaft Bearing Installation:

   Align the oil holes of the new camshaft bearing with the oil holes in the engine block, 2, then drive the new bearing into place using Tool No. FNH01255 and Handle, Tool No. FNH01442.



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NOTE: *A positive alignment check can only be made with the crankshaft removed, when a 4.6 mm (0.18″) diameter rod may be passed down the oil passage from the crankshaft main bearing. The liner is correctly positioned when the end of the rod passes through the oil hole in the liner.*

Installation

Installation of the camshaft follows the removal procedure in reverse. On installation, observe the following requirements:

Apply petroleum jelly to each tappet foot and coat the tappet body with oil. Install the tappets in the bores from which they were removed.

Oil the camshaft journals and apply petroleum jelly to the cam lobes before carefully installing the camshaft into the engine.

Install the spacer and a new key on the front of the camshaft.

Align the camshaft drive gear timing mark and recheck the camshaft end play.

TIMING GEAR

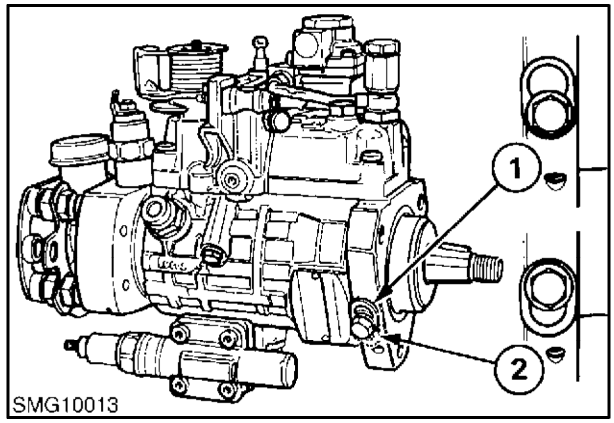
Op. 10 106

Removal

***NOTE:** The engine front cover and timing gears can only be serviced after removing the radiator and oil cooler assembly. See “Engine Removal” procedure in this section.*

1. Drain the engine oil and remove the oil pan.
2. If the fuel pump will not be removed, rotate the engine in the normal direction of rotation to 29° BTDC compression stroke. Lock the pump locking tag using the bolt to 13 N·m (9.6 ft. lbs.). Locking tab location “1” is unlocked, and location “2” is locked.

***NOTE:** If the fuel pump will be disassembled, fuel pump timing adjustment will be necessary.*



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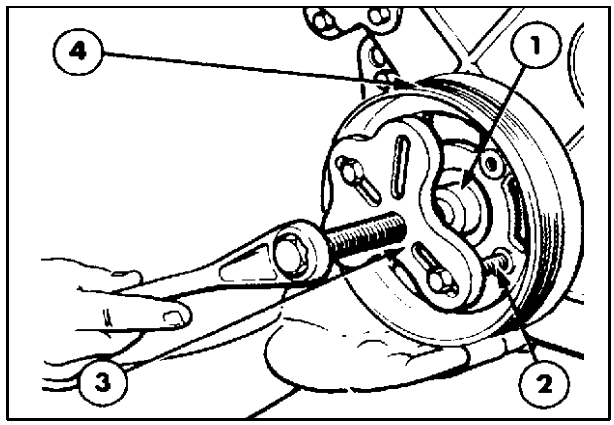
3. Remove the fan drive belt and withdraw the bolt and washer from the center of the crankshaft pulley.

Op. 10 106 66

4. Using Puller No. FNH09539, 3, and Shaft Protector No. FNH09212, 1, remove crankshaft pulley, 4.
5. Withdraw the retaining bolts, then remove the front cover and gasket. Remove the oil slinger.



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6. Before removing the timing gears, measure the backlash between each set of mating gears.

   Op. 10 106 60

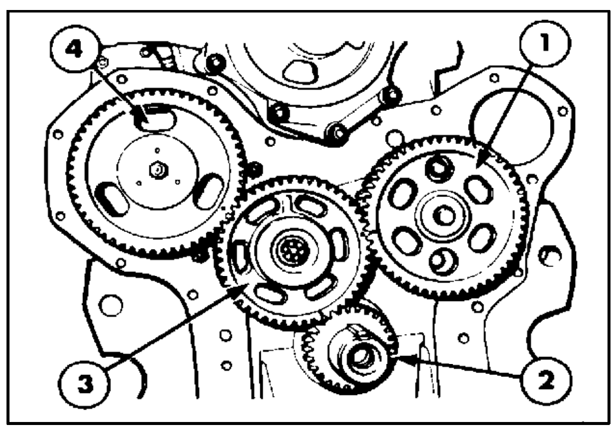
   1 Camshaft gear

   Op. 10 106 68

   2 Crankshaft gear

   3 Camshaft drive gear

   4 Injection pump drive gear



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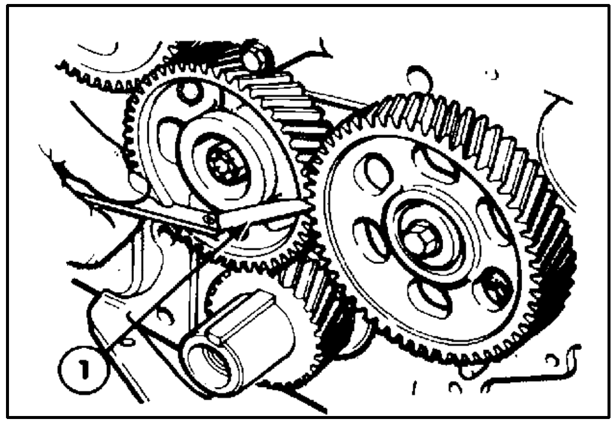
Use a dial indicator or feeler gauges, 1, to measure the backlash between each set of mating gears. Rotate the gears and check the backlash at four equidistant points on the gears. Replace the gears if the backlash exceeds the specified limits. See “Specifications Service Standards” in this section.



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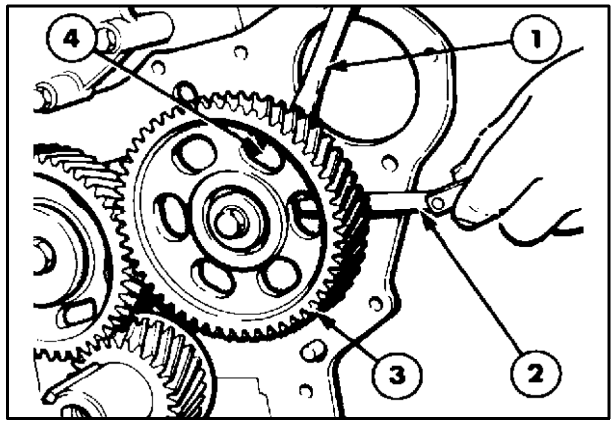
7. Pry the camshaft gear, 3, away from the thrust plate, 4, using a pry bar, 1. Use a dial indicator or feeler gauges, 2, to measure the clearance. Replace the gears if the camshaft end play exceeds the specified limits, see “Specifications Service Standards” in this section.



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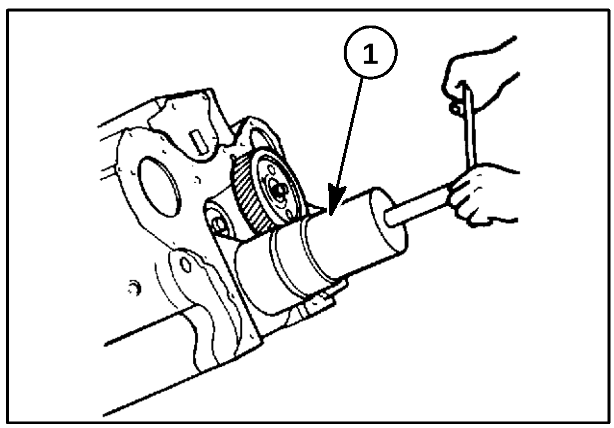
8. Remove the fuel injection pump drive gear, camshaft drive gear and adapter, and the camshaft gear. Use Tool No. FNH02134, puller, with FNH01237, adapter, 1, to remove the crankshaft gear.

NOTE: *The crankshaft gear should only be removed if it shows signs of wear.*



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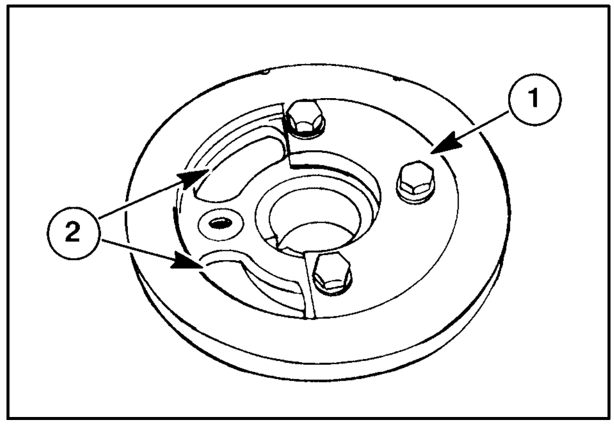
Inspection And Repair

1. Wash the gears and adapter in a suitable solvent and dry with a clean lint-free cloth or compressed air.
2. Examine the gear teeth for wear, burrs, or scratches. Any minor burrs or scratches may be removed with a fine abrasive; ensure such parts are thoroughly washed before reassembly.
3. Ensure the camshaft drive gear adapter oil passage is free from obstruction and the drive gear bushing is not damaged.
4. Check the key and keyway in the end of both the camshaft and crankshaft for damage. Replace the keys if necessary.
5. Inspect the front crankshaft pulley for the counterweight and correct position. The counterweight is shown properly positioned at 1. The counterweight must be positioned opposite the open slots, 2, in the pulley.

   If the counterweight is missing, order one #E8NN - 6N310-AA and install as described and shown.

   If the counterweight is positioned incorrectly, remove the weight retaining bolts and reposition as shown

   The counterweight can be either a single-piece or two-piece construction. The two-piece weight will be installed in the same manner as the single-piece weight. The two-piece weight is the same shape as the single-piece weight and requires two weights bolted together to equal the same weight as the single-piece weight. Both styles of counterweight are acceptable for engine use.



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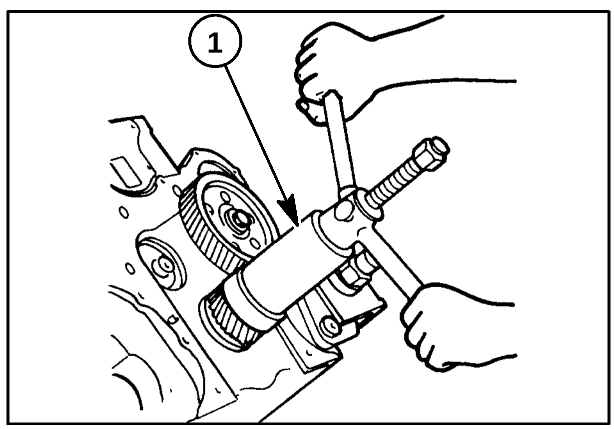
Installation

1. Install the spacer, key, and the camshaft gear, then recheck the camshaft end play.
2. Locate the key, then use Tool No. FNH02134, puller, and FNH01237, adapter, 1, to install the crankshaft gear.



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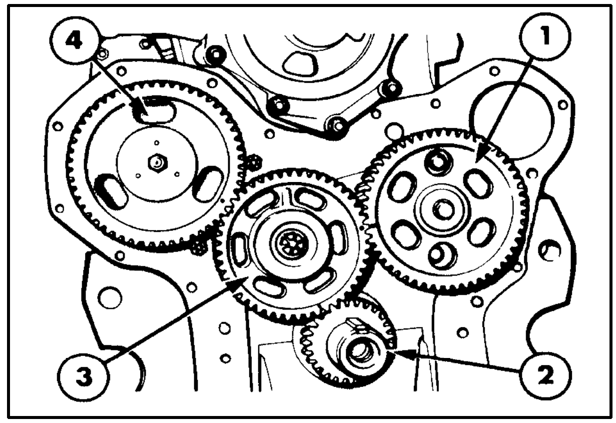
3. Position No. 1 piston at Top Dead Center (refer to Engine Timing section to determine Top Dead Center). Install the camshaft drive gear, 3, and adapter with the timing marks aligned with those of the other gears.

   Tighten the bolt to the specified torque and recheck the backlash between the gears.

4. Asemble the fuel injection pump to the engine front plate. Check No. 1 piston is at T.D.C. and install the injection pump drive gear, 4, with the timing mark aligned with that of the camshaft drive gear, 3.



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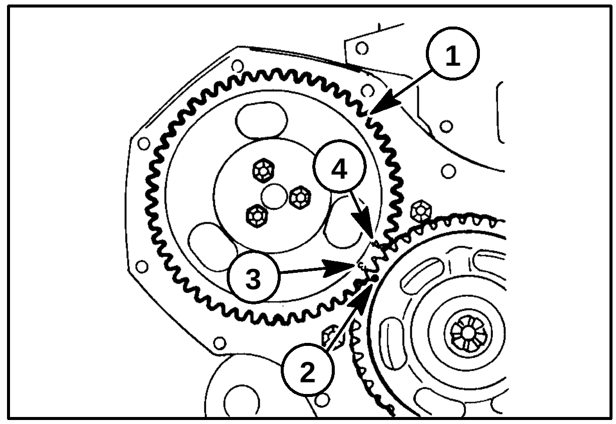
NOTE: *All engines with a rotary (distributor) type fuel injection pump have a common fuel injection pump drive gear. This gear features two timing marks identified by numerals 3 and 4 for 3- and 4-cylinder engines, respectively. When installing the pump drive gear, 1, ensure the 3-cylinder timing mark aligns with the camshaft drive gear, 2, timing mark.*



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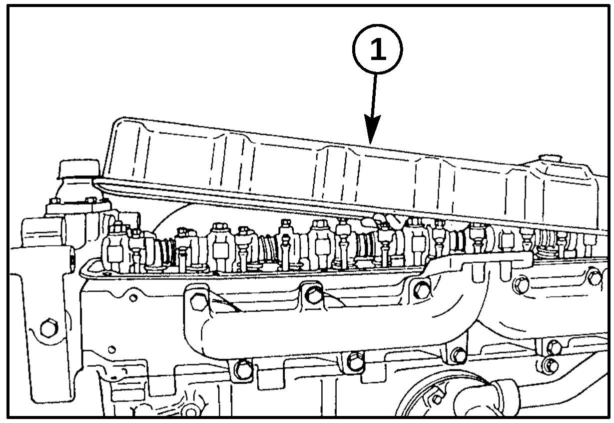
5. Install a new dust seal in the front cover. Lubricate the oil seal with petroleum jelly and use a Tool FNH09210 adapter to press the seal into the front cover.
6. Locate the oil slinger onto the crankshaft with the dished face outward.
7. Position a new gasket on the engine front plate and install the front cover ensuring the cover aligns with the dowel pins. Tighten the bolts to the specified torque.
8. Lubricate the crankshaft pulley spacer and slide over the key. Replace the pulley hub and tap onto the crankshaft. Tighten the securing bolt to the specified torque. See “Specifications Service Standards” in this section.
9. Install the oil pan with a new gasket and tighten the bolts to the specified torque. See “Specifications Service Standards” in this section.
10. Refill the engine with the correct grade and quantity of oil. See “Specifications Service Standards” in this section.

ENGINE TIMING

1. Remove the rocker cover and observe the valves and rocker arms of the No. 1 cylinder while rotating the engine. Rotate the engine until the exhaust valve moves fully open then begins to close.



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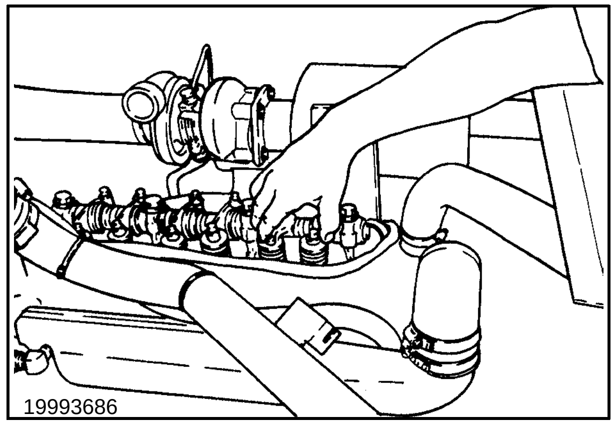
When the exhaust valve is nearly closed, the intake valve begins to open. This is Top Dead Center (TDC) for the exhaust stroke.

NOTE: *If the tappets are set to the proper specifications, the intake valve opens at 12° before TDC and the exhaust valve closes at 12° after TDC. This is referred to as "valve overlap."*



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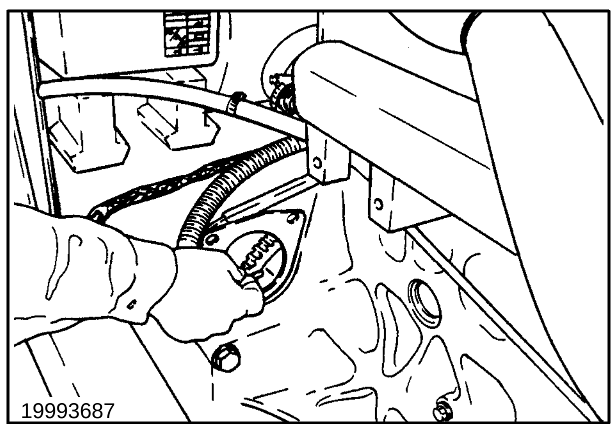
2. Mark the flywheel or pulley with chalk and continue to rotate the engine clockwise. Rotate one full turn (360°) minus 29° of advance (331° total). This position is the No. 1 piston to nearly TDC on the compression stroke.



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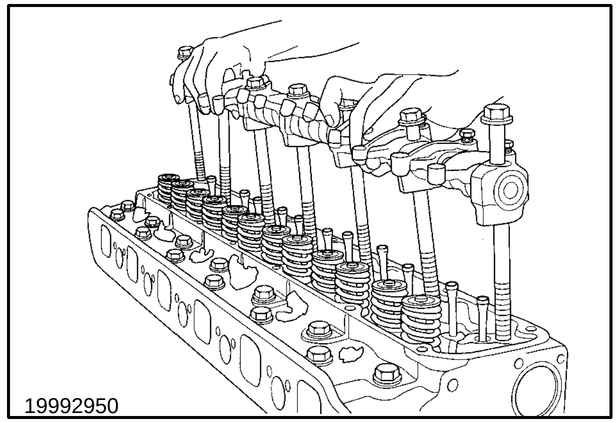
3. Remove the rocker arm and shaft assembly and set it aside in a clean location.



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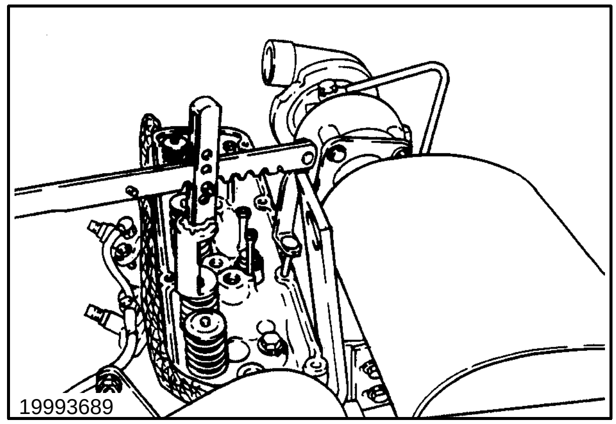
4. Use a suitable valve spring compressor to remove the valve keepers from either thr intake or exhaust valve on the #1 cylinder. This allows the valve to drop slightly if the piston is at top center. Lightly tap the end of the valve with a soft mallet to be sure that the valve is against the piston.

IMPORTANT: *Do not strike the valve with a metal hammer or other similar tool. Striking the valve stem with too much force will damage it, requiring expensive valve repair and replacement.*



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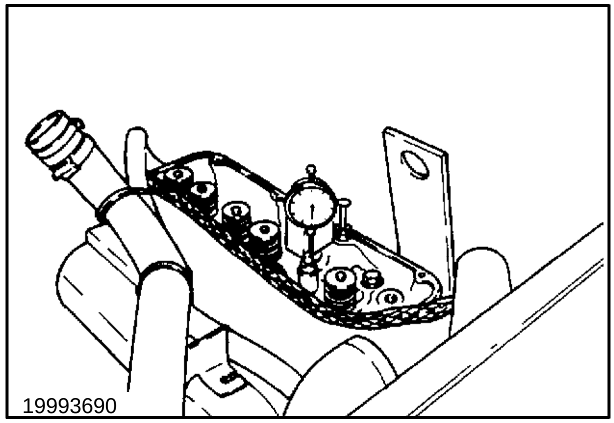
5. Set a dial indicator over the valve stem and set it to zero. Turn the engine clockwise, then counterclockwise, moving several degrees each direction. Reset the dial indicator to zero with the valve stem at its highest point.
6. Turn the engine counterclockwise until the valve lowers and the dial indicator reads at least 12.52 mm (0.500 in.).
7. Turn the engine clockwise, keeping the valve against the piston, until the indicator shows the correct measurement.

Pump Timing Degree Chart

No. of Cylinders	Engine Timing	Pump Lock Degree	#1 Piston Drop
3	29° BTDC	340°	7.59 ± 0.025 mm (0.299 ± 0.001 in.)

NOTE: *Piston drop distance includes the average protrusion of the piston above the block face as required when using the drop valve timing method.*

8. Install the locked, pre-timed fuel injection pump (see “Installing the Fuel Injection Pump”).



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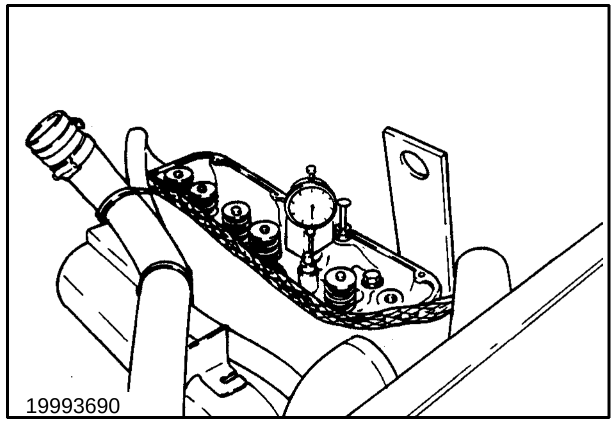
9. Turn the engine clockwise until the dial indicator reads zero. Set the valve spring, valve guide and keepers in place on the valve stem. Fully seat the keepers into the groove in the valve stem.



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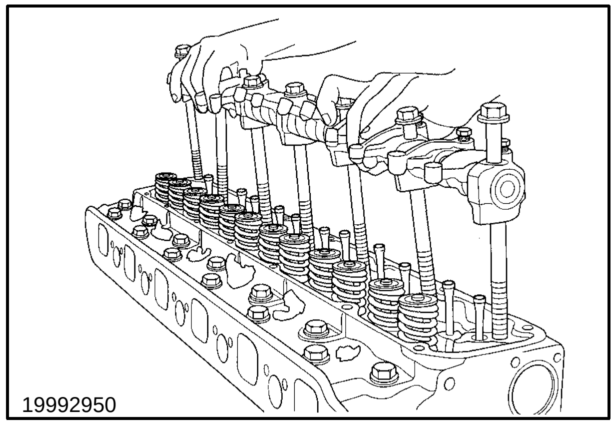
10. Reinstall the rocker arm and shaft assembly. Tighten the bolts to 217 N·m (160 ft. lbs.) and set the valve clearances.

    Intake Valve Lash:
    0.36 - 0.46 mm (0.014 - 0.018 in.)
    Exhaust Valve Lash:
    0.43 - 0.53 mm (0.017 - 0.021 in.)

    Turn the engine at least two full revolutions to ensure that all valves open and close fully.



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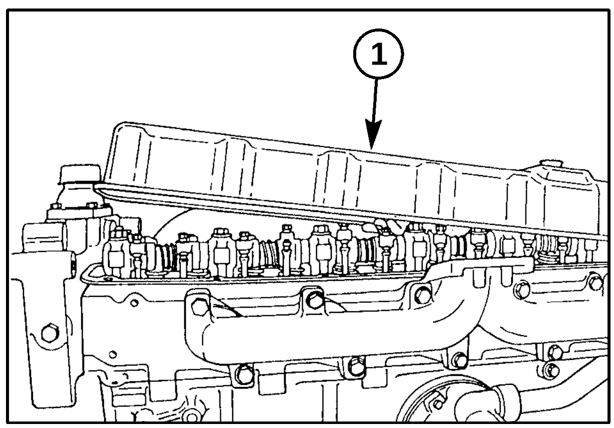
11. Reinstall the rocker cover with its gasket. Tighten the rocker cover bolts to 20 - 27 N·m (15 - 20 ft. lbs.).



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Op. 10 400

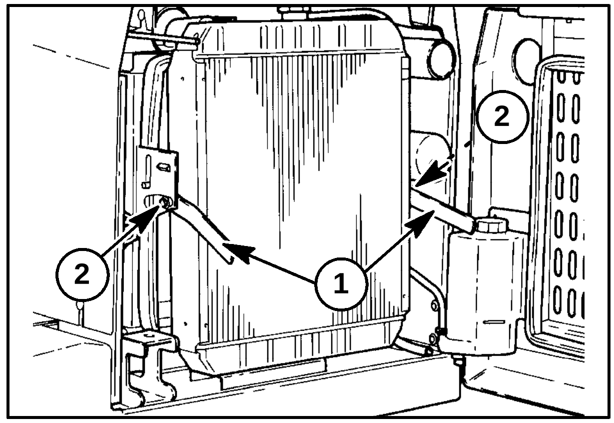
COOLING SYSTEM - LS180

RADIATOR

Op. 10 406 10

Removal

1. Drain the engine coolant system.
2. Lift up on the two handles, 1, to move the radiator rearward.
3. Remove the upper and lower radiator hoses.
4. Remove the radiator overflow hose to the overflow tank.
5. Remove two cap screws and spacers, 2. Remove the radiator.



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Inspection and Repair

1. Inspect the fins for damage and ensure they are free from obstruction.
2. Check the radiator for leaks.

Installation

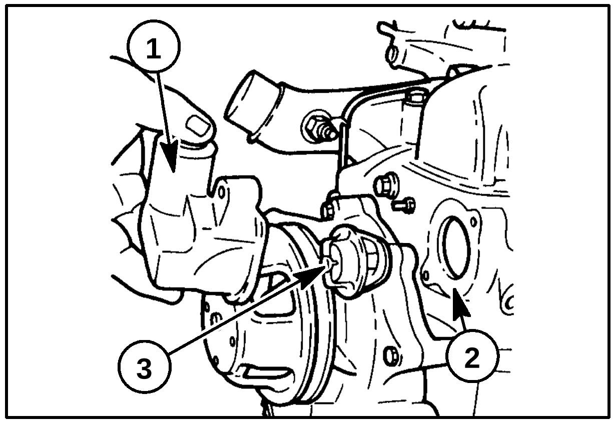
Installation of the radiator follows the removal procedure in reverse. On installation, observe the following requirements:

Depending upon the weather conditions, ensure the correct grade and quantity of antifreeze is added to the coolant. See “Specifications Service Standards” in this section.

Run the engine for several minutes and check the radiator and connections for leaks.

Op. 10 402 30

THERMOSTAT REMOVAL



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1. Drain the cooling system to below the level of the coolant outlet connection, 1.
2. Remove the coolant outlet connection retaining bolts and slide the connection with the hose attached to one side.
3. Remove the thermostat, 3, and gasket, 2.

Inspection and Repair

Place the thermostat in a container of water and heat the water. If the thermostat valve does not open at or near the specified temperature, or fails to close, install a new thermostat. For opening temperature, see “Specifications Service Standards” in this section.

Installation

Installation of the thermostat follows the removal procedure in reverse. On installation observe the following requirements:

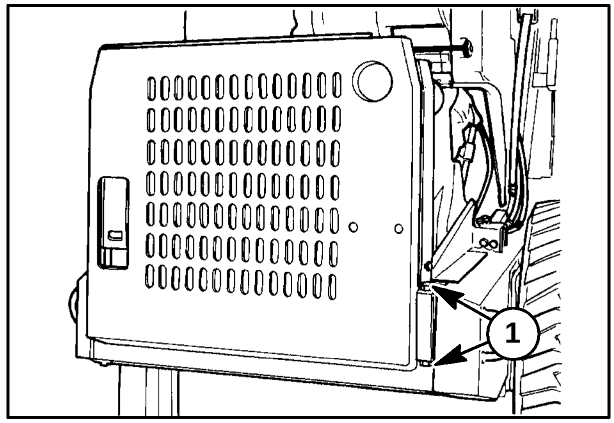
Coat a new coolant outlet connection gasket with sealer and position on the cylinder head or manifold prior to installing the thermostat.

Coat the edge of the thermostat with grease and install with the heat element located in the cylinder head.

Op. 10 402 10

WATER PUMP REMOVAL

1. Open the rear door and disconnect the radiator overflow hose at the overflow tank. Remove cap screw and nut, 1. Remove the rear door.
2. Drain the engine coolant system.



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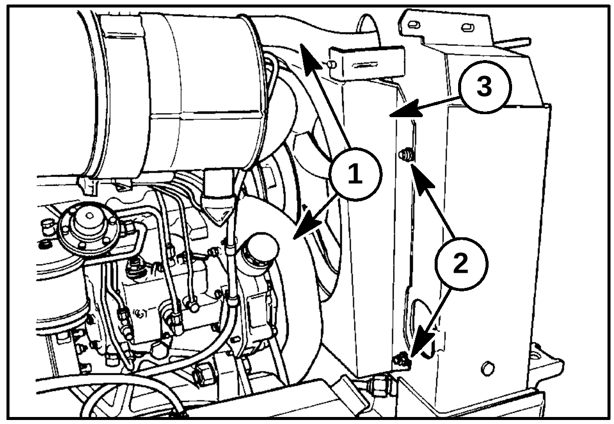
3. Remove the upper and lower radiator hoses, 1, from the engine block and plug the hoses with plastic plugs.
4. Remove cap screws and nuts, 2. Slide fan shroud, 3, forward to access the oil cooler line connection.
5. Disconnect the oil cooler bottom left line and cap to prevent loss of oil.



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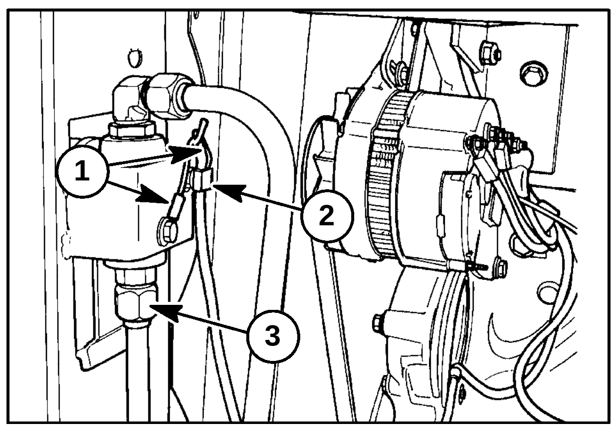
6. Remove the hydraulic oil filter restriction switch wires, 1, and harness clamps, 2.
7. Disconnect hydraulic line, 3, from the oil filter base.



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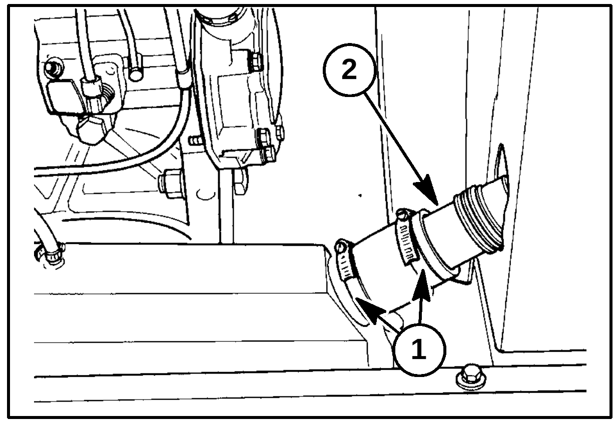
8. Loosen clamps, 1, and remove the fuel tank filler neck, 2.



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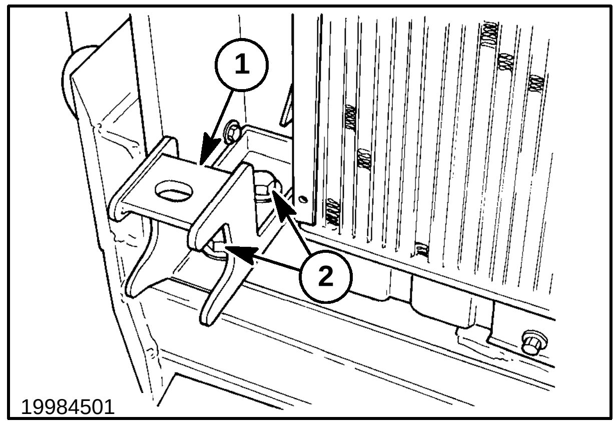
9. Remove the rear door latch bracket, 1, by removing the two capscrews, 2.



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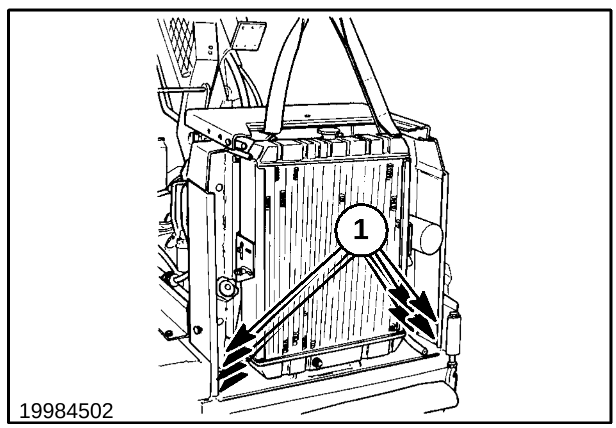
10. Remove eight mounting cap screws, 1, (four screws on each side). Remove the radiator/oil cooler assembly from the skid steer.

NOTE: *The radiator/oil cooler assembly is heavy and may require a lifting device to remove.*

11. Remove the alternator drive belt.
12. Withdraw the four bolts which pass through the water pump into the block and remove the pump.



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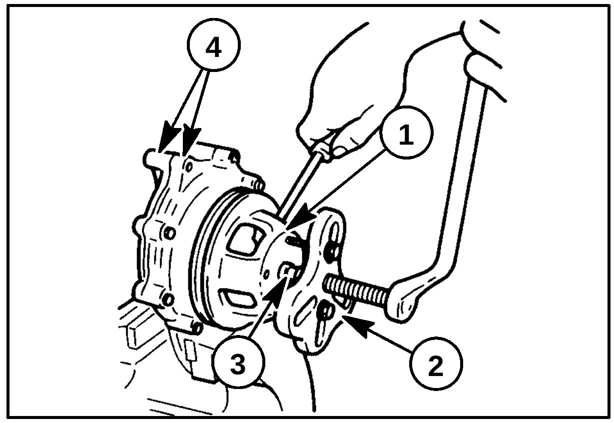
Op. 10 402 28

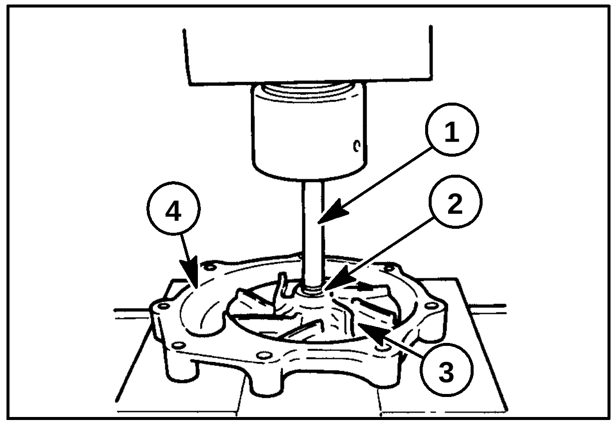
Disassembly

1. Withdraw the attaching bolts and remove the fan from the pump pulley, 1.
2. Use Puller Tool No. FNH09539, 2, and a sleeve, 3, slightly smaller than the pulley shaft to remove the pump pulley, 1.
3. Remove the retaining bolts, then separate the pump covers, 4, and discard the gasket.



87

4. Use a sleeve, 1, with a diameter slightly smaller than the bearing shaft to press the shaft and bearing assembly, 2, out of the impeller, 3, and pump housing, 4.

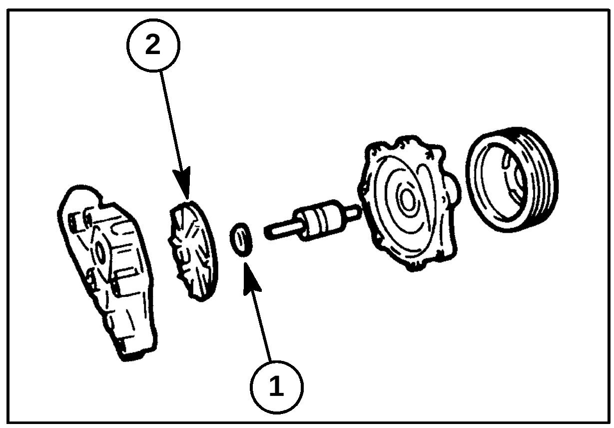


88

5. Use a suitable sleeve and press the seal assembly, 1, out of the impeller side, 2, of the pump housing. Discard the seal assembly, 1.

Inspection And Repair

1. Check the impeller, 2, for worn or damaged vanes and inspect the seal surface on the rear face of the impeller. Install a new impeller if the seal surface or vanes are damaged.
2. Inspect the bearing shaft for scoring or any other damage.
3. Check both parts of the pump housing for cracks or signs of leakage. Replace any defective parts.



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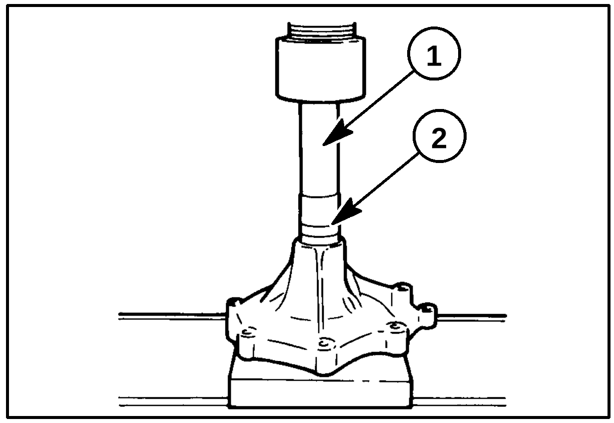
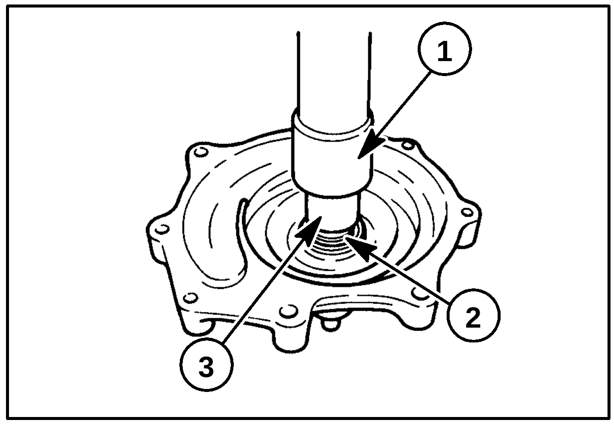
Reassembly

1. Use a sleeve, 1, which passes over the shaft and rests on the outside diameter of the bearing, to press the bearing and shaft assembly, 2, into the housing until the bearing is flush with the face of the housing. Use a straightedge to check the final position.



90

2. Turn the pump housing over and position in a press, 1, with the seal bore facing upwards.
3. Coat the outer diameter of the seal flange with a thin application of thread sealer and position the seal assembly over the shaft in the center bore of the housing.
4. Place Tool No. FNH04672, 3, over the shaft and onto the seal assembly, 2. Press the seal into the bore until the flange is flush with the top of the housing.



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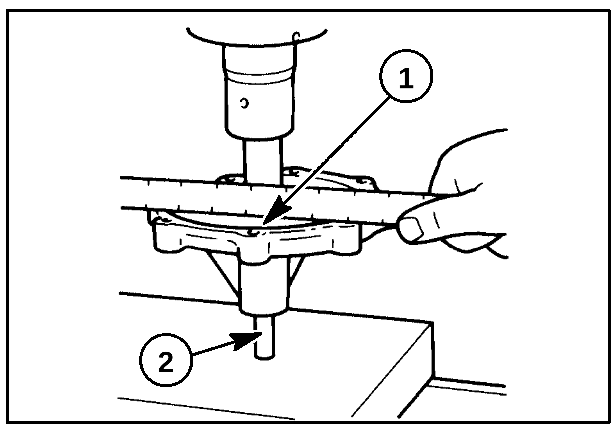
5. Support the shaft on a block of wood and use a length of pipe of suitable internal diameter to press the impeller, 1, onto the shaft, 2, and flush with the rear face of the housing. Check the final position with a straightedge.



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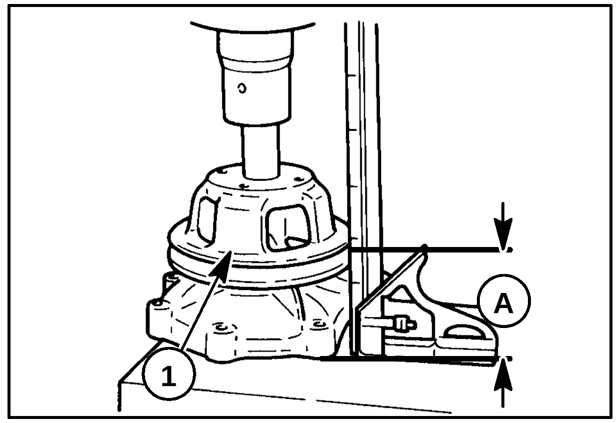
6. Support the shaft on a block of wood and press the pulley onto the shaft, to 63 mm (2.48″), dimension “A.” This dimension is from the rear face of the front cover to the center of the pulley V-groove. After installation, ensure the pulley, 1, runs true on the shaft.
7. Install a new gasket and assemble the front and rear halves of the pump together and tighten the bolts to the specified torque. See “Specifications Service Standards” in this section.
8. Install the fan on the pulley and tighten the bolts to the specified torque. See “Specifications Service Standards” in this section.



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Installation

1. Installation of the water pump follows the removal procedure in reverse. On installation observe the following requirements:

   Install a new pump gasket.

   Adjust the alternator drive belt tension. See “Adjust Belt Tension” in this section.

   After installation of the radiator, fill the cooling system and run the engine to check for leaks.

Op. 10 304

LUBRICATION SYSTEM - LS180

Op. 10 102 10

OIL PAN REMOVAL

The oil pan can be removed with the engine installed in the skid steer by first removing the rear engine belly pan. This allows ready access to the pan securing bolts.

Inspection And Repair

1. Scrape all gasket material from the gasket surface, then wash the oil pan sump in a suitable solvent and dry with a clean lint-free cloth or compressed air.
2. Inspect the sump for cracks, damaged drain plug threads, or distorted gasket surface.

Installation

On installation, observe the following requirements:

Ensure the gasket surfaces on the oil pan and block are clean.

Install a new gasket and apply a thin film of sealer to the gasket, front cover, and oil pan.

Position the oil pan and install a bolt finger tight at each corner.

Install the remaining bolts, tighten the rear bolts first, then tighten from the middle outward in each direction to the specified torque.

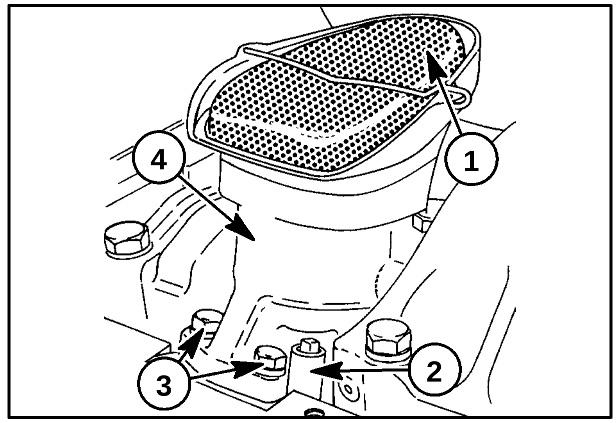
Fill the engine with the correct grade and quantity of oil.

Operate the engine and check for oil leaks.

OIL PUMP REMOVAL

Op. 10 304 34

1. Remove the oil pan as described earlier in this section.
2. Remove oil pump retaining bolts, 3. Remove the oil pump, 4, with the filter screen, 1. Withdraw the intermediate shaft, 2.



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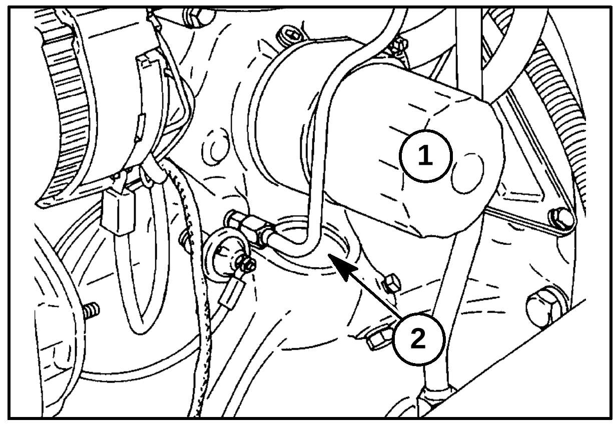
3. Remove the engine oil filter, 1.
4. Remove plug, 2, then withdraw the drive shaft adapter assembly and the oil pump drive gear.



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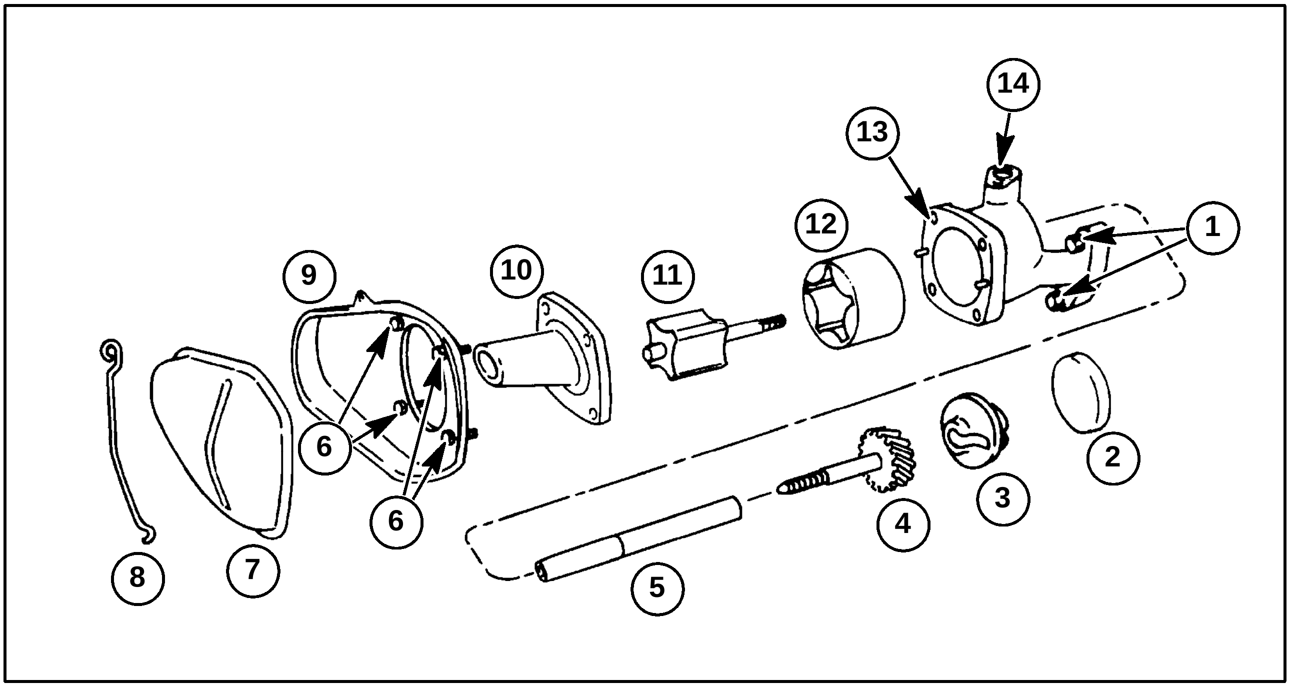

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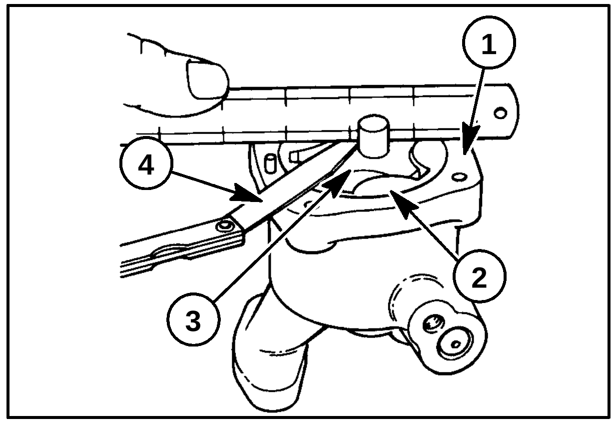
Disassembly

1. Remove the pump screen.
2. Withdraw the retaining screw and washer assemblies, then separate the inner and outer covers from the body and extract the rotor and shaft assembly.
3. Insert a self-tapping screw into the relief valve plug and pull the plug out of the body. Withdraw the relief valve and spring.

1. Oil pump retaining bolts
2. Plug
3. Drive shaft adapter mounting base
4. Oil pump drive shaft and gear assembly
5. Intermediate shaft
6. Screw and washer assemblies
7. Screen
8. Spring
9. Outer cover
10. Inner cover
11. Inner rotor and shaft assembly
12. Outer rotor
13. Body
14. Pressure relief valve assembly

Inspection And Repair

1. Wash all parts in a suitable solvent and dry with a clean lint-free cloth or compressed air.
2. Inspect the inside of the pump cover and body for excessive wear.
3. Use a straightedge and feeler gauges, 4, to measure the end play between the inner rotor, 3, and the pump body, 1, and measure the clearance between the outer rotor, 2, and the pump body, 1.



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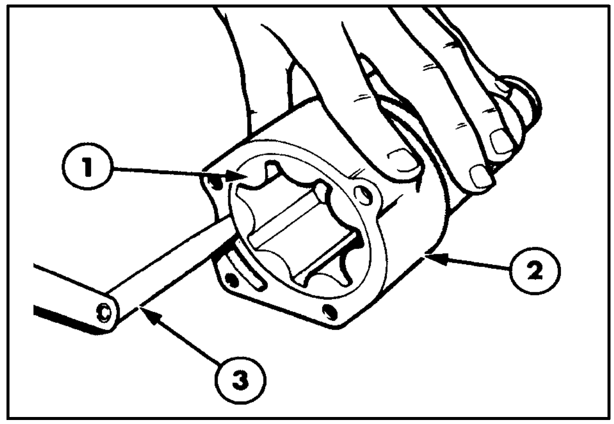
4. Use feeler gauges, 3, to measure the clearance between the periphery of the outer rotor, 1, and the pump body, 2.
5. Check the relief valve spring tension. See "Specifications Service Standards" in this section.
6. Inspect the relief valve for wear and check for freedom of movement within the bore.
7. Check the oil pump drive gear for worn or damaged teeth.
8. Examine the intermediate drive shaft socket ends for wear.



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Reassembly

Reassembly of the oil pump components follows the disassembly procedure in reverse. On reassembly, observe the following requirements.

Oil all the parts.

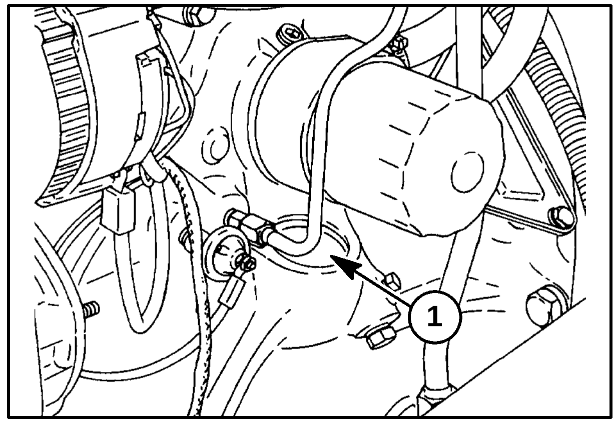
The inner rotor and shaft assembly and the outer rotor are serviced as an assembly.

Prior to installation, introduce clean engine oil into the inlet port and rotate the pump shaft by hand.

Installation
Installation of the oil pump follows the removal procedure in reverse. On installation, observe the following requirements.

Apply silicone sealant to the mating surface of plug, 1.

Remove all traces of seal material from the locating surface, then install a new oil filter and seal. Apply a light, even coat of clean engine oil to the seal surface prior to installation. Hand tighten the filter until the seal contacts the locating surface, then tighten an additional one-half to three-quarters of a turn.



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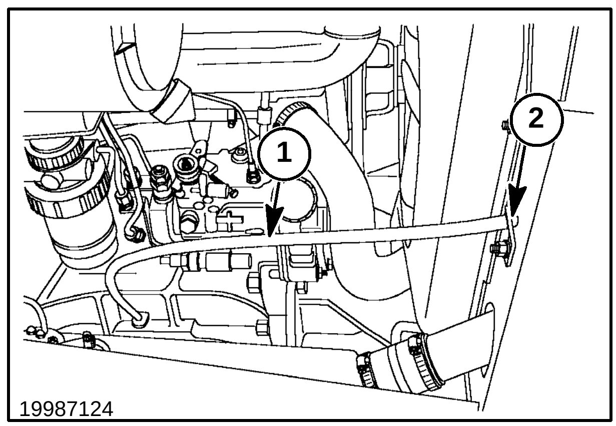
IMPORTANT: *Never use a tool to tighten the spin-on filter.*

Op. 10 304 06

OIL LEVEL DIPSTICK

If the engine oil level dipstick is difficult to remove or reinstall, the end of the dipstick may be bent or broken off. This can be caused by the dipstick tube.

The long rubber tube, 1, allows the oil level to be checked from the rear of the loader. The rubber tube must connect correctly to the engine and the back frame for the level reading to be accurate. Check that the rubber tube is completely against the rear frame support, 2.



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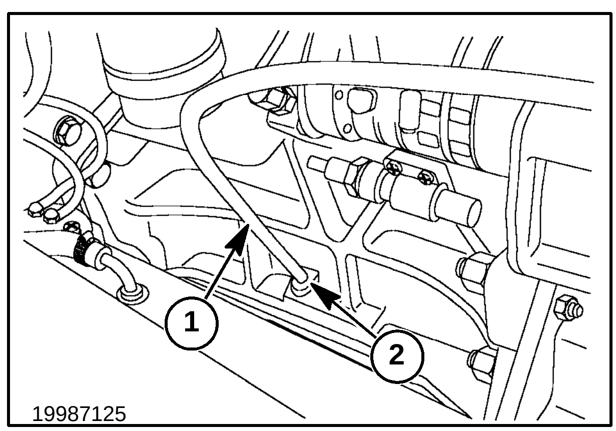
Push the end of the rubber tube, 1, to make sure it contacts the engine block, 2.



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Op. 10 200

FUEL SYSTEM - LS180

The diesel fuel system consists of a fuel tank, electric lift pump, fuel filter/sediment separator, DPS 200 series fuel injection pump, fuel injectors and inter connecting fuel lines. A dry type air cleaner removes dirt and contaminants from the air intake.

DP203

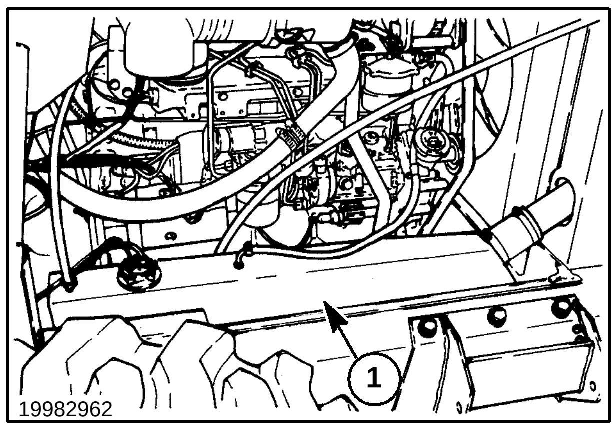
The fuel is drawn from the fuel tank, through the sediment separator and fuel filter by the electric lift pump, and then fed into the injection pump.

The transfer pump delivers fuel to the injection pump to supply fuel at high pressure to each injector and also provides extra fuel which lubricates and cools the injection pump. This extra fuel is recirculated via a fitting on the fuel injection pump governor control housing to the fuel tank by means of the injector leak off line.

The excess fuel that leaks past the needle valve of the injectors is directed back into the fuel tank at the filler neck by means of the injection leak off line.

FUEL TANK

A plastic fuel tank, 1, is located on the lower left rear of the machine.



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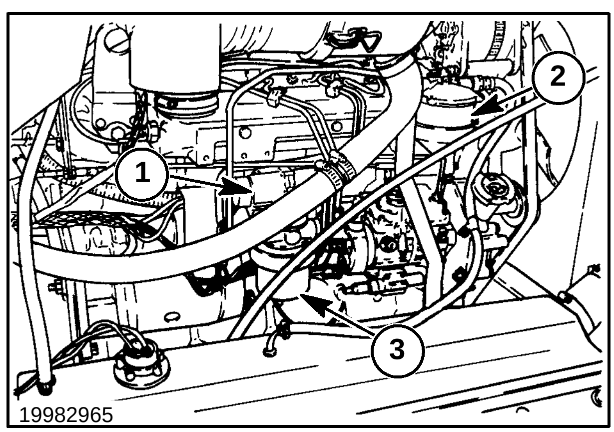
Op. 10 210 21

ELECTRIC LIFT PUMP

Mounted on the left hand side of the engine above the fuel filter is an electrical lift pump, 1. The pump draws fuel through the sediment separator, 2, and the fuel filter, 3. The fuel is then pressurized and fed into the fuel injection pump.



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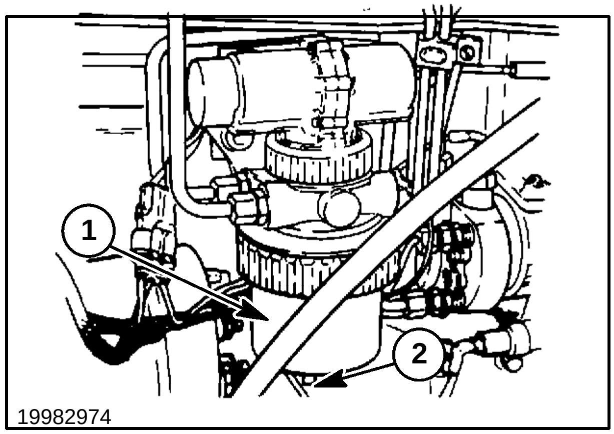
Op. 10 206 10

FUEL FILTER

The filter, 1, positioned on theright hand side of the engine behind the injection pump directs the fuel through the filter head to be directed down through the filter paper into the base chamber. The filtered fuel then flows up the center tube of the element to the filter head outlet and flows onto the injection pump.

The drain plug, 2, permits contaminated fuel to be drained from the filter.



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THERMOSTART

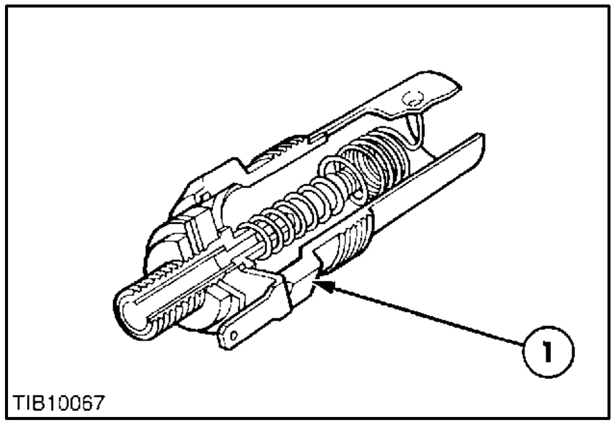
To aid engine starting in cold weather conditions, a thermostart system incorporating an integral reservoir system is available.

The thermostart system is made up of a plug assembly screwed intothe intake manHold, afuel line connected to the injector leak off tube and an electrical circuit, connected to the ignition switch.

The plug assembly, 1, consists of a check valve and electrically heated element.

Fuel is gravity fed to the plug assembly and, when operating the key starVstop switch and the thermostart switch, the heater and “igniter” coils are both energized. The “heater” coil opens a check valve which allows diesel fuel to flow through the thermostart. The fuel is ignited by the “igniter” coil in the manifold, heating the intake manifold air prior to H entering the combustion chamber.

When the thermostart switch is released to the off position, the electrical current is disconnected from the thermostart and the check valve closes.



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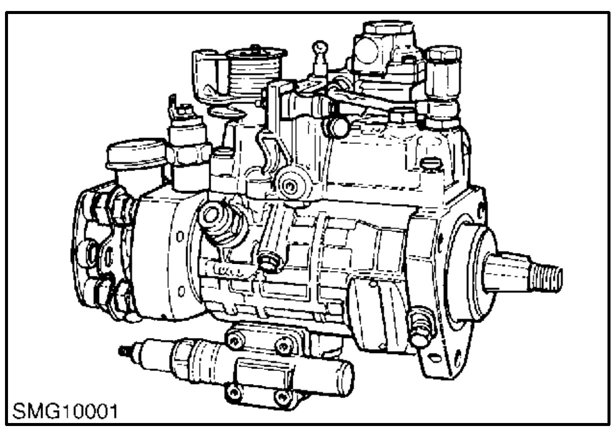
Op. 10 246 14

FUEL PUMP

The fuel injection pump fitted to these vehicles is the DP203 (emissionized) type. The fuel pump, which is fed by an electric lift pumper, supplies fuel at high pressure to the fuel injectors.



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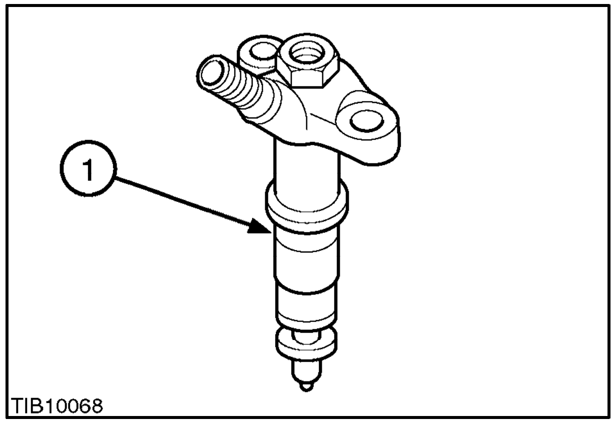
Op. 10 218 34

INJECTORS

The fuel injectors, 1, mounted in the cylinder head supply fuel in the form of a spray pattern into the cylinder bores. The controlled amounts of fuel ensure optimum engine performance throughout the operating ranae.



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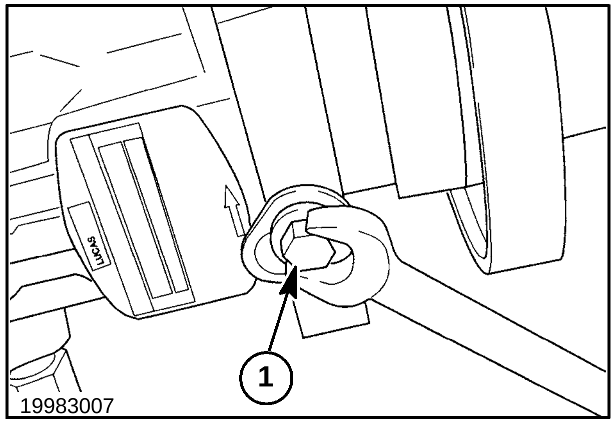
ADJUSTMENTS

INJECTION PUMP LOCK TIMING (ON BENCH)

1. Unlock the pump by loosening the locking screw, 1.



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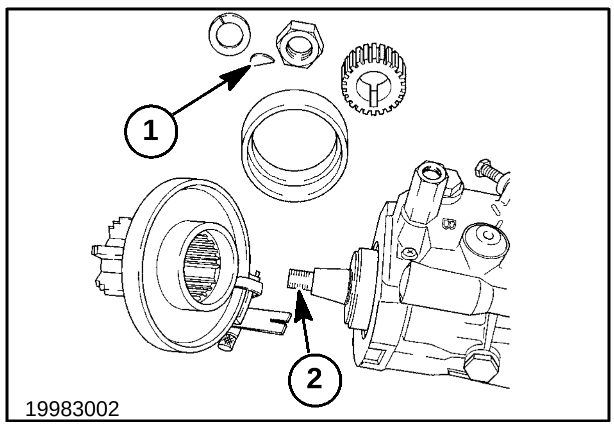
2. Install a key, 1, P/N 74145S, into the slot in the fuel injection pump drive shaft, 2.



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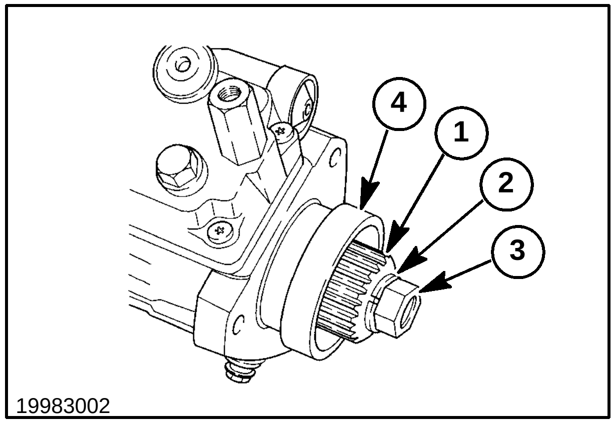
3. Place the small adapter, 1, P/N PD67/3, onto the shaft. Place the key in the slot to make sure the adapter is properly aligned. Use the lock washer, 2, P/N D8NN9G593AA, and nut, 3, P/N D8NN9N904AA. Hold the adapter counterclockwise while tightening the nut to 27 Nm (20 ft lbs).
4. Place the guide, 4, P/N MS67B/8, over the shaft and pilot area of the pump housing, followed by the protractor assembly.

NOTE: *Preset the protractor to the 29 degree mark.*



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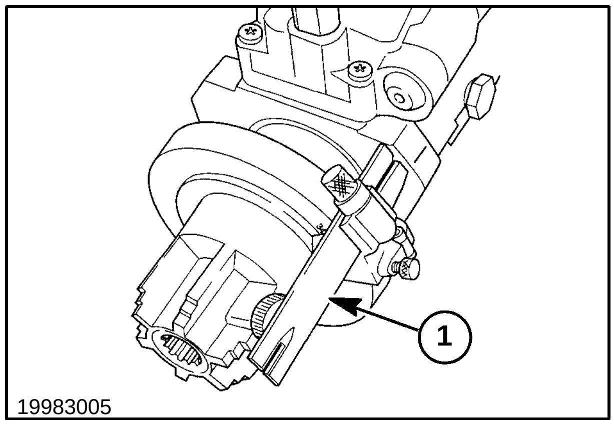
Pump Timing Degree Chart

No. of Cylinders	Engine Timing	Pump Lock Degree	#1 Piston Drop
3	29° BTDC	340°	7.59 ± 0.025 mm (0.299 ± 0.001 in.)

5. Place the protractor, 1, on the adapter and into the support. The marker (pointer) should extend to allow maximum visibility for the pump timing mark in the slot.



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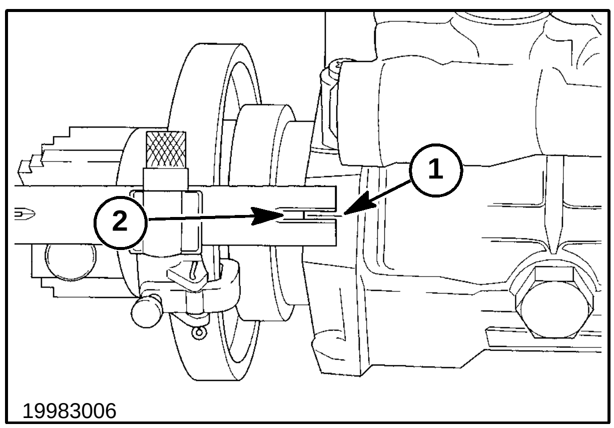
6. Rotate the pump until the timing mark, 1, on the pump flange is centered in the marker (pointer) slot, 2.



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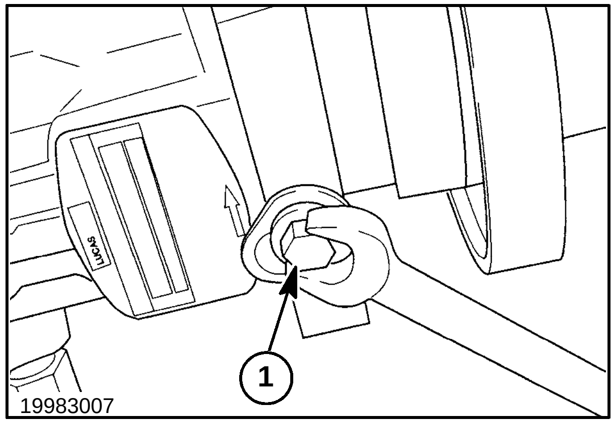
7. Lock the pump shaft as follows: Loosen the locking screw, 1, remove or realign the washer so the large hole fits over the shoulder of the screw, then retighten the screw against the pump shaft to 41 Nm (30 ft lbs).

NOTE: *Verify that the marker aligns with the pump timing mark.*

8. Remove the timing tool, nut and lock washer. Loosen the adapter from the shaft.

IMPORTANT: *Remove the key from the pump.*

9. Install the pump on the engine (refer to Engine Timing Section).



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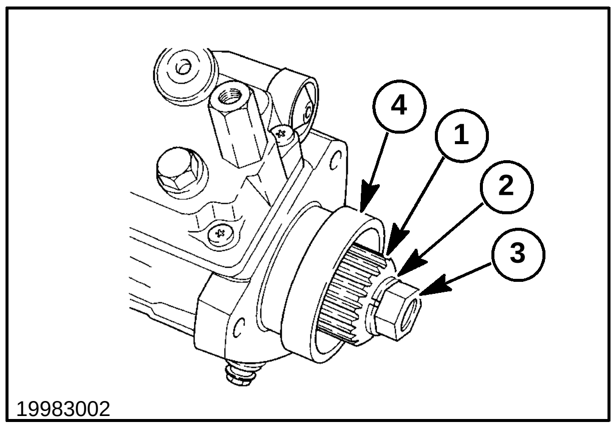
VERIFYING PUMP TIMING

1. Set the engine on its basic timing mark (see chart).
2. Lock and remove the pump (see “Removing the Injection Pump”).
3. Install a key, P/N 74145S, into the slot in the fuel injection pump drive shaft.
4. Place the small adapter, 1, P/N PD67/3, onto the shaft in alignment with the key. Use the lock washer, 2, P/N D8NN9G593AA, and nut, 3, P/N D8NN9N904AA. Hold the gear counterclockwise to prevent the pump from rotating while tightening the nut to 27 N·m (20 ft lbs).
5. Place the guide, 4, P/N MS67B/8, over the shaft and pilot area of the pump housing.



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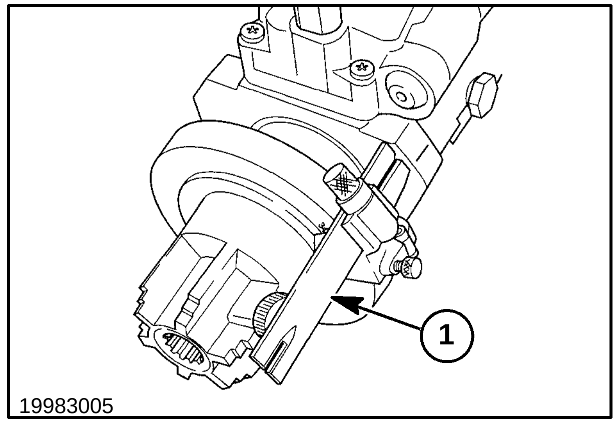
Pump Timing Degree Chart

No. of Cylinders	Engine Timing	Pump Lock Degree	#1 Piston Drop
3	29° BTDC	340°	7.59 ± 0.025 mm (0.299 ± 0.001 in.)

6. Loosen the marker (pointer) and place the protractor, 1, on the adapter and into the support. The marker should extend to allow maximum visibility for the pump timing mark in the slot.



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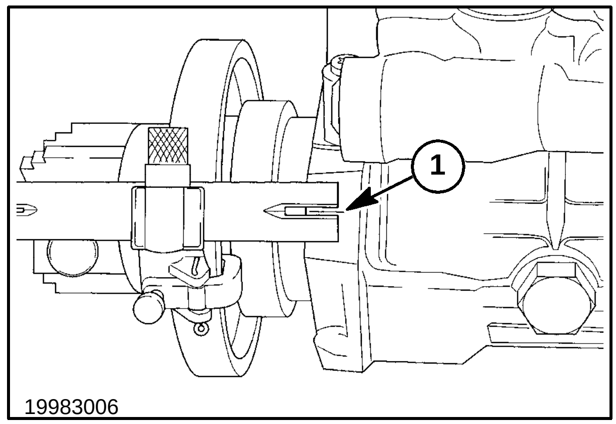
7. Slide the pointer bar until it aligns with the timing mark, 1, on the pump flange.
8. If the reading is 29°, the pump is properly timed. If the reading differs, the pump is out of time. Follow the procedure in “Injection Pump Lock Timing” to retime the pump. Each degree the pump varies from the proper timing equals two engine degrees of timing.



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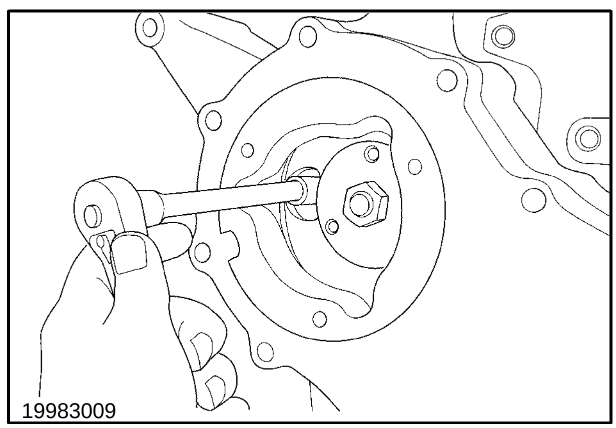
INSTALLING THE INJECTION PUMP

1. Place the locked, pre timed fuel Injection pump on the engine. The mounting bolts install from inside the front cover. Two bolts thread into the pump flange, while the third bolt uses a nut on the outside of the pump flange. Tighten to 20 - 25 Nm (15 - 18 ft Ibs).

IMPORTANT: *Use an O ring, P/N 14437585, on each mounting bolt prior to inserting if through the mounting holes. Failure to install new O rings on the bolts may allow engine lubricant to leak out.*

2. Place the washer and retaining nut on the gear, leaving the nut loose for now.



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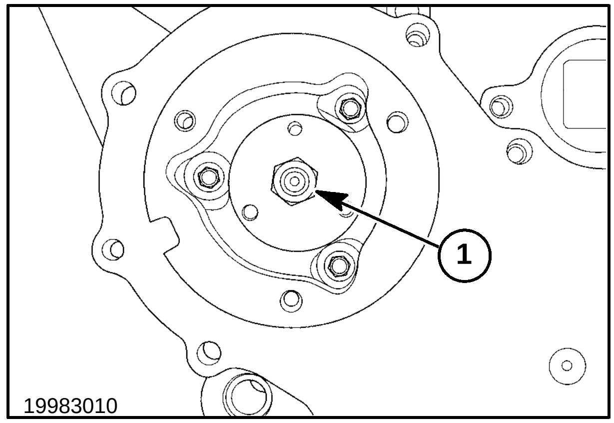
3. Hold the gear counterclockwise to take up any backlash between the pump gear and idler gear. While holding the gear, tighten the nut, 1, to 74.5 - 81.3 Nm (55 - 60 ft lbs). Do not move the gear train.



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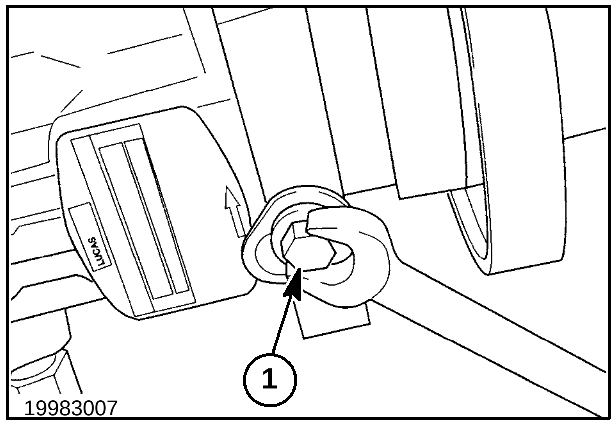
4. Unlock the fuel pump by loosening the lock screw, 1, and installing or realigning the washer so that the small opening is under the screw head. Retighten the lock screw to 11 - 13 Nm (8 - 10 ft lbs). Do not overtighten.
5. Reinstall all fuel lines, tubing, access covers and other hardware that was removed during service. Use proper gaskets or sealants, and tighten all hardware to the appropriate torque.
6. Prime the fuel system and start the engine. Inspect the fuel system and repair any leaks.

NOTE: *Always run the engine and inspect all connections and components to be sure they function properly before returning the unit to service.*



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Priming The Fuel System

NOTE: *The fuel system should be primed whenever fuel system components are removed or disconnected In order to expel any air In the system.*

1. Make sure there is sufficient fuel in the tank and all connections are tight.
2. Operate key start switch to activate the electric fuel pump. An audible difference is dectectable when the system is primed, this may take up to 5 minutes.

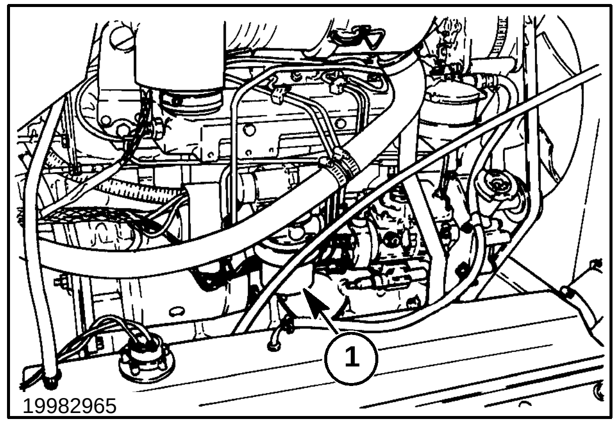
NOTE: *The bleed screw, 1, in the filter head is on the intake side and must be kept closed during priming.*

NOTE: *Attempt to start the engine. If It does not start, continue through Step 4.*

3. With the throttle in the maximum no load speed position, operate the starting motor to crank the engine. The fuel injection pump is self venting and does not require bleeding.

IMPORTANT: *Do not crank the starting motor continuously for more than 60 seconds as doing so may cause starting motor failure.*

4. If the engine fails to start after 60 seconds, repeat the priming procedure outlined above.
5. Run the engine and check for leaks.



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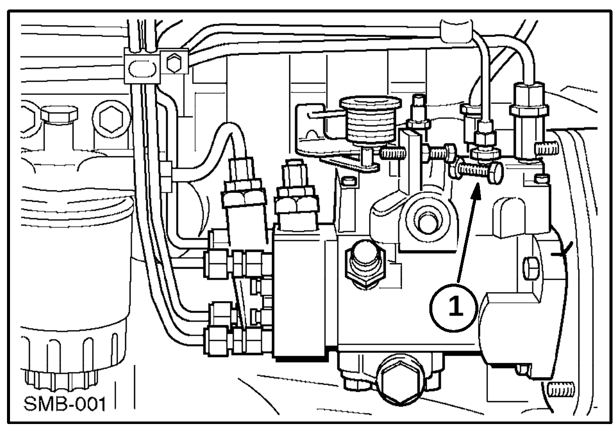
IDLE SPEED ADJUSTMENT

1. With the engine running and at normal temperature, disconnect the throttle cable at the injection pump.
2. Loosen the locknut and adjust the idle speed stop screw, 1, until the specified idle speed of 700 - 800 RPM is obtained. Tighten the locknut and reconnect the throttle cable.
3. Operate the throttle lever several times and check that the idle speed is correct. If excessive free play is felt in either the foot or hand throttle after adjustment, proceed to “Throttle Linkage Adjustments” in this section.



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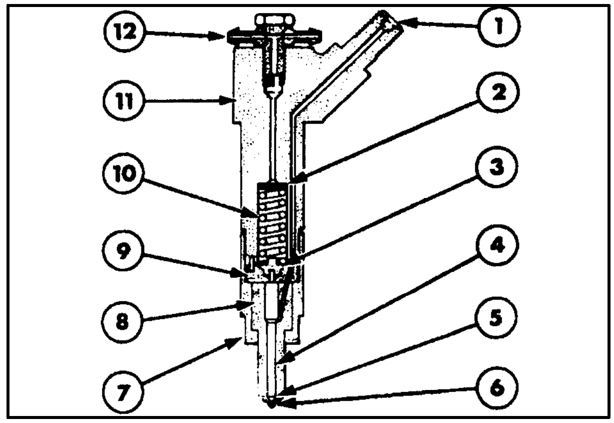
Op. 10 218 34

INJECTORS

Coupled to the fuel injection pump are low inertia type injectors. The turbocharged engine incorporates five hole nozzle low inertia injectors. The overhaul procedure for the low inertia injector is described below.



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1 Fuel inlet
2 Shims
3 Spring seat
4 Nozzle valve
5 Nozzle valve seat
6 Nozzle tip
7 Nozzle retaining nut
8 Nozzle
9 Doweled adapter plate
10 Spring
11 Injector body
12 Leak-off line

Injector Testing

WARNING

The spray from an injector tester can pierce human skin with serious results. When an injector is spraying, the nozzle should be turned away from the operator and any other persons.

During the nozzle opening pressure and spray pattern tests, collect the spray in a container partly filled with rags to absorb the spray.

When conducting the nozzle seat leakage test, release the injector tester pump pressure before touching the nozzle tip with a sheet of blotting paper.

The spray is flammable - ensure no bare lights are in the area of the tester and do not generate excessive vapor.

1. Fill the injector tester with a calibrating fuel oil (ISO 4113) and leave the filler cap loose to prevent a vacuum forming during testing.
2. Prime the tester until oil is emitted from the tester line, then connect the injector.
3. Ensure the knob on the right-hand side of the tester is screwed in to prevent the gauge being overpressurized if the injector nozzle is blocked.
4. Pump the tester and check that the nozzle is free to open. Open the pressure gauge valve and begin injector testing. If the nozzle is blocked or the needle jammed, begin the disassembly procedures.
5. Nozzle opening pressure setting: Slowly pump the injector tester and observe the pressure at which the needle valve lifts and fuel is injected from the nozzle tip. The opening pressure should be 227 bar (3381 PSI). If the opening pressure is incorrect, dismantle the injector and add or subtract shims as necessary to obtain the correct opening pressure (± 0.02 mm of shims equals ± 3 bar [44 PSI] approximately). When new shims are assembled and the nozzle retaining nut tightened to the correct torque, 48 N·m (35 ft. lbs.), assemble to the tester, prime and recheck the opening pressure.

NOTE: *If a new spring has been fitted, the opening pressure should be set to 3528 PSI (236 bar) to allow for spring settling.*

Nozzle Seat Leakage:

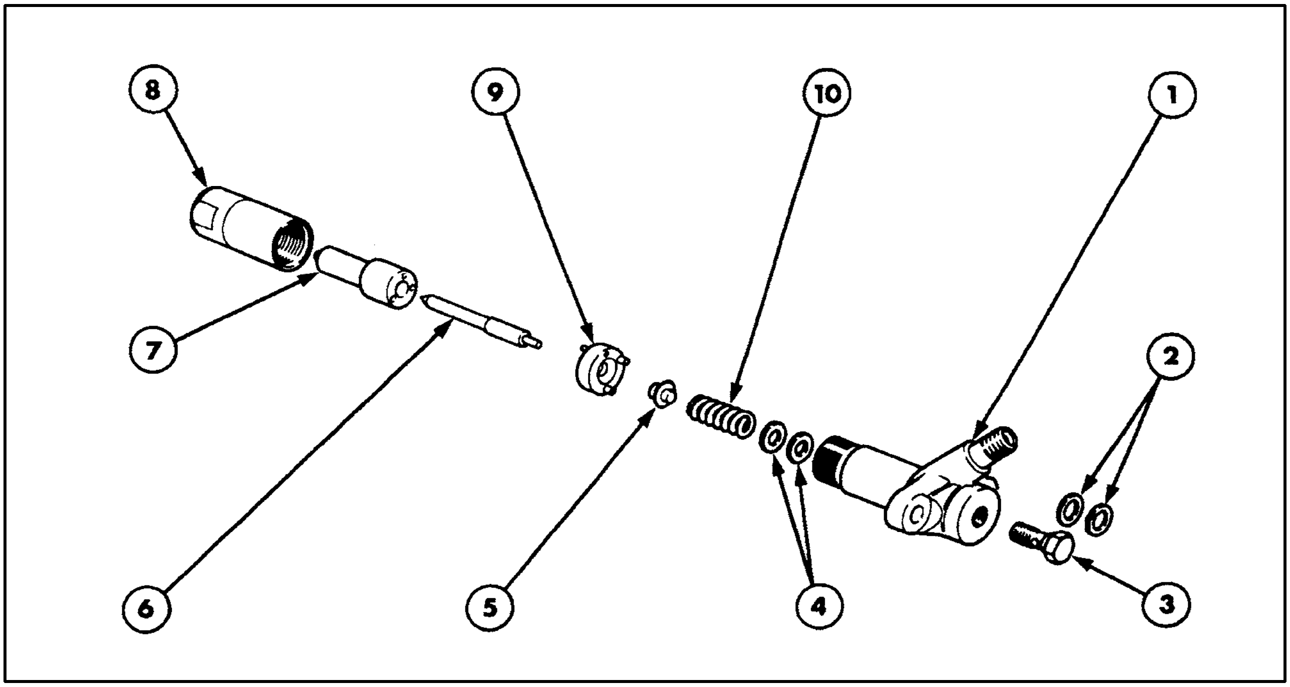
Wipe the nozzle tip dry and apply a pressure of 217 bar (3234 PSI), i.e., 10 bar (147 PSI) below the opening pressure. The nozzle tip and bottom face must remain essentially dry, and there must be no tendency for blobs of fuel to collect or drip. A slight dampness can be ignored. If there is any leakage from the nozzle seat, the nozzle assembly must be scrapped.

Nozzle Back Leakage:

Apply a pressure of 217 bar (3234 PSI), i.e., 10 bar (147 PSI) below the opening pressure, then release the handle. The time/pressure drop should be between 148 - 99 bar (2205 and 1470 PSI) within 45 seconds to 6 seconds. If below 6 seconds, the nozzle assembly must be scrapped. If above 45 seconds, check for carbon on the valve and/or blocked back leak drillings.

Spray Pattern:

Pump the tester rapidly (80 - 90 strokes per min.) and observe the spray pattern from the five holes. An atomized spray free from distortion, irregular streaks of unvaporized fuel and hosing should be observed. The tester is not regarded as providing a substitute for atomization under working conditions but gives an approximate indication of the working of the nozzle.



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FUEL INJECTOR OVERHAUL

Op. 10 218 34

Disassembly

1. Place the injector in a holding fixture with the nozzle uppermost. Do not clamp the injector body in a vise. Remove the nozzle retaining nut complete with the nozzle body, nozzle valve, and the doweled adapter plate.
2. Remove the injector body, 1, from the holding fixture, invert and carefully remove the spring seat, 5, spring, 10, and adjustment shims, 4. To avoid damage, place all dismantled components in suitable baths of clean fuel oil.

1 Injector body
2 Copper sealing washers
3 Leak-off line connector
4 Shims
5 Spring seat
6 Nozzle valve
7 Nozzle
8 Nozzle retaining nut
9 Doweled adapter plate
10 Spring

Inspection And Repair

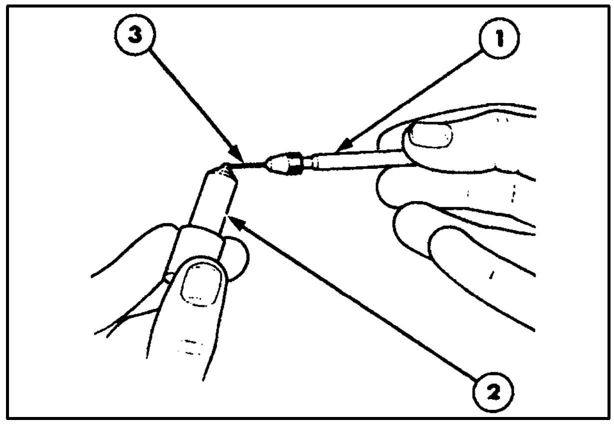
***NOTE:** To prevent corrosion of injector components after cleaning, rinse in clean fuel oil and place in a suitable bath of clean fuel oil.*

1. Clean the injector body by soaking in a carbon solvent and brushing with a brass wire brush. Inspect the body threads and pressure face for damage, ensuring the fuel galleries are thoroughly clean with no signs of corrosion or pitting.
2. Clean the spring and spring seat using a brass wire brush and check for scoring, pitting or corrosion.
3. Clean the doweled adapter plate using a brass wire brush. Inspect the plate for loose or bent dowels, damaged pressure face or corrosion.
4. Clean the nozzle valve and body by soaking in a carbon solvent and brushing with a wire brush. Using the tools included in a proprietary injector nozzle cleaning kit, clean the nozzle, 2, as follows:

***NOTE:** If the nozzle valve is in any way damaged or blued, it must be discarded and a new matched nozzle valve and nozzle body assembly obtained. It is not possible to grind or lap the three special angles on the valve point.*

a. Clean the spray holes with a 0.30 mm nozzle cleaning wire, 3, held in a pin vise, 1, so that it protrudes for only 1.5 mm, thereby giving maximum resistance to bending. Insert the wire into each hole, pushing and rotating gently until each hole is cleared.

b. Clean the nozzle valve seat using the valve seat scraper, 1, by rotating and pushing the tool onto the valve seating.



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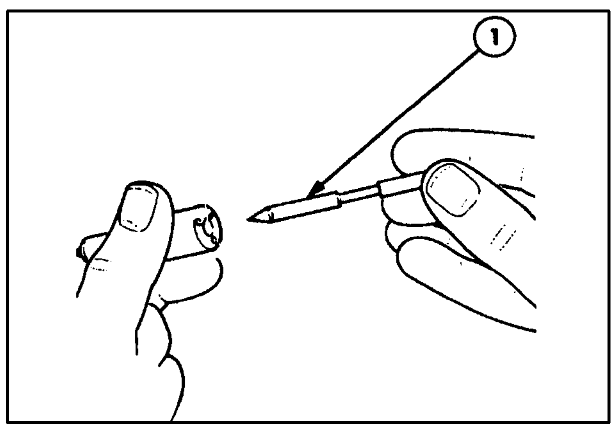

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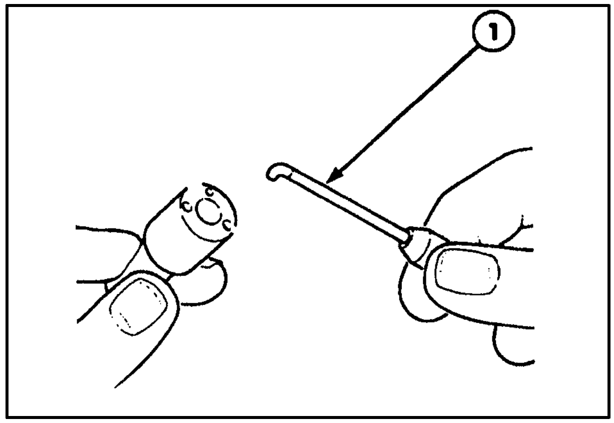
c. Clean the fuel gallery using the fuel gallery scraper, 1. Insert the scraper into the gallery, press hard against the side of the cavity, and rotate to clear all carbon deposits from this area.



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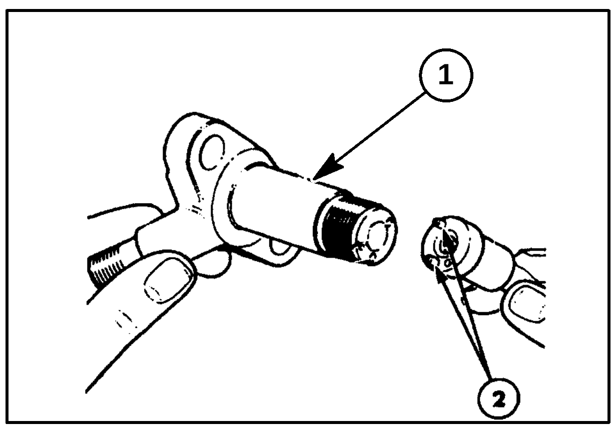
5. Use a Reverse Flush Adapter, Tool No. FNH08124, on the injector tester and reverse flush the nozzle to remove the carbon loosened during cleaning step 4.
6. Inspect the nozzle valve and body for scoring or pitting and ensure there are no deposits of carbon or corrosion. Check that the spray holes and fuel galleries are clean and that no blueing is present. The nozzle valve must move freely within the nozzle body.
7. Clean the nozzle retaining nut using a brass wire brush and check that the threads are not damaged and are free from carbon deposits.

Reassembly

1. Ensure all parts are absolutely clean and undamaged prior to reassembly. Rinse all parts in clean fuel oil and assemble the components while still wet.
2. Place the shims, spring and spring seat into the injector body bore. Place the injector body into the holding fixture.
3. Assemble the nozzle valve into the nozzle body and then position the doweled adapter plate onto the nozzle body. Insert this assembly into the nozzle retaining nut.
4. Carefully assemble the doweled adapter plate, 2, and the nozzle retaining nut assembly onto the injector body, 1, and tighten the retaining nut to 48 N·m (35 ft. lbs.).



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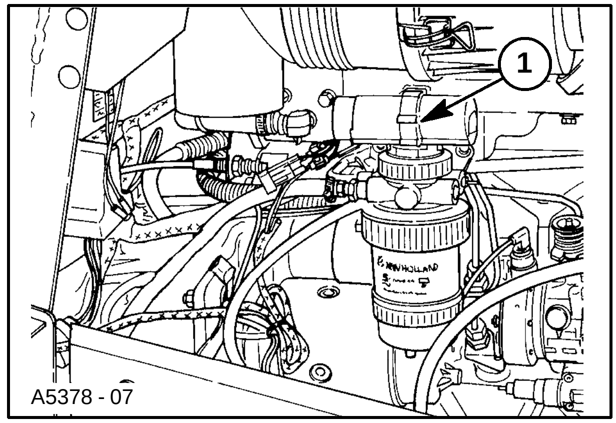
Op. 10 210 21

ELECTRIC LIFT PUMP - LS180

The pump, 1, is mounted into the head of the fuel filter and is activated via the key-start switch.

The fuel is drawn up from the tank through the separator and filter assemblies and then out to the FIP inlet.



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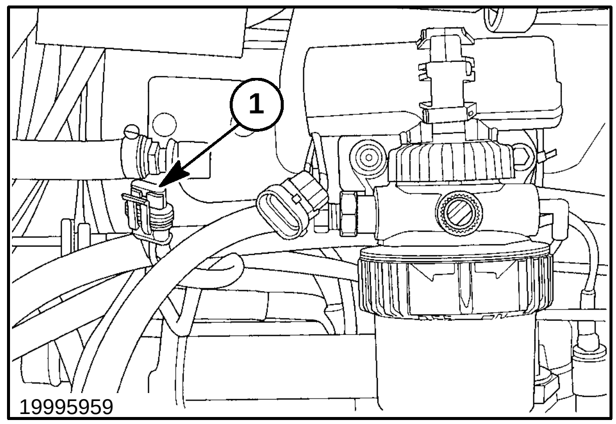
1. With the key start on, check for 12V at the electrical copnnector of the pump, 1. If 12V is not present, check fuses, relay and wiring.
2. If there is no/little delivery, and voltage and fuel are present at the pump, the pump should be replaced.



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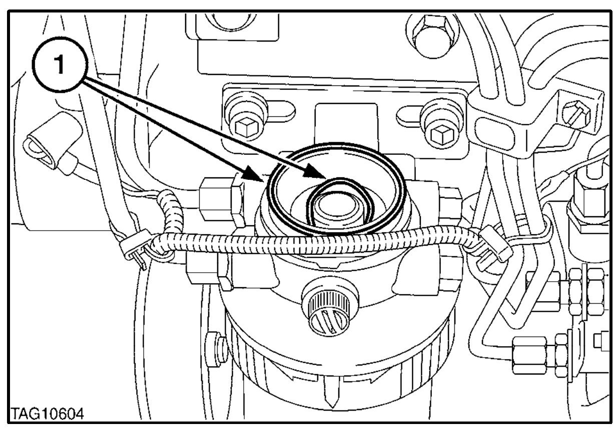
Removal

1. Disconnect battery.
2. Remove the two wires from the pump.
3. Unscrew the filter head/pump assembly connection and lift away from filter assembly.

Installation is reverse procedure, ensure O rings, 1, are serviceable.



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Pump Testing

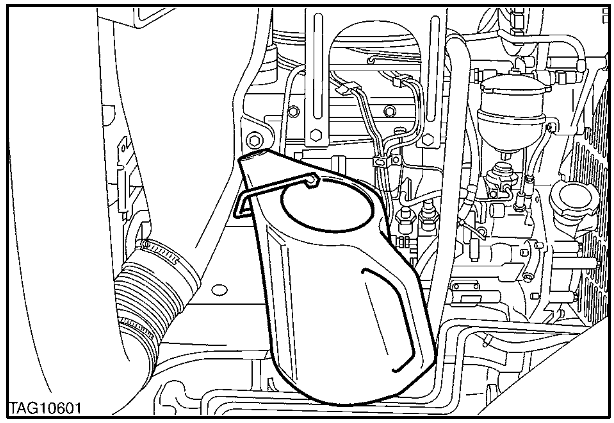
Fuel pump may be checked on the vehicle.

Ensure initially that the filter is serviceable and there are no other restrictions between the fuel tank and filters.

Disconnect the filter outlet to pump tube and reconnect to the filter, allowing the outlet to be positioned into a suitable measuring jar.

Turn the key start to the first position for a measured amount of time and record the fuel delivered.

Compare against specification.



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PUMP TEST CONDITION	POSSIBLE CAUSES	CORRECTION
Low pressure at pump outlet	1. Low or no fuel in tank 2. Blocked filter in lift pump 3. Actuating Shaft Worn 4. Pump Worn	1. Refill tank 2. Clean filter 3. Replace Shaft 4. Replace Pump
Air in the fuel from pump outlet	1. Blocked fuel tank breather 2. Loose fuel connections 3. Fuel Pump Diaphragm Perforated 4. Fuel pump body seam Leaking 5. Pump Worn	1. Clear blockage 2. Check and tighten 3. Replace Pump 4. Replace Pump 5. Replace Pump

FUEL TANK - LS180

Op. 10 216 10

REMOVAL

1. Securely block the skid steer with all four wheels off the ground. Refer to Section 1 for more detailed information on properly supporting the skid steer.

CAUTION

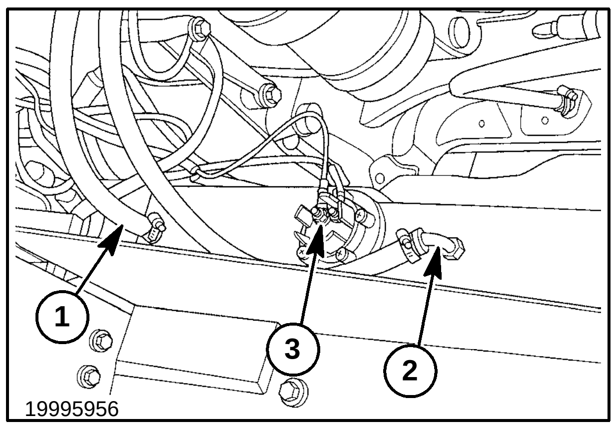
Failure to securely support the skid steer could result in movement of the loader causing serious injury or damage to the equipment.

2. Open the rear door and remove the left engine side shield to gain access to the fuel tank.
3. Remove the rear engine belly pan.

CAUTION

Use a floor jack to support the belly pan to prevent serious injury.

4. Drain the fuel tank. Loosen the clamp and remove the fuel tank filler neck.
5. Remove fuel lines, 1 and 2.
6. Disconnect fuel sender wires, 3.



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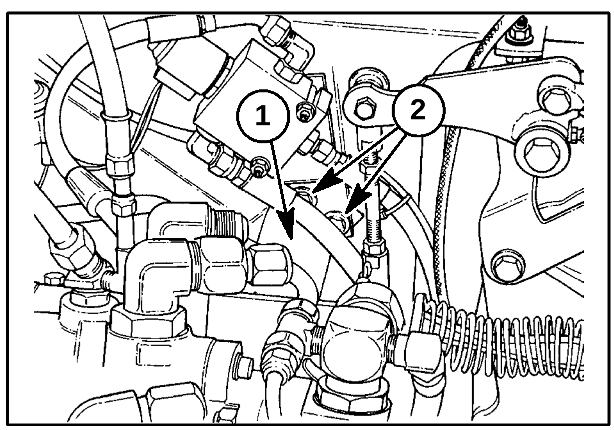
7. Remove cap screws, 2. Remove bracket, 1.



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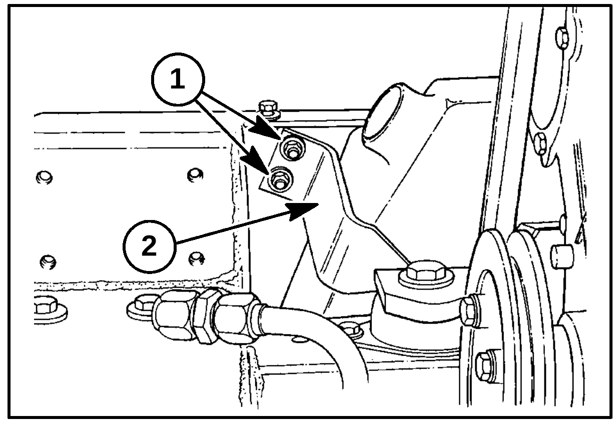
8. Support the fuel tank before removing the rear bracket. Remove the cap screws, washers, and nuts, 1. Remove bracket, 2.
9. Lower the fuel tank and slide rearward.



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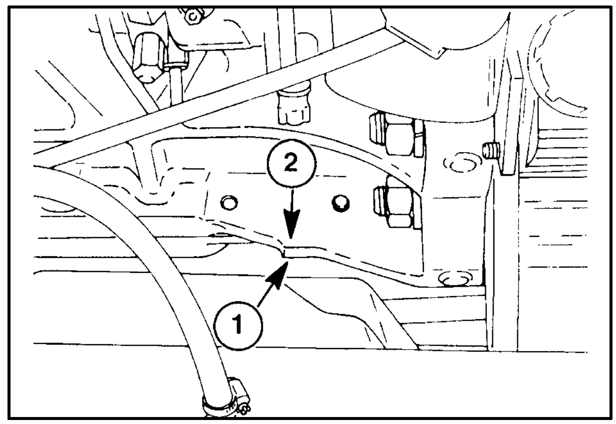
INSPECTION

If the fuel tank shows signs of contact by block protrusion, 2, the protrusion can be ground flat with the surrounding area.

DO NOT grind the block beyond flat with the surrounding web (dotted line).



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INSTALLATION

1. Install the fuel tank into the loader and secure with retaining hardware.

NOTE: *Use silicone sealant on the two cap screws holding the front retaining bracket to the final drive case.*

2. Install the fuel lines and fuel level sender wires.
3. Install the fuel tank filler neck. Tighten the hose clamp.

NOTE: *A redesigned fill tube was introduced into production during July of 1997. This tube allows free flow of fuel into the tank, without the restrictions of the previous tube.*

For machines with restricted fill flow, new replacement tubes can be obtained through the Service Parts System. No additional parts are needed.

To replace the tube, loosen the hose clamp, retaining the fill tube to the connector hose, and remove the old tube. Insert the new fill tube (part #86542122) into the connector hose, until it contacts the inlet to the fuel tank, and retighten the hose clamp.

4. Fill the fuel tank.
5. Install the engine belly pan and left side shield.
6. Lower the skid steer.

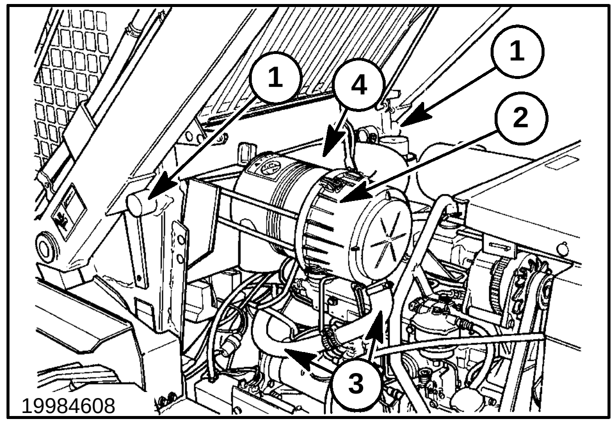
AIR INTAKE AND EXHAUST SYSTEM - LS180

AIR CLEANER

Op. 10 202 40

Removal

To service the engine air cleaner, the boom must be raised and supported on the boom lock pins, 1.



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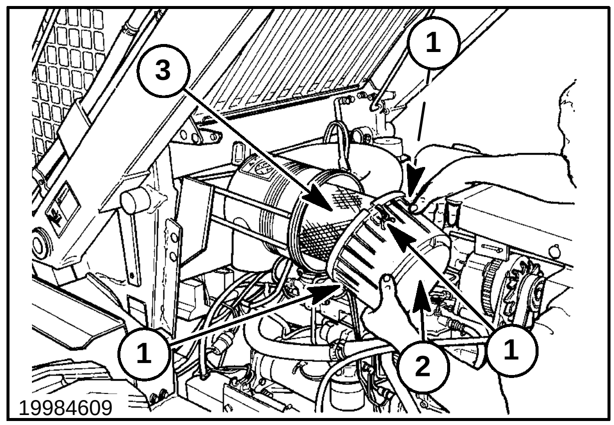
The air cleaner, 2, is accessed by opening the rear door and top engine cover and left engine side shield. The air cleaner assembly uses two elements, a primary element and a safety element.

Disconnect the outlet hose, 3, and inlet hose, 4.

To access the air filter elements, loosen the three clamps, 1, and unlatching end cap from air cleaner body.

To remove the primary element, remove the end cap, 2. This exposes the primary element, 3.



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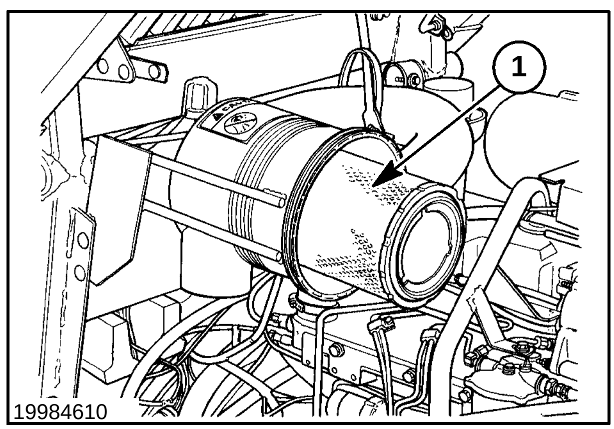
Inspection

1. Pull the primary element, 1, from the canister. Clean any loose dirt from the canister and inspect the end of the canister for dirt that may prevent the new element from sealing properly. Replace the primary element when the EIC indicates air cleaner restriction. Do not attempt to remove the element when the engine is running because dirt will be sucked into the engine. Do not attempt to clean the element by beating or rapping it.

IMPORTANT*: Do not attempt to remove the element when the engine is running because dirt will be sucked into the engine. Change the air cleaner element if a loss of power is noted. When installing a new element make sure it seals properly in the canister.*



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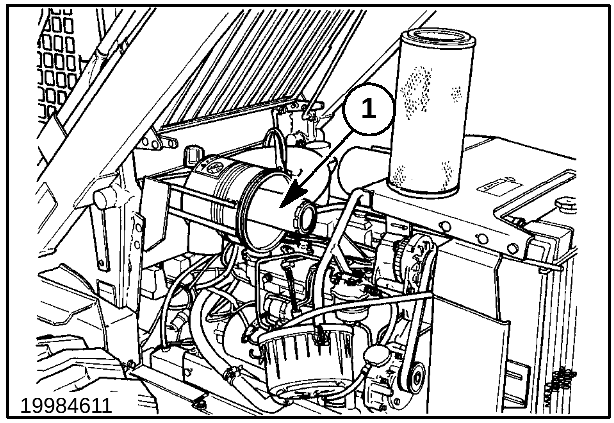
IMPORTANT: *Clean any dirt and dust from the canister before reinstalling the cleaner element. Make sure the inner end of the canister is clean and free of dirt to insure the element will seal properly to prevent dirt from entering the intake of the engine. Failure of a good seal between the filter and canister may cause major engine damage.*

2. Do not clean the inner safety filter element, 1. Once the element becomes partially clogged, replace it. To remove safety element pull the element from the canister.

   Visual inspection can be done by placing a light inside the element. If the element is partially clogged, little light will show through the element.

   If the element becomes clogged, it will cause air restriction which will cause loss of engine power or excessive exhaust smoke. For maximum engine protection and air cleaner service life, replace the safety element with a new safety element every third primary element change or 1000 hours - whichever occurs first.



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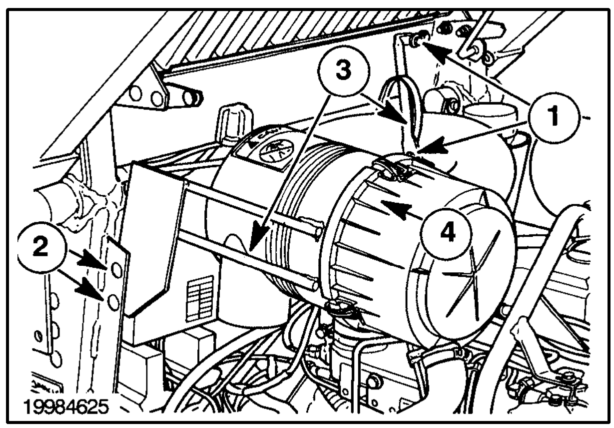
IMPORTANT*: Clean any dirt and dust from the canister before reinstalling the cleaner element. Make sure the inner end of the canister is clean and free of dirt to insure the element will seal properly to prevent dirt from entering the intake of the engine. Failure of a good seal between the filter and canister may cause major engine damage.*

The optional pre-cleaner/aspirator exhaust system can be installed to replace the standard system to extend the air cleaner element life.

3. Inspect the support rod hardware, 1, and the canister support mounting hardware, 2.

   Check that the support rods, 3, are not bent.

   Check that the end cover, 4, fits snugly over the outer canister with no large gaps.



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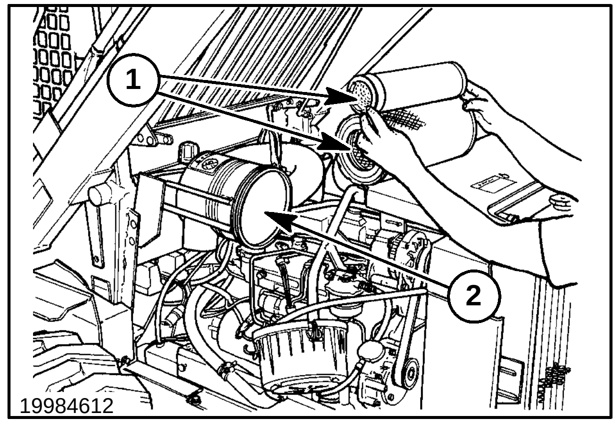
Reinstallation
Install a new primary element and/or safety element by inserting the open end of the elements, 1, into the canister, 2. Push the elements into the canister firmly for proper sealing inside the canister.



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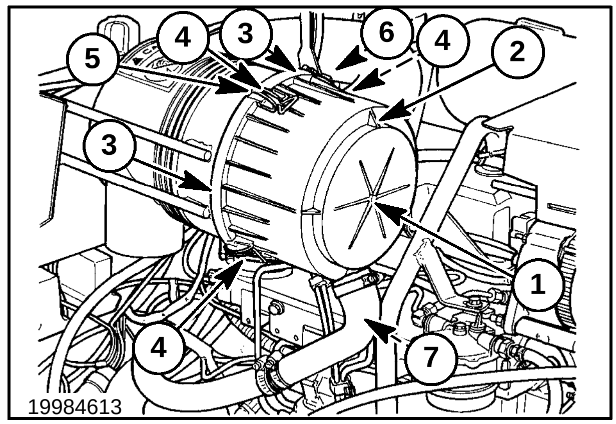
Reinstall the end cap, 1, by positioning the top of the end cap at 2. Seat the end cap into the lip on the canister at 3, pushing the elements and end cap into position.

Relatch the clamps, 4, by catching the top clamp into a slot in the canister lip at 5. Relatch the second two clamps after the top is clamped securely.

Reconnect the inlet hose, 6, and outlet hose, 7, to the canister.



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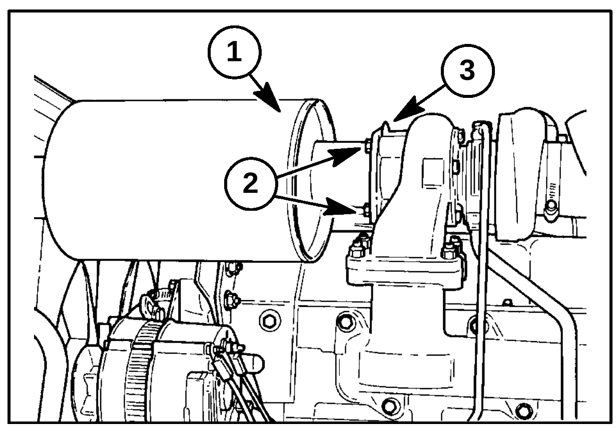
EXHAUST MUFFLER

Op. 10 254 40

Removal

1. Remove the right side engine shield to access the exhaust muffler.
2. Remove four cap screws, 2. Remove the exhaust muffler, 1, and gasket, 3.



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Inspection
Check for damage to the housing and mounting flange.

Installation
After installing a new gasket, reverse the procedure previously outlined.

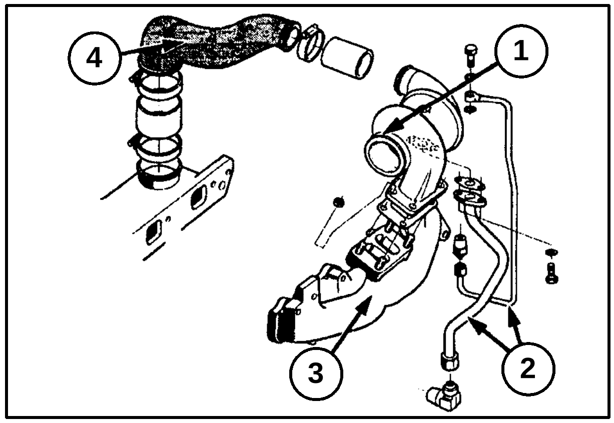
TURBOCHARGER

Op. 10 250 30

Removal

1. Remove the left side engine shield.
2. Remove the exhaust muffler.
3. Disconnect the air cleaner to the turbocharger tube and the turbocharger, 1, to intake manifold tube, 4.
4. Disconnect the oil supply and return tubes, 2, from the turbocharger, 1. Cap the ends of the tubes and oil ports of the turbocharger to prevent entry of foreign material.

NOTE: *Before removing and cleaning the unit, look for signs of oil and/or gas leakage, also wheel damage, which may not be evident after cleaning.*



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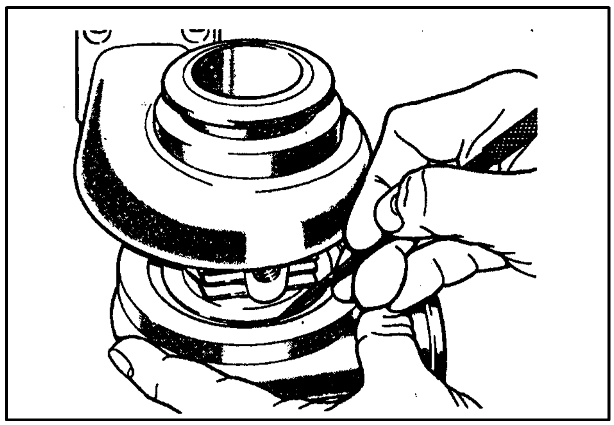
5. Remove the turbocharger and gasket from the exhaust manifold, 3. Cover the opening in the exhaust manifold to prevent the entry of dirt which could cause damage to the turbine wheel blades after installation and startup.

Disassembly

1. Clean the exterior of the turbocharger using a non-caustic cleaning solvent to remove accumulated surface matter before disassembly.
2. Mark the compressor housing, turbine housing, and center housing with a punch or scribe to facilitate correct positioning of the housings during reassembly.



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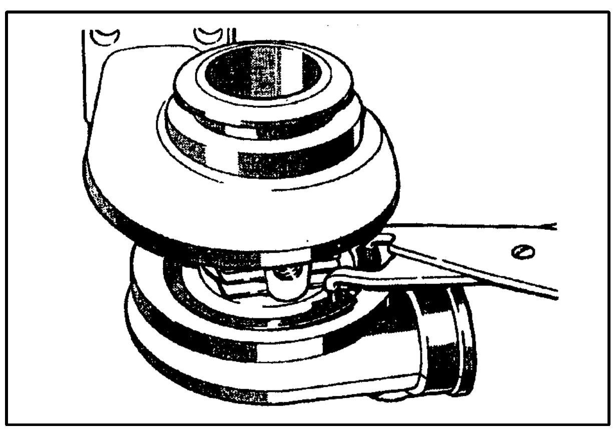
3. Remove the compressor housing C clip from the center housing intake side.



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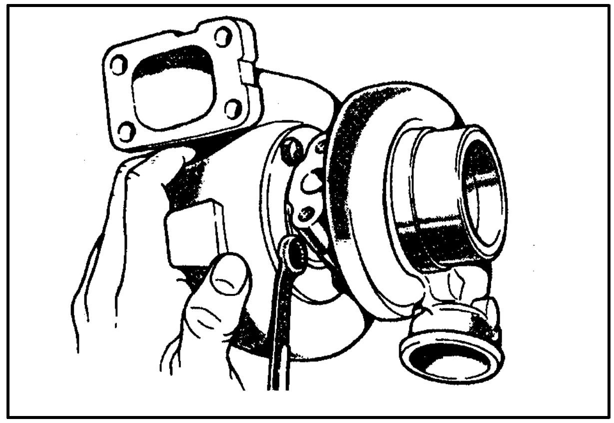
4. Loosen and remove the bolts from the turbine housing exhaust side and lockplates.



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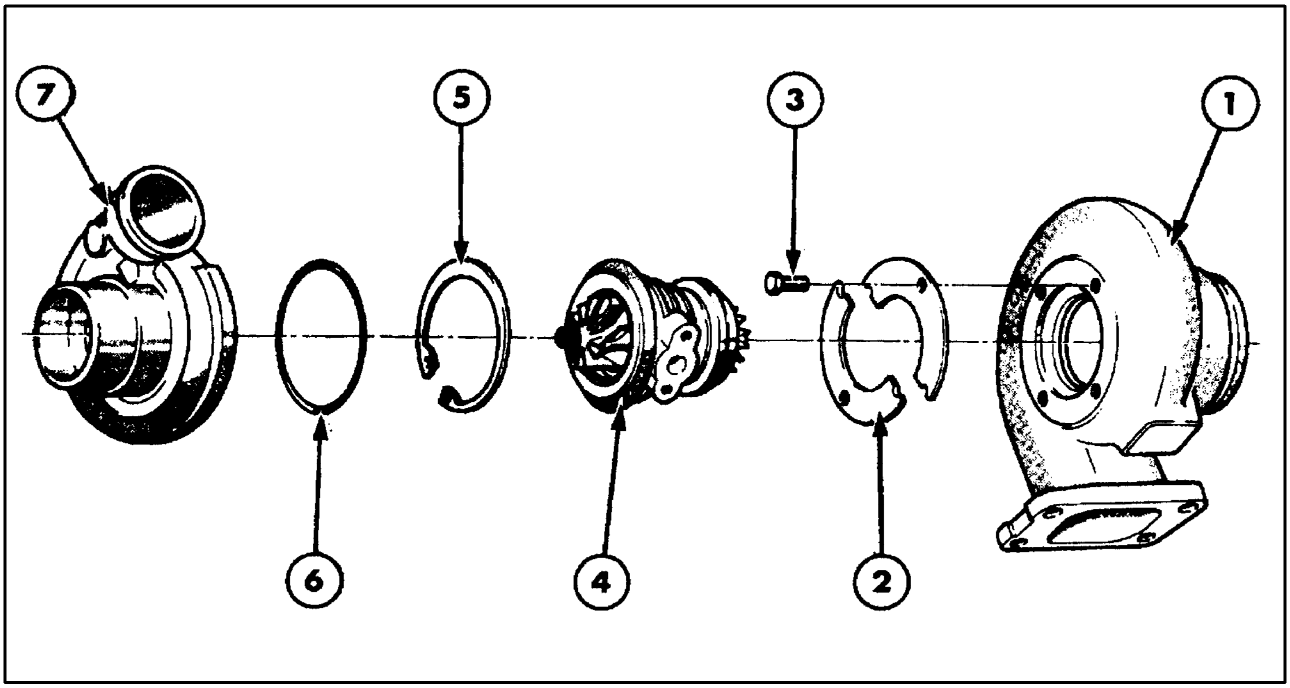

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Exploded View of Turbocharger

1. Turbine housing
2. Retainer plates
3. Retainer bolts
4. Center housing and rotating assembly (CHRA)
5. C clip
6. O ring
7. Compressor housing

NOTE: *Exercise care when removing the compressor housing to avoid damaging the compressor wheel blades.*

Tap the turbine housing with a soft-faced hammer if force is needed to remove.

Cleaning

Before cleaning, inspect all parts for burning, rubbing, or impact damage that may not be evident after cleaning. Clean all parts in a non- caustic solution, using a soft bristle brush, a plastic blade scraper, and dry compressed air to remove residue.

DO NOT use abrasive cleaning methods which might damage or destroy machined surfaces.

DO NOT immerse the CHRA in solvent.

DO NOT blow under the compressor wheel with compressed air.

DO NOT permit the wheel/shaft assembly to spin when blowing off solvent and residue.

Inspection

1. Inspect the compressor housing assembly for the following defects:

   Wheel rub damage in the contour area that cannot be polished out with 80-grit silicon carbide abrasive cloth.

   Worn, broken, or corroded snap ring grooves.

   Nicks, dents, or distortion that could prevent proper sealing between the compressor housing and the CHRA.

NOTE: *Replace the compressor housing if any of the above defects are found.*

2. Inspect the turbine housing assembly for the following defects.

   Wheel rub damage in the contour area that cannot be polished out with 60-grit silicon carbide abrasive cloth.

   Worn, broken, or corroded snap ring grooves (snap ring turbine housing models).

   Nicks, dents, or warpage that could prevent proper sealing between the turbine housing and the CHRA.

NOTE: *If there is any compressor or turbine wheel blade damage, the CHRA must be replaced. Operating a turbocharger with damaged blades will result in further damage to component parts or the engine.*

   Blades cannot be straightened in service.

Center Housing And Rotating Assembly (CHRA)

IMPORTANT: *The CHRA as an assembly has been balanced at the factory under precision conditions. As such, it must not be disassembled in any way. If disassembled, the balance will be destroyed and a new CHRA must be fitted.*

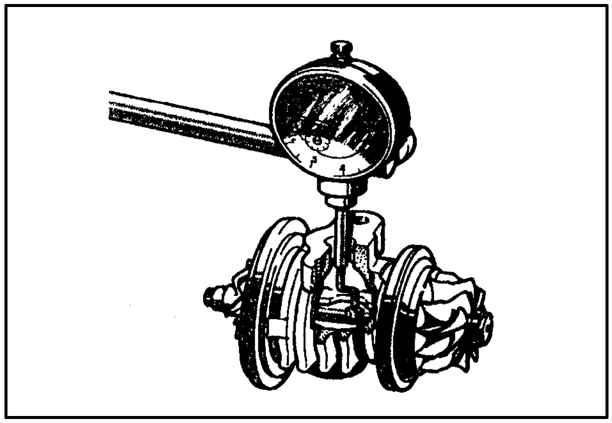
Center Shaft Radial Check

Check the journal bearing radial clearance whenever there is reason to suspect that the bearings are worn enough to allow either the compressor wheel or the turbine wheel to rub on its housing. This may be heard as a high-pitched whine.

1. With the turbocharger removed, attach an indicator with a dogleg probe, to the center housing. The indicator plunger should extend through the oil outlet port and contact the shaft of the turbine wheel assembly.
2. Manually apply equal and simultaneous pressure to the compressor and turbine wheels to move the shaft as far as it will go away from the dial indicator probe.
3. Set the dial indicator to zero.
4. Manually apply equal and simultaneous pressure to the wheels to move the shaft as far as it will go toward the plunger. Make a note of the shaft movement shown on the indicator dial.

NOTE: *To make sure the reading indicated is the maximum possible, roll the wheels slightly in both directions while applying pressure.*

5. Manually apply equal and simultaneous pressure to the compressor and turbine wheels to move the shaft away from the plunger again. Note that the indicator pointer returns exactly to zero.
6. Repeat steps 2 through 5 several times to ensure that maximum radial clearance, indicated by maximum shaft movement, has been measured.



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7. If the maximum clearance is less than 0.056 mm (0.0022″) or greater than 0.127 mm (0.0050″), replace the CHRA.

   Troubleshoot the engine to find the cause of the bearing failure and correct the problem before resuming operations.

Axle Clearance Check

Check the thrust bearing axial clearance as follows:

1. Place a dial indicator with the probe on the compressor end of the turbocharger shaft assembly.
2. Manually move the compressor/turbine wheel assembly as far as it will go away from the plunger.
3. Set the dial indicator, 1, at zero.
4. Manually move the compressor/turbine wheel assembly as far as it will go toward the dial indicator plunger. Make a note of the shaft movement shown on the indicator dial.
5. Manually move the compressor/turbine wheel assembly as far as it will go away from the plunger. Note that the indicator plunger returns to zero.
6. Repeat steps 2 through 5 several times to make sure that the maximum axial clearance, as indicated by maximum shaft movement, has been measured.
7. If the maximum clearance is less than 0.0254 mm (0.0010″) or greater than 0.084 mm (0.0039″), replace the CHRA.

Reassembly

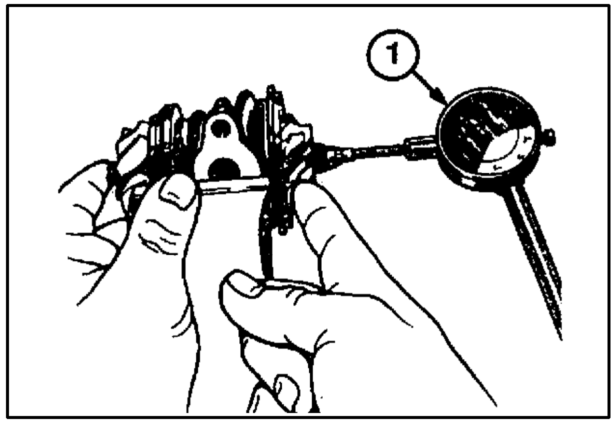
1. Replace the following with factory- authorized parts only at each overhaul or whenever parts are removed.

   Snap ring, compressor housing retainer

   O ring seal, compressor housing

   Retainer plates, turbine housing

   Bolts, turbine housing retainers



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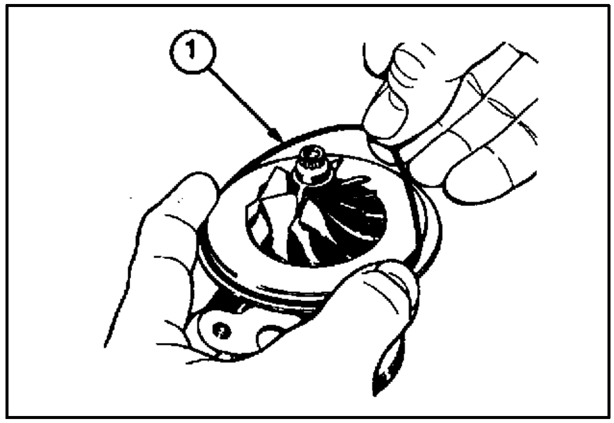
2. Parts that require changing if faulty or damaged.
   CHRA, turbine assembly

   Compressor housing

   Turbine housing

3. Inspect all mating surfaces and snap ring groove to ensure that they are free of burrs, foreign matter, and corrosion deposits.
4. Transfer scribe marks from old snap rings to new and coat with a light coating of new engine oil.
5. Install oiled snap ring on compressor end of CHRA with beveled face toward the turbine end.
6. Install an O ring, 1, on the center housing compressor end flange and place compressor housing assembly in position. Be careful not to damage the compressor wheel blades.
7. Carefully rotate the compressor housing onto the CHRA to line up the scribed marks.
8. Install the oiled snap ring, lug first, into the compressor housing groove. Be sure that the beveled side faces the turbine end and the scribe marks are aligned.
9. Tap the inner circumference or lug ends of the ring with an appropriately sized drift to ensure proper seating.

NOTE: *When installing a new CHRA or turbine housing, transfer the scribed alignment marks from the old to the new parts.*



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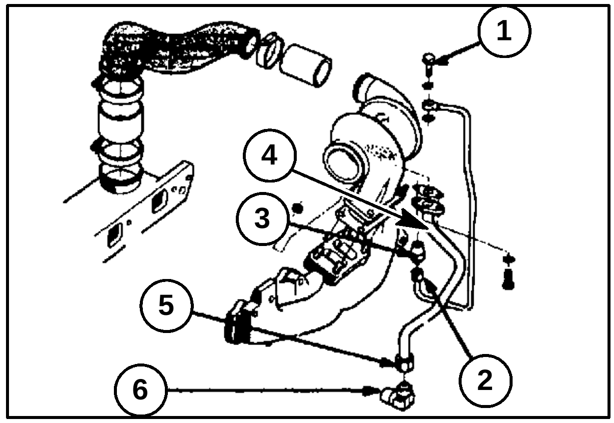
10. Position the turbine housing discharge side down on a flat, level surface. Place the CHRA turbine wheel end into the housing, using care to avoid damaging the wheel blades. Check visually for proper alignment.
11. Carefully rotate the CHRA in the turbine housing to line up the scribed marks. Recheck for proper alignment and position the locking plates.
12. Coat the bolts in a suitable antiseize compound and tighten to a torque of 20 - 25 N·m (15 - 18 ft. lbs.).

Installation

1. Prior to installation, fill the turbocharger center housing with new clean oil and rotate the main shaft to lubricate the bearings.
2. Installation of the turbocharger follows the removal procedure in reverse. Install a new manifold gasket and tighten to 41 - 47 N·m (30 - 35 ft. lbs.).
3. Replace the washers and reconnect the oil feed tube banjo bolt, 1, and torque to 30 - 40 N·m (22 - 30 ft. lbs.).
   - Oil feed tube to turbocharger (banjo bolt)
   - Oil feed tube to filter head connector
   - Connect to filter head
   - Oil return tube from turbocharger to block
   - Oil return tube to block connector
   - Oil return connector to block
4. The oil feed tube connector to oil filter head assembly, 3, if disturbed, should be refitted. Apply sealer to connector. See “Specifications Service Standards” in this section and torque to 54 - 81 N·m (40 - 60 ft. lbs.).
5. Apply sealer. See “Specifications Service Standards” in this section. Assemble the oil feed tube to the oil filter head connector, 2, and tighten to 18 - 20 N·m (13 - 15 ft. lbs.).
6. Place a suitable receptacle below the oil outlet port and **with the electrical solenoid wire disconnected at the fuel injection pump,** crank the engine until oil flows from the outlet port.
7. Reconnect the oil outlet tube, 4, using a new gasket and tighten the retaining bolts at the turbocharger to 20 - 25 N·m (15 - 18 ft. lbs.).
8. Tighten the oil return tube to cylinder block connector, 5, to 54 - 81 N·m (45 - 50 ft. lbs.).
9. If disturbed, oil return tube to block connector, 6, should have sealer applied. See “Specifications Service Standards” in this section. Torque to 27 N·m (20 ft. lbs.).



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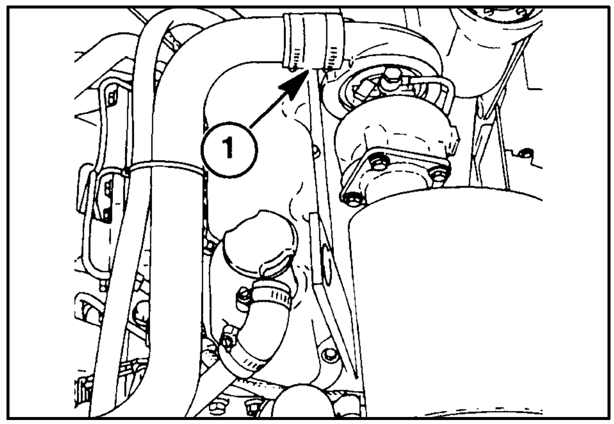
10. Reconnect the air inlet and outlet tubes with the hose clamps and torque to 1.7 - 2.3 N·m (15 - 20 in. lbs.).
11. Reconnect the fuel injection pump solenoid wire.
12. Check the engine oil level and add oil if required. Idle the engine and check all tubes and gaskets for leaks.
13. Run the engine at rated speed and listen for sounds of metallic contact from the turbocharger. If any noise is apparent, stop the engine immediately and correct the cause.

NOTE: *After the unit has reached operating temperatures, the rotating assembly should coast freely to a stop after the engine is stopped. If the rotating assembly jerks to a sudden stop, the cause should be corrected immediately.*

Turbocharger Leaking Oil at Pressure Hose Connection

Oil leakage in the area of the connecting hose between the turbocharger and crossover tube to the intake manifold at 1. This is a result of oil weeping out the joint between the turbocharger and the hose.



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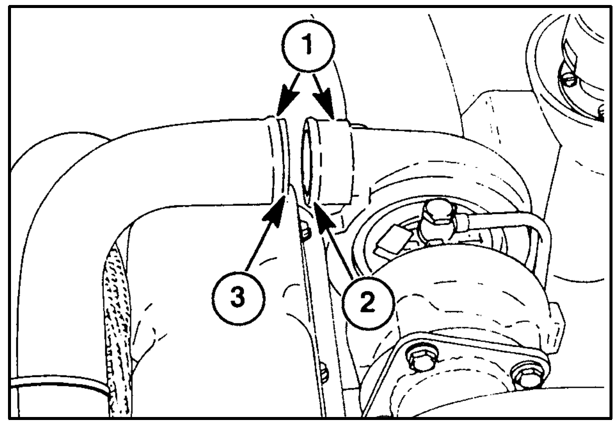
A small amount of oil blow-by is normal in this turbocharger skid steer application. Due to the extremely high speeds in a turbocharger, the turbine shaft rides on a film of oil. It is a fluid bearing, not a metal bearing, which supports the shaft and keeps it cool. At the ends of the shaft, the oil is not fully sealed with a typical rubber lip seal. A labyrinth seal is used for the shaft to allow the high rotational speed. The labyrinth seal can protect against oil splashing out, but it will allow pressurized oil to pass by it. When the turbocharger is running, excessive oil blow-by can be demonstrated by intentionally blocking the air intake into the turbocharger. This occurs because the high vacuum causes the oil to travel across the labyrinth seal. This phenomena occurs to a much smaller degree under normal engine operating conditions. However, it is somewhat worse with an application such as with skid steers, where the engine is not operated at a constant speed and load.

The oil blow-by is not staying inside the hose and tubing, but it is leaking to the outside surfaces, where it collects dirt and gives the appearance that something has failed. Oil leaking at this connection will also give the appearance that there is an oil leak between the turbine housing and the compressor housing at the retaining ring and O ring.

To correct a leak, remove the hose from the turbocharger and tube at 1, and thoroughly clean the connections. Remove and discard the original hose clamps. These clamps are not properly seating and sealing the hose to the rough casting of the turbocharger or steel tube.



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NOTE: *When the hose is removed, there may be evidence of oil at this connection and inside of the hose and tube. This is normal in the skid steer application.*

Order and install two (2) new hose clamps, part #58880, and tighten them to 35 in. lbs.

Install the hose and clamp onto the turbocharger at 1, half the length of hose, making sure that the hose is positioned to allow enough area of hose past the rolled edge on the turbocharger at 2, to insure the hose clamp will properly seat the hose to the turbocharger.

Install the hose and clamp onto the crossover tube at 3, making sure the tube is fully inserted into the hose so the hose clamp will seal the hose and tube past the rolled edge on the tube.

STARTING A TURBOCHARGED ENGINE AFTER INSTALLATION OF A TURBOCHARGER

1. Disconnect the outlet oil pipe from the turbocharger.
2. Disconnect the electrical wire at the fuel injection pump fuel shutoff solenoid. Place a suitable container below the turbocharger oil outlet port and crank the engine until oil flows from the outlet port.
3. Reconnect the oil outlet tube, using a new gasket, and tighten the fittings to the following specifications.

   Return line tube to turbocharger - 20 - 27 N·m (15 - 20 ft. lbs.)

   Return line tube to block connector - 60 - 70 N·m (45 - 50 ft. lbs.)

4. Crank the engine until oil pressure rises. Reconnect the fuel solenoid wire. Start the engine and let it idle for one minute.
5. Check the engine oil level and add oil if necessary. Start the engine and check for oil and air leaks.

ENGINE INSTALLATION - LS180

ENGINE ASSEMBLY SEQUENCE

The following assembly procedure is suggested for installing external components onto the engine. Refer to the appropriate section when installing engine components.

1. Install crankshaft pulley.
2. Install oil pan.
3. Install transmission housing and flywheel. (See Section 27.)
4. Install starting motor.
5. Install water pump.
6. Install fuel filter, fuel supply pump, and fuel line.
7. Install dipstick, oil filter, engine oil cooler and hoses.
8. Install coolant outlet connection with thermostat and new gasket.
9. Install rocker arm cover with vent tube.
10. Install turbocharger and exhaust manifold.
11. Install fan, fan belts, and alternator.
12. Fill coolant and engine oil to proper level.

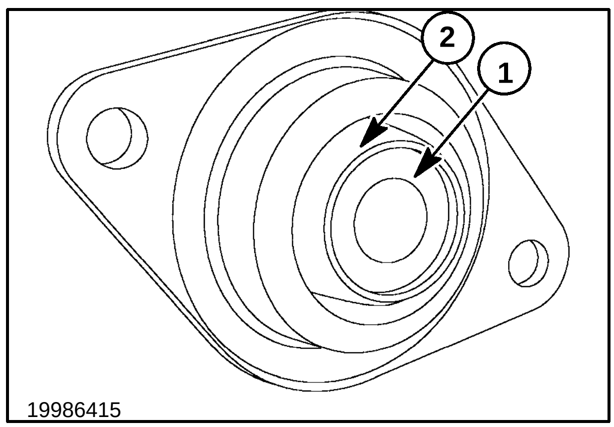
INSTALLATION INTO LOADER

Before installing the engine into the skid steer, check the condition of the engine isolator mounts and replace if necessary.

Examine the three isolation mounts, part #9803221, for wear or damage to the inner steel bushing. Damage may be in the form of wear or crushing to the end bushing surface, 1, on either end of the inner steel bushing. Severe damage may result in cracking of inner bushing, 2. The inner bushing length should measure EXACTLY 2.25″. If the bushing is less than 2.25″ replace it.

Bushing damage results if the center retaining hardware is overtorqued.

If damaged, replace all three bushings.



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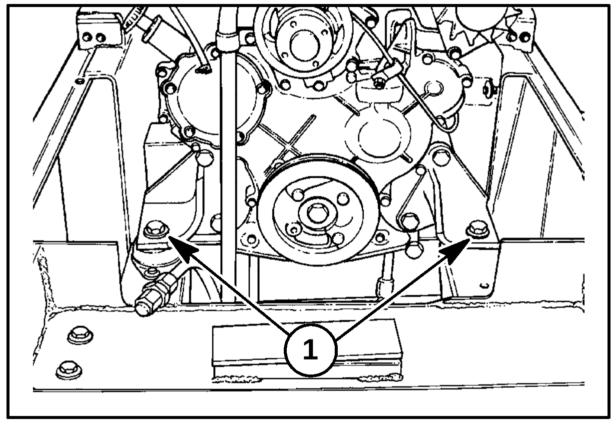
1. Install the engine assembly into the skid steer, aligning the engine mounts.
2. Install the engine mounting hardware, 1. Torque the mounting cap screws to 172 N·m (127 ft. lbs.).
3. Install the hydrostatic pumps. Refer to Section 5 for hydrostatic pump installation.
4. Install previously removed ground wires and harness clamps to the transmission gearbox.
5. Install engine fan.



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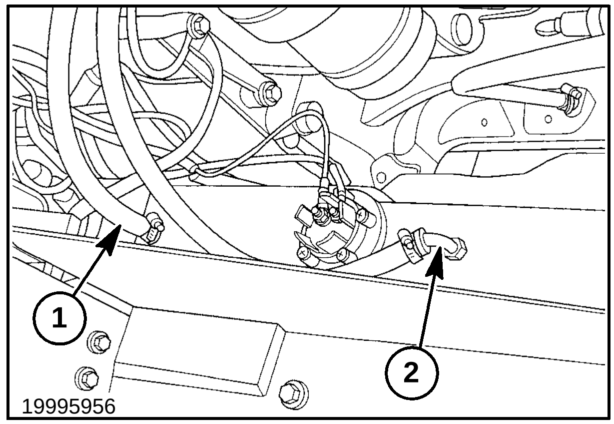
6. Install fuel supply line, 1, and return line, 2.
7. Connect throttle cable. Adjust as required.



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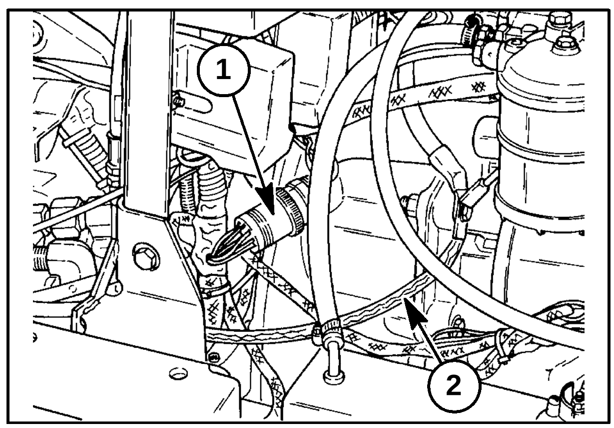
8. Connect the engine main harness connector, 1. Install ground strap, 2.



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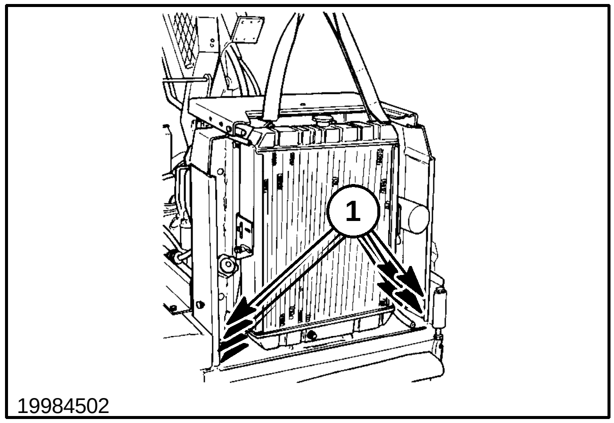
9. Install the radiator/oil cooler assembly onto the skid steer. Secure with the eight mounting cap screws, 1.



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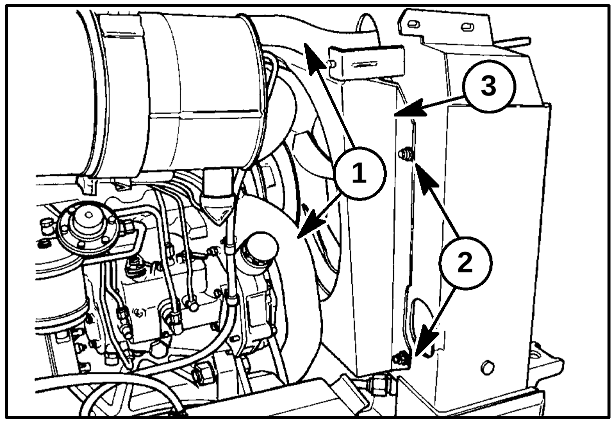
10. Connect the oil cooler bottom left line.
11. Install fan shroud, 3, and secure with four cap screws and nuts, 2.
12. Install the upper and lower radiator hoses, 1.



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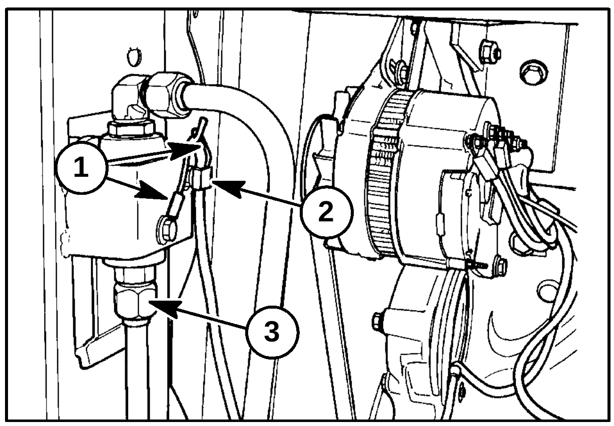
13. Connect hydraulic line, 3, to the filter base.
14. Connect the hydraulic oil filter restriction switch wires, 1, and harness clamp, 2.
15. Install the air cleaner and tighten all hose clamps.
16. Install the fuel tank filler neck and tighten clamps.
17. Install the rear door latch bracket.
18. Install the rear door and connect the overflow hose to the tank.
19. Install the battery. Refer to Section 3 for the battery installation procedure.
20. Refill all fluids to the proper level.



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OPERATING THE ENGINE AFTER OVERHAUL

1. Check level of engine oil, coolant and fuel.
2. Disconnect the wiring harness connector at the engine stop solenoid.
3. With the turbocharger oil return line removed, place a suitable container below the oil outlet port. Crank the engine until oil flows from the open port. Reinstall the oil return line.
4. Crank the engine until the oil pressure lamp is extinguished.
5. Connect the wiring harness connector to the engine stop solenoid.
6. Move the hand throttle to the 1/3 or 1/2 open position and start the engine. Operate at no more than 1500 RPM.
7. Run the engine at 1500 RPM for about 30 minutes to allow it to fully warm up and begin the ring seating process. During warmup observe the following:
   - Listen for abnormal sounds.
   - Monitor engine temperature.
   - Check for fluid leaks (oil, coolant, fuel).

ELECTRICAL COMPONENT MAINTENANCE - LS180

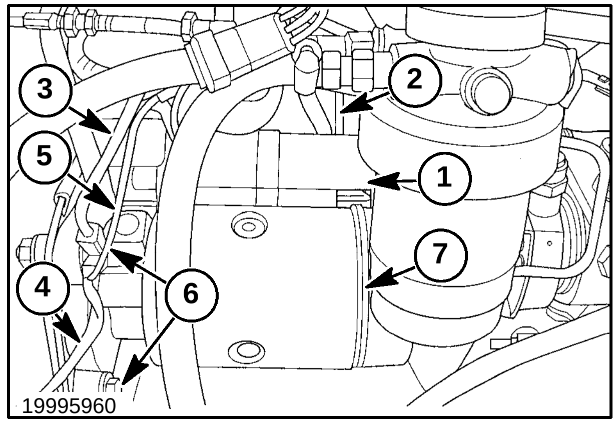
CRANKING CIRCUIT (STARTING MOTOR)

Op. 55 201 50

Removal

IMPORTANT: *Always disconnect the negative (-) battery cable before removing the starter or a short circuit could result.*

1. Disconnect the negative (-) battery cable.
2. Remove solenoid cover, 1, from rear of solenoid.
3. Disconnect the positive battery cable, red wiring leads and W/R wiring lead, 2, from the starter solenoid.
4. Remove the oil dipstick cap screws and lower for starter removal clearance.
5. Remove the negative battery cable, 3; ground strap, 4; and black wiring lead, 5.
6. Remove three cap screws, 6. Remove starting motor, 7.



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Installation

1. Reverse the removal procedure previously outlined.

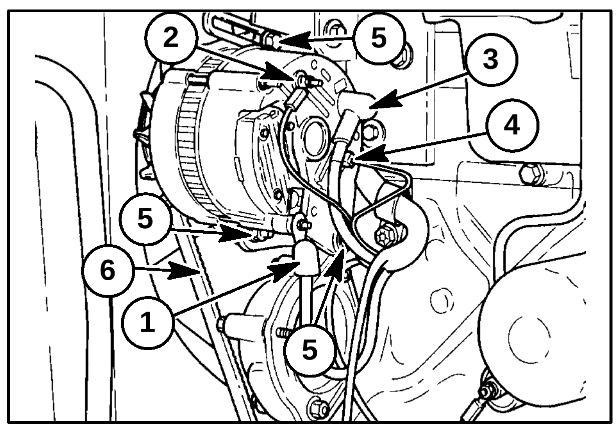
CHARGING CIRCUIT

Op. 55 301 10

Alternator Removal

IMPORTANT: *Always disconnect the negative (-) battery cable before removing the alternator or a short circuit could result.*

1. Disconnect the negative (-) battery cable.
2. Disconnect the R/DK BL wiring lead, 3, from terminal B+ and PU/R wiring lead, 2, from terminal W.
3. Disconnect B wiring lead, 1, and Y/DK BL electrical connector, 4.
4. Remove the three cap screws, 5. Remove belt, 6. Remove the alternator.



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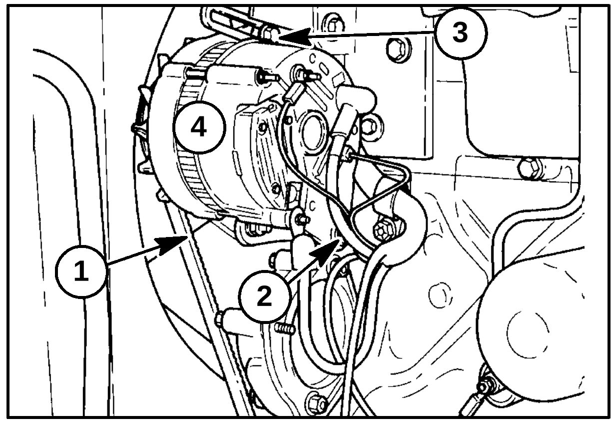
Installation

1. Reverse the removal procedure previously outlined.
2. Adjust belt tension.

ADJUST BELT TENSION

Check and adjust the alternator belt, 1, for proper tension every 50 hours of operation. The belt is tightened properly when a force of 1 kg (2 lbs.) is applied perpendicular to the belt at the center of the span with a 3 mm (1/8″) deflection. To adjust belt tension, loosen the pivot bolt, 2, and the adjustor bolt, 3, and pivot the alternator, 4, until the proper tension is obtained. Retighten all hardware securely.

IMPORTANT: *To prevent possible damage to the alternator when replacing a belt, disconnect the negative (-) ground cable from the battery.*



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SPECIAL TOOLS - LS180

DESCRIPTION	TOOL NO.
Adjustable Bridge Puller	FNH09539
Shaft Protectors	FNH09212
Step Plate Adapters	FNH09210
Bushing Kit	FNH09514
Crankshaft Gear Remover/Installer Adapter/Insert	 FNH02134 FNH01237
Valve Guide Reamer Kit	FNH02136
Camshaft Bearings Remover/Installer Handle	 FNH01225 FNH01442
Water Pump Seal Replacer	FNH04672
Reverse Flush Adapter	FNH08124
Crankshaft, Seal Replacer Front Seal Rear Seal	 FNH10103 FNH01301
Fuel Injection Pump Timing Gauge, Splined Shaft and Slotted Arm	NH013141

LABOR GUIDE - LS180

The following labor amounts are listed as a guide only. Machine and working conditions and experience will vary the actual time required to perform a repair operation.

Op. 10 001 10

ENGINE REMOVAL FROM SKID STEER
(5.0)

Includes tilting the cab, removal of the oil cooler and filter and radiator as an assembly. Disconnecting hydrostatic drive pumps.

ENGINE OVERHAUL

Op. 10 001 53

Major overhaul (16.0)
Engine removed from machine.

Steam clean and completely dismantle, clean all parts, flush all oil and water passages and replace plugs, check crankshaft for wear and inspect all parts.

Deglaze cylinder bores as required. Does not include rebore or fitting new sleeves.

Replace or repair pistons with new rings.

Replace crankshaft main and rod bearing liners, camshaft bearings. Does not include regrind of crankshaft.

Recondition cylinder head including reseating valves, repair/replace valve guides, overhaul rocker shaft assembly. Service fuel injectors.

Inspect and replace timing gears as necessary. Inspect and repair as required water pump, oil pump and turbocharger.

Reassemble engine completely using new gaskets and seals and tighten to specifications. Set valve clearances. Run engine and check for leaks. Reset valve clearances.

Minor overhaul (oil consumption rectification)
Engine in machine. (9.0)

Engine removed from machine. (8.0)

Remove cylinder head, oil pan and oil pump.

Remove all pistons and connecting rods.

Deglaze all cylinder bores.

Clean and check pistons for wear. Repair as necessary and replace piston rings.

Strip and clean cylinder head. Reseat valves and service fuel injectors.

Inspect oil pump and repair/replace as necessary.

Reassemble all parts using new gaskets and seals.

Run engine and check for leaks. Reset valve clearances.

CYLINDER BLOCK

Op. 10 001 54

Replace bare block (12.5)
Engine removed from machine.

Steam clean complete engine, dismantle, clean and inspect all parts to be reused.

Reassemble engine complete into new bare block with same or new pistons using new rings, crankshaft main and rod bearings, camshaft bearings, gaskets and seals. Reinstall cylinder head. Tighten to specifications.

PISTON ASSEMBLY

Op. 10 105 10

Connecting rod
Replace one. (4.0) Engine in machine.

Includes remove and replace cylinder head, oil pan, piston and rod assembly. Clean, reinstall with new gaskets. Run engine, check for leaks. Reset valve clearances.

Small end bushing
Replace one. Engine in machine. (4.2)

Each additional (0.5)

Includes remove and replace connecting rod.

Op. 10 105 12

Piston
Replace one. Engine in machine. (4.5)

Each additional (0.3)

Includes remove and replace cylinder head, oil pan, piston and rod assembly. Clean, fit new rings, reinstall with new gaskets. Run engine, check for leaks. Reset valve clearances.

CYLINDER HEAD

Valve Rocker Arm Cover
Remove and replace. (0.4)

Cylinder Head Overhaul
Engine in machine. (6.5)

Engine removed from machine. (5.5)

Remove cylinder head and gasket. Clean head and block surface.

Reseat all valves. Grind all valve seats, reface all valves.

Additional time: Replace valve seat - each (0.2)

Clean and inspect valve guides. Ream and fit new valves as necessary.

Inspect and shim valve springs.

Install head, set valve clearances. Run engine and check for leaks. Reset valve clearances.

Op. 10 101 20

Cylinder Head Remove and Replace
Engine in machine (2.5)

Includes remove and replace valve rocker cover and shaft assembly. Adjust valve clearances. Install new gaskets.

Valve Spring
Change one. (0.8)

Head not removed.

Includes remove and replace rocker arm cover.

Change all. (1.3)

Head not removed.

Includes remove and replace rocker arm cover.

CAMSHAFT, TIMING GEARS AND COVER ASSEMBLY

Camshaft
Remove and replace. Engine removed from machine. (3.1)

Includes remove and replace rocker shaft assembly, timing gear cover.

Valve Lifters
Remove and replace all. Camshaft removed from engine. (0.7)

Includes remove and replace oil pan.

Timing Gear Cover
Remove and replace. Engine in machine. (2.0)

Remove and replace. Engine removed from machine. (0.7)

Includes remove and replace radiator support (in machine) and crankshaft pulley.

FUEL SYSTEM

Injection Pump
Remove and replace. (2.4)

Includes remove and replace starter, high-pressure and low-pressure pipes, bleed system.

High-Pressure Pipes
Remove and replace one (0.2)

Remove and replace all. (0.4)

Fuel Injector
Remove and replace one (0.5)

Remove and replace set (1.2)

Includes injector test.

Dismantle and clean one injector (0.7)

Includes remove and replace and retest.

Dismantle and clean all injectors (2.0)

Includes remove and replace and test.

Fuel filter element (0.2)
Change
Includes bleeding system.

Fuel pump stop solenoid (0.2)
Remove and replace.

Fuel tank (1.0)
Remove and replace.

Fuel level sender (0.1)
Remove and replace.

Fuel pickup tube (0.1)
Remove and replace.

Fuel lines (supply & return) (0.1)
Remove and replace.

Electric lift pump (1.0)
Remove and replace.

AUXILIARY EQUIPMENT

Alternator (0.3)
Remove and replace.

Oil filter (0.1)
Remove and replace.

Starter motor (0.4)
Remove and replace.

Starter solenoid (0.7)
Remove and replace.

With starter removed from engine.

Thermostat (0.8)
Remove and replace.

Turbocharger (0.8)
Remove and replace.

Engine fan (0.8)
Remove and replace.

Fan belt (0.2)
Remove and replace.

Water pump (1.6)
Remove and replace.

Radiator (0.5)
Remove and replace.

Chapter 2 – LS190 - 450/NC

CONTENTS

Chapter 2 – LS190 - 450/NC

Op. 10 000

INTRODUCTION

This engine section has two parts to cover the two engines. Refer to the chapter that pertains to the engine being serviced.

Chapter 1 - LS180, 332T/JF engine (3-cylinder, turbocharged)

Chapter 2 – LS190, 450/NC engine (4-cylinder, naturally aspirated)

SAFETY PRECAUTIONS

CAUTION

Do not change the specification of the engine.

Do not smoke when you put fuel in the tank.

Clean away any fuel which has spilled and move material which has fuel contamination to a safe place.

Do not put fuel in the tank during engine operation (unless absolutely necessary).

Never clean, lubricate, or adjust the engine during operation (unless you have had the correct training when extreme caution must be used to prevent injury).

Do not make any adjustments you do not understand.

Ensure the engine is not in a position to cause a concentration of toxic emissions.

Persons in the area must be kept clear during engine and equipment or vehicle operation.

Do not permit loose clothing or long hair near parts which move.

Keep away from parts which turn during operation. Note that fans cannot be seen clearly while the engine is running.

Do not run the engine with any safety guards removed.

Do not remove the radiator cap while the engine is hot and the coolant is under pressure, as dangerous hot coolant can be discharged.

Do not use salt water in the fresh water cooling system or any other coolant which can cause corrosion.

Keep sparks or fire away from batteries (especially during charge) or combustion can occur. The battery fluid can burn and is also dangerous to the skin and especially the eyes.

Disconnect the battery terminals before you make a repair to the electrical system.

Only one person must be in control of the engine.

Ensure the engine is only operated from the control panel or operator’s position.

If your skin comes into contact with high-pressure fuel, get medical assistance immediately.

Diesel fuel and used engine oils can cause skin damage to some persons. Use protection on the hands (gloves or special skin protection solutions).

Do not move equipment unless the brakes are in good condition.

Ensure that the transmission drive control is in neutral position before the engine is started.

Do not use ether to start the engine.

LS190 ENGINE SERVICE

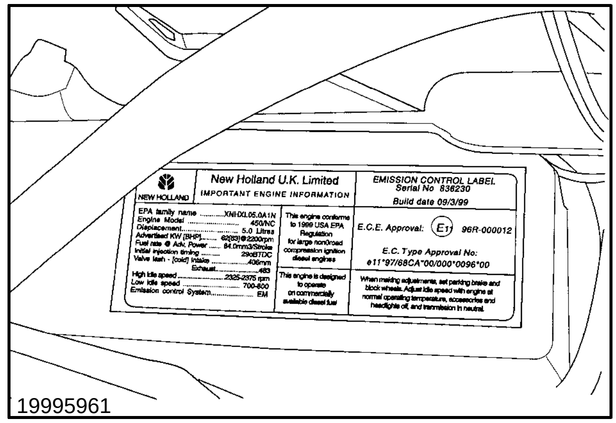
GENERAL ENGINE INFORMATION

DESCRIPTION AND OPERATION

The LS190 450/NC engine is a four-cylinder, naturally aspirated engine.

The engine features cross flow cylinder heads, with the inlet and exhaust manifolds on opposite sides of the cylinder head. The fuel and air combustion process takes place in the specially designed bowl in the crown of the pistons.

The engine model number, serial number, date of manufacture, and other inormation are located on the name plate on the front of the engine valve cover.



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Cylinder Head Assembly

The cylinder head incorporates valves and springs, with the valve rocker arm shaft assembly bolted to the cylinder block through the cylinder head. Cylinder head retaining bolts are evenly spaced with a six point pattern around each cylinder. This pattern ensures an even clamping load across the cylinder head area.

The intake and exhaust manifolds are bolted to the head. The intake manifold is mounted on the right hand side of the engine, with the diesel injectors mounted outside the rocker cover. The exhaust manifold is mounted on the left hand side of the engine. Water outlet connections and thermostat attach to the front of the cylinder block directly behind the radiator.

Valve guides are integral in the cylinder head, and valves with oversize stems are available in service. Special replaceable cast alloy valve seats are pressed into each valve port during manufacture, with oversize valve seats also available in service.

The exhaust valves are fitted with positive valve rotators, with all valves using umbrella type oil seals. Valve lash is maintained by adjustment of the self locking adjusting screws mounted in each of the rocker arms.

CAMSHAFT ASSEMBLY
The camshaft runs in 3 replaceable bearings. The camshaft drive gear is in mesh with, and driven by, the camshaft idler gear and crankshaft timing gear.

Camshaft end thrust is controlled by a thrust plate bolted to the block between the camshaft gear and the front camshaft journal.

A helical gear is mounted on the rear of the camshaft and drives the engine oil lubrication pump mounted forward of the flywheel.

CRANKSHAFT ASSEMBLY
The crankshaft is supported in the cylinder block by 5 main bearings. The crankshaft is manufactured from nodular cast iron with machine-finished crank webs. End thrust is controlled by a thrust bearing incorporated in the center main bearing of the crankshaft.

One piece seals, designed for long and durable service life, seal the front and rear crankshaft oil.

CONNECTING RODS
Connecting rods (wedge) shaped at the small end have been designed to reduce the reciprocating weight at the piston end. The connecting rods are of a heavy beam construction and are assembled as a matched set to the engine. Insert-type bearings attach the connecting rods to the crankshaft.

The rods are retained in position by the connecting rod big end cap and secured by two bolts per rod. The small end of the connecting rod is fitted with a replaceable bronze bushing, through which the free floating piston pin is fitted. The steel pin is held in place within the piston by two snap rings.

PISTONS
Pistons are constructed of an aluminium silicon alloy with an iron insert for the top ring. The combustion chamber is recessed into the piston crowns. Each piston has two compression rings and one oil control ring to reduce friction and increase positive sealing. All rings are located above the piston pin.

MANIFOLDS
The cross flow design aluminum intake and cast iron exhaust manifolds are on opposite sides of the cylinder head. This maintains balanced heat distribution within the cylinder head. The configuration of the manifolds also ensures minimum heat transfer to the intake manifold.

A hose connects the air cleaner to the intake manifold. A tapped hole in the rear end of the manifold is for a thermostart cold starting aid.

NOTE: *On loaders where cold start equipment is not installed, make sure the plug in the intake manifold is kept tight at all times. Considerable damage to the cylinder bores may be incurred by entry of dust or other foreign material if the plug is left loose or missing. Also, dirt and grit may be drawn through the air cleaner connections if they are not properly secured.*

CYLINDER BLOCK ASSEMBLY
The cylinder block is an alloy cast iron, with deep cylinder skirts and water jackets for cooling the cylinders. The cylinder bores are machined integral with the cylinder block during the manufacturing process.

Cylinders are in-line, vertical and numbered from 1 to 4 from the front to the rear of the engine. They can be bored oversize for fitting sleeves, which are available in service.

The oil pan attached to the bottom of the cylinder block is the reservoir for the engine oil lubrication system. An aluminum engine front cover and front plate attaches to the front of the engine and covers all of the timing gear assembly.

TIMING GEARS
The crankshaft timing gear is heated and press- fitted on to the front of the crankshaft. The manufacturing process has a high degree of accuracy. This maintains precise timing during the life of the engine. The crankshaft gear drives the camshaft idler gear, which is attached to the front of the cylinder block. The idler gear then drives the camshaft and the injection pump via meshing helical gears. The camshaft gear is bolted to the front of the camshaft and keyed to maintain the position of the gear on the camshaft.

LUBRICATION SYSTEM

A rotor-type pump lubricates the engine. The rotor-type oil pump mounts to the rear of the engine block behind the flywheel. The oil pump is driven from the rear of the camshaft and draws oil from the engine oil pan through a tube and screen assembly.

A spring-loaded relief valve is integral with the oil filter body mounted on the left hand side of the engine block. The relief valve prevents over pressurization of the system.

An integral radiator/engine oil cooler is fitted. Oil flows from the filter to the main oil gallery, which runs the length of the block and intersects the camshaft follower chamber.

The main gallery also supplies oil to the crankshaft main bearings, connecting rods, big ends, and small ends. The underside of the pistons and pins are lubricated by oil pressure jets mounted adjacent to each main journal housing.

The camshaft drive gear bushing is pressure-lubricated through a drilled passage from the front main bearing. The gear has small oil passages machined on both sides allowing excess oil to escape.

Timing gears are lubricated by splashed oil from the cam follower chamber and the pressure lubricated camshaft drive gear bushing.

An intermittent flow of oil is directed to the valve rocker arm shaft assembly via a drilled passage in the cylinder block. This is located vertically above No. 1 camshaft bearing, and aligns to a hole in the cylinder head. The rotation of the camshaft allows a controlled intermediate flow of lubrication.

COOLING SYSTEM

NOTE: *Do not operate an engine without a thermostat. It is recommended that a solution of a 50% clean water, and 50% recommended antifreeze, see specifications, is used. When the recommended Antifreeze is not used, a 5% solution of the recommended inhibitor must be added to the cooling system.*

The function of the water pump mounted at the front of the engine, is to maintain a continuous flow of water around the cooling system. This is essential to ensure correct engine temperature, and performance, during vehicle operation.

The pump is driven by a ‘Multi V’ Belt from the crankshaft pulley, when the engine is running.

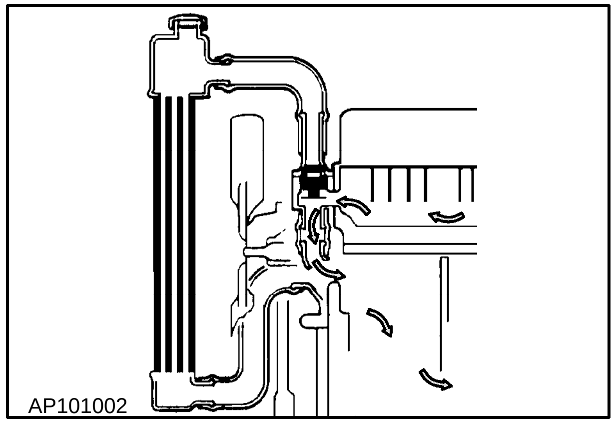
The cooling system for the new generation engines, is of the recirculating by-pass type with full length water jackets for each cylinder. The coolant is drawn from the bottom tank of the radiator by the water pump, which passes the coolant to the cylinder block. This coolant then cools the cylinder walls.

Passages in the cylinder head gasket allow coolant to flow from the cylinder block, into the cylinder head. Cored passages also conduct the coolant to the fuel injector nozzle locations, before re-entering the water pump below the thermostat.

The thermostat is located in the top of the water pump body, and controls the flow of the water as required by temperature changes.

NOTE: *A faulty thermostat may cause the engine to operate at too hot, or cold, an operating temperature. If not replaced this could result in a damaged engine, or impaired engine performance.*

When the thermostat is closed, a recirculating by-pass is provided to allow the coolant to recirculate from the head to the block to effect a faster warm-up.



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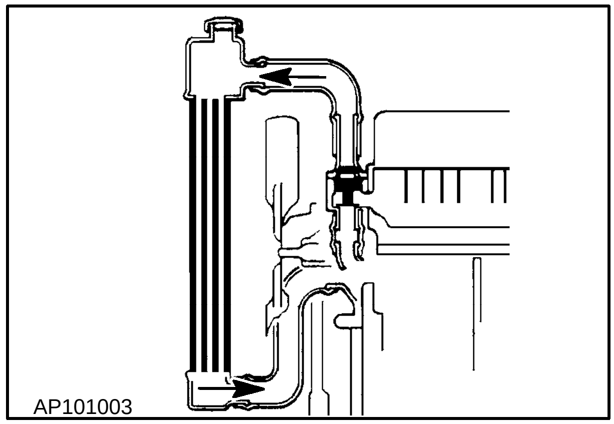
Once the engine has reached its normal operating temperature, the thermostat will open and allow water to be drawn through the radiator by the pump action. Cooled water then returns to the engine system.

Cooling occurs as the coolant passes down through the radiator cores, which are exposed to the air as it is drawn through the radiator by the fan.



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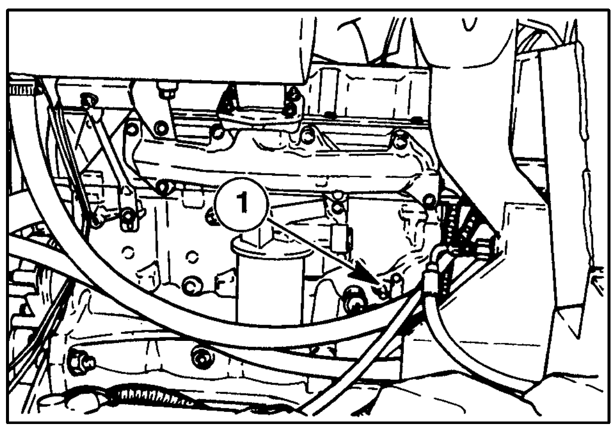
The cooling system incorporates a drain plug on the right hand side of the cylinder block, 1.



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GENERAL ENGINE SPECIFICATIONS - LS190

Model	**LS190**
Engine Model	450/NC
Type	4-cylinder, 4-stroke, naturally aspirated diesel
Bore	111.8 mm (4.40″)
Stroke	127.0 mm (5.00″)
Displacement	5 L (304 cu. in.)
Compression Ratio	17.5:1
Firing Order	1 - 3 - 4 - 2
Horsepower	
(Gross) MFG rating	83 @ 2200 RPM
(SAE NET)	75 @ 2200 RPM
Torque	
(Gross) MFG rating	325 N·m (240 ft. lbs.) @1300 RPM
Ignition Type	Compression
Injection Pump	Distributor Type
Injection Timing	29° BTDC
Speeds	
Fast (no load)	2325 to 2375 RPM
Idle (no load)	700 to 800 RPM
Cooling System	Liquid with water pump and radiator
Capacity	15.1 L (16 qt.)
Lubricating System	
Oil Capacity (including filter)	10.9 L (4.0 Gal)
Electrical System	
Starter	12V
Alternator	12V, 45 amps
Batteries	12V, 650 amps @ - 18°C (0°F)
Recommended Engine Fluids	
Lubricating Oil	SAE 10W - 30 API SH/CG4
Fuel	Use clean, quality No. 1-D or No. 2-D fuel (ASTM D975). Use No. 1-D if the ambient temperature is expected to be less than 4°C (40°F) or if the loader is to be used at an altitude exceeding 1524 m (5000′). The sulfur content of the fuel should be no more than 0.5%. The sediment and water content should not exceed 0.5%. To prevent fuel flow problems in cold weather, use No. 1 - 2 diesel fuel with a pour point of at least 10°F below the expected ambient temperature. Minimum cetane number is 40. Lower temperature or high altitude operation may require the use of fuel with a higher cetane number.
Coolant	Clean soft water. Maximum antifreeze concentration 50% with 5% corrosion inhibitor.

TROUBLESHOOTING - LS190

PROBLEM	POSSIBLE CAUSES	CORRECTION
Engine does not develop full power	Clogged air cleaner	Clean or renew element
	Fuel line obstructed	Clean
	Faulty injectors	Clean and reset
	Incorrect valve lash adjustment	Check and reset
	Burnt, worn or sticking valves	Replace valves with new or oversize, and/or machine the valve guide bores
	Blown head gasket	Check head flatness and fit new gasket
	Incorrect fuel delivery	Check injectors and pump
	Low cylinder compression	Renew piston rings or re-bore/re-sleeve as necessary
Oil pressure warning light fails to operate	Bulb burnt out	Renew bulb
	Warning Light pressure switch faulty	Renew pressure switch
	Warning light circuit faulty	Check and renew wiring
Excessive exhaust smoke	Air cleaner dirty or restricted	Clean
	Excessive fuel delivery	Overhaul injection pump and injectors
Water temperature gauge fails to reach normal operating temperature	Faulty temperature sender	Renew sender switch
	Incorrect or faulty thermostat	Renew thermostat
	Faulty water temperature gauge	Renew temperature gauge

PROBLEM	POSSIBLE CAUSES	CORRECTION
Engine knocks	Diluted or thin oil	Check crankshaft bearings for damage, change as required. Drain and refill with specified oil and renew filter. Ascertain cause of dilution
	Insufficient oil supply	Check oil level and top up as necessary. Overhaul or renew pump as necessary. Check oil filter is not clogged
	Low oil pressure	Overhaul pump or relief valve as necessary
	Excessive crankshaft end play	Install new thrust bearing liner
	Flywheel or ring gear run-out excessive	Skim flywheel or fit new ring gear
	Excessive connecting rod or main bearing clearance	Install new bearing inserts and/or re-grind crankshaft
	Bent or twisted connecting rods	Renew connecting rods
	Crankshaft journals out-of-round	Re-grind crankshaft and fit undersize bearing inserts
	Excessive piston-to-cylinder bore clearance	Re-bore/re-sleeve block and fit new pistons
	Excessive piston ring clearance	Fit new pistons and rings
	Broken rings	Fit new rings, check bore and pistons for damage
	Excessive piston pin clearance	Fit new piston or pin
	Piston pin retainer loose or missing	Install new retainer, and check bore/pistons for damage
	Excessive camshaft play	Renew timing gear
	Imperfections on timing gear teeth	Install new thrust plate
	Excessive timing gear backlash	Renew timing gear

PROBLEM	POSSIBLE CAUSES	CORRECTION
Engine overheats	Hose connection leaking or collapsed	Tighten hose connection, renew hose if damaged
	Radiator cap defective or not sealing	Renew radiator cap
	Radiator leakage	Repair/renew radiator
	Improper fan belt adjustment	Re-adjust fan belt
	Radiator fins restricted	Clean with compressed air
	Faulty thermostat	Renew thermostat
	Internal engine leakage	Check for source of leakage, renew gasket or defective parts
	Water pump faulty	Overhaul water pump
	Exhaust gas leakage into cooling system	Renew cylinder head gasket, check head for damage or distortion
	Coolant aeration	Tighten all connections and check coolant level is correct. Ensure cylinder head gasket has not blown
	Cylinder head gasket improperly installed	Renew cylinder head gasket
	Hot spot due to rust and scale or clogged water jackets	Reverse flush entire cooling system
	Obstruction to radiator air flow	Remove the obstruction
	Extended engine idling	Do not allow engine to idle for long periods
	Oil cooler tube blocked	Clean
	Radiator core tubes blocked	Check free flow

PROBLEM	POSSIBLE CAUSES	CORRECTION
Low oil pressure	Engine oil level low	Top up, as necessary
	Wrong grade of oil	Drain and refill with correct grade of oil
	Blocked oil pump sump screen	Clean pump screen
	Oil pressure relief valve faulty	Fit new relief valve
	Oil pump worn	Renew Oil Pump
	Excessive oil pump rotor and shaft assembly clearance	Overhaul pump
	Excessive main or connecting rod bearing clearance	Install new bearings inserts and / or re-grind crankshaft
Excessive oil consumption	Engine oil level too high	Reduce oil level
	External oil leaks	Renew gaskets and seals, where necessary. Check mating surfaces for damage or distortion
	Worn valves, valve guides or bores	Renew
	Cylinder head gasket leaking	Renew gasket. Check head for damage or distortion
	Oil loss past the pistons and rings	Renew rings and/or rebore/ re-sleeve block as necessary
	Oil cooler leak	Repair/renew oil cooler assembly
	Rocker cover oil filter blocked	Change filter
Engine tends to keep firing after fuel is shut off	Air cleaner dirty or restricted	Clean or renew element

FUEL SYSTEM

PROBLEM	POSSIBLE CAUSES	CORRECTION
Fuel not reaching injection pump	Restricted fuel filters	Check and flush the fuel filters clean.
	Air in system	Bleed the fuel filters.
	Fuel leakage	Check the fuel lines and connectors for damage.
Fuel reaching nozzles but engine will not start	Low cranking speed	Check the cranking speed
	Incorrect throttle adjustment	Check the throttle control rod travel
	Incorrect pump timing	Check the pump timing
	Fuel leakage	Check the fuel lines and connectors for leakage
	Faulty injectors	See injector troubleshooting
	Low compression	Check the engine compression
Engine hard to start	Low cranking speed	Check the cranking speed
	Incorrect pump timing	Check the pump timing
	Restricted fuel filters	Replace filters
	Contaminated fuel	Check for water in the fuel
	Low compression	Check the engine compression
	Air in system	Check for air leaks on the suction side of the system
Engine starts and stops	Fuel starvation	Check and flush clean restricted fuel lines or fuel filters
	Contaminated fuel	Check for water in the fuel
	Restricted air intake	Check for restrictions in the air intake
	Engine overheating	Check cooling system
	Air in system	Check for air leaks on the suction side of the system

PROBLEM	POSSIBLE CAUSES	CORRECTION
Erratic engine operation (surge, misfiring, poor governor regulation)	Fuel leakage	Check the injector lines and connectors for leakage
	Fuel starvation	Check and flush clean restricted fuel lines or filters
	Incorrect pump timing	Check the pump timing
	Contaminated fuel	Check for water in the fuel
	Air in system	Bleed the fuel system
	Faulty or sticking injector nozzles	See injector troubleshooting
	Incorrect engine timing	Check for faulty engine valves
Engine emits black smoke	Restricted air intake	Check for restricted air intake
	Engine overheating	Check cooling system
	Incorrect timing	Check the pump timing
	Faulty injectors	See injector troubleshooting
	Low compression	Check the engine compression
	Incorrect engine timing	Check the engine valves
Engine does not develop full power or speed	Incorrect throttle adjustment	Check for insufficient throttle control movement
	Incorrect maximum no-load speed	Check maximum no-load speed adjustment
	Fuel starvation	Check and flush clean restricted fuel lines and filters
	Air in system	Check for air leaks on the suction side of the system
	Incorrect timing	Check pump timing
	Low compression	Check engine compression
	Incorrect engine timing	Check for improper valve adjustment or faulty valves

FUEL INJECTORS

PROBLEM	POSSIBLE CAUSES	CORRECTION
Engine emits black smoke	Faulty injectors	Overhaul or replace injectors
Nozzle does not “buzz” while injecting	Dirty or sticking needle valve	Clean or replace needle valve and nozzle holder
	Valve seat leakage	Clean or replace valve and nozzle assembly
	Damaged nozzle retaining nut	Replace retaining nut
Nozzle leak back	Worn needle valve	Replace needle valve and nozzle holder
	Dirty nozzle and/or holder	Clean or replace nozzle and holder
	Loose nozzle retaining nut	Tighten nut
Nozzle opening pressure incorrect	Adjusting nut loose	Tighten nut
	Damaged nozzle or seized needle valve	Replace needle valve and nozzle holder
	Blocked nozzle holes	Clean nozzle
	Incorrect shims fitted	Adjust shim pack
Nozzle seat leakage	Dirty nozzle and/or nozzle holder	Clean or replace needle valve and nozzle holder
	Sticking needle valve	Clean or replace nozzle and nozzle holder
Incorrect spray pattern	Dirty nozzle and/or nozzle holder	Clean or replace nozzle and nozzle holder
	Restricted nozzle holes	Clean or replace nozzle and nozzle holder
	Damaged needle valve or nozzle	Replace needle valve and nozzle holder

ELECTRICAL SYSTEM - STARTER MOTOR

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
Loader will not start (Starter will not rotate)	Starter circuit	Inoperative seat switch or operator not sitting in seat	Check seat switch, sit in seat
		Seat belt not buckled	Buckle seat belt
		No power to ignition switch	Check battery Check 5 amp fuse in engine fuse panel
		No power to EIC	Check seat switch, check battery Check 5 amp fuse in engine fuse panel
		No power to starter	Check ignition switch, EIC, seat switch, seat belt, start relay, battery Check 15 amp fuse in engine fuse panel
Pinion fails to advance when key switch is closed	Wiring	Open circuit, battery and switch terminal connections	Repair or replace
		Open circuit, fuse	Replace fuse
	Key switch	No contact	Repair or replace
	Starter motor	Sleeve bearing burnt out	Repair or replace
		Lever spring or shaft lever broken	Replace
	Magnetic switch	Magnetic switch plunger movement defective or coil open or shorted.	Repair or replace
Starter motor rotates but no rotation transmitted to engine	Starting motor	Starter drive defective	Replace
		Reduction gear damaged	Replace
Motor rotates before pinion meshes with ring gear	Starting motor	Lever spring weak, shift lever damaged	Replace
		Slip ring defective	Replace
		Pinion teeth worn	Replace
		Pinion push out position defective	Replace
	Engine	Ring gear worn	Replace
	Starter solenoid	Starter solenoid defective	Replace

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
Pinion meshes with ring gear but starting motor fails to turn	Battery	In discharged state	Recharge or replace
	Wiring	Line connecting starter solenoid switch to battery broken or defective ground.	Repair or replace
		Lead wire connecting starter solenoid to motor tightened improperly.	Repair or replace
	Starting motor	Ball bearing locked	Replace
		Installation defective	Reinstall
		Brush worn	Replace
		Brush spring defective	Replace
		Commutator dirty	Clean
		Armature or field coil defective	Repair or replace
		Field coil to brush connection defective	Repair
	Starter solenoid	Contact not touching properly	Replace
		Contact contacting surface roughened	Replace
Starter motor fails to stop after engine starts and key switch is turned off	Key switch	Switch defective	Replace
	Starter solenoid	Starter solenoid defective	Replace

ELECTRICAL SYSTEM - ALTERNATOR

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
No charging	Wiring	Loose connection, short circuit	Repair
	Alternator	Loose connection, no ground, short circuit	Repair or replace
		Defective rectifier	Replace
		Loose connection of RF resistor	Replace
	Regulator	Defective regulator	Replace
		Loose connection of alternator or regulator	Repair or replace

PROBLEM	FAULT LOCATION	POSSIBLE CAUSES	CORRECTION
Insufficient charging	Wiring	Loose connection or short circuit	Repair
	Alternator	Loose drive belt	Repair
		Short in rotor coil	Replace
		Short in stator coil	Replace
		Defective rectifier	Replace
		Insufficient brush contact	Repair or replace
	Regulator	Defective regulator	Replace
		Loose connection at alternator and regulator	Repair
Overcharge	Battery	Internal short	Replace
	Regulator	Defective regulator	Replace
Unstable charging circuit	Wiring	Loose connection or open wire	Repair or replace
	Alternator	Loose drive belt	Repair
		Short in rotor coil	Replace
		Short in stator coil	Replace
		Insufficient brush contact	Repair or replace
		Broken brush or spring	Replace
		Loose connections	Repair
	Regulator	Defective regulator	Replace
		Loose connection at alternator and regulator	Repair or replace
Abnormal noise of alternator	Alternator	Loose mounting hardware	Repair
		Defective bearings	Repair or replace
		Rotor core and stator in contact	Replace
		Defective diode	Replace
		Short in stator coil	Replace

SPECIFICATIONS SERVICE STANDARDS - LS190

CYLINDER BLOCK

Taper of Cylinder Bore . . . . 0.025 mm (0.001 in.) Repair Limit
0.127 mm (0.005 in.) Wear Limit

Cylinder Bore out of Round . . . . 0.03 mm (0.0015 in.) Repair Limit
0.127 mm (0.005 in.) Wear Limit

Cylinder Bore Diameters . . . . 111.778 - 111.841 mm (4.4007 - 4.4032 in)

Rear Oil Seal Bore Diameter . . . . 140.77 - 140.87 mm (5.542 - 5.546 in.)

Block to Head Surface Flatness . . . . 0.08 mm (0.003 in.) in any 152 mm (6 in.)
0.03 mm (0.001 in.) in any 25.40 mm (1 in.)

CYLINDER HEAD

Valve Guide Bore Diameter . . . . 9.469 - 9.495 mm (0.3728 - 0.3738 in.)

Head to Block Surface Flatness . . . . 0.03 mm (0.001 in.) in any 25.4 mm (1 in.),
or 0.127 mm (0.005 in.) overall limit

EXHAUST VALVES

Face Angle . . . . 44.15° - 44.30° Relative to the Head of Valve

Stem Diameter . . . . Std: 9.401 - 9.421 mm (0.3701 - 0.3709 in.)
0.003 in. (0.076 mm)
Oversize: 9.477 - 9.497 mm (0.3731 - 0.3739 in.)
0.38 mm (0.015 in.)
Oversize: 9.781 - 9.802 mm (0.3851 - 0.3859 in.)
0.76 mm (0.030 in.)
Oversize: 10.163 - 10.183 mm (0.4001 - 0.4009 in.)

Head Diameter . . . . 42.88 - 43.13 mm (1.688 - 1.698 in.)

Stem to Guide Clearance . . . . 0.048 - 0.094 mm (0.0019 - 0.0037 in.)

Lash Clearance (Cold) . . . . 0.43 - 0.53 mm (0.017 - 0.021 in.)

INTAKE VALVES

Face Angle . . . . 29.15° - 29.30° Relative to Head of Valve

Stem Diameter . . . . Std: 9.426 - 9.446 mm (0.3711 - 0.3719 in.)
0.076 mm (0.003 in.)
Oversize: 9.502 - 9.522 mm (0.3741 - 0.3749 in.)
0.381 mm (0.015 in.)
Oversize: 9.807 - 9.827 mm (0.3861 - 0.3869 in.)
0.762 mm (0.030 in.)
Oversize: 10.188 - 10.208 mm (0.4011 - 0.4019 in.)

Head Diameter . . . . 47.37 - 47.63 mm (1.865 - 1.875 in.)

Stem to Guide Clearance . . . . 0.023 - 0.069 mm (0.0009 - 0.0027 in.)

Lash Clearance (Cold) . . . . 0.36 - 0.46 mm (0.014 - 0.018 in.)

VALVE SPRINGS

Number per Valve 1

Free Length . . . . 60.7 mm (2.39 in.)
Length, loaded at 27.7 - 31.3 kg (61 - 69 lb) . . . . 48.26 mm (1.900 in.)
Length, loaded at 61 - 69 kg (135 - 153 lb) . . . . 35.69 mm (1.405 in.)

VALVE TIMING

Intake Opening . . . . 12° Before Top Dead Center

Intake Closing . . . . 38° After Bottom Dead Center

Exhaust Opening . . . . 48° Before Bottom Dead Center

Exhaust Closing . . . . 12° After Top Dead Center

VALVE INSERTS

Insert Oversize	Exhaust Valve Insert Counter bore Diameter in Cylinder Head	Intake Valve Seat Insert Counter bore Diameter in Cylinder Head
0.254 mm (0.010 in.)	44.17 - 44.20 mm (1.739 - 1.740 in.)	50.01 - 50.04 mm (1.969 - 1.970 in.)
0.508 mm (0.020 in.)	44.42 - 44.45 mm (1.749 - 1.750 in.)	50.27 - 50.29 mm (1.979 - 1.980 in.)
0.762 mm (0.030 in.)	44.68 - 44.70 mm (1.759 - 1.760 in.)	50.52 - 50.55 mm (1.989 - 1.990 in.)

VALVE SEATS

Exhaust Valve Seat Angle . . . . 45.0° - 45.3°

Intake Valve Seat Angle . . . . 30.0° - 30.3°

Interference Valve Face Angle to Valve Seat Angle . . . . 0.85° - 1.0°

Concentricity With Guide Diameter . . . . 0.051 mm (0.002 in.) Total Indicator Reading Max

Seat Width Exhaust Valve . . . . 1.8 - 2.3 mm (0.072 - 0.092 in.)
Intake Valve . . . . 2.0 - 2.5 mm (0.079 - 0.098 in.)

CAMSHAFT IDLER GEAR

Number of teeth 47

End Play . . . . 0.076 - 0.35 mm (0.003 - 0.014 in.)

Bushing Inside Diameter . . . . 50.813 - 50.838 mm (2.0005 - 2.0015 in.)

Adaptor Outside Diameter . . . . 50.762 - 50.775 mm (1.9985 - 1.9990 in.)

Backlash with Crankshaft Gear . . . . 0.15 - 0.46 mm (0.006 - 0.018 in.)

Backlash with Camshaft Gear . . . . 0.025 - 0.381 mm (0.001 - 0. 015 in.)

Backlash with Fuel Injection Pump . . . . 0.10 - 0.15 mm (0.004 - 0.006 in.)

CAMSHAFT GEAR

Number of Teeth 52

Timing Gear Backlash . . . . 0.15 - 0.46 mm (0.006 - 0.018 in.)

ROCKER ARM SHAFT

Shaft Diameter . . . . 25.40 - 25.43 mm (1.000 - 1.001 in.)

Shaft Support Internal Diameter . . . . 25.45 - 25.50 mm (1.002 - 1.004 in.)

ROCKER ARM

Inside Diameter . . . . 25.48 - 25.50 mm (1.003 - 1.004 in.)

TAPPETS

Clearance to Bore . . . . 0.015 - 0.053 mm (0.0006 - 0.0021 in.)

Tappet Diameter . . . . 25.118 - 25.130 mm (0.9889 - 0.9894 in.)

Tappet Bore Diameter . . . . 25.15 - 25.17 mm (0.9900 - 0.9910 in.)

CAMSHAFT

Bearing Journal Diameter . . . . 60.693 - 60.719 mm (2.3895 - 2.3905 in.)

Bearing Clearance . . . . 0.025 - 0.076 mm (0.0010 - 0.0030 in.)

End Play . . . . 0.051 - 0.18 mm (0.0020 - 0.0070 in.)

CONNECTING RODS

Small End Bushing (Internal Diameter) . . . . 38.113 - 38.120 mm (1.5005 - 1.5008 in.)

Clearance Bushing to Piston Pin . . . . 0.013 - 0.025 mm (0.0005 - 0.0010 in.)

Side Float . . . . 0.13 - 0.33 mm (0.0050 - 0.0130 in.)

Maximum Twist . . . . 0.30 mm (0.0120 in.)

Maximum Bend . . . . 0.10 mm (0.0040 in.)

PISTON PIN

Outside Diameter . . . . 38.095 - 38.100 mm (1.4998 - 1.5000 in.)

PISTONS

Skirt to Cylinder Clearance . . . . 0.140 - 0.171 mm (0.0055 - 0.0067 in.) - *New engines*
0.140 - 0.28 mm (0.0055 - 0.011 in.) - *Run engines*

Taper (Out of Round) . . . . 0.063 - 0.127 mm (0.0025 - 0.0050 in.)

Grading Diameter (at Right Angles to Piston Pin) . . . . 111.64 - 111.74 mm (4.3951 - 4.3991 in.)
0.0127 mm (in increments of 0.0005 in.)

Piston Pin Clearance . . . . 0.0030 - 0.0140 mm (0.00012 - 0.00055 in.) at 21°C (70°F)

Piston Crown to Block Face . . . . 0.28 - 0.58 mm (0.011 - 0.023 in.)

PISTON RINGS

Compression rings,
Number and Location . . . . 2 off - 1st and 2nd from the top of the piston
Top Compression Ring . . . . Parallel Sides-Inner Chamfer or no Chamfer
2nd Compression Ring . . . . Straight Face-Inner Step

Oil Control,
Number and Location . . . . 1 off - Directly above the Piston Pin,
Type . . . . Slotted With Expander

Side Face Clearance To Ring Groove,
Top Compression Ring . . . . 0.112 - 0.155 mm (0.0044 - 0.0061 in.)
2nd Compression Ring . . . . 0.099 - 0.142 mm (0.0039 - 0.0056 in.)
Oil Control Ring . . . . 0.061 - 0.104 mm (0.0024 - 0.0041 in.)

Gap Width,
Top Compression Ring . . . . 0.38 - 0.84 mm (0.015 - 0.033 in.)
2nd Compression Ring . . . . 0.66 - 1.12 mm (0.026 - 0.044 in.)
Oil Control Ring . . . . 0.38 - 0.84 mm (0.015 - 0.033 in.)

CRANKSHAFT

Main Journal Diameter . . . . 85.631 mm (3.3713 in.) 85.656 mm (3.3723 in.)

Main Journal Length (except thrust, rear, or intermediate) . . . . 36.96 - 37.21 mm (1.455 - 1.465 in.)

Main Journal Wear Limits . . . . 0.127 mm (0.005 in.) Maximum

Main and Crankpin Fillet Radius . . . . 3.048 - 3.556 mm (0.12 - 0.14 in.)

Thrust Bearing Journal Length . . . . 37.06 - 37.11 mm (1.459 - 1.461 in.)

Intermediate Bearing Journal Length . . . . 36.96 - 37.21 mm (1.455 - 1.465 in.)

Rear Bearing Journal Length . . . . 37.97 - 38.48 mm (1.495 - 1.515 in.)

Crankpin Journal Length . . . . 42.62 - 42.72 mm (1.678 - 1.682 in.)

Crankpin Diameter . . . . 69.840 - 69.850 mm (2.749 - 2.7500 in.)

End Play . . . . 0.10 - 0.20 mm (0.004 - 0.008 in.)

Crankpin Out of Round . . . . 0.005 mm (0.0002 in.) Total Indicator Reading

Taper Surface Parallel to Center Line of Main Journal . . . . 0.005 mm (0.0002 in.)

Crankshaft Rear Oil Seal Journal Diameter . . . . 122.12 - 122.28 mm (4.808 - 4.814 in.)

Crankshaft Pulley Journal Diameter . . . . 44.45 - 44.48 mm (1.750 - 1.751 in.)

Crankshaft Timing Gear Journal Diameter . . . . 46.23 - 46.25 mm (1.820 - 1.821 in.)

Crankshaft Flange Runout . . . . 0.038 mm (0.0015 in.) Maximum

CRANKSHAFT DRIVE GEAR

Number of teeth 26

MAIN BEARING

Liner length (except thrust liner) . . . . 27.94 - 28.19 mm (1.10 - 1.11 in.)

Liner Length (Thrust Liner) . . . . 39.91 - 39.96 mm (1.453 - 1.455 in.)

Vertical Assembled Bearing Clearance . . . . 0.055 - 0.117 mm (0.0021 - 0.0046 in.)

CRANKPIN BEARINGS

Liner Length . . . . 35.56 - 35.81 mm (1.40 - 1.41 in.)

Vertical Assembled Bearing Clearance . . . . 0.035 - 0.094 mm (0.0014 - 0.0037 in.)

CRANKSHAFT RE-GRINDING

When re-grinding a crankshaft the main and crankpin journal diameters should be reduced the same amount as the undersize bearings used, and the following dimensions apply. The rear end of the crankshaft should be located on the 60° Chamfer of the pilot bearing bore.

UNDERSIZE BEARING AVAILABLE	MAIN JOURNAL DIAMETERS
0.051 mm (0.002 in.)	85.580 - 85.593 mm (3.3693 - 3.3698 in.)
0.254 mm (0.010 in.)	85.390 - 85.402 mm (3.3618 - 3.3623 in.)
0.508 mm (0.020 in.)	85.136 - 85.148 mm (3.3518 - 3.3523 in.)
0.762 mm (0.030 in.)	84.882 - 84.894 mm (3.3418 - 3.3423 in.)
1.016 mm (0.040 in.)	84.628 - 84.640 mm (3.3318 - 3.3323 in.)

UNDERSIZE BEARING AVAILABLE	CRANKPIN JOURNAL DIAMETERS
0.051 mm (0.002 in.)	69.789 - 69.799 mm (2.7476 - 2.7480 in.)
0.254 mm (0.010 in.)	69.956 - 69.606 mm (2.7400 - 2.7404 in.)
0.508 mm (0.020 in.)	69.342 - 69.352 mm (2.7300 - 2.7304 in.)
0.762 mm (0.030 in.)	69.088 - 69.098 mm (2.7200 - 2.7204 in.)
1.016 mm (0.040 in.)	68.834 - 68.844 mm (2.7100 - 2.7104 in.)

BALANCER

Gear Backlash . . . . 0.05 - 0.25 mm (0.002 - 0.010 in.)

Shaft to bushing clearance . . . . 0.0127 - 0.038 mm (0.0005 - 0.0015 in.)

Shaft Diameter . . . . 25.133 - 25.40 mm (0.9895 - 1.000 in.)

Backlash between balancer / crankshaft gear . . . . 0.05 - 0.20 mm (0.002 - 0.008 in.)

End float balancer gear to support . . . . 0.20 - 0.51 mm (0.008 - 0.020 in.)

FLYWHEEL

Ring Gear Runout . . . . 0.63 mm (0.025 in.)

Flywheel Runout . . . . 0.127 mm (0.005 in.)

Maximum depth to be skimmed from face . . . . 3 mm (0.118 in.)

OIL PUMP

Rotor Clearance . . . . 0.025 - 0.15 mm (0.001 - 0.006 in.)

Rotor to Pump Housing Clearance . . . . 0.15 - 0.28 mm (0.006 - 0.011 in.)

Rotor End Play . . . . 0.025 - 0.089 mm (0.001 - 0.0035 in.)

Oil Pressure . . . . 1.24 bar (18 PSI) minimum at idle speed,
2.76 bar (40 PSI) minimum at rated speed

Pump Gear to Camshaft Gear Backlash . . . . 0.40 - 0.56 mm (0.016 - 0.022 in.)

OIL FILTER SUPPORT

Relief Valve, Operating Pressure . . . . 4.0 bar (59 PSI)

Flow Rate . . . . 68 litres/min (15 imp gals/min) 18 US gals/min

Relief Valve, Spring Free Length . . . . 52.8 mm (2.08 in.)

LUBRICATION REQUIREMENTS

Temperature	Oil Viscosity and Type	API Classification	Engine Oil & Filter Change Period (hours)
- 12°C (Below 10°F)	Low Ash, SAE 5W or Low Ash SAE 5W/20 or SAE 10W - 30	SH/CG4	150 150 150
- 12°C to 4°C (10°F to 40°F)	Low Ash, SAE 10W Series 3 or SAE 10W - 30	SH/CG4	150 300
0°C to 32°C (32°F to 90°F)	Low Ash, SAE 30W Series 3 or SAE 10W - 40	SH/CG4	300 300
Above 24°C (75°F)	Low Ash, SAE 30W Series 3 or SAE 15W - 40	SH/CG4	300

NOTE: *When using diesel fuel with a sulphur content below 1.0%, Series 3 diesel engine oil with an A.P.I. classification of CD may be used instead of CF - 4 oil, but the oil and filter interval must be reduced to 150 hours.*

When using diesel fuel with a sulphur content between 1% and 1.3% use only oils listed above but reduce the oil and filter change period to every 50 hours.

THERMOSTAT

Opening Temperature . . . . 79 - 83°C (174 - 181°F)
Fully Open . . . . 93 - 96°C (199 - 205°F)

RADIATOR CAP

Opening Pressure . . . . 0.9 bar (13 PSI)

WATER PUMP

Type . . . . Centrifugal
Drive . . . . Multi V Belt

COOLING FLUID

Content Mixture - . . . . Use Anti-freeze (50%) plus clean, soft water (50%)
Type . . . . Ambra Agriflu (NH 900 A)

MINIMUM HARDWARE TIGHTENING TORQUES

IN FOOT POUNDS (NEWTON-METERS) FOR NORMAL ASSEMBLY APPLICATIONS

INCH HARDWARE AND LOCKNUTS

	SAE GRADE 2		SAE GRADE 5		SAE GRADE 8		LOCKNUTS		
NOMINAL SIZE	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	UNPLATED or PLATED SILVER	PLATED W/ZnCr GOLD	GR.B w/GR5 BOLT	GR.C w/GR8 BOLT	NOMINAL SIZE
1/4	55* (6.2)	72* (8.1)	86* (9.7)	112* (13)	121* (14)	157* (18)	61* (6.9)	86* (9.8)	1/4
5/16	115* (13)	149* (17)	178* (20)	229* (26)	250* (28)	324* (37)	125* (14)	176* (20)	5/16
3/8	17 (23)	22 (30)	26 (35)	34 (46)	37 (50)	48 (65)	19 (26)	26 (35)	3/8
7/16	27 (37)	35 (47)	42 (57)	54 (73)	59 (80)	77 (104)	30 (41)	42 (57)	7/16
1/2	42 (57)	54 (73)	64 (87)	83 (113)	91 (123)	117 (159)	45 (61)	64 (88)	1/2
9/16	60 (81)	77 (104)	92 (125)	120 (163)	130 (176)	169 (229)	65 (88)	92 (125)	9/16
5/8	83 (112)	107 (145)	128 (174)	165 (224)	180 (244)	233 (316)	90 (122)	127 (172)	5/8
3/4	146 (198)	189 (256)	226 (306)	293 (397)	319 (432)	413 (560)	160 (217)	226 (306)	3/4
7/8	142 (193)	183 (248)	365 (495)	473 (641)	515 (698)	667 (904)	258 (350)	364 (494)	7/8
1	213 (289)	275 (373)	547 (742)	708 (960)	773 (1048)	1000 (1356)	386 (523)	545 (739)	1

NOTE: Torque values shown with * are inch pounds.

IDENTIFICATION
CAP SCREWS AND CARRIAGE BOLTS

SAE GRADE 2

SAE GRADE 5

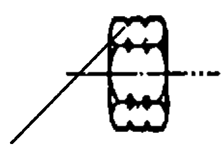
SAE GRADE 8

REGULAR NUTS

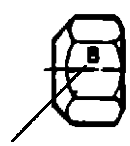
SAE GRADE 5 HEX NUTS

SAE GRADE 8 HEX NUTS

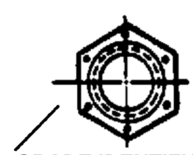
LOCKNUTS



GRADE IDENTIFICATION
GRADE A NO NOTCHES
GRADE B ONE CIRCUMFERENTIAL NOTCH
GRADE C TWO CIRCUMFERENTIAL NOTCHES



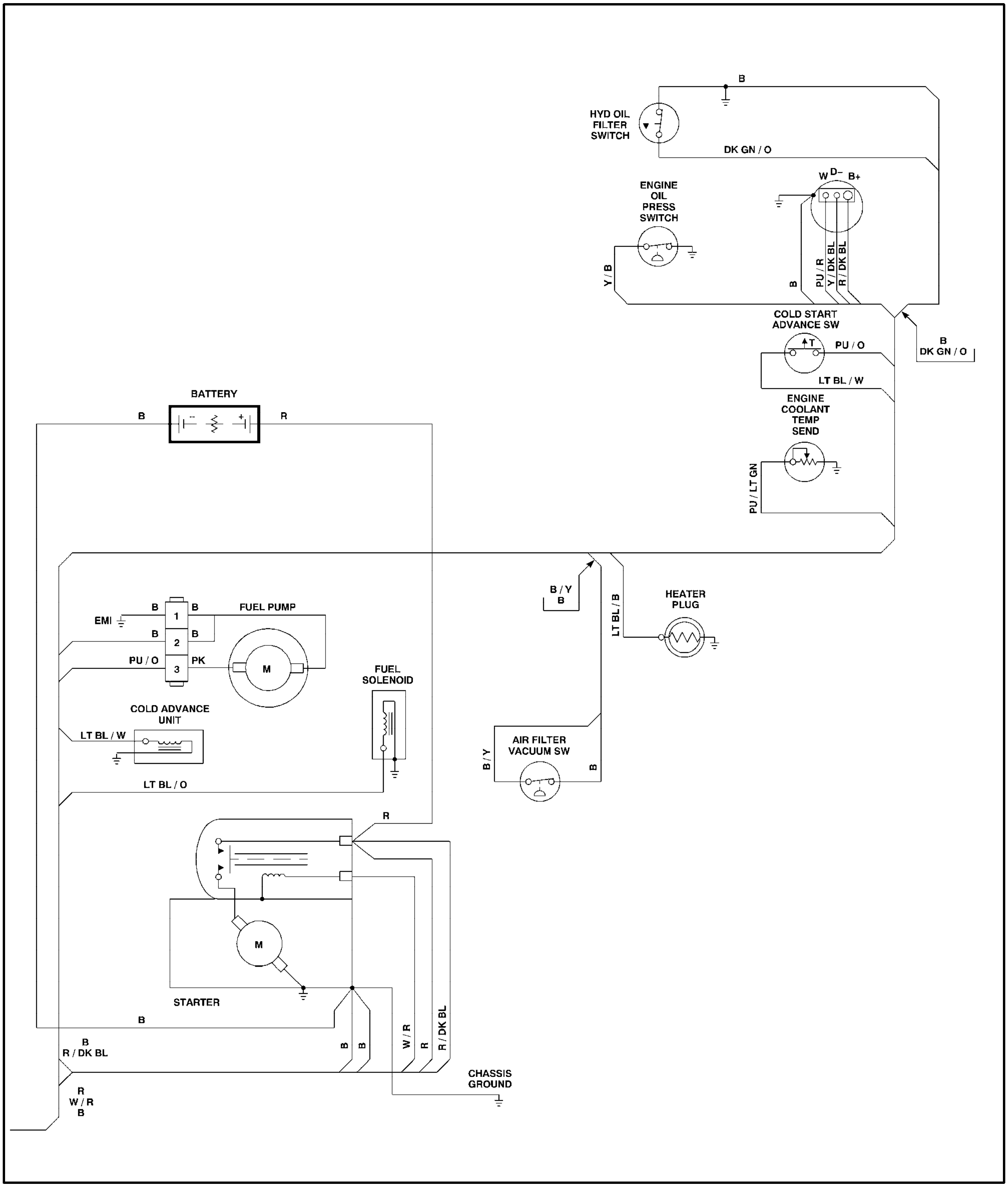
GRADE IDENTIFICATION
GRADE A NO MARKS
GRADE B LETTER B
GRADE C LETTER C



GRADE IDENTIFICATION
GRADE A NO MARKS
GRADE B THREE MARKS
GRADE C SIX MARKS
MARKS NEED NOT BE LOCATED AT CORNERS

TORQUE VALUES - VARIOUS	N·m	ft. lbs.	Kgf m
Main Bearing Bolts	197	145	20.0
Connecting Rod Bolts	149	110	15.2
Cylinder Head Bolts (with Engine Cold)	217	160	22.0
Intake Manifold-to-Cylinder Head	35	26	3.5
Exhaust Manifold-to-Cylinder Head	38	28	3.9
Exhaust Pipe-to-Flange	31	23	3.2
Flywheel-to-Crankshaft	197	145	20.0
Oil Pan Drain Plug	41	30	4.2
Valve Rocker Cover Bolts	24	18	2.4
Crankshaft Pulley-to-Crankshaft	224	210	23.0
Self-Locking Screw - Valve Rocker Arm	24	18	2.4
Injector Attachment Bolts	23	17	2.3
Cover Bolts	31	23	3.1
Oil Pump to Block	23	17	2.3
Water Pump-to-Cylinder Block	48	35	3.6
Water Pump Cover-to-Pump	27	20	2.8
Oil Pan-to-Cylinder Block (Cast)	38	28	3.9
Injector Line Nuts	24	18	2.4
Leak-off Tube Banjo Fitting Bolts	11	8	1.1
Injection Pump-to-Front Cover	24	18	2.4
Camshaft Idler Drive Gear-to-Block	237	175	24.0
Front Cover-to-Cylinder Block	24	18	2.4
Thermostat Housing Bolts	24	18	2.4
Camshaft Gear Bolt	69	51	7.0
Camshaft Rear Gear Plate Bolts	47	35	4.8
Oil Filter Adaptor Bolts	42	31	4.2
Oil Filter Mounting Bolt Insert	34	25	3.5
Starting Motor-to-Rear Adaptor Plate	31	23	3.2
Injection Pump-to-Gear Nut	79	58	8.0
Oil Pressure Switch Assembly	31	23	3.2
Turbocharger-to-Exhaust Manifold Nut	44	33	4.5
Fan Blade to Support Body	27	21	2.8
Crankshaft Rear Oil Seal Retainer -			
Initial Tightening	12	9	1.2
Final Tightening	23	17	2.3
Belt Tensioner Pulley Bolt	54	40	5.5
Temperature Senders	20	15	2.0
Tensioner to Water Pump Bolt	54	40	5.5
Idler Pulley Bolt	54	40	5.5
Pump Connector to Block	24	18	2.4

ENGINE ELECTRICAL COMPONENTS - LS190



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ENGINE REMOVAL BY TILTING THE CAB AND BOOM FORWARD - LS190

1. Securely block the skid steer with ALL FOUR wheels off the ground. Refer to Section 00 for detailed information on properly supporting the skid steer.

CAUTION

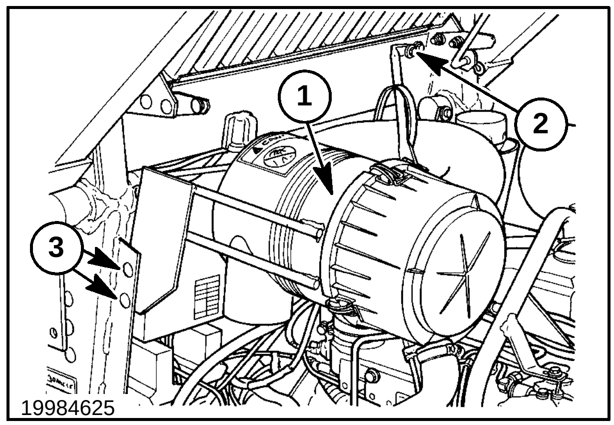
Failure to securely support the skid steer could result in movement of the skid steer, causing serious personal injury or damage to the equipment.

NOTE: *Block the skid steer at a sufficient height to allow for access under the skid steer during engine removal.*

2. Tilt the cab and boom forward. Refer to Section 00 for detailed information on this procedure.

NOTE: *Dealer installed options that interfere with tilting the cab forward include the Cab Heater/Defroster Kit and Rear Bumper Kit. Disconnect the hoses of the heater and remove the rear bumper prior to tilting the cab.*

3. Disconnect the air hoses at the air cleaner, 1. Remove the support rod hardware, 2. Remove the air cleaner canister support hardware, 3.



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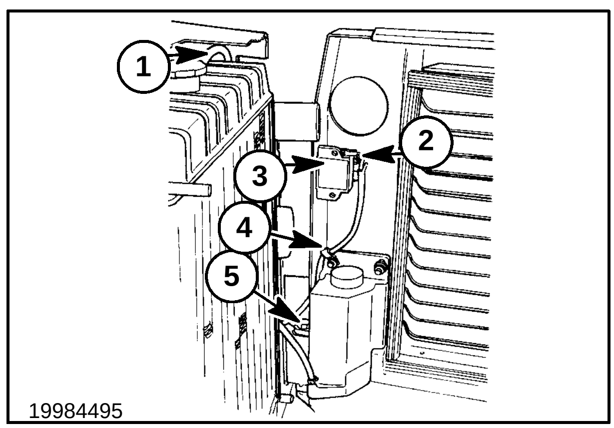
4. Open the rear radiator housing door and disconnect the radiator over-flow hose, 1, at the radiator and secure the hose to the back door, keeping it suspended above the fluid level in the overflow reservoir.

   If the unit is equipped with a Backup Alarm Kit, disconnect the two wires, 2, from the alarm module, 3. Remove the wires from the wire clip, 4, at the radiator overflow reservoir and pull the wire clear of the door and back into the engine compartment.

   Remove the rear door by removing the hinge nut and capscrew, 5.



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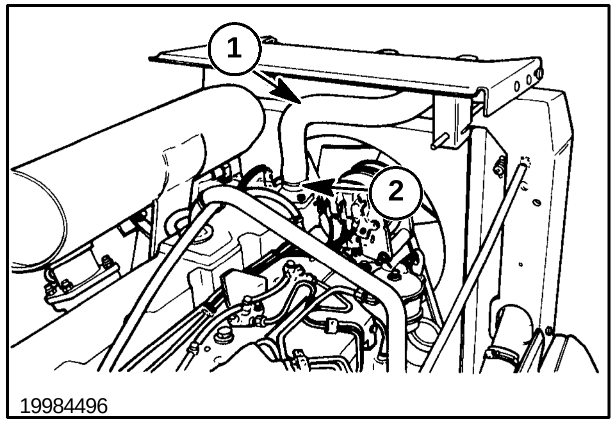
CAUTION

The radiator housing back door assembly is heavy and should be lifted using an appropriate lifting device.

5. Drain the engine coolant system by removing the drain plug at the radiator base, and drain the coolant into a suitable container. When the radiator is empty, reinstall the radiator drain plug using thread sealant on the plug threads.

CAUTION

Make sure that the engine is cooled prior to draining the radiator and engine coolant system to prevent serious injury and possible equipment damage.



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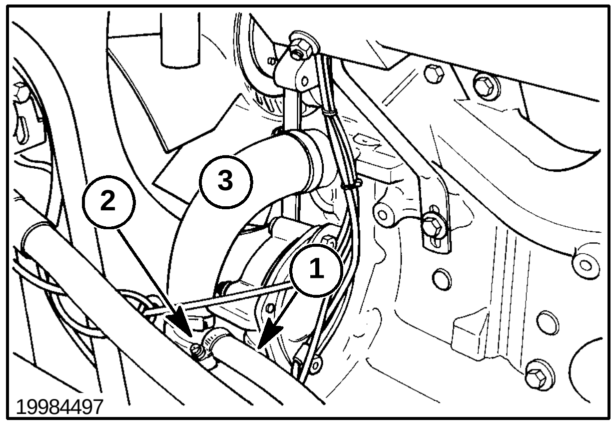
6. Remove the upper and lower radiator hoses. Disconnect the upper radiator hose, 1, at its engine connection, 2.

   Disconnect the lower radiator hose, 3, from the water pump connection. Plug and cap the coolant lines to prevent dirt from entering or coolant from spilling.

NOTE: *If the unit is fitted with a Cab Heater/Defroster Kit, it will also be necessary to disconnect the Cab Heater/Defroster return hose, 1, from the “T” connection, 2, installed in the lower radiator hose, 3.*



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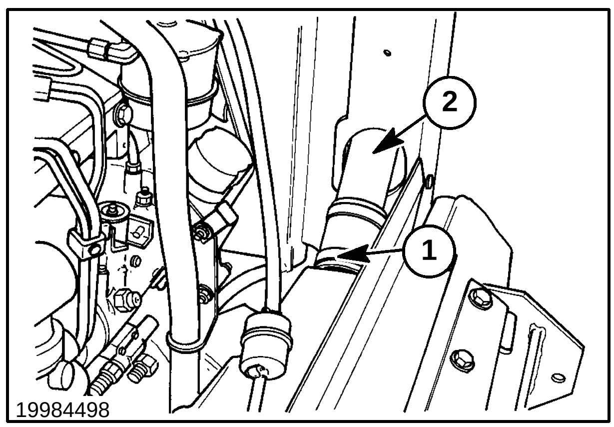
7. Remove the fuel tank filler neck by loosening the clamp, 1, and retracting the filler neck, 2, from the tank. Cover the opening of the fuel tank to prevent contamination and limit the fuel vapors escaping the tank.



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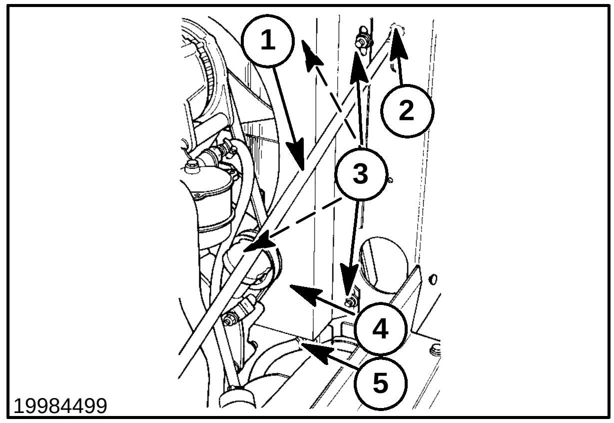
8. Disconnect the engine oil dipstick line 1, from the radiator housing, 2, and cap off the end of the line to prevent dirt from entering the opening.
9. Remove the four (two on each side) capscrews and nuts, 3. Slide the fan shroud, 4, forward to allow for access to the oil cooler line connection.
10. Disconnect the oil cooler bottom left line, 5, and cap both the hydraulic line and cooler connection to prevent oil loss and contamination of the hydraulic system.

IMPORTANT: *It is critical to maintain the cleanliness of the hydraulic fluid system. Contamination could lead to premature component failure or faulty hydraulic system operation.*



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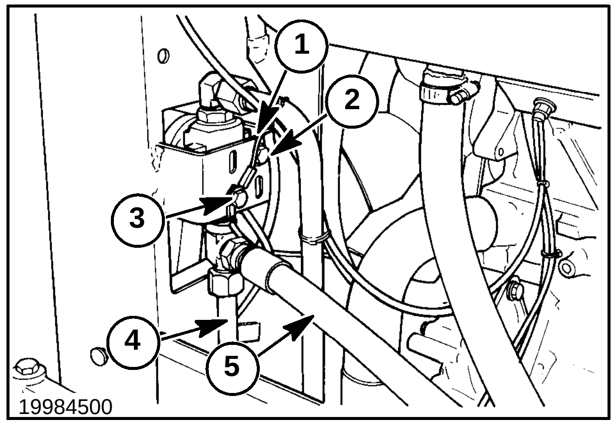
11. Disconnect the hydraulic oil filter restriction switch wires, 1, harness clamp, 2, and ground wire connections, 3.
12. Disconnect the hydraulic line, 4, from the oil filter base. If the unit is fitted with a High-Flow Hydraulic Kit, also disconnect the high-flow hydraulic line, 5, from the “T” connection on the hydraulic oil filter base. Cap the hydraulic filter connection and hose connections to prevent contamination of the hydraulic system and fluid loss.

IMPORTANT: *It is critical to maintain the cleanliness of the hydraulic fluid system. Contamination could lead to premature component failure or faulty hydraulic system operation.*



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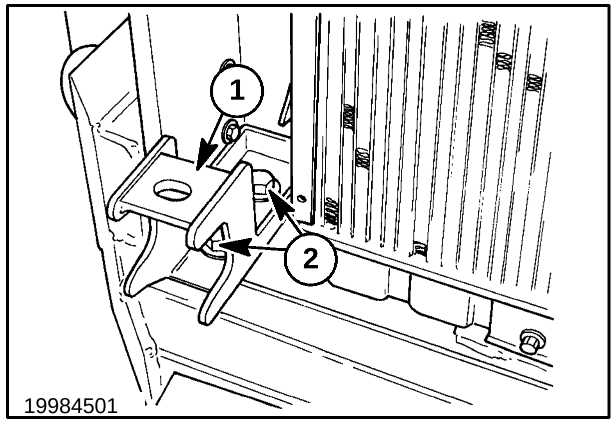
13. Optional Battery Removal - Remove the engine compartment right engine compartment shield. Disconnect the battery positive (+) cables (negative cable previously removed during cab tilt procedure). Remove the battery hold down brackets and lift the batteries out of the engine compartment.

CAUTION

If the batteries are left in the skid steer loader, extreme care must be taken to protect the batteries from damage during engine removal and installation.

14. Remove the rear door latch bracket, 1, by removing the two capscrews, 2.



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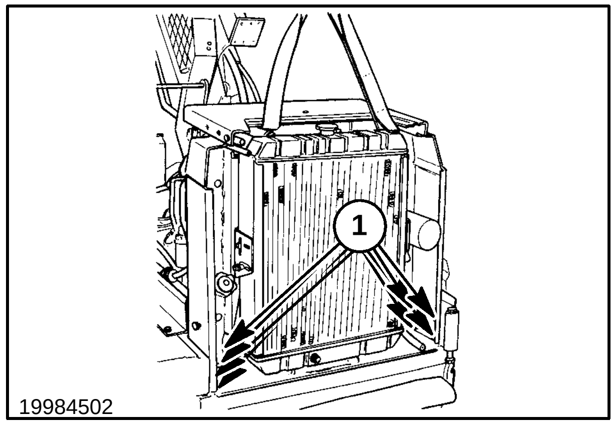
15. Support the radiator housing assembly with suitable lifting gear and detach the assembly by removing the eight (four per side) mounting capscrews, 1. Then lift the radiator/oil cooler assembly from the skid steer, ensuring that the fan shroud housing does not fall from the engine compartment.

CAUTION

The radiator/oil cooler assembly is heavy and should only be lifted using an appropriate lifting device.



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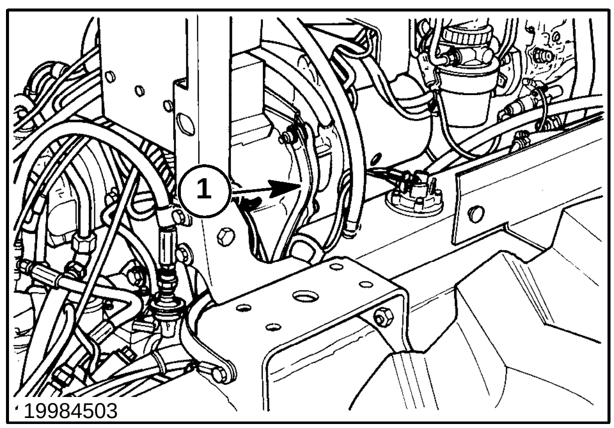
16. Disconnect the engine ground strap, 1, at the engine, and engine wiring harness at the engine components:
    - Fuel compensator solenoid
    - Fuel shut off solenoid
    - Electric fuel pump
    - Starter
    - Engine pre-heater
    - Alternator
    - Engine coolant temperature element
    - Oil pressure switch



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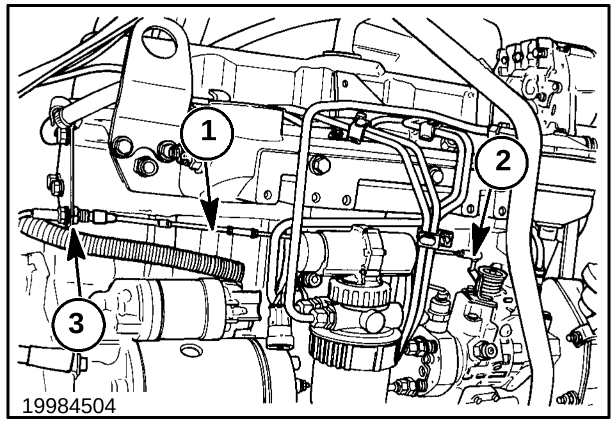
17. Disconnect the throttle cable, 1, from the throttle body plate 2. Remove the cable from its mounting bracket, 3, and pull it back out of the engine compartment.



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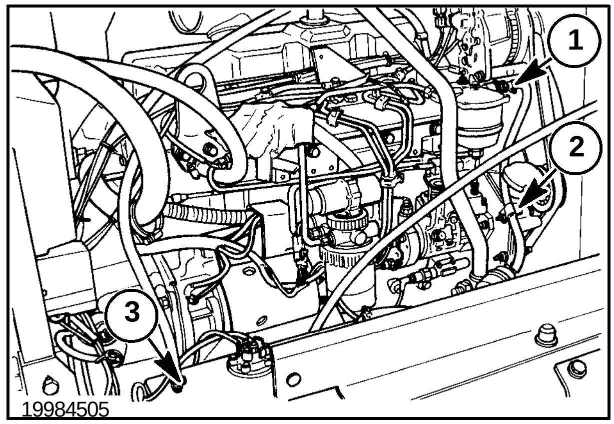
18. Remove the fuel supply line, 1, at the engine connection. Remove the retaining clip, 2, and the fuel return line, 3, at the fuel tank connection. Cap the line and fittings to prevent dirt from entering the fuel system.
19. Remove the fan from the water pump shaft to prevent damage during the engine removal process.
20. Drop the skid steer center belly cover plate to allow access to the forward engine mounting bolt and the lower attachment points for the hydrostatic pumps.

IMPORTANT: *It is critical to maintain the cleanliness of the hydraulic fluid system. Contamination could lead to premature component failure or faulty hydraulic system operation.*

NOTE: *Detailed information for removing the hydrostatic pumps can be found in Section 29 - Hydrostatic Transmission, if needed. Information concerning the High-Flow Hydraulic Kit, if installed, can be found in Section 88 - Accessories.*



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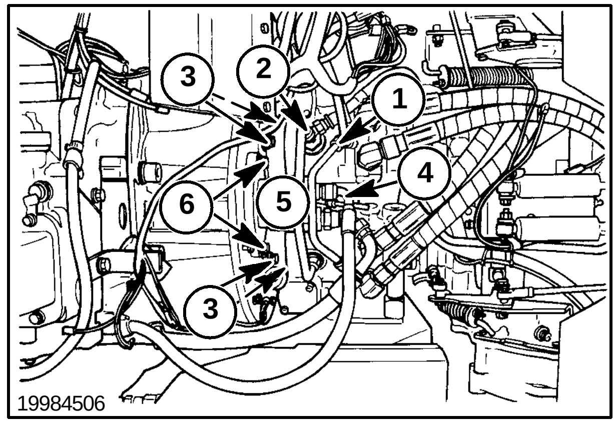
21. Drain the transmission gear case oil to prevent oil from spilling out of the pump transmission gear case mounting cover during engine removal.

22. Disconnect the hydrostatic pump charge pressure crossover tube, 1, and case drain tube, 2. Cap the pump connections to prevent loss of hydraulic oil and possible system contamination. Removing the crossover lines will also aid in engine reinstallation.
23. Detach the hydrostatic pumps from the transmission gearbox by removing the upper and the lower bolts, 3, from each pump.
24. High-Flow Hydraulics - If the unit is equipped with a High-Flow Hydraulic Kit, disconnect the high pressure (line to the selector valve) hydraulic line, 4, from the High-Flow pump, 5, and hose bracket. Cap the pump and hose openings to prevent fluid loss and contamination of the hydraulic system.

    Remove the High-Flow Hydraulic pump from the transmission gearbox by removing the two mounting bolts, 6, and the hose bracket. Protect the pump gears from damage and transmission gearbox from contamination.



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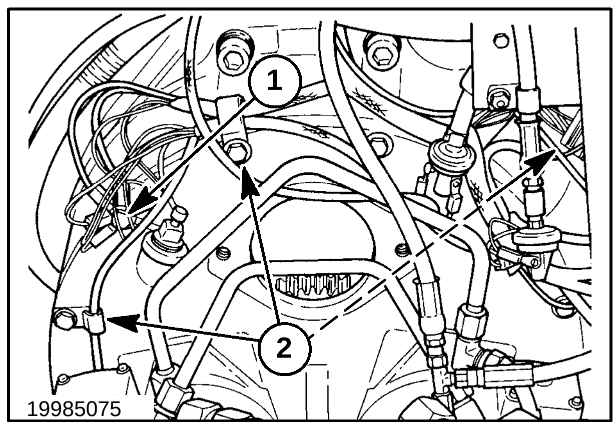
25. Remove the ground wire connections, 1, and wire harness clamps, 2, from the transmission gearbox.
26. Completely pull the engine and auxiliary equipment wire harnesses from the engine, ensuring the engine is free from all wiring attachments.



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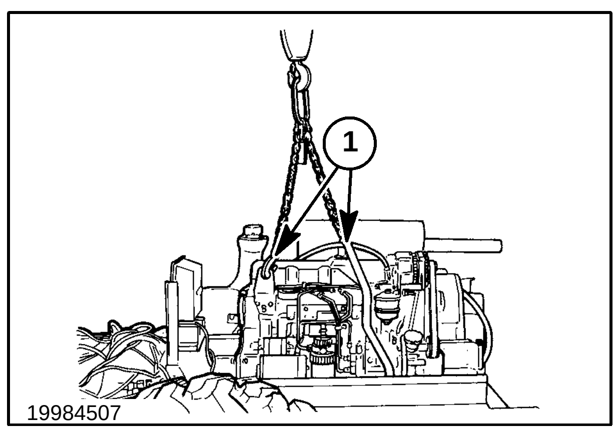
27. Attach a chain or cable to the engine lift eyes, 1, and use an appropriate lifting device to support the engine.

NOTE: *If nylon slings are used to lift the engine, lifting shackles of the appropriate rating must be used to attach the nylon sling to the engine attachment points to prevent cutting of the sling.*



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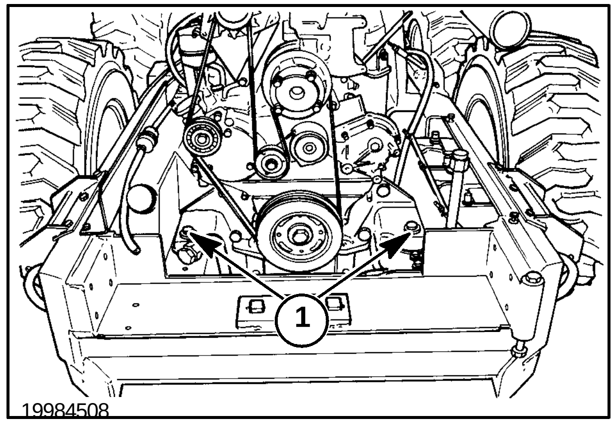
28. Remove the two engine mounts, 1, at the rear of the skid steer and the forward engine mount located between the hydrostatic pumps.
29. Lift the engine slightly to allow the engine to slide rearward towards the back of the skid steer. Make sure all components that could interfere with the engine are clear.

CAUTION

If the batteries remained in the skid steer, take extreme care to protect the batteries from damage during engine removal.



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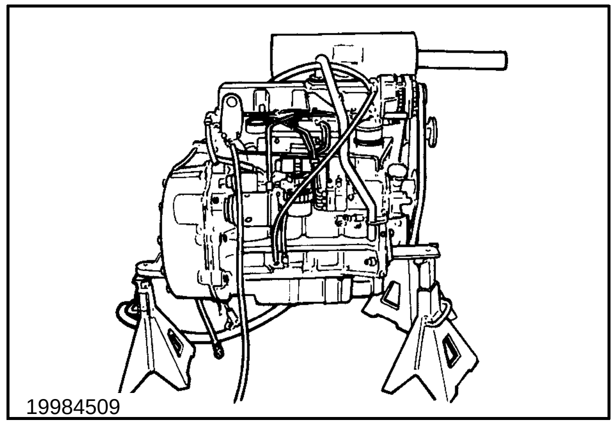
30. Either place the engine on floor jacks (blocking under the engine motor mounts), or place the engine in a suitable engine repair stand.



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MOUNTING THE ENGINE FOR MAINTENANCE - LS190

The approximate weight of the engine is 1000 lbs. (450 kg). Use an engine repair stand with a minimum capacity of 1000 lbs. (450 kg).

The engine repair stand should be used only by qualified service technicians familiar with the equipment.

To maintain shear strength specifications, alloy steel SAE Grade 8 or higher bolts must be used to mount the engine.

For full thread engagement, check that tapped mounting holes in the engine blocks are clean and not damaged. A thread engagement equal to 1 - 1/2 screw diameters minimum is required to maintain strength requirements.

To avoid structural or personal injury, do not exceed the maximum capacity rating of the engine stand.

To avoid an unsafe off-balance load condition, the center of balance of an engine must be located near the engine stand rotating shaft. The engine center of balance is generally located a few millimeters above the crankshaft. Adjust engine mounting to avoid an off-balance condition.

To prevent possible personal injury due to engine slippage, recheck to make sure the engine is solidly mounted while releasing support from the engine lifting device.

Never permit any part of the body to be positioned under an engine or component being lifted or suspended. Accidental slippage may result in personal injury.

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ENGINE DISASSEMBLY SEQUENCE - LS190

The following preliminary disassembly procedure is suggested to remove external components when complete disassembly for overhaul is required. Refer to the appropriate section when removing individual engine components.

1. Drain all coolant and engine oil. Check engine oil for metal contaminates.
2. Remove fan, fan belts, and alternator.
3. Remove exhaust manifold.
4. Remove rocker arm cover with vent tube.
5. Remove coolant outlet connection with thermostats and gasket.
6. Remove oil filter, engine oil cooler, and hoses.
7. Remove fuel filter, fuel supply pump, and fuel line.
8. Remove water pump.
9. Remove starting motor.
10. Remove transmission housing and flywheel. (See Section 27)
11. Remove oil pan.
12. Remove crankshaft pulley.

ENGINE COMPONENT MAINTENANCE - LS190

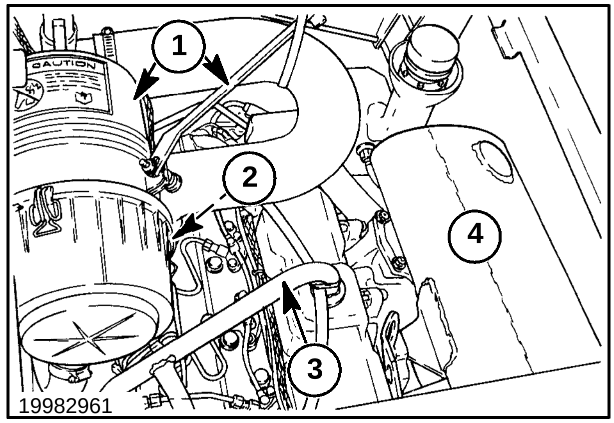
CYLINDER HEAD AND VALVES

Op. 10 101 20

Removal

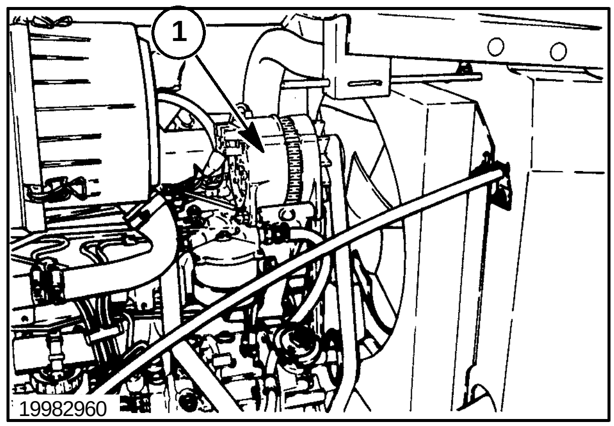
NOTE: *The cylinder head can be removed with the engine installed in the machine.*

1. Disconnect the battery.
2. Remove the hood and side panels.
3. Drain the radiator and cylinder block. Remove the upper radiator hose.
4. Remove the air cleaner, 1, and bracket assembly, disconnecting the outlet hose at the intake manifold, 2. Remove the air cleaner restriction indicator switch electrical connections.
5. Disconnect and remove the valve rocker cover ventilation tube, 3.
6. Remove the muffler, 4.



187

7. Remove the alternator, 1.



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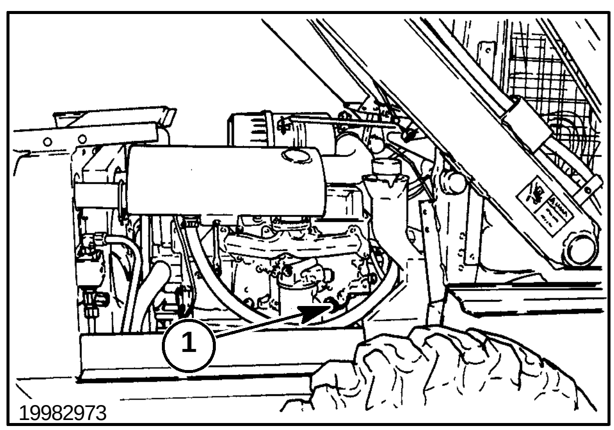
8. Remove the oil pressure sender switch electrical connection, 1.



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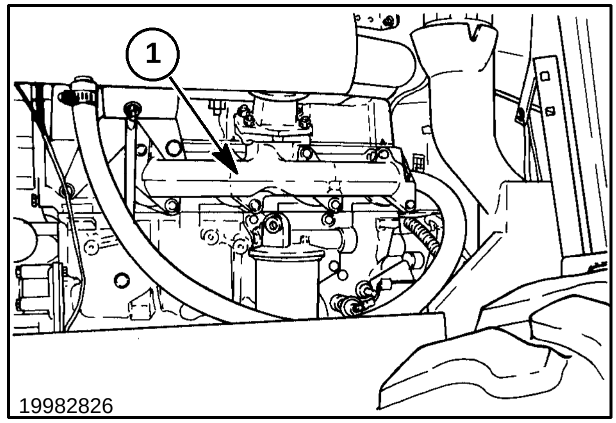
9. Remove the exhaust manifold, 1, and gasket.



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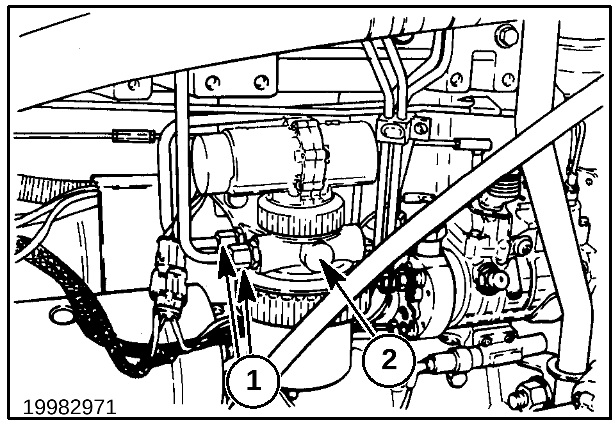
10. Disconnect the fuel lines, 1, and remove the filter assembly, 2, from the intake manifold.



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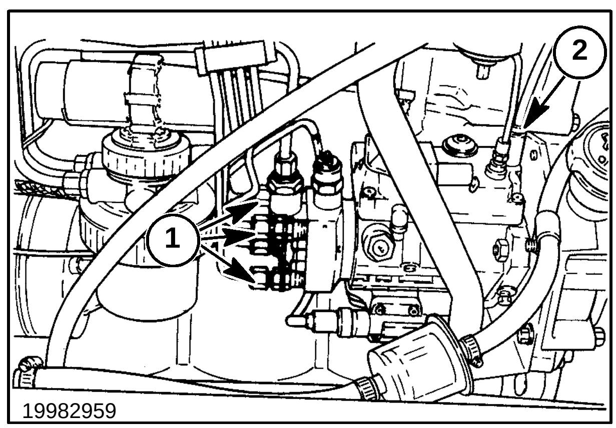
11. Remove the injector lines, 1, from the injection pump and the injectors. Remove the fuel leakoff line from the injection pump, 2. Cap all openings to prevent dirt from entering.
12. Disconnect the fuel and electrical connections at the intake manifold heater located at the inlet to the manifold.
13. Disconnect and plug the heater hoses.
14. Remove the retaining bolts and lock washers. Remove the intake manifold and gasket.
15. Remove the rocker arm cover from the engine.



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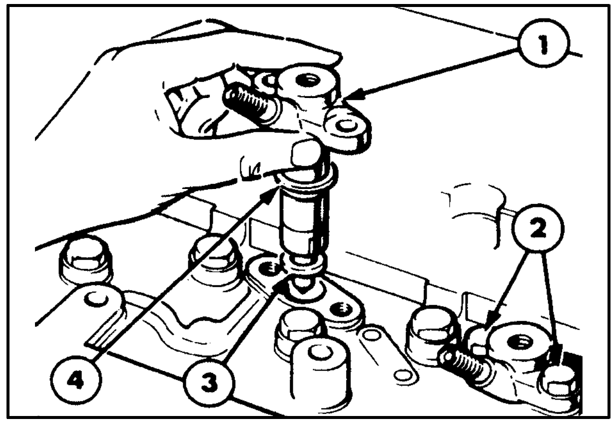
16. Hold the leak-off pipe at each injector and carefully disconnect the fuel injector leak-off pipes. Clean the area surrounding the fuel injectors, then remove the bolts, 2, and carefully withdraw the fuel injectors, 1, and washers, 3 and 4.
17. Check the pushrods for straightness by rotating the rods with the valve closed and identify any bent rods.



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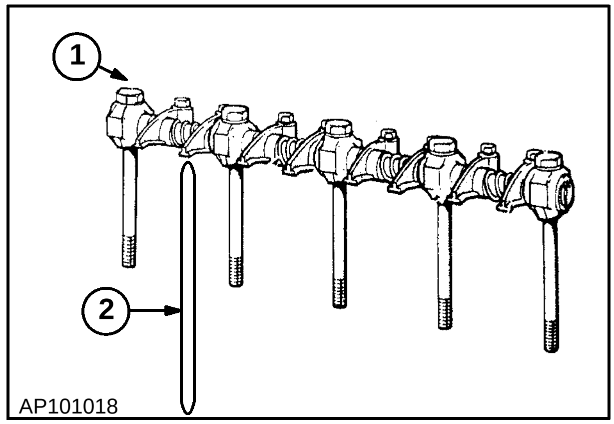
18. Loosen the rocker shaft retaining bolts, 1, which also serve as cylinder head bolts, evenly and alternately. Remove the rocker shaft assembly.

NOTE: *Leave the bolts in the rocker shaft supports during removal as they retain the supports on the shaft.*

19. Remove the pushrods, 2, and place in a numbered rack.
20. Remove the remaining cylinder head bolts and washers working inward from the ends to the center of the head.
21. Lift the cylinder head from the block. If necessary, lever the head off on the pads provided, taking care not to damage the cylinder head or block faces.



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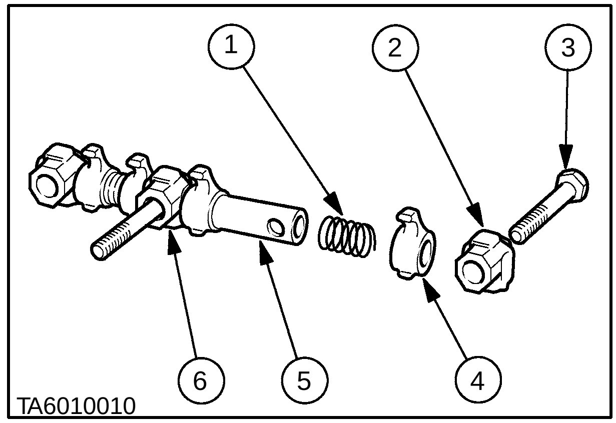
DISASSEMBLY

Op. 10 106 20

Rocker Shaft Disassembly

NOTE: *Leave bolts in the rocker shaft supports during removal as they retain the support on the shaft, 5.*

1. Remove the cylinder head bolts, 3, and withdraw the supports, 2, springs, 1, rockers, 4, and spacers, 6.



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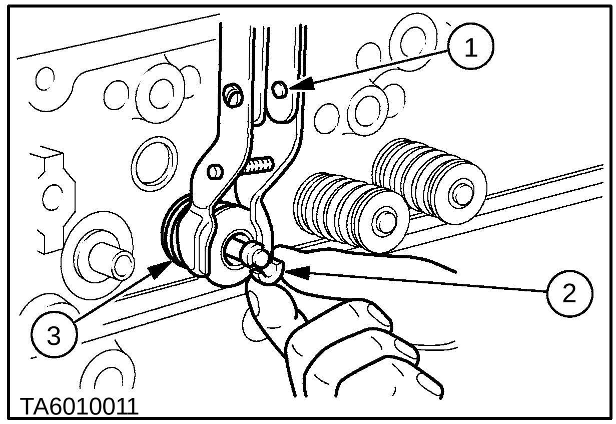
Valve and Spring Assembly Removal

1. Using a valve spring compressor, 1, remove the retainer locks, 2, springs, 3, seals, rotators and place in a numbered rack.



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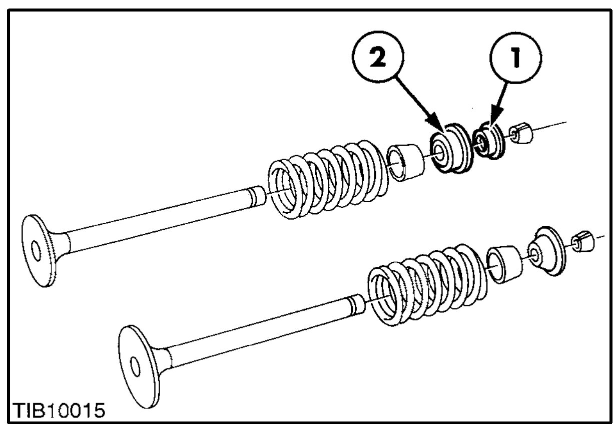
NOTE: *The exhaust valves are fitted with inner, 1, and outer, 2, rotators.*



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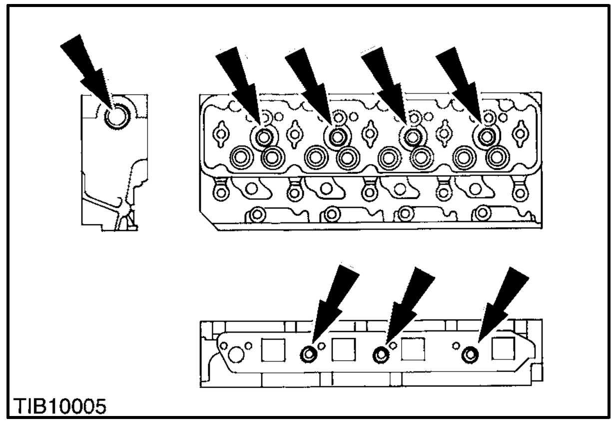
Inspection and Repair, Cylinder Head

IMPORTANT: *Before cleaning the cylinder head inspect for signs of discoloration, leaking or cracks, once cleaned concerns may not be apparent.*



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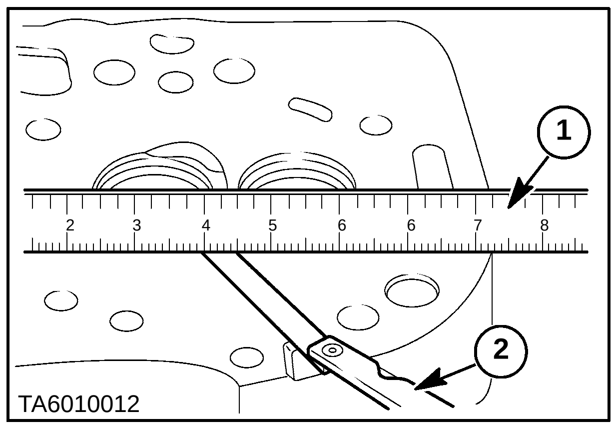
Op. 10 101 21

Cylinder Head

1. Clean the cylinder head, and remove carbon deposits from around the valve heads.
2. Cylinder head core plugs if discolored (rusty), or leaking will require changing. Before fitting new plugs remove all old sealer from the cylinder head. Apply sealant (Threadlocker® 262/271), refer to ‘Specifications’, to the new plug mating faces, and drive the new plugs into location.

   Core plugs required in the cylinder head:
   4 off, In the top of the cylinder head.
   1 off, in the rear of the cylinder head.
   3 off, are mounted in the intake face.

3. Scrape all gasket surfaces clean and wash cylinder head in a suitable solvent, also cleaning valve guide bores.
4. Inspect cylinder head for nicks and burrs on mating face. Remove using a suitable abrasive and ensure faces are clean after repair.
5. Using a straight edge, 1, and feeler gauge, 2, check flatness of cylinder head in all directions does not exceed,
   0.03 mm (0.001 in.) in any 25.4 mm (1 in.), or 0.127 mm (0.005 in.), overall limit.
6. If the cylinder head has been resurfaced, determine all head bolt faces will seat. By placing the cylinder head less gasket, on the cylinder block and installing bolts hand tight.



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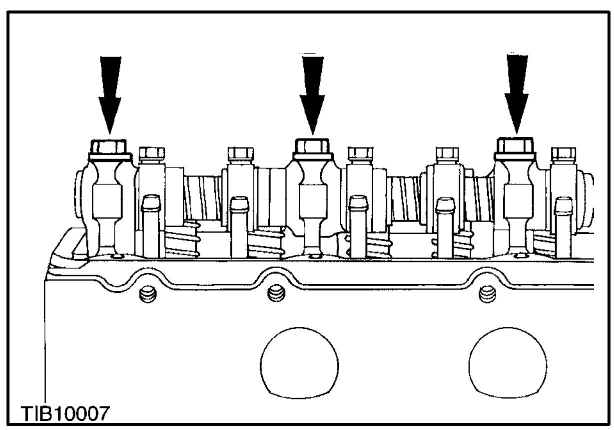
7. Ensure rocker shaft supports are fitted with long bolts. Using a feeler gauge, check clearance between underside of bolt heads and cylinder head or rocker shaft support.
8. If a 0.25 mm (0.010 in.) feeler gauge can be inserted under the bolt head the bolt has bottomed. Therefore the cylinder block thread must be increased using a 9/16 - 13 UNC - 2A Thread tap. Identify the bolt heads and ensure they are reinstalled in the bolt holes they were checked in.



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Valve Inserts

Insert Oversize	Counter Bore in Cylinder Head	
	Exhaust valve insert	Intake valve insert
0.25 mm (0.010 in.)	44.17 - 44.20 mm (1.739 - 1.740 in.)	50.01 - 50.04 mm (1.969 - 1.970 in.)
0.51 mm (0.020 in.)	44.42 - 44.45 mm (1.749 - 1.750 in.)	50.27 - 50.29 mm (1.979 - 1.980 in.)
0.76 mm (0.030 in.)	44.68 - 44.70 mm (1.759 - 1.760 in.)	50.52 - 50.55 mm (1.989 - 1.990 in.)

NOTE: *Refacing the valve seat should always be coordinated with refacing of the valve to ensure a compression tight fit.*

Valve Seats

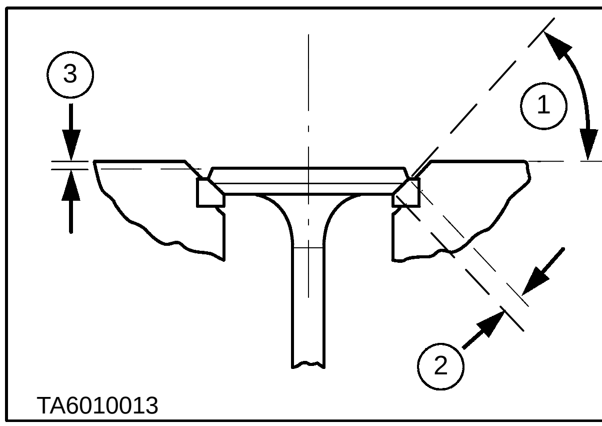
Op. 10 101 55

1. Examine the valve seat inserts and reface if pitted, renew if loose or damaged.
2. To install a new valve insert, the cylinder head must be counter bored, as described in the above chart. The new insert must be chilled in dry ice prior to installation.

   Valve Seat Specifications.
   Valve seat angle, 1:
   Intake – 30.0° - 30.30°
   Exhaust – 45.0° - 45.30°

   Valve seat width, 2:
   Intake – 2.0 - 2.5 mm (0.079 - 0.098 in.)
   Exhaust – 1.8 - 2.3 mm (0.072 - 0.092 in.)

   Valve Head Face to Cylinder Head Face Depth, 3:
   Intake – 0.86 - 1.32mm (0.034 - 0.052 in.)
   Exhaust – 1.2 - 1.6 mm (0.047 - 0.065 in.)



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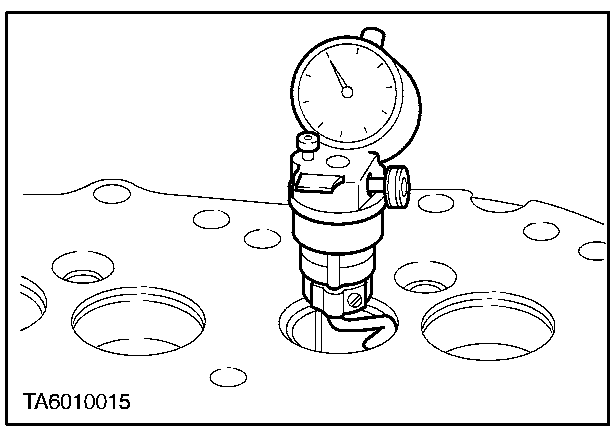
NOTE: *Valve inserts of 0.25 mm (0.010 in.) and 0.5 mm (0.020 in.) oversize on diameter are sometimes installed during manufacture. Cylinder Heads with oversize inserts are stamped SO15OS, SO20OS, on the exhaust manifold side in line with the valve seat concerned.*

3. Check the width of the valve seat inserts, and reface by grinding as required.
4. Measure the concentricity of valve seats, using a dial indicator and measure concentricity of seat to the valve guide bore.
   Total Indicator Reading should not exceed 0.051 mm (0.002 in.).



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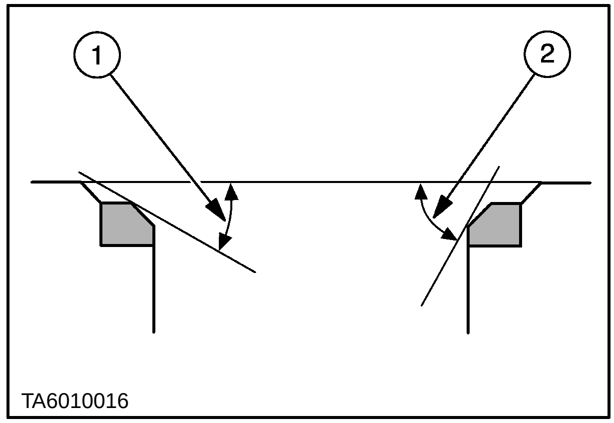
5. Use a seat cutter to correct any seat eccentricity, or clean up of pits and grooves. Ensure after any rework that seat width is within specified limits.
6. Rotate a new or refaced valve in the seat using engineering blue, ensure all the blue is transferred to the valve head protrusion, If any blue remains below or around the seat raise or lower the seat accordingly, in the following manner.

Lower the valve seats by removing material from the top of seat, 1, by using:
30° grinding wheel for Exhaust valves and a 15° grinding wheel for Intake valves.

Raise, the valve seats, by removing material from the bottom of seat, 2, by using:
60° grinding wheel for Exhaust valves and a 45° grinding wheel for Intake valves.



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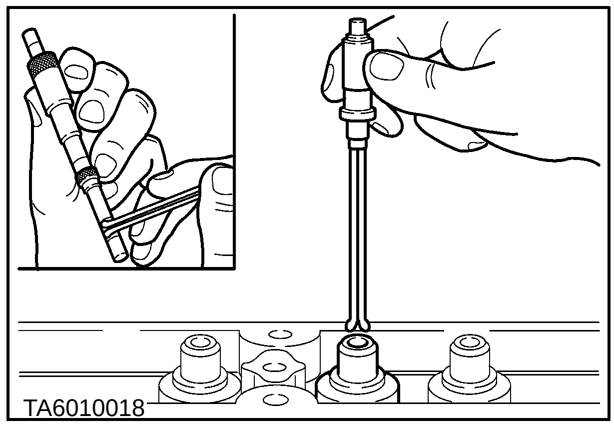
Valve Guides

1. Using a telescopic gauge and micrometer measure the valve guide bore clearance, and ensure it does not exceed:
   0.023 - 0.069 mm (0.0009 - 0.0027 in.)
   on the intake valve stem,
   0.048 - 0.094 mm (0.0019 - 0.0037 in.)
   on the exhaust valve stem.

NOTE: *Production cylinder heads may have one or more machined, oversize valve guide bores, or valves installed 0.38 mm (0.015 in.). Such cylinder heads have 15 or VO15OS stamped on the cylinder head exhaust manifold side adjacent to the valve concerned.*



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2. Using a suitable reamer, ream out the valve stem guide with three reamer and pilot combinations as follows:
3. When going from a standard valve stem to an oversize, always use reamers in sequence.

0.076 mm (0.003 in.) oversize reamer, and standard diameter pilot.

0.38 mm (0.015 in.) oversize reamer, and 0.076 mm (0.003 in.) oversize pilot.

0.76 mm (0.030 in.) oversize reamer, and 0.38 mm (0.015 in.) oversize pilot.

Valve Springs

1. Checked on a flat surface squareness, should not exceed 1.52 mm (0.060 in.), between the square and spring at the top edge.

Length of valve springs should be checked on both free length, and loaded length.

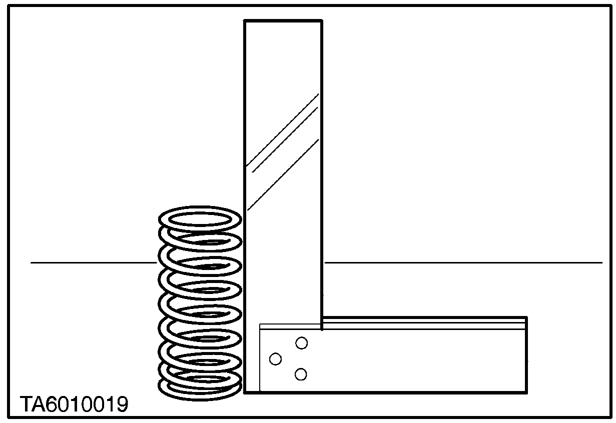
Free length = 60.7 mm (2.39 in.)

Installed length = 47.2 - 49.6 mm (1.86 - 1.95 in.)

Loaded length = 48.26 mm (1.9 in.) using a weight of 28 - 31 kg (61 - 69 lb)

Loaded length = 35.69 mm (1.4 in.) using a weight of 61 - 69 kg (135 - 153 lb)

Ensure the valve spring retainer locks are in good condition, and replace if worn or damaged.



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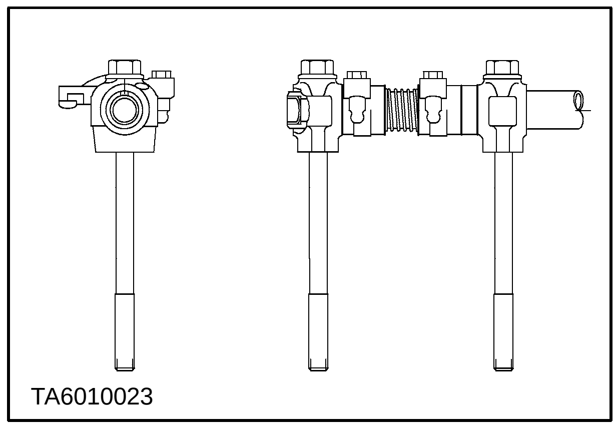
Rocker Shaft Inspection and Reassembly

1. Inspect rocker arm adjusting screws, and push rod ends of the rocker arm, including the ball end of the screws for nicks, damage, or excess wear.
2. Also inspect the inside diameter of the rocker arm for damage or wear. If any of these characteristics are not to specification, replace with new parts.
3. Check the ends of the push rods for damage or wear. If not to specification or push rods were found not to be straight during dismantling, install new rods.

NOTE: *Do not attempt to straighten bent push rods, replace with new.*

4. Check the rocker shaft for signs of wear or damage on internal and external diameters. If not to specification replace with new. If reused, before reassembly clean thoroughly in solvent making sure all oil passages are clear.
5. Position the shaft identification groove forwards and upwards. This ensures oil grooves and holes face downwards.
6. Assemble rocker shaft support with long head bolts, ensuring springs and spacers are reassembled and torque to 217 N·m (160 ft. lbs.).



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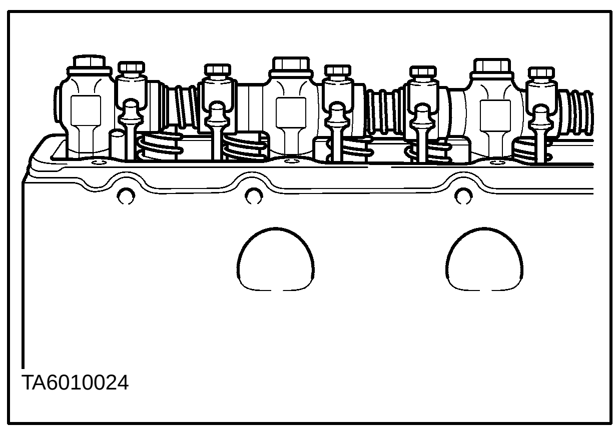

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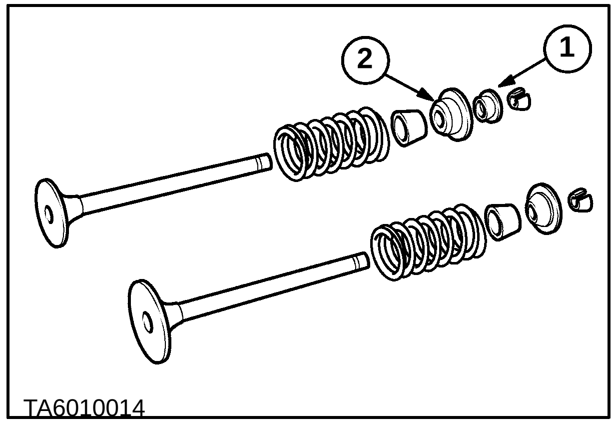
CYLINDER HEAD REASSEMBLY

1. Insert the valves into the guide bores from which they were removed and lap with a suitable paste, ensure all traces of paste are removed after lapping.
2. Lubricate all components with clean engine oil on reassembly. Use a spring compressor to reassemble the valves, valve springs, rotators, and collets with new umbrella seals.

NOTE: *Exhaust valves are fitted with inner, 1, and outer, 2, rotators.*

3. Coat all components with clean engine oil prior to assembly, and insert each push rod into its original position, ensuring each ball end is seated in its cam follower.



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CYLINDER HEAD INSTALLATION

Installation of the cylinder head assembly and components is the reverse of the removal procedure, observing the following,

1. Install new cylinder head, intake and exhaust manifold gaskets.

NOTE: *Ensure exhaust manifold gasket is fitted correctly to suit profile of exhaust ports.*

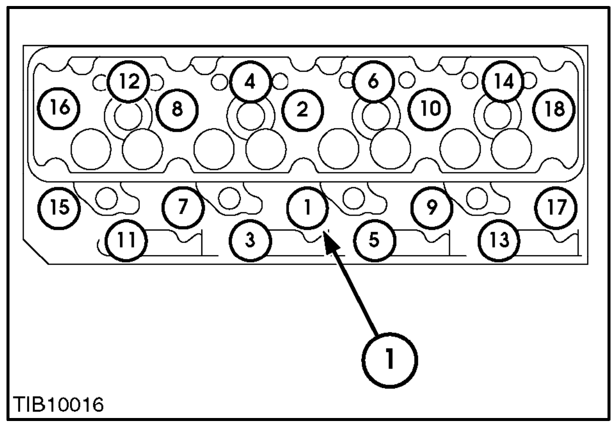
2. Tighten the cylinder head bolts in sequence from the center of the head, progressively in three stages.

Stage 1, 156 N·m (115 ft. lbs.)

Stage 2, 190 N·m (140 ft. lbs.)

Stage 3, 217 N·m (160 ft. lbs.)

NOTE: *Lubricate the bolts prior to assembly, and tighten to torque specification with the engine cold.*



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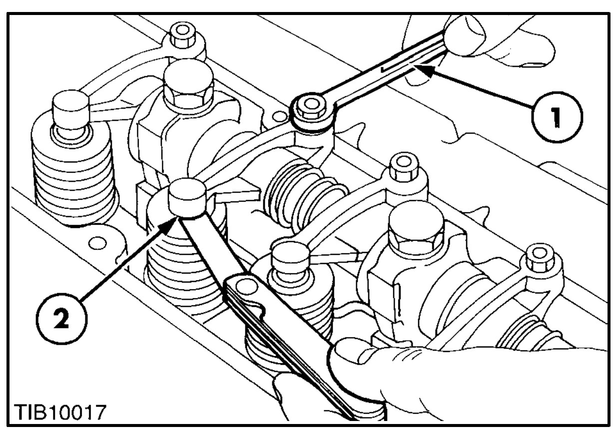
3. Adjust valve lash setting with each piston in turn at Top Dead Center, and rockers free to move, by adjusting the rocker bolt, 1, and measuring with a feeler gauge, 2.

Intake Valve Lash:
0.36 - 0.46 mm (0.014 - 0.018 in.).

Exhaust Valve Lash:
0.43 - 0.53 mm (0.017 - 0.021 in.).

NOTE: *Set the valve lash only when the engine is cold.*



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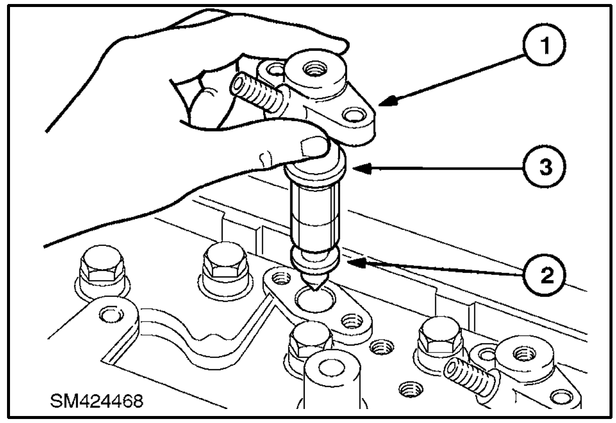
4. Install the injectors, 1, with new seat washers, 2, cork seals, 3, and torque to 23 N·m (17 ft. lbs.).
5. Install the injector lines and leak off pipes with new washers, and torque the leak off banjo bolts to 10 N·m (8 ft. lbs.).

NOTE: *Hold the leak off plastic tubing when tightening to prevent the pipes from pivoting.*

6. Exhaust manifold bolts are to be refitted and tightened to a torque of, 38 N·m (28 ft. lbs.).
7. Refit intake manifold bolts and tightened to a torque of, 38 N·m (28 ft. lbs.).



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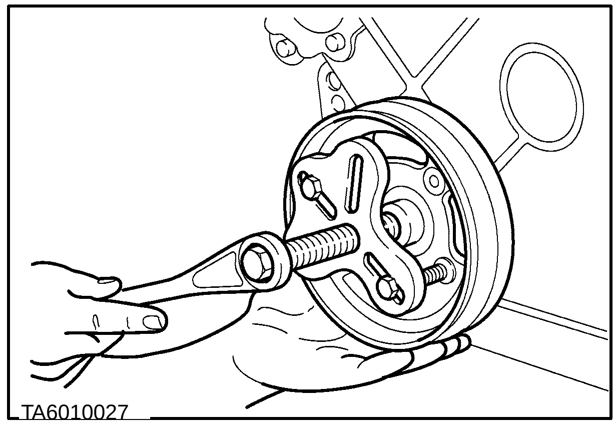
Op. 10 102 40

ENGINE FRONT COVER AND TIMING GEAR REMOVAL

NOTE: *Timing cover and gears can only be serviced after removing the radiator.*

1. Remove the fan belt and withdraw the bolt and washer, from the crankshaft pulley.
2. Using puller, FNH 09539, and shaft protector FNH 09212, remove pulley, spacer and O-ring from the shaft.



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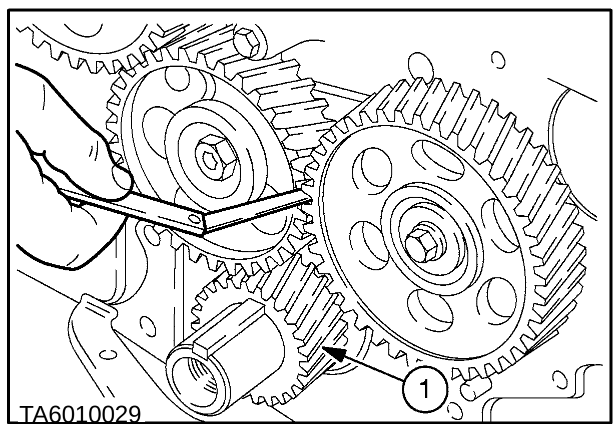
3. Withdraw the bolts retaining the front cover plate, and remove the front plate.

IMPORTANT*: The crankshaft timing gear, 1, must not be removed. The gear is heat shrunk onto the crankshaft and aligned to the crankshaft No1 pin, to within 0.10mm (0.004 in). If the gear is damaged a new crankshaft is required.*

4. Before removing the timing gears, use a dial indicator or feeler gauge, to measure the backlash between each set of gears.



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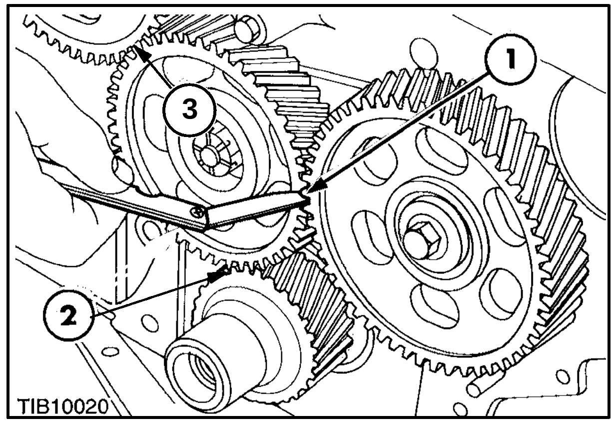
5. Rotate the gears and check the backlash, using a feeler gauge, or dial indicator at four equal points on the gears. Renew if the backlash exceeds the following.

Backlash to camshaft gear, 1:
0.15 - 0.46 mm (0.006 - 0.018 in.)

Backlash to crankshaft gear, 2:
0.15 - 0.46 mm (0.006 - 0.018 in.)

Backlash to fuel injection pump gear, 3:
0.10 - 0.15 mm (0.004 - 0.006 in.)



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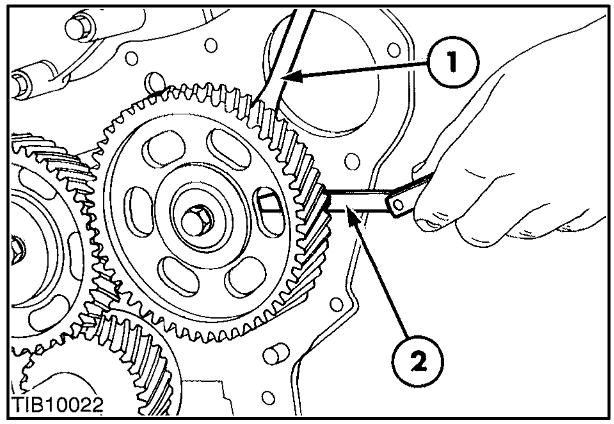
Op. 10 106 40

CAMSHAFT DRIVE GEAR

1. Pry the camshaft gear using a lever, 1, away from thrust plate. Using a dial indicator or feeler gauge, 2, check the clearance, if outside of 0.076 - 0.35mm (0.003 - 0.014 in.) limit, fit a new camshaft thrust plate.
2. Remove the camshaft idler gear retaining bolt, gear, and adaptor from the block, then remove the camshaft gear bolt and disassemble.
3. If the fuel pump will not be removed, rotate the engine in the normal direction of rotation to 29° BTDC compression stroke. Lock the pump locking tag using the bolt to 13 N·m (9.6 ft. lbs.). Locking tab location “1” is unlocked, and location “2” is locked.



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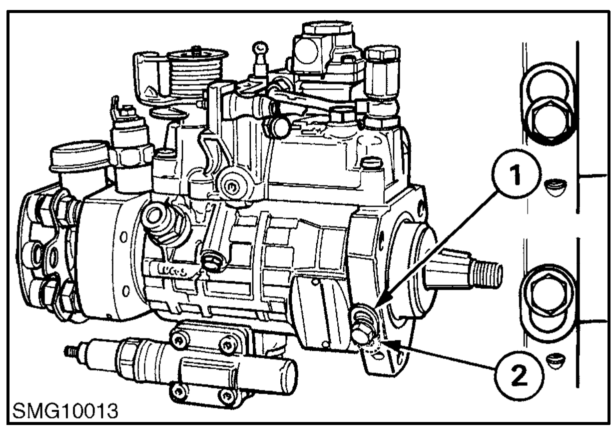
NOTE: *If the fuel pump will be disassembled, fuel pump timing adjustment will be necessary.*

4. Remove retaining nut and washer from the fuel pump and remove the gear from the shaft using a puller.
5. If required, the timing gear rear cover may now be removed. Remove the six retaining bolts and carefully pry the cover from the engine block.



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Inspection and repair of gears

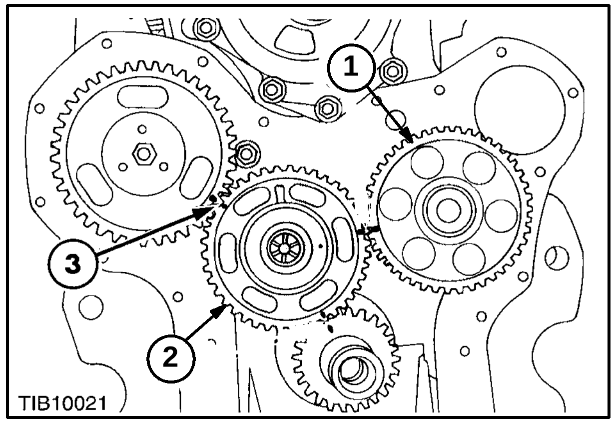
6. Wash the gears using a suitable solvent, and examine gear teeth for wear, burrs, or scratches. Minor marks can be removed using a fine abrasive. Thoroughly clean before re-assembly.
7. Ensure the camshaft idler gear adaptor is free from obstruction and bushing is not damaged. Camshaft key and key-way should be checked for damage and repaired as required.

Installation

1. Position piston No.1 at Top Dead Center, install the camshaft gear, 1, and tighten bolt to 69 N·m (51 ft. lbs.).

NOTE: *Refer to Engine Timing section to determine Top Dead Center.*

2. Install the camshaft idler gear, 2, to the block, aligning the timing marks to the crankshaft and camshaft gears and torque to 250 N·m (184 ft. lbs.).



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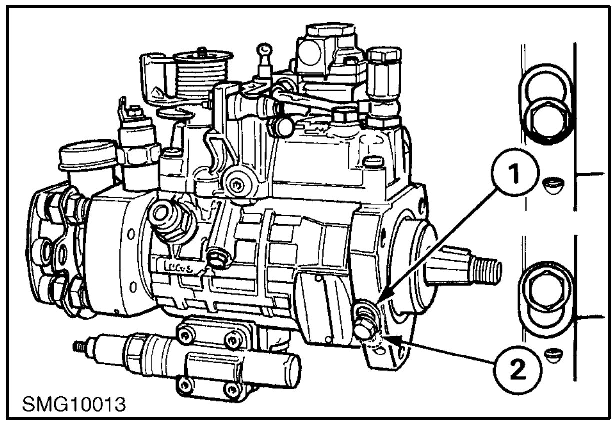
NOTE: *The correct timing adjustment procedure must be followed.*

With engine at 29° BTDC compression stroke, during engine timing, assemble the 'LOCKED', 2, pre-timed fuel injection pump with a new O ring, to the front cover. Torque pump retaining bolts to 24 N·m (18 ft. lbs.). Install the pump gear over the pump shaft. Assemble the washer and nut to the shaft, leaving loose at this stage to allow the gear to rotate freely on the pump shaft.



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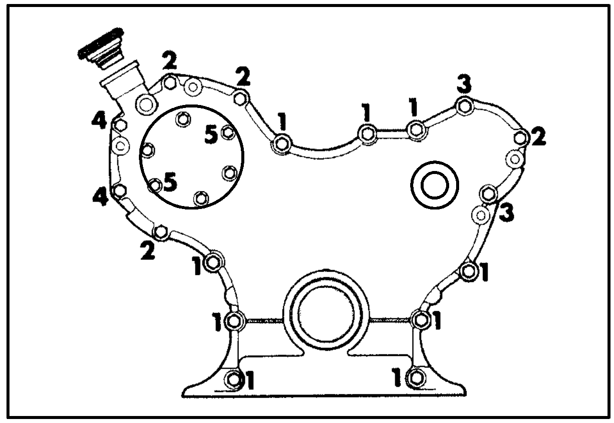
NOTE: *Do not tighten the injection pump shaft nut at this stage. Proceed to reassemble the front cover.*

3. Initially tighten the injection pump gear nut to a torque of 9 N·m (6.7 ft. lbs.) while holding the gear in a counterclockwise position to remove back-lash from gears. 'UNLOCK' the pump by releasing the locking bolt and installing the spacer between the pump body and bolt head, 1. The pump gear retaining nut can now be fully tightened to a torque value of 81 N·m (60 ft. lbs.)
4. The front oil seal should be replaced every time the front plate is removed. Drive out the old seal using a punch, taking care not to damage the front plate. Assemble the front to Engine as described below and then install the seal.
5. Ensure the front cover mating face and cylinder block face are thoroughly clean before reassembly. Apply a 2 mm (0.1 in.) wide bead of sealer 518 Gasket Eliminator® along the center of each mating face. Position a new gasket on the front cover.

6. Install the front cover ensuring alignment with dowel pins and tighten the bolts in order of sequence.

5/16 in. - 18 UNC bolts tighten to 18 - 24 N·m (13 - 18 ft. lbs.).

3/8 in. - 16 UNC bolts tighten to 34 - 41 N·m (25 - 30 ft. lbs.).



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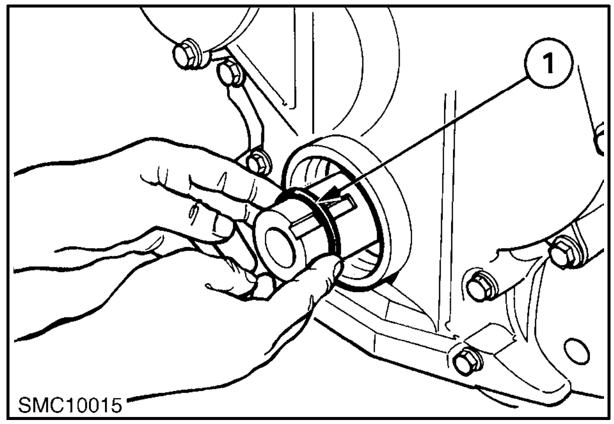
Seal Installation

7. Clean all parts and install new O ring, 1.



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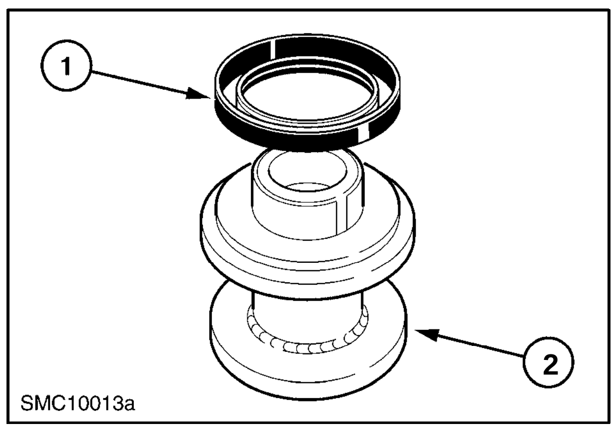
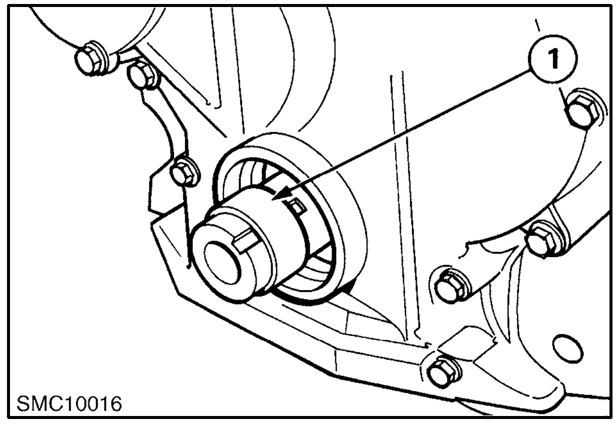
8. Lubricate seal, 1, and push onto the seal installer, 2, special tool NH 10 - 103.
9. Press seal into front cover using tool NH10 - 103. Install the seal sleeve into the seal.



221

10. Install the Access cover, 1, for the injection pump gear nut. Clean surfaces and apply a 3mm bead of flexible gasket sealant. tighten the retaining bolts to 37 N·m (28 ft. lbs.).



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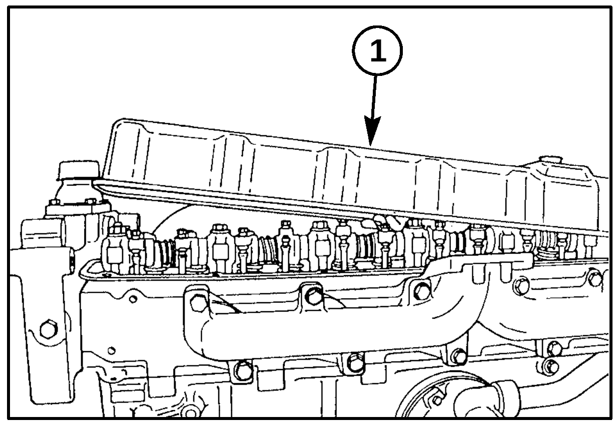
ENGINE TIMING

1. Remove the rocker cover and observe the valves and rocker arms of the No. 1 cylinder while rotating the engine. Rotate the engine until the exhaust valve moves fully open then begins to close.



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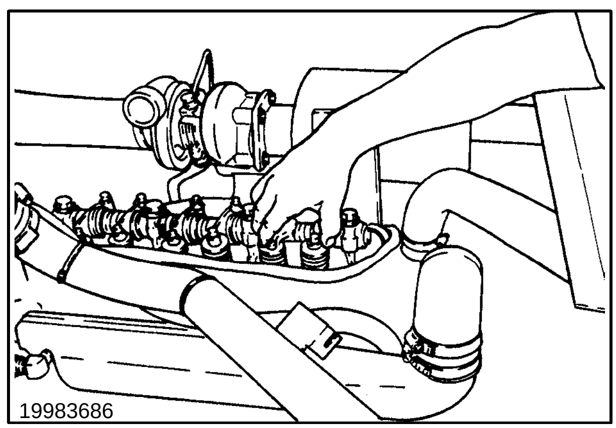
When the exhaust valve is nearly closed, the intake valve begins to open. This is Top Dead Center (TDC) for the exhaust stroke.

NOTE: *If the tappets are set to the proper specifications, the intake valve opens at 12° before TDC and the exhaust valve closes at 12° after TDC. This is referred to as “valve overlap.”*



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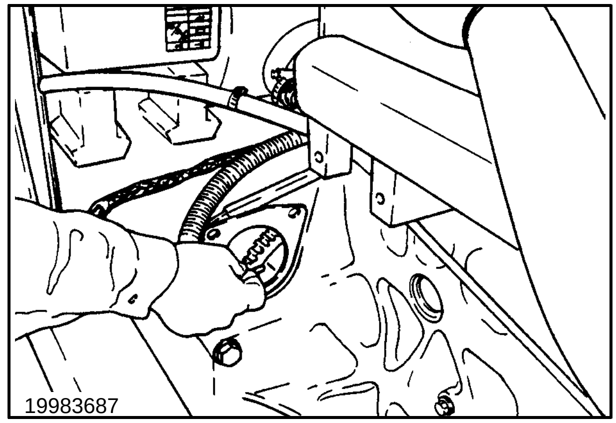
2. Mark the flywheel or pulley with chalk and continue to rotate the engine clockwise. Rotate one full turn (360°) minus 29° of advance (331° total). This positions the No. 1 piston to nearly TDC on the compression stroke.



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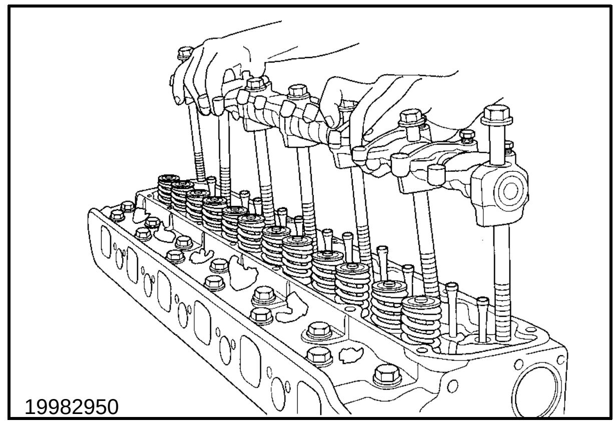
3. Remove the rocker arm and shaft assembly and set it aside in a clean location.



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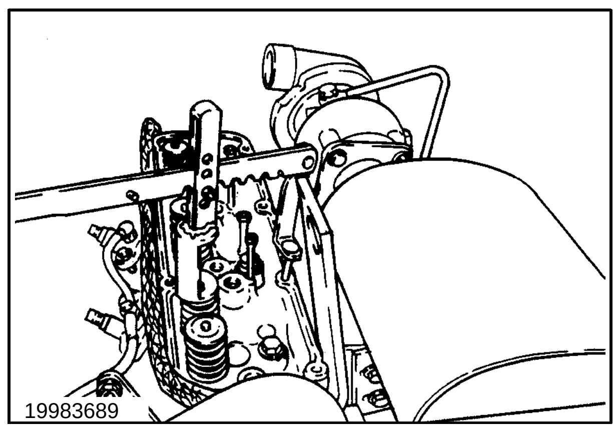
4. Use a suitable valve spring compressor to remove the valve keepers from either the intake or exhaust valve on the No. 1 cylinder. This allows the valve to drop slightly if the piston is at top center. Lightly tap the end of the valve with a soft mallet to be sure that the valve is against the piston.

IMPORTANT: *Do not strike the valve with a metal hammer or other similar tool. Striking the valve stem too much force will damage it, requiring expensive valve repair and replacement.*



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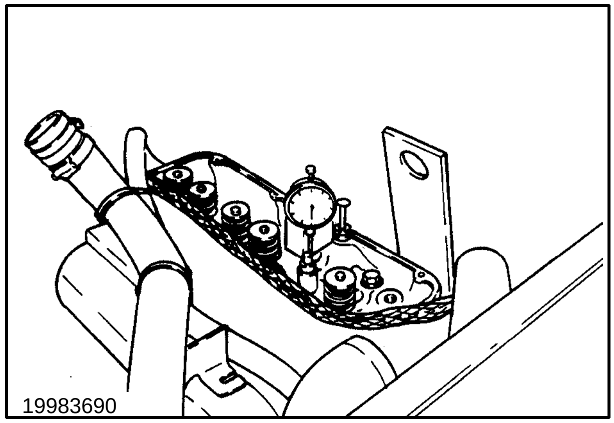
5. Set a dial indicator over the valve stem and set it to zero. Turn the engine clockwise, then counterclockwise, moving several degrees each direction. Reset the dial indicator to zero with the valve stem at its highest point.
6. Turn the engine counterclockwise until the valve lowers and the dial indicator reads at least 12.52 mm (0.500 in.).
7. Turn the engine clockwise, keeping the valve against the piston, until the indicator shows the correct measurement.

Pump Timing Degree Chart

No. of Cylinders	Engine Timing	Pump Lock Degree	#1 Piston Drop
4 N/A	29° BTDC	29°	10.39 ± 0.025 mm (0.409 ± 0.001 in.)

NOTE: *Piston drop distance includes the average protrusion of the piston above the block face as required when using the drop valve timing method.*

8. Install the locked, pre-timed fuel injection pump (see “Installing the Fuel Injection Pump”).



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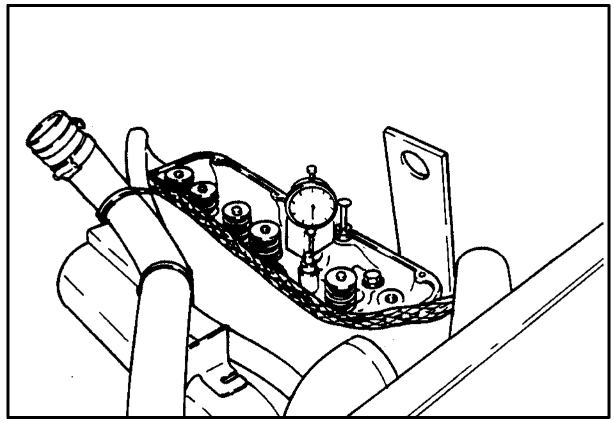
9. Turn the engine clockwise until the dial indicator reads zero. Set the valve spring, valve guide and keepers in place on the valve stem. Fully seat the keepers into the groove in the valve stem.



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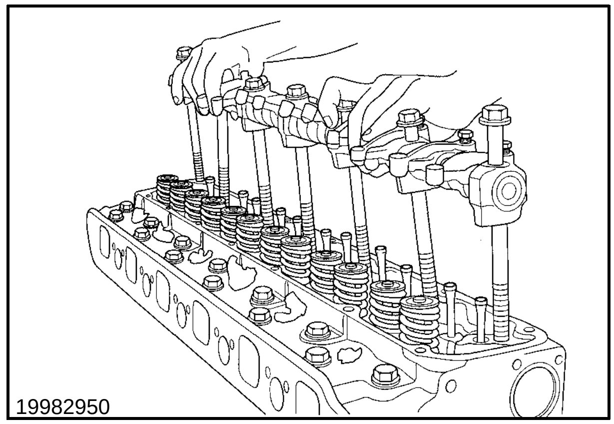
10. Reinstall the rocker arm and shaft assembly. Tighten the bolts to 217 Nm (160 ft. lbs.) and set the valve clearances.

    Intake Valve Lash:
    0.36 - 0.46 mm (0.014 - 0.018 in.)
    Exhaust Valve Lash:
    0.43 - 0.53 mm (0.017 - 0.021 in.)

    Turn the engine at least two full revolutions to ensure that all valves open and close fully.



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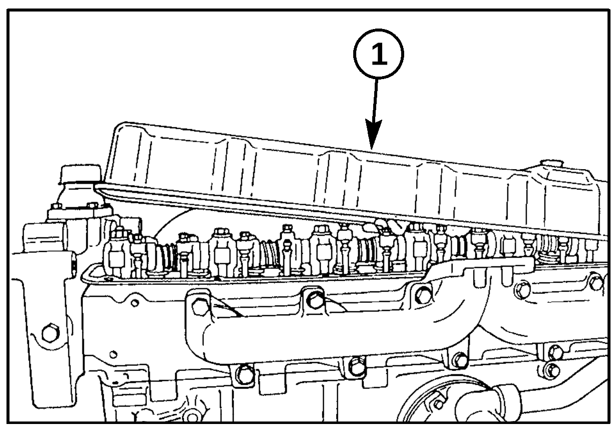
11. Reinstall the rocker cover with its gasket. Tighten the rocker cover bolts to 20 - 27 N·m (15 - 20 ft. lbs.).



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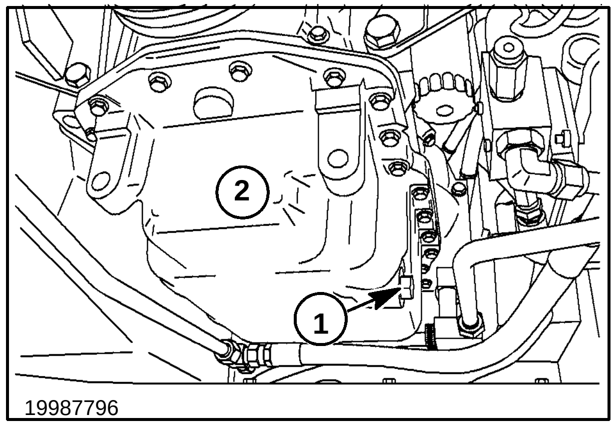
Op. 10 102 10

OIL PAN REMOVAL

1. Drain engine oil through oil pan plug, 1, and into a suitable clean receptacle and remove oil level indicator.

NOTE: *To facilitate removal of the oil pan, 2, it may be necessary to first remove the propshaft.*

2. Remove oil pan bolts and lower to ground.



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Inspection and repair

1. Clean gasket material from sump face, clean sump in a suitable solvent, inspect sump for cracks damaged threads or damaged sump face.

Installation

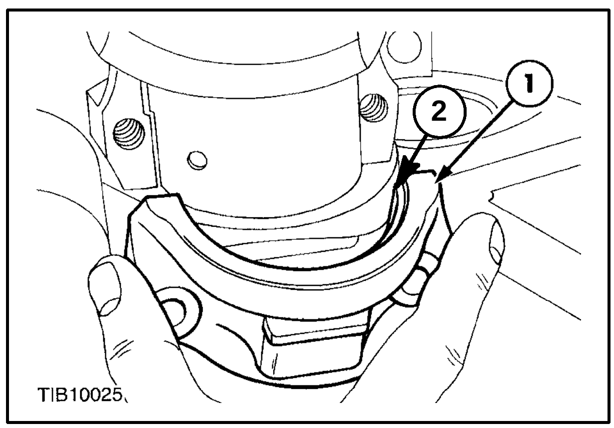
1. Installation is the reverse of removal but with the following requirements.
2. Ensure block face is clean and free of gasket material. Install a new gasket to the front cover, and oil pan. Ensure sealer 518 Gasket Eliminator® is applied to the front plate, and rear oil seal return joints.
3. Position the oil pan and install a bolt at each corner finger tight to hold in position, install remaining bolts, and torque from the center of the pan to the end to 38 N·m (28 ft. lbs.).

Op. 10 105 10

CONNECTING RODS, BEARINGS, PISTONS, AND RINGS REMOVAL

NOTE: *The connecting rods and pistons can be removed with the engine installed after removal of the cylinder head and oil pan.*

1. With cylinder head removed, clean off any ridge from the top of the cylinder bores with a ridge remover to enable removal of the pistons. This is essential if old pistons are to be reused, as failure to do so could result in ring land damage.
2. With the piston at the bottom of the stroke remove the end cap bolts, cap, 1, and liner, 2. Using the handle end of a hammer push the piston assembly out through the top of the block, and remove the bearing liner from the connecting rod.



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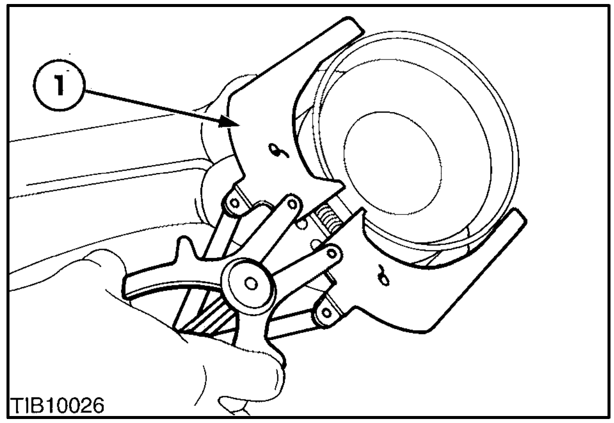
NOTE: *Bearing caps and liners must be kept with their respective connecting rods.*

3. Turn the crankshaft again and repeat the process for the remaining pistons.
4. Remove piston pin snap rings from each side of piston and remove pin. Using an expander, 1, remove the piston rings.
5. Ensure each piston and rod assembly, remains matched together for reassembly into the same location within the cylinder block.



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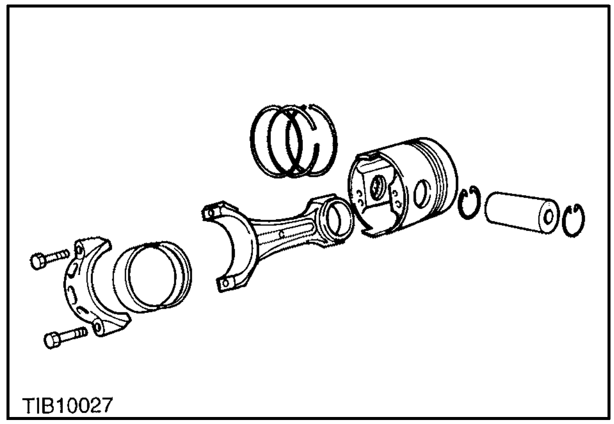
Op. 10 105 22

Inspection and Repair

1. Clean the piston and connecting rod assembly in a suitable solvent and inspect for damage to ring lands, skirts, or pin bosses.



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2. Check connecting rod components for damage, and place in an alignment fixture to check for distortion, and ensure that any distortion is within specification as follows.

   Maximum Twist ‘A’ 0.30 mm (0.012 in.).

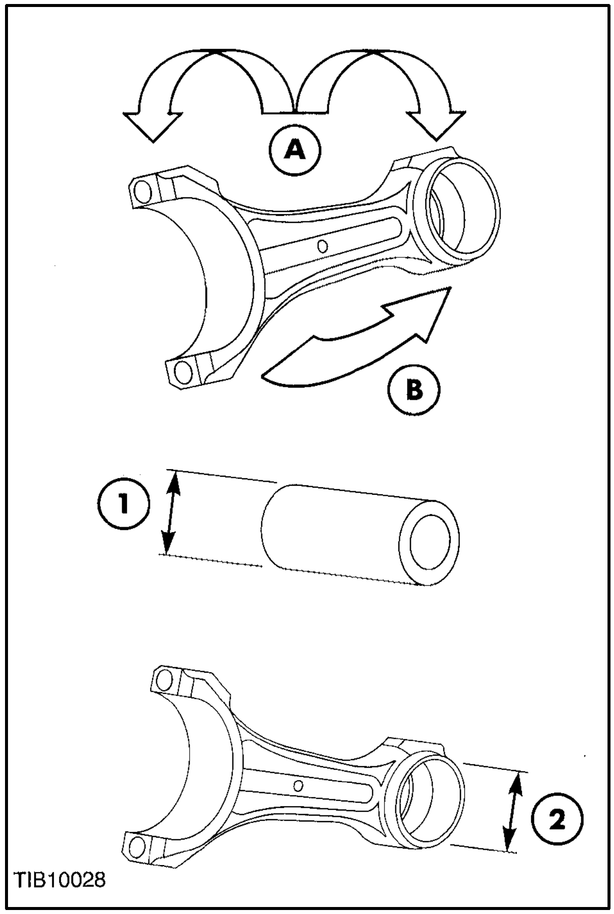
   Maximum Bend ‘B’ 0.10 mm (0.004 in.).

3. Check piston pin bushing for damage or wear in the following manner.

Measure the outside diameter of the piston pin and inside diameter of the connecting rod bushing, and compare to the following:

Piston Pin Outside Diameter, 1:
38.095 - 38.100 mm (1.4998 - 1.500 in.).

Connecting Rod Bushing Internal Diameter, 2:
38.113 - 38.120 mm (1.5005 - 1.5008 in.).



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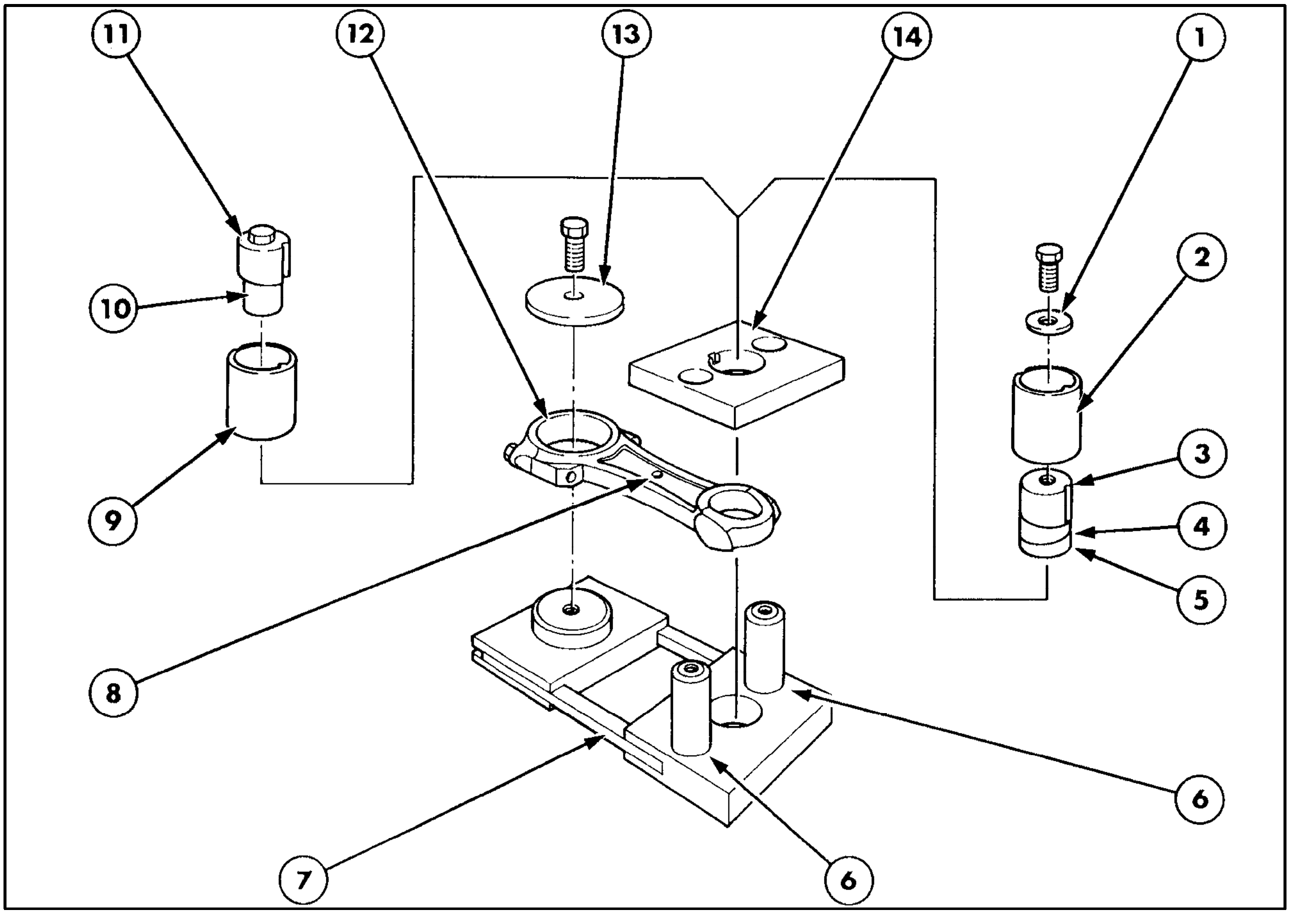

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T1B10029 Connecting Rod Bushing Removal and Installation

1. Washer
2. Collar
3. Installation Insert 1
4. Bushing
5. Installation Insert 2
6. Pins
7. Fixture
8. Connecting Rod Facing up
9. Remover Insert 1
10. Remover Insert 2
11. Remover Insert 3
12. Connecting Rod Location
13. Washer
14. Location Plate

CONNECTING ROD BUSHING

4. If not to specification, use tool # FNH 00053 and press out the old bushing using the removal fixture as shown. Press fit a new bushing through the fixture using the installation detail, and into the connecting rod. After fitting a new bushing, ensure all sharp edges and burrs are removed.

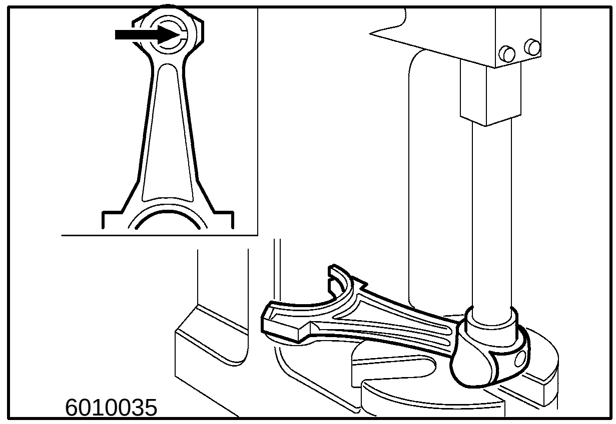
IMPORTANT: *Ensure the split in the small end bushing is at right angles to center line of connecting rod.*

Connecting rods should only be changed as matched sets.

5. Where special tooling is not available for the removal or fitting of the connecting rod bushing, a standard bushing can be fitted in the following manner.
6. Place the connecting rod securely in a bench press. Manufacture from suitable bar stock a press tool with the end face ground at an angle to suit the connecting rod bushing side face. Position the tool on the bushing and gently drive the bushing from its position. It is recommended a guide is manufactured to assist alignment of the bar stock during this operation.

7. A new bushing can then be fitted in a similar manner, by using a suitable piece of bar stock with an end face machined flat to suit the standard parallel bushing. Use a guide as described, and gently drive in the new bushing into the connecting rod.

NOTE: *The seam of the new bushing must be placed at 90° to the center line of the connecting rod.*



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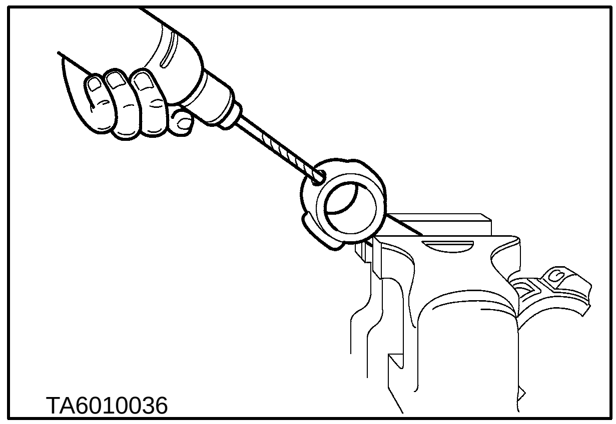
8. After installation, grind the side faces of the new bushing to match the side faces of the connecting rod. Ensure all sharp edges are removed, and loose chippings are cleaned from the connecting rod before reassembly into the engine.



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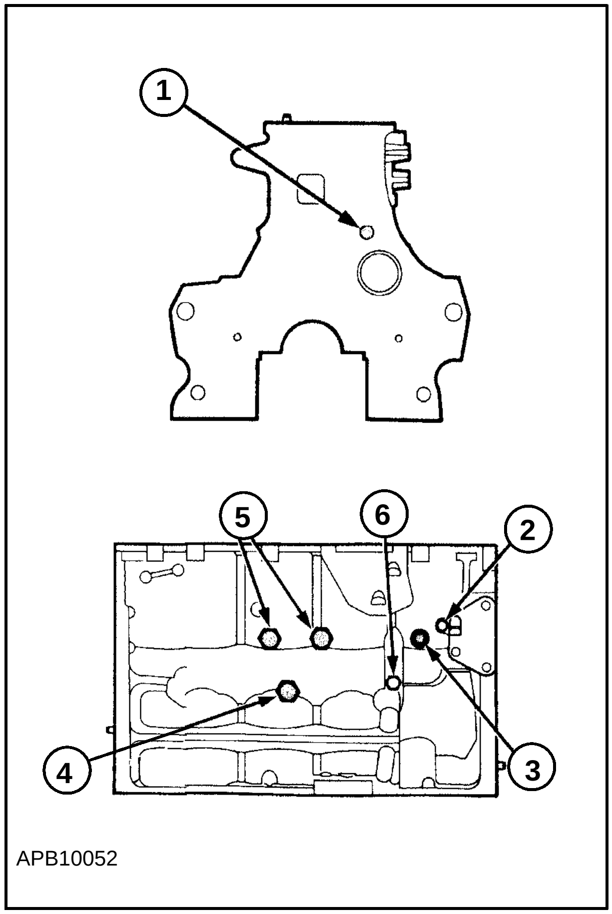
9. With a new bushing fitted, drill a hole through the top of the connecting rod using a 4.6 mm (0.181 in.) bit. Drill through the existing oil hole.
10. Use an expanding reamer to obtain correct bushing to piston pin clearance referring to specification section. Remove burrs, and chippings, before refitting.

CYLINDER BLOCK OVERHAUL

1. Cylinder block plugs and senders must be replaced if leaking or rusty. Clean the old sealant off the block and fit new plugs with sealer.

NOTE: *New part mating faces and threads should be coated in sealant. Assemble in the following manner.*



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Front and left hand side of the engine block.
Plug, 1, Apply sealant Threadlocker® 262/271 and drive in to block.

Plug, 2, Apply sealant PST Pipe Sealant 565 and torque to 8 - 14 N·m (6 - 10 ft. lbs.).

Fitting, 3, Apply sealant PST Pipe Sealant 565 and torque to 24 - 34 N·m (18 - 25 ft. lbs.).

Plug, 4, Apply sealant PST Pipe Sealant 565 and torque to 68 - 95 N·m (50 - 70 ft. lbs.).

Fitting, 5, Apply sealant PST Pipe Sealant 565 and torque to 24 - 34 N·m (18 - 25 ft. lbs.).

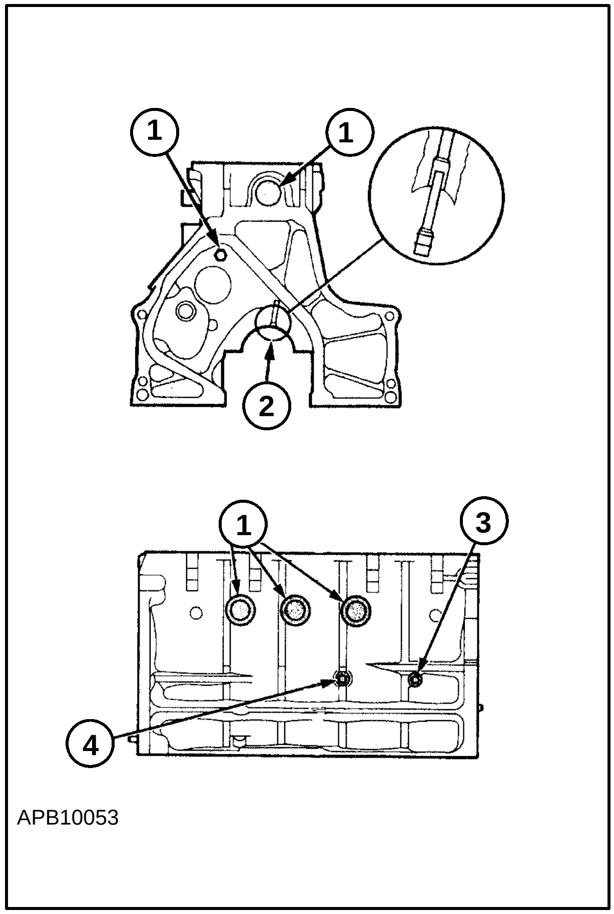
Plug, 6, Apply sealant PST Pipe Sealant 565 and torque to 27 - 47 N·m (20 - 35 ft. lbs.).

Rear and right hand side of the engine block.
Plug, 1, Apply sealant Threadlocker® 262/271 and drive in to block.

Oil Jets, 2, replace with new if damaged, apply engine oil only on re-assembly ‘‘Do not use sealant”**.**

Fitting, 3, Apply sealant PST Pipe Sealant 565 and torque to 8 - 14 N·m (6 - 10 ft. lbs.).

Plug, 4, Apply sealant PST Pipe Sealant 565 and torque to 54 - 81 N·m (40 - 60 ft. lbs.).



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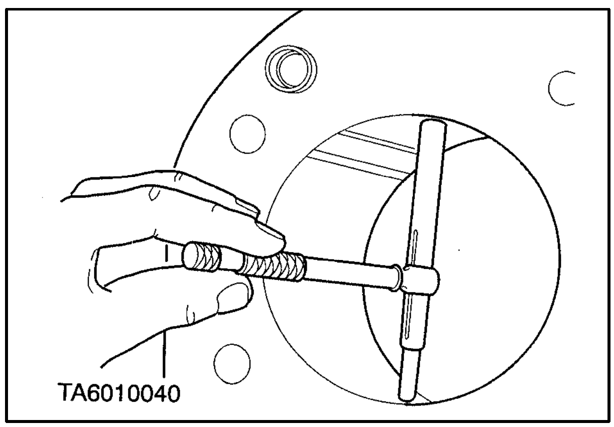
CYLINDER BORE

Check the cylinder bore for scuffing or rings around the ring travel area. Irregularities can be felt by running a finger over the surface. To check ovality, wear, or taper, use a telescopic gauge.

Measure lengthwise, A to B, and C to D, and compare dimensions. Variances between the readings will indicate “taper.”

Measure crosswise, compare dimensions A to C, and B to D. Variances will indicate “ovality.”



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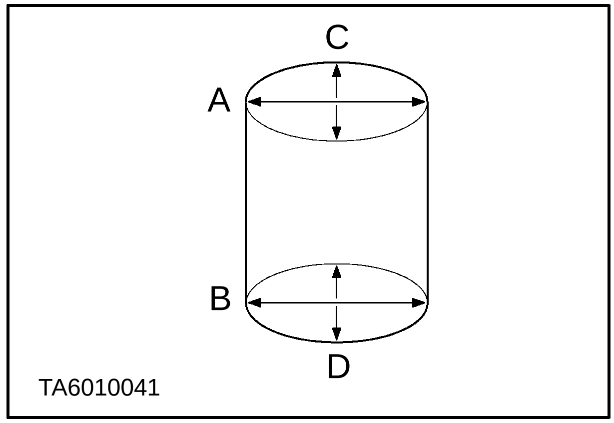
NOTE: *"Repair Limit" refers to the tolerance allowed after a repair has been performed. The "Wear Limit" is the tolerance prior to repair.*

Taper or cylinder:
repair limit – 0.025 mm (0.001 in.)
wear limit – 0.127 mm (0.005 in.)

Cylinder bore out of round:
repair limit – 0.03 mm (0.0015 in.)
wear limit – 0.127 mm (0.005 in.)

Cylinder bore diameter
111.78 - 111.841 mm (4.4007 - 4.4032 in.)



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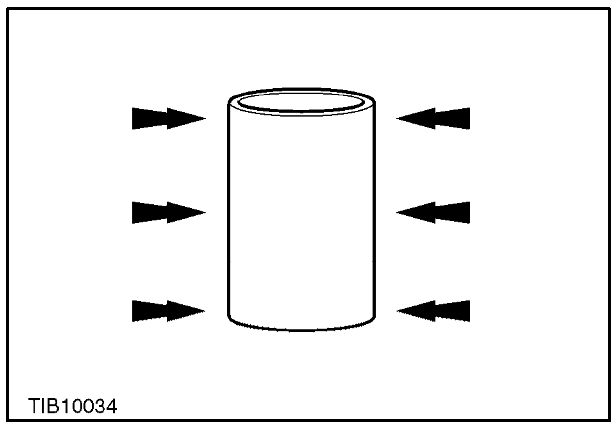
2. Where only minor imperfections exist and bores are to specifications, hone the bores prior to installing new piston rings, provided piston to bore clearance is less than 0.280 mm (0.011 in.).
3. Sleeving of the cylinder bores becomes expedient when:
   - Cylinder bore is beyond specification limits.
   - Replacing sleeves already installed in service.

SLEEVING - BORING AND HONING

1. Measure the outside diameter of the sleeve in several places, and average the dimension. Counter bore the cylinder block (see step 2) using the average dimension to obtain a press fit, between bore and sleeve. Interference of sleeve to the cylinder bore is to be: 0.025 - 0.076 mm (0.001 - 0.003 in.).
2. Counter bore to a depth of 204.7 mm (8.06 in.) from the block face, surface finish of the bore is not to exceed (80 microns). Leave a step at the bottom of the bore a minimum of 9.60 - 10.16 mm (0.380 - 0.400 in.), allowing for run out of chamfers.



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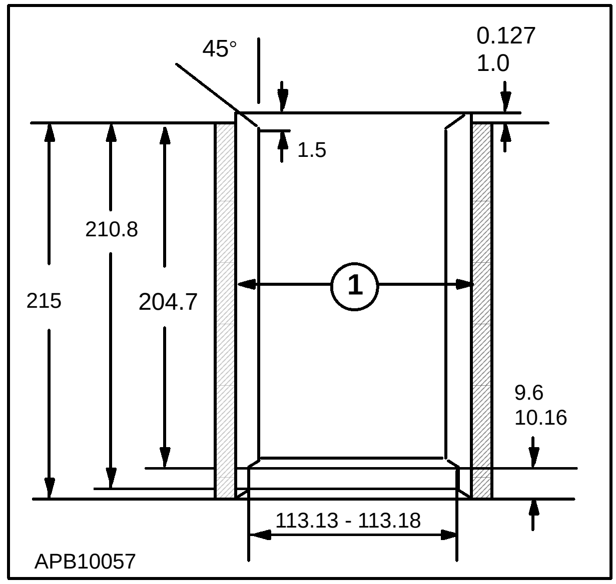
3. Bore through diameter to the diameter of 113.13 - 113.18 mm (4.454 - 4.456 in.).
4. Clean the cylinder bores and thoroughly dry.
5. Grease the sleeve with NH720A or similar, and press the sleeve home to the lip in the bore. The top of the sleeve should protrude through the top of the block, 0.127 - 1.0 mm (0.005 - 0.040 in.).
6. Bore the sleeve to: 111.7 - 111.76 mm (4.3985 - 4.400 in.).
7. Skim the block face and top of sleeves to achieve the specified flatness of: 0.08 mm (0.003 in.) in any 6 in. (152 mm); 0.001 in (0.03 mm) in any 1 in. (25.4 mm). A chamfer in the internal diameter at the top of the sleeve to 45° x 0.020 in. (0.5 mm) should be maintained, to prevent piston damage on reassembly.
8. Break the sharp edge at the bottom of the sleeve prior to honing.
9. Hone the cylinder bore to give the correct cylinder to bore clearance as described below.

NOTE: *Surface finish to be an average of 20 to 30 Microns, cross hatched at 35° - 55°.*

Maximum Taper:
0.025 mm (0.001 in.) through to bottom of the bore.

Maximum Ovality:
0.038 mm (0.0015 in.) through to bottom of the bore.



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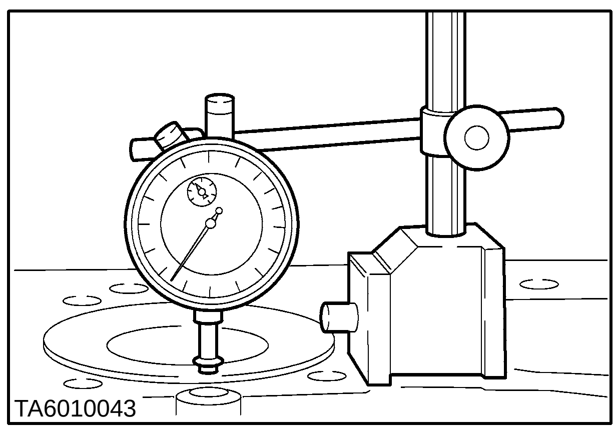
Reassembly

NOTE: *Pistons that are replaced must be of the same type that were removed and have the same identification letters and numbers, as embossed on the underside of the old piston.*

1. Upon reassembly with the piston at Top Dead Center, ensure the piston to block height is correct using a dial indicator: 0.28 - 0.58 mm (0.011 - 0.023 in.).



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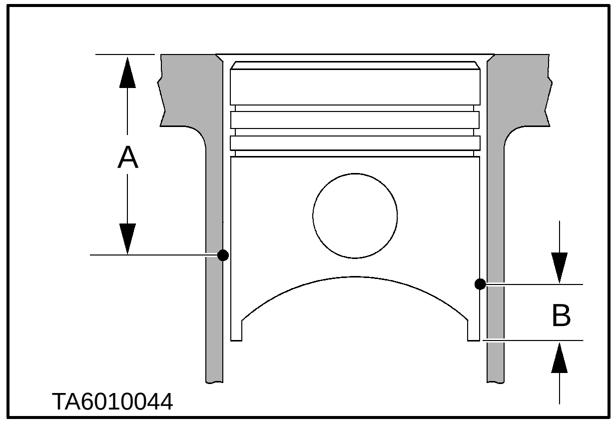
2. Check the piston to bore clearance in the following manner.

Measure the cylinder bore diameter from the top of the block to point: “A”, 82.6 mm (3.25 in.).

Measure the diameter of the piston at point: “B”, 97.28 mm (3.83 in.).

Subtract piston diameter from the bore diameter and the resultant figure for a new engine should be: 0.140 - 0.171 mm (0.0055 - 0.0067 in.).



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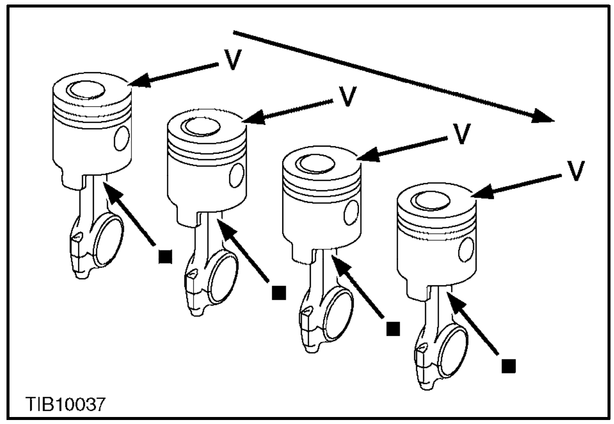
After an engine has run and settled down the maximum bore to piston clearance allowed is 0.28 mm (0.011 in.).

NOTE: *Pistons are only available as standard. New pistons should always be fitted if the clearance exceeds specification.*

If clearance is **“**greater,” try a similar new piston. If limit is still exceeded, it will be necessary to rebore and resleeve.

If the clearance is “less,” hone bore to obtain desired clearance.



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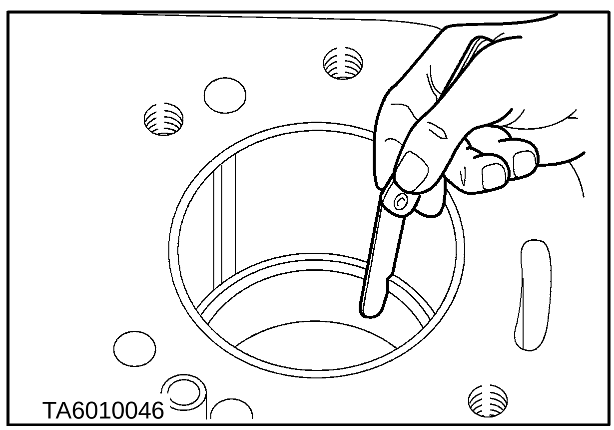
IMPORTANT: *Prior to reassembly ensure the letter or grade mark on the piston is aligned to the pip on the connecting rod and installed facing to the front of the engine.*

3. Lubricate all of the components with engine oil and assemble the connecting rod/piston.
4. Check the piston ring gap width, using a feeler gauge, in a vertical position at the top, middle, and bottom of the bore to:

   Top compression ring:
   0.38 - 0.84 mm (0.015 - 0.033 in.)

   2nd compression ring:
   0.66 - 1.12 mm (0.026 - 0.044 in.)

   Oil control ring:
   0.38 - 0.84 mm (0.015 - 0.033 in.)



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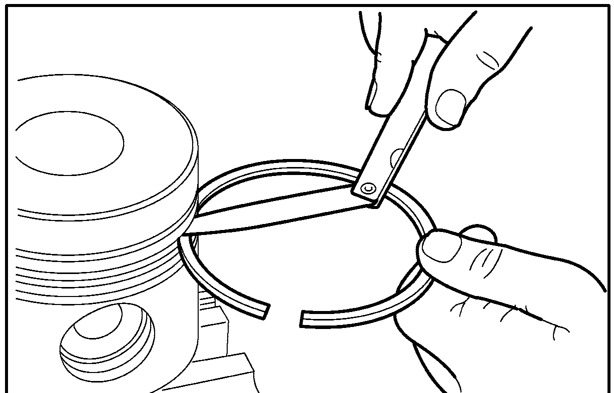
5. Using a new piston ring and a feeler gauge, check the gap between the ring and groove.

   Top compression ring:
   0.112 - 0.155 mm (0.0044 - 0.0061 in.)

   2nd compression ring:
   0.099 - 0.142 mm (0.0039 - 0.0056 in.)

   Oil control ring:
   0.061 - 0.104 mm (0.0024 - 0.0041 in.)



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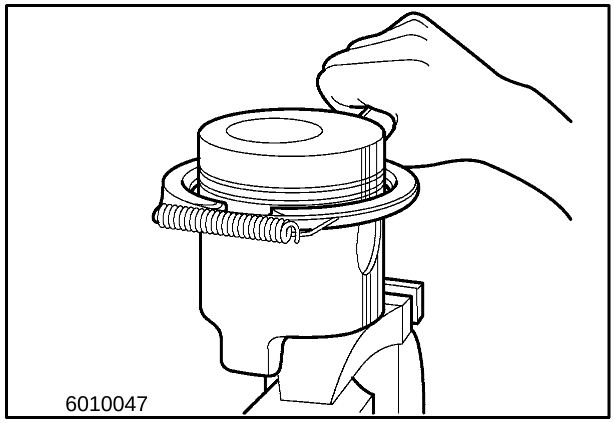
6. Ensure the correct expander is used to remove or install rings.
7. Install new piston rings but note the following.



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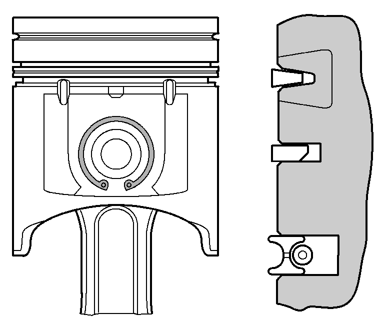
8. Install the top and second compression rings with the word top towards the top of the piston.

NOTE: *Before installing new pistons and rings into a used cylinder bore, remove the high polish from the cylinder walls by honing as previously described. Ensure the ring gaps are staggered equally around the piston circumference.*



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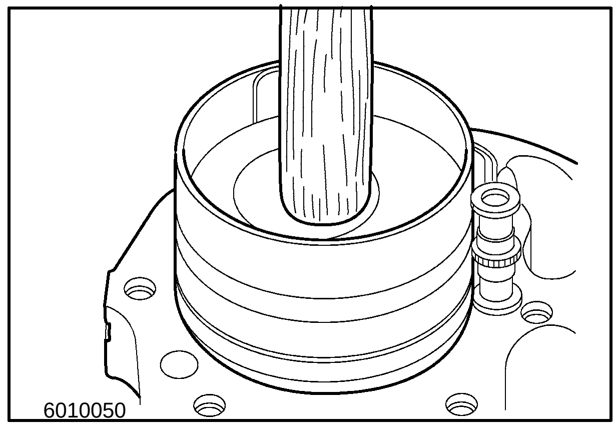
Piston Assembly Installation Into Block

1. Select the correct bearing liners as in the following crankshaft section, and install in the rod and cap, ensure the liner tang locates in the slots of the rod and cap.
2. Turn the crankshaft to position No 1 crankpin at the bottom of the stroke, and lubricate all parts with new engine oil. Using a ring compressor, and a soft drive, slide pistons into bores, ensuring grade letter on pistons, is towards the front of the engine.



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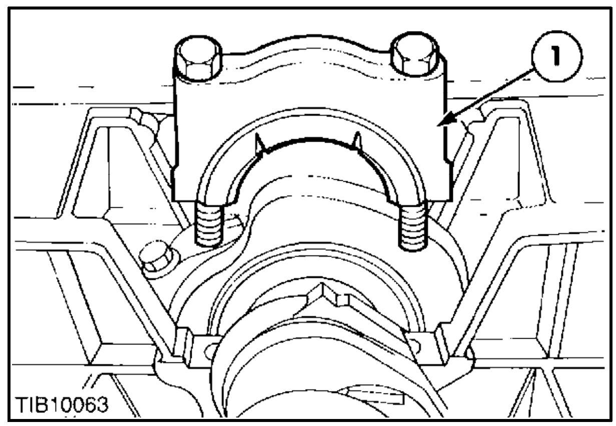
***NOTE:** Replaceable bearing liners are installed in production to ensure correct crankshaft journal to bearing clearance is maintained in service. The main bearings can be overhauled with the engine in the tractor. The crankshaft can only be serviced after removal from the tractor.*



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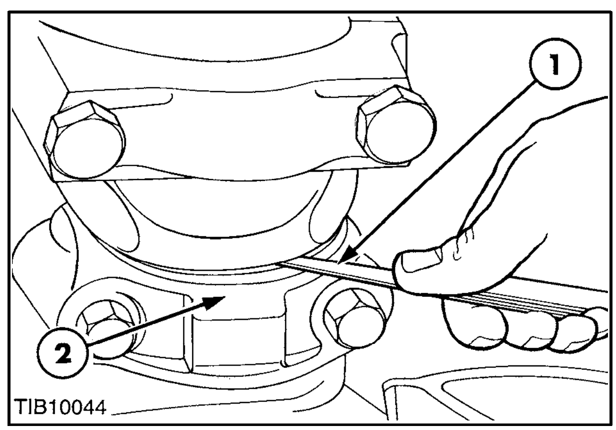
3. Ensure the connecting rod bearing liner seats on the crankpin with the bearing cap fitted to the connecting rod as a matched assembly. It is recommended that new bolts are fitted and lubricated with oil and tightened to a torque value of 149 N·m (110 ft. lbs.).
4. Using feeler gauges, 1, check the side clearance of each connecting rod, 2, to crankshaft and continue for remaining assemblies: 0.13 - 0.33 mm (0.005 - 0.013 in.).



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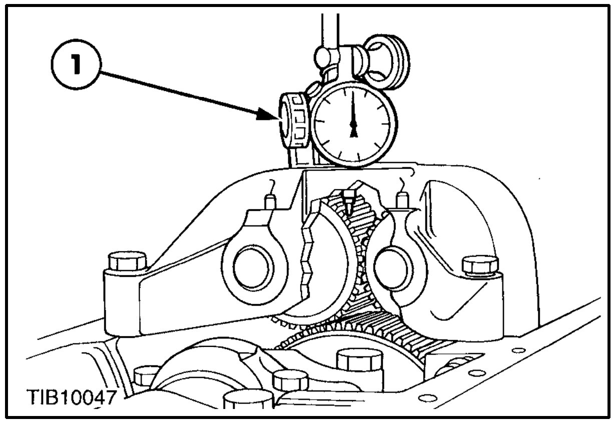
BALANCER / VIBRATION DAMPER

Removal

1. Remove the oil pan to expose the balancer. Using a dial indicator gauge, 1, check backlash between crankshaft gear and balancer drive gear. Position the dial plunger to the face of one of the drive gear teeth, then rock the gear to measure backlash. Readings should be taken at 90° intervals around the drive gear: 0.05 - 0.30 mm (0.002 - 0.012 in.). If the specification is exceeded, install new balancer gears.



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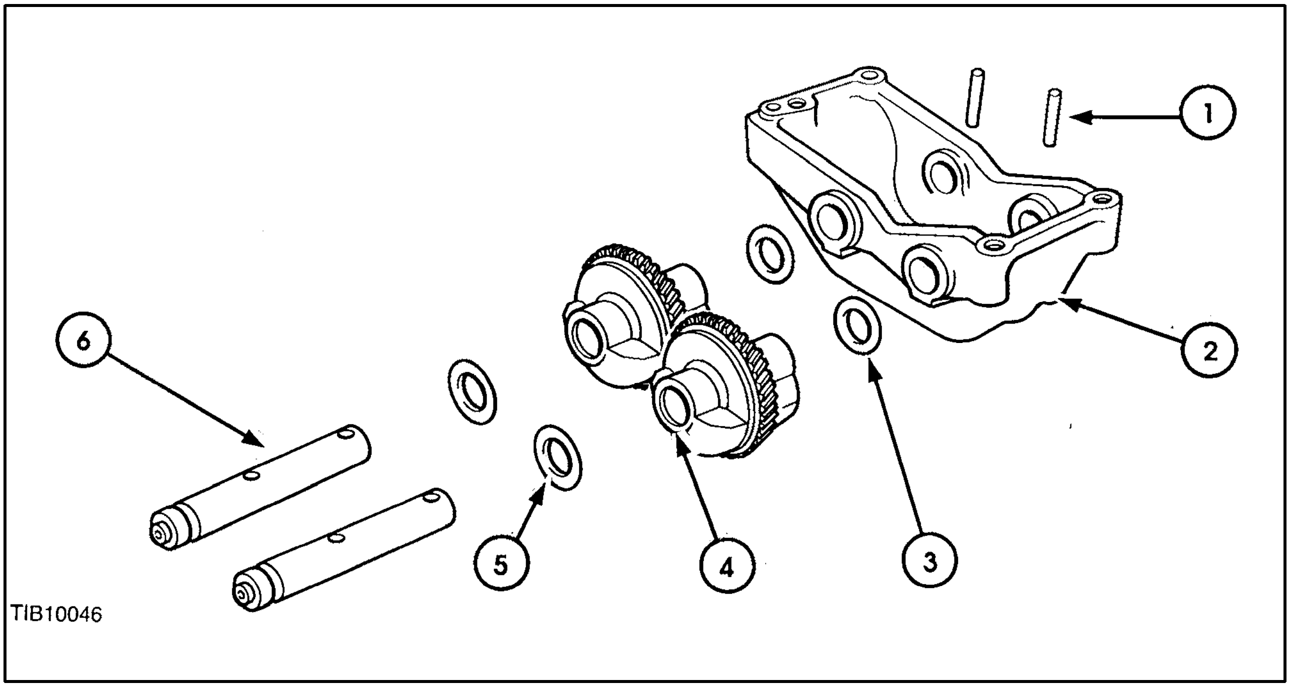

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Balancer Assembly

1. Roll Pins
2. Balancer Housing
3. Washers
4. Balancer Gears
5. Washers
6. Balancer Gear Shafts

Disassembly

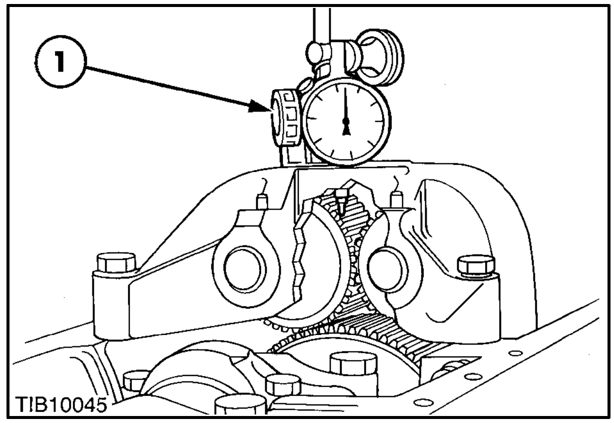
1. Extract the roll pins, 1, securing the shafts to the housing and disassemble the balancer.

Inspection and repair

1. Measure the outside diameter of shafts, 6, and the inside diameter of the gear bushings, 4, and establish if clearance is to specification: 0.012 - 0.038 mm (0.0005 - 0.0015 in.). If exceeded, replace shaft and/or gear assembly.

Reassembly

1. Position balancer gears and thrust washers in the housing with timing marks aligned, and facing the roll pin side of the balancer. Install shafts from the opposite side and secure with roll pins.
2. Using a feeler gauge measure end float, of assembled gears is to the specification of: 0.20 - 0.51 mm (0.008 - 0.020 in.).
3. Position a dial indicator gauge, 1, to the tooth of one gear, and hold the other firmly. Rocking the free gear, measure backlash at 90° intervals around the gears to specification: 0.05 - 0.20 mm (0.002 - 0.008 in.).
4. Examine shafts and balancer gear teeth for wear and damage, and replace as necessary. Ensure lubrication holes in the shafts are free from obstruction upon reassembly.



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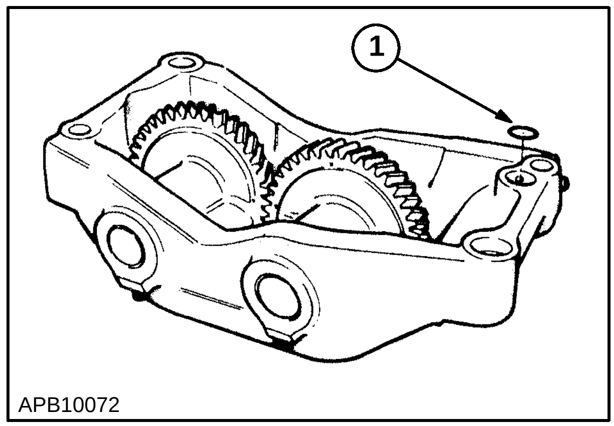
Installation

1. Clean all the mating surfaces, and install a new seal, 1, around the lubrication passage.
2. Rotate crankshaft until timing mark on crankshaft gear aligns with timing mark on balancer drive gear, position balancer on dowels install the bolts and torque to 108 - 120 N·m (80 - 90 ft. lbs.).
3. Recheck the gear backlash between crankshaft and balancer gear, as previously described and replace the oil pan.



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Op. 10 103 10

MAIN BEARING REMOVAL

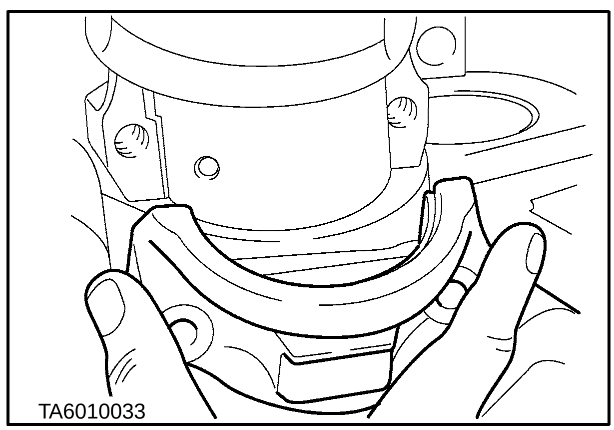
1. Remove oil pan and balancer to gain access to the crankshaft. Remove the main bearing caps, and install one set at a time.

Inspection and Repair

1. Thoroughly clean bearing liners, journals, caps, and inspect for wear, scores, or damage. Replace as required**.**

Installation

1. Coat all parts in new engine oil prior to assembly. Position bearing cap with locking tang towards camshaft side of engine and tighten the bolts to 190 - 203 N·m (140 - 150 ft. lbs.).
2. If fitting a new thrust bearing liner, it must be aligned as in the following crankshaft section.



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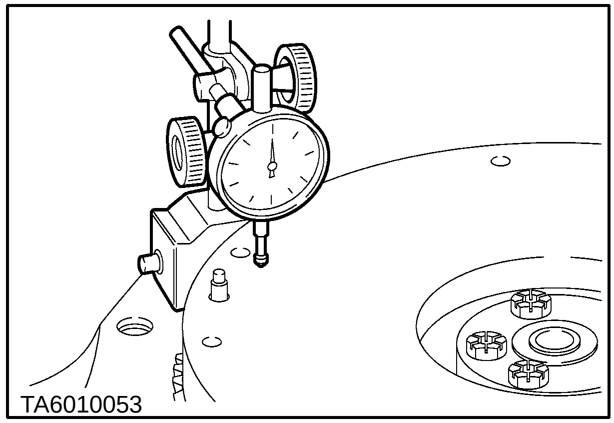
Op. 10 103 70

FLYWHEEL REMOVAL

1. To gain access to the flywheel, separate the engine to transmission.
2. Using a dial indicator, measure the flywheel runout. If runout exceeds 0.127 mm (0.005 in.) check the flywheel to crankshaft seating.



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Inspection and Repair

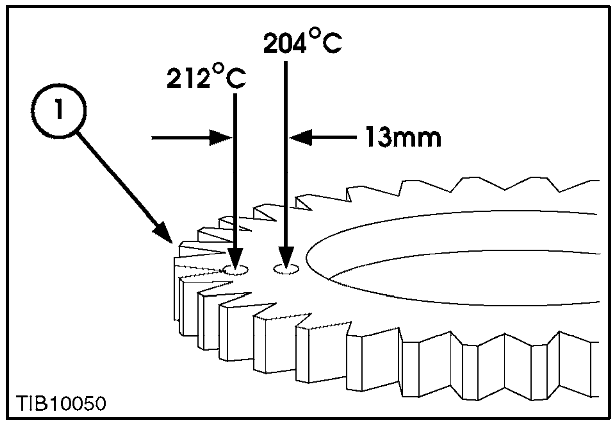
Ring Gear

1. Inspect the flywheel ring gear, and if damaged renew in the following manner:

   Cut old ring gear free from the flywheel.

   Clean the mating surfaces of the new ring gear and flywheel.

2. Use temperature indicating crayons to mark the side face of the ring gear, 1, in six equal places, mark with a 204°C (400°F) crayon at a point 13 mm (0.5 in.) below the root of the teeth, and mark with a 212°C (450°F) crayon at a point just below root of the teeth.
3. Use an oxy-acetylene torch with a tip size of No 2 maximum, and direct the flame against the internal face of the gear.
4. Stop applying heat when the 204°C (400°F) crayon mark melts but before the 212°C (450°F) crayon mark melts.



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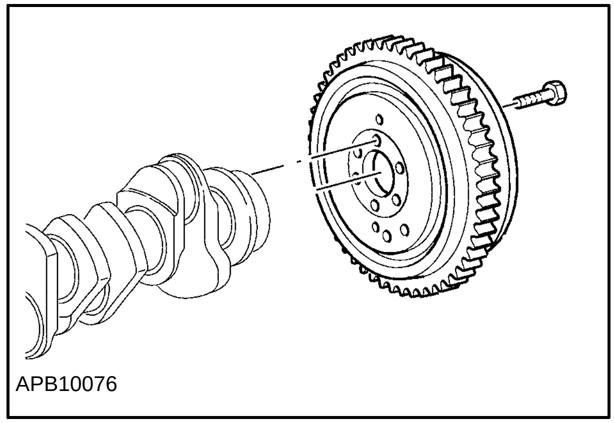
5. Quickly place the hot gear on the flywheel with flat face against the shoulder on the flywheel. The gear to flywheel runout should be checked using a dial indicator and should not exceed a Total Indicator Reading of 0.63 mm (0.025 in.).



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Flywheel Surface

1. In the event of flywheel surface damage due to excessive clutch wear, the surface may be skimmed. A maximum of 3 mm (0.118 in.) is to be removed from the face of the flywheel.

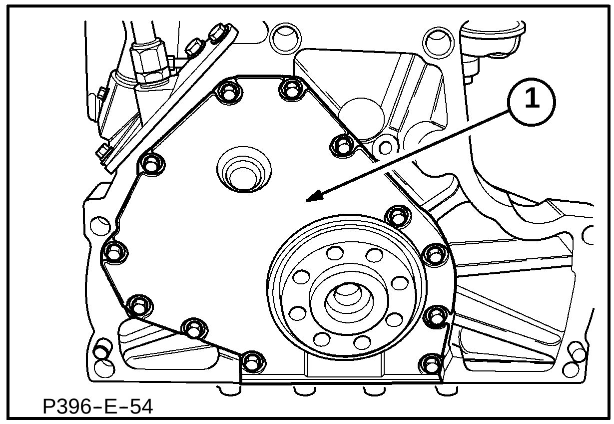
Installation

1. Clean the crankshaft rear flange and mating surface of the flywheel, install the flywheel, and torque the bolts to 197 N·m (145 ft. lbs.).

Op. 10 102 40

REAR COVER PLATE REMOVAL

To gain access to the engine oil pump, camshaft gear, or end of crankshaft, remove the oil pan as previously described along with the rear cover, in the following manner.



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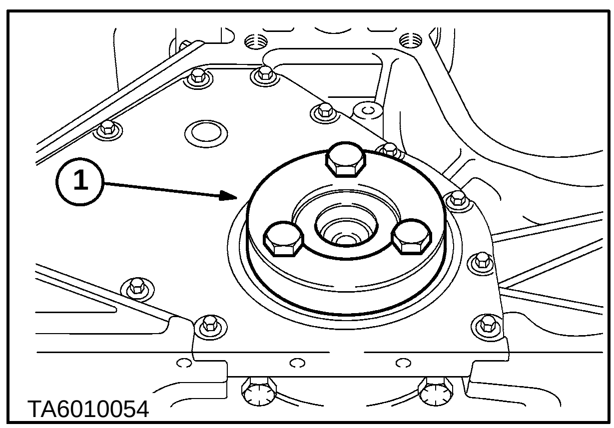
1. With rear of engine exposed, loosen and remove the 12 attaching bolts and gently pry off cover plate, 1.
2. Clean off all sealer, remove crankshaft oil seal, and check for damage or distortion around the sealing faces.

Installation

1. Ensure rear of block face is clean and free of old sealer, install a new gasket and apply sealer to faces, 1. With the plate in the recess, install and leave the bolts loose.
2. Apply a liberal coating of new engine oil on a new oil seal and position the rear seal over the end of the crankshaft. Locate tool, # FNH 01301, on the end of the crankshaft using the three attaching bolts. Tighten evenly and squarely until the seal is fully seated.



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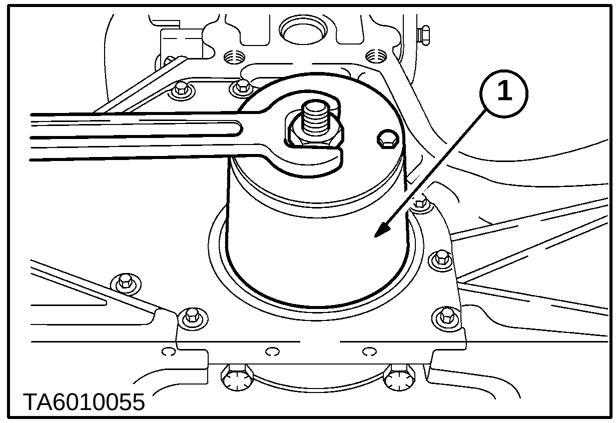
As an alternative, the rear crankshaft oil seal can be installed using the following installation tool.

3. Apply a liberal coating of clean engine oil to the rear seal retainer, seal, and journal. A new seal should be mounted on the crankshaft, then bolt tool # FNH 01301 to crankshaft end and install the new seal squarely.
4. Secure center stock of tool, 1, to crankshaft flange with two screws. Assemble cylinder end plate to center stock and secure with nut and washer. Tighten the nut until outer diameter of tool abuts retainer. Tool must not be over tightened as stress and distortion could be imposed on the retainer.



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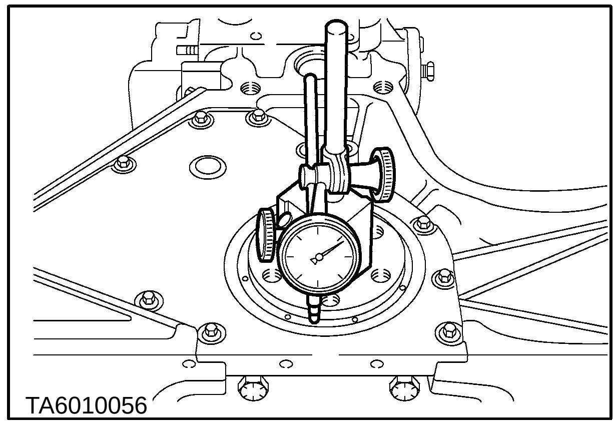
5. Remove the tool after assembly and check the crankshaft seal run out with a dial indicator.

NOTE: *The first seal replacement should be pushed into retainer with plain end of tool and subsequent seals with stepped end of tool which will reposition seal 1.52 mm (0.060 in.) further in.*



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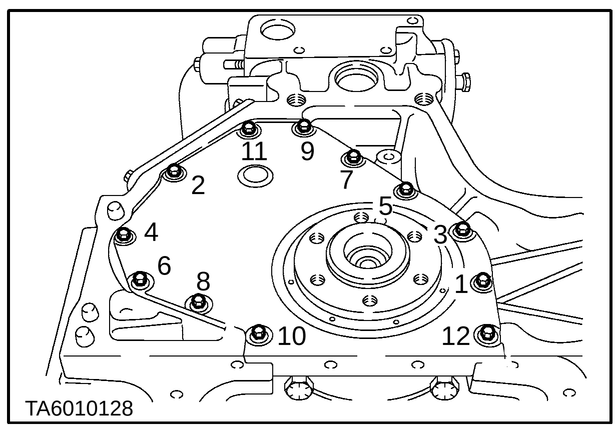
6. Tighten the twelve bolts in sequence to 16 - 23 N·m (12 - 17 ft. lbs.).



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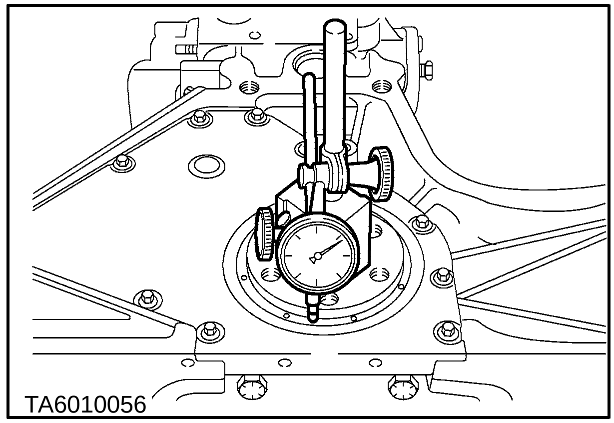
7. With new crankshaft seal installed, place a dial indicator on the end of the crankshaft and ensure seal runout is within 0.51 mm (0.020 in.) Total Indicator Reading.



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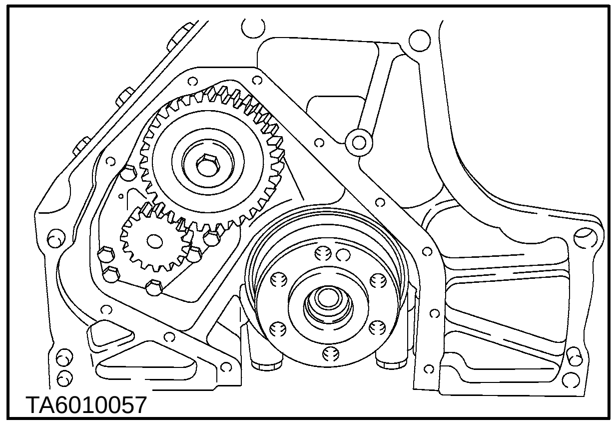
Op. 10 304 34

OIL PUMP REMOVAL

1. Prior to pump removal check pump gear to camshaft gear backlash does not exceed 0.40 - 0.56 mm (0.016 - 0.022 in.).



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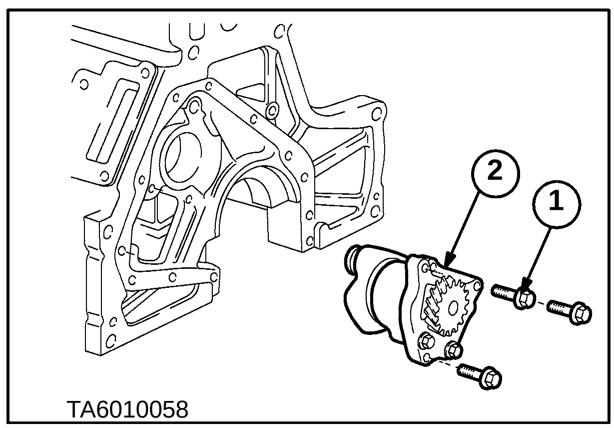
2. Loosen and remove the camshaft gear to expose the oil pump, detach the 3 pump mounting bolts, 1, and withdraw the pump from the block, 2.



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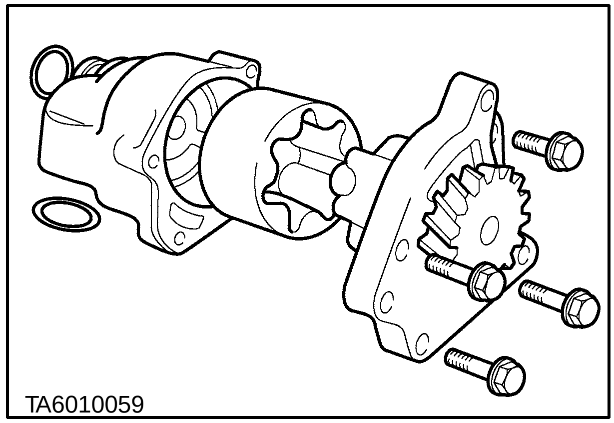
Installation

1. Clean and coat parts in new engine oil.
2. Fit a new O ring to the pump output tube and into suction port. Lubricate and insert the pump into the block tightening the bolts to 23.0 - 28.4 N·m (17 - 21 ft. lbs.).



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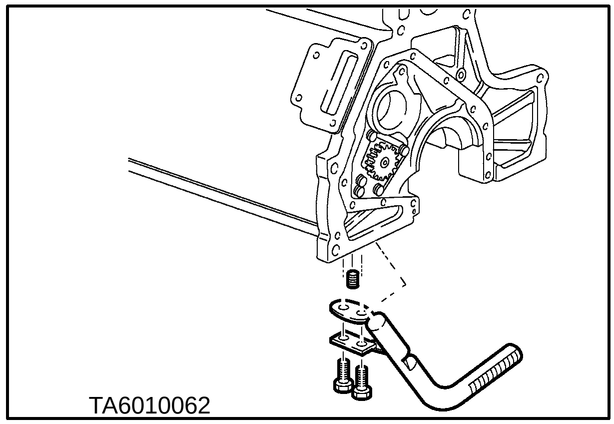
3. Insert tube/screen assembly into pump through bottom of engine. Fitting a new gasket, and torque the attaching bolts to 27 - 34 N·m (20 - 25 ft. lbs.).



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Oil Filter Support Assembly

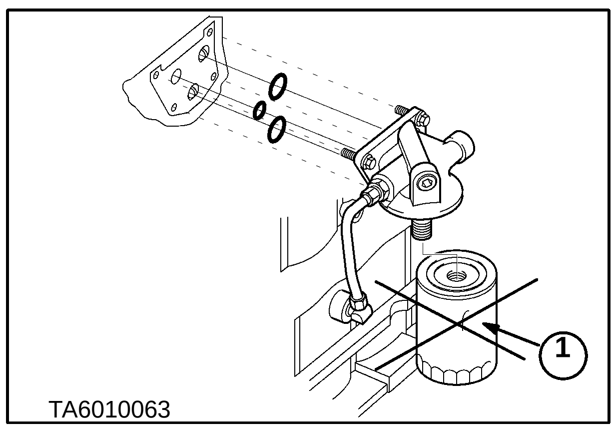
Removal

1. Unscrew and discard the old filter, 1. Loosen the attaching bolts and oil connections and remove the filter support assembly from the block. Discard the O rings.
2. Clean assembly in a suitable solvent and ensure all ports are free of dirt.

Installation

1. Lubricate the pressure relief valve and spring and insert into housing, ensuring free movement.

   Fit a new O ring to the plug and torque to 55 N·m (42 ft. lbs.).



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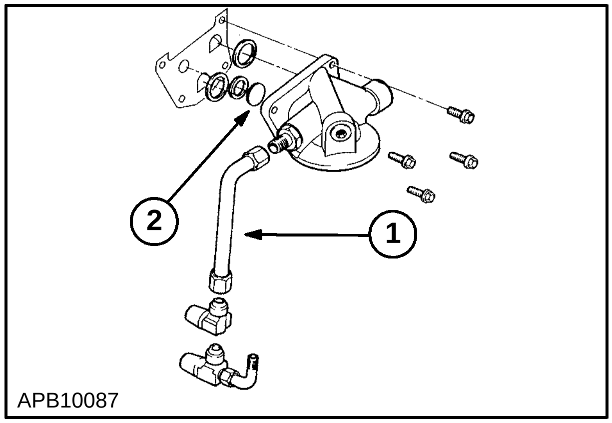
NOTE: *On some models, the pressure relief valve "end plug" is replaced by an oil return tube, 1, from the engine block. Where this pipe is fitted, a plug, 2, is used to blank the oil return port to the engine block.*

2. Fit tube to the connector and torque to 27 N·m (20 ft. lbs.).
3. Refit the oil filter head to the engine block with new O rings and plug where required as above and torque the bolts to 34 - 47 N·m (26 - 35 ft. lbs.).



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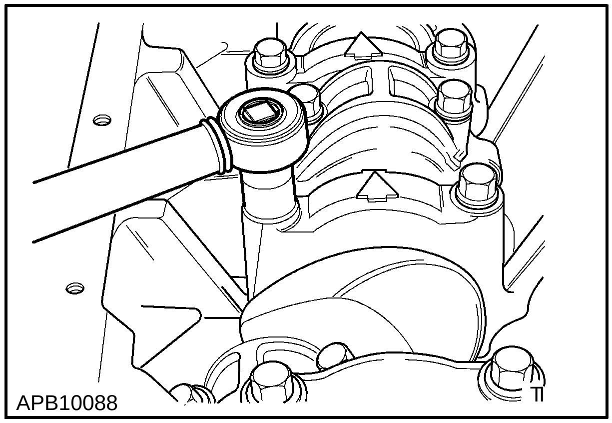
Op. 10 103 10

CRANKSHAFT REMOVAL

1. Remove the engine from the loader and place on an engine stand.
2. Remove the flywheel, rear cover plate, crankshaft pulley and engine front cover.

NOTE: *If crankshaft is removed with cylinder head in position, ensure all timing marks are realigned prior to reassembly. This action will prevent possible interference between valves and pistons during reassembly.*

3. Remove the oil pan and oil pump.
4. Remove the connecting rod caps, main bearing caps and liners, and identify to facilitate reassembly.
5. Carefully remove crankshaft from cylinder block.



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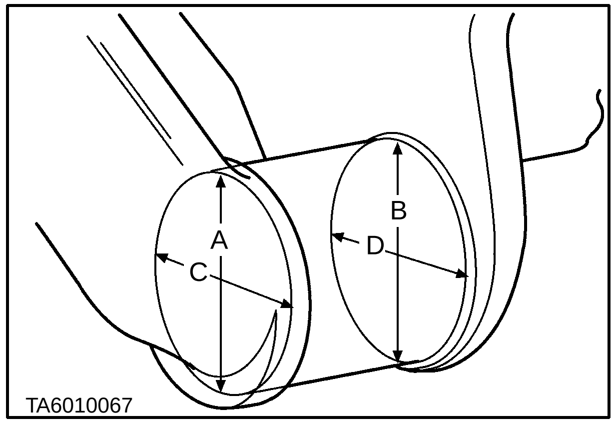
Inspection and repair

NOTE: *Current production engines may have a crankshaft with main or crankpin journals ground 0.010 in. (0.25 mm) undersize. These are identified with the letters 010 MUS and or 010 PUS respectively, letters being stamped on one of the crankshaft counter balance weights.*



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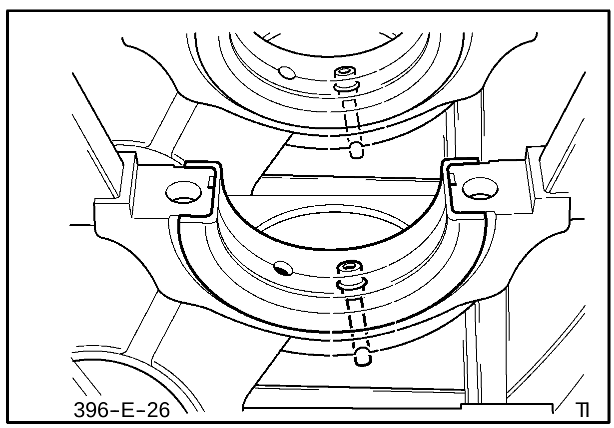
1. If crankshaft timing gear teeth are worn or damaged replace as necessary as described.
2. Wash the crankshaft and drilled passages in a suitable solvent. Dress minor imperfections using an oil stone but for severely marked journals, machine to the next size to suit available service bearings.
3. Measure diameter of each journal in four places to determine out-of-round, taper, or wear.
   Measuring A compared with B indicates vertical taper.
   Measuring C compared with D indicates horizontal taper.
   Measuring A and B compared with C and D indicates journal out-of-round.
4. If the journal exceeds specified limits refer to “specifications” and refinish journal to the next service bearing available.
5. Examine the rear oil seal journal for score marks, remove minor imperfections with fine emery cloth, and if severely damaged renew the crankshaft.

With the crankshaft removed check the oil lubrication jets situated in the block journals are clear and free of contaminates.

If replacing the oil jets, gently tap out the old ones and replace with new.



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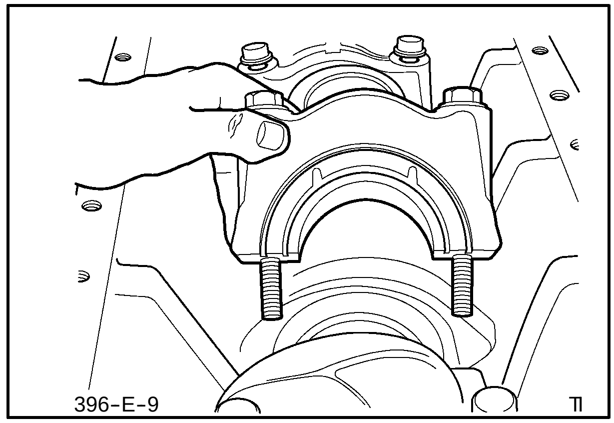
CRANKSHAFT REASSEMBLY

NOTE: *Normally main bearing journals wear evenly and will not be out-of-round, but if a liner which is to specification is fitted to an out-of-round journal, ensure liner suits maximum diameter of journal.*

1. If these combinations of liners do not produce specified clearance, refinish crankshaft and fit suitable service bearings.

IMPORTANT: *Engines may be assembled with liners of different material, but liners of the same material must be used on the same journal.*

2. Position the bearing liners and caps in the block and coat with oil. If the crankshaft has been refinished, fit the correct service bearing liners.
3. Ensure the bearing surfaces are clean and bearing liner tangs align with slots in the block and cap.
4. Align the timing mark on the crankshaft gear with that of the camshaft idler gear and install the crankshaft. Install a thrust bearing cap with flange-type bearing liner first, installing remaining bearing caps to their original location.
5. Tighten all bearing caps (except thrust bearing cap, leave finger tight) to a torque of 197 N·m (145 ft. lbs.).



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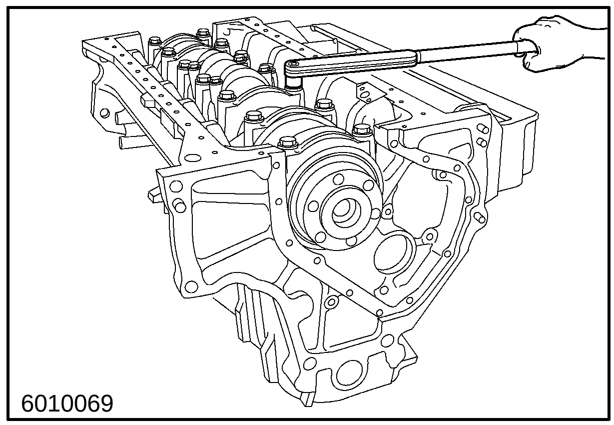

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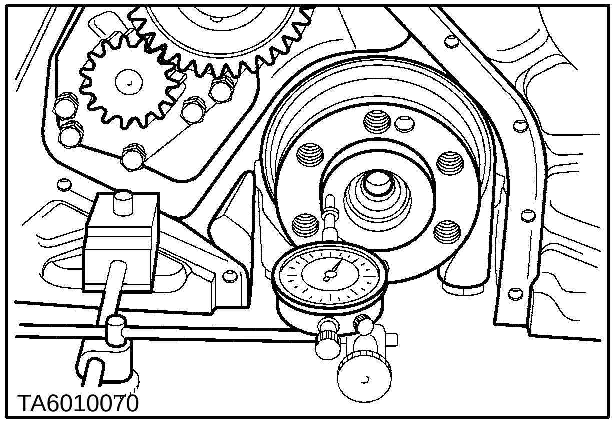
6. Pry the crankshaft forward against thrust surface of bearing, hold crankshaft forward and pry bearing cap rearwards, taking care not to pry against flange of bearing liner. This will align thrust surfaces of both halves of bearing. Hold forward pressure on crankshaft and tighten bearing cap bolts to a torque of 197 N·m (145 ft. lbs.).

NOTE: *Do not pre-install seal into retainer. To ensure seal concentricity, it must be assembled with rear plate and installation tool when fitted to crankshaft.*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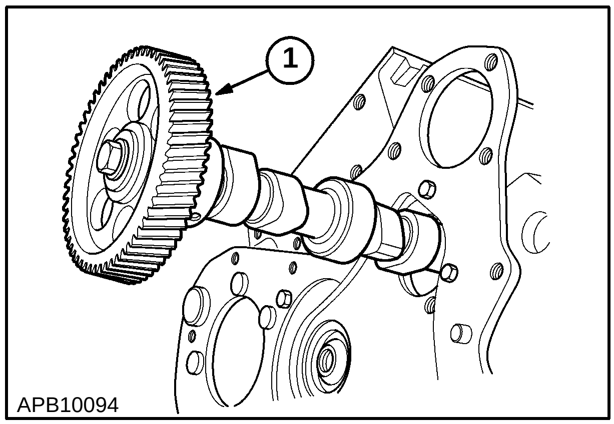
7. Check crankshaft end play with a dial indicator gauge, pry crankshaft towards front of engine and set dial indicator to zero. Pry crankshaft towards rear of engine and note reading on dial. If end play exceeds 0.10 - 0.20 mm (0.004 - 0.008 in.), fit a new thrust bearing liner.
8. If the end play is less than specification, check thrust bearing for burrs, scratches, or dirt, and realign thrust bearing.
9. Install rear crankshaft oil seal as previously described in back plate removal.

Op. 10 106 40

CAMSHAFT REMOVAL

NOTE: *The camshaft bearings and tappets can only be serviced with engine removed from the loader.*



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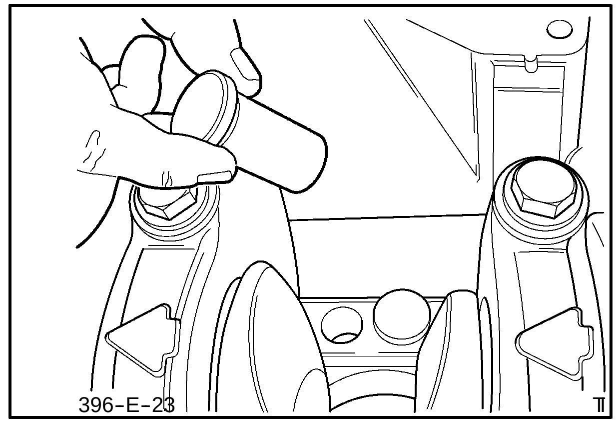
1. Remove the engine front cover and cylinder head.
2. Check the camshaft end play (see timing gears section) and remove gear, or remove the thrust plate bolts for removal of gear and camshaft as an assembly.
3. After removal of the flywheel and rear cover, remove the camshaft oil pump drive gear.
4. Invert the engine on the stand if camshaft bearings are to be replaced, and remove the oil pan.
5. Carefully withdraw the camshaft from the rear of engine.

6. Lift out the tappets and place in a numbered rack for reassembly.



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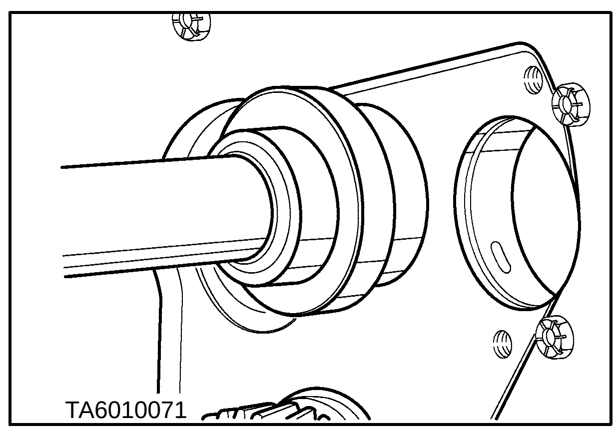
Inspection and repair

1. Inspect the camshaft journals and lobes, for damage, pitting, or heat discoloration. If any of these conditions exist, install a new camshaft.
2. Inspect the oil pump drive gear on camshaft for broken or worn teeth, and mating gear on oil pump. If any wear or damage is apparent, fit new gears.
3. Check each tappet for wear or damage and check diameters, if not to specification renew: 25.15 - 25.17 mm (0.9900 - 0.9910 in.).
4. Measure the diameter and out-of-round condition of bearing journals, if exceeded fit a new camshaft: 60.693 - 60.719 mm (2.389 - 2.390 in.).

CAMSHAFT BEARINGS

1. Inspect the camshaft bearings for wear or damage. Measure the clearance between the internal diameter of bearing and outside diameter of respective journal: 0.025 - 0.076 mm (0.001 - 0.003 in.).
2. If specification is exceeded, install new bearings using Remover/Replacer Tool # FNH 01225 (or 1255) and handle Tool # FNH 01442.
3. To remove, position tool against bearing to be removed and attach handle, driving bearing from bore.
4. To install, align oil holes of new bearing with holes in block, and drive bearing into bore using tools as described.



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NOTE: *A positive alignment check can only be made with crankshaft removed, when a 4.6 mm (0.18 in.) rod can be passed down the oil passage from the crankshaft main bearing. Liner is correctly positioned when end of rod passes through oil hole in the liner.*

Installation

1. Apply petroleum jelly to each tappet foot, and coat tappet body with oil. Install tappets in bores from which they were removed.
2. Oil camshaft journals and apply petroleum jelly to the cam lobes, and install camshaft into engine.
3. Install new spacer and keyway on end of camshaft.
4. Install a new thrust plate and torque 41 - 54 N·m (30 - 40 ft. lbs.).
5. Install camshaft gear, and align the camshaft gear timing mark and torque bolt to 55 - 77 N·m (43 - 58 ft. lbs.), and recheck end play.
6. Apply sealant Ultra Black® to the sealing flange of the front cover plate on reassembly.

ENGINE COMPRESSION TEST

TEST PROCEDURE

1. Be sure battery performance meets specifications.
2. Warm up the engine by operating for a minimum of half an hour at 1200 rev / min.
3. Stop the engine and remove the injector and seat washer from each cylinder.
4. Clean the injector bore and crank the engine to blow out any loose carbon particles.
5. Install a proprietary engine compression test gauge into the injector bore, using a new seat washer and the injector mounting bolts.
6. Connect the gauge and hose to the adapter.
7. Crank the engine at 200 rev/min with the electric fuel shut off wire disconnected to prevent engine start-up.
8. Observe the gauge reading, and repeat the compression test, steps 5 - 7 for each cylinder.
9. All cylinder compressions should be uniformly within 1.7 bar (25 PSI) of each other.
10. A reading of more than the 1.7 bar (25 PSI) below the other cylinders indicates leakage at the cylinder head gasket, piston rings or valves.
11. A reading of more than 1.7 bar (25 PSI) above the other cylinders indicates excessive carbon deposits on the piston and cylinder head.
12. A low even compression in two adjacent cylinders indicates a cylinder head gasket leak. Check this item before condemning the rings or valves.

TEST CONCLUSION

To determine whether the rings or the valves are at fault, squirt the equivalent of a tablespoon of heavy oil into the combustion chamber. Crank the engine to distribute the oil and repeat the compression test.

The oil will temporarily seal any leakage past the rings. If approximately the same reading is obtained, the rings are satisfactory, but the valves are leaking.

If compression has increased over the original reading, there is leakage past the rings.

During a compression test, if the pressure fails to climb steadily and remains the same during the first two successive strokes, but climbs higher on the succeeding strokes, or fails to climb during the entire test, suspect a sticking valve.

Op. 10 400

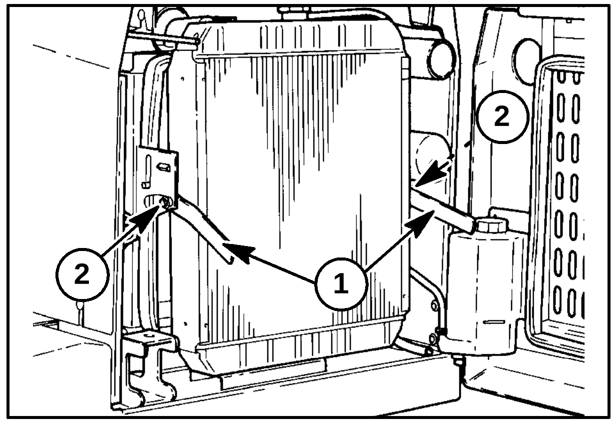
COOLING SYSTEM - LS190

RADIATOR

Op. 10 406 10

Removal

1. Drain the engine coolant system.
2. Lift up on the two handles, 1, to move the radiator rearward.
3. Remove the upper and lower radiator hoses.
4. Remove the radiator overflow hose to the overflow tank.
5. Remove two cap screws and spacers, 2. Remove the radiator.



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Inspection And Repair

1. Inspect the fins for damage and ensure they are free from obstruction.
2. Check the radiator for leaks.

Installation

1. Installation of the radiator follows the removal procedure in reverse. On installation, observe the following requirements:

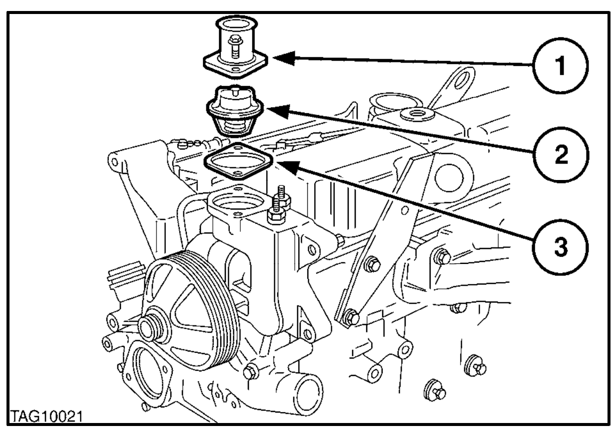
Depending upon the weather conditions, ensure the correct grade and quantity of antifreeze is added to the coolant. See “Specifications Service Standards” in this section.

Run the engine for several minutes and check the radiator and connections for leaks.

Op. 10 402 30

THERMOSTAT REMOVAL

1. Drain the coolant system below that of the level of the thermostat housing.
2. Remove the thermostat housing retaining bolts, 1, and move the housing with tube attached to one side.
3. Withdraw the thermostat, 2, from the housing, along with the gasket, 3.



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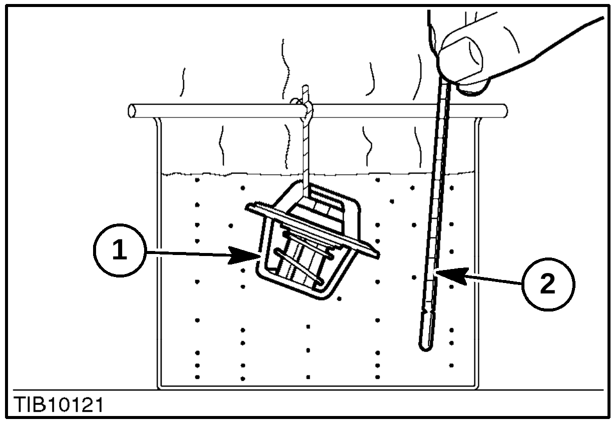
Inspection and Repair

1. Place the thermostat, 1, in a container filled with a 50/50 mixture of antifreeze and water.
2. Place a high temperature thermometer, 2, in the coolant mixture and heat the container.
3. Note the coolant temperature at which the thermostat starts to open and when it is fully open.
4. Replace the thermostat if it fails to open at the specified temperature.

   Thermostat opening temperature start to open : 79 - 83°C (174 - 181°F) Fully open: 93 - 96°C (199 - 205°F)

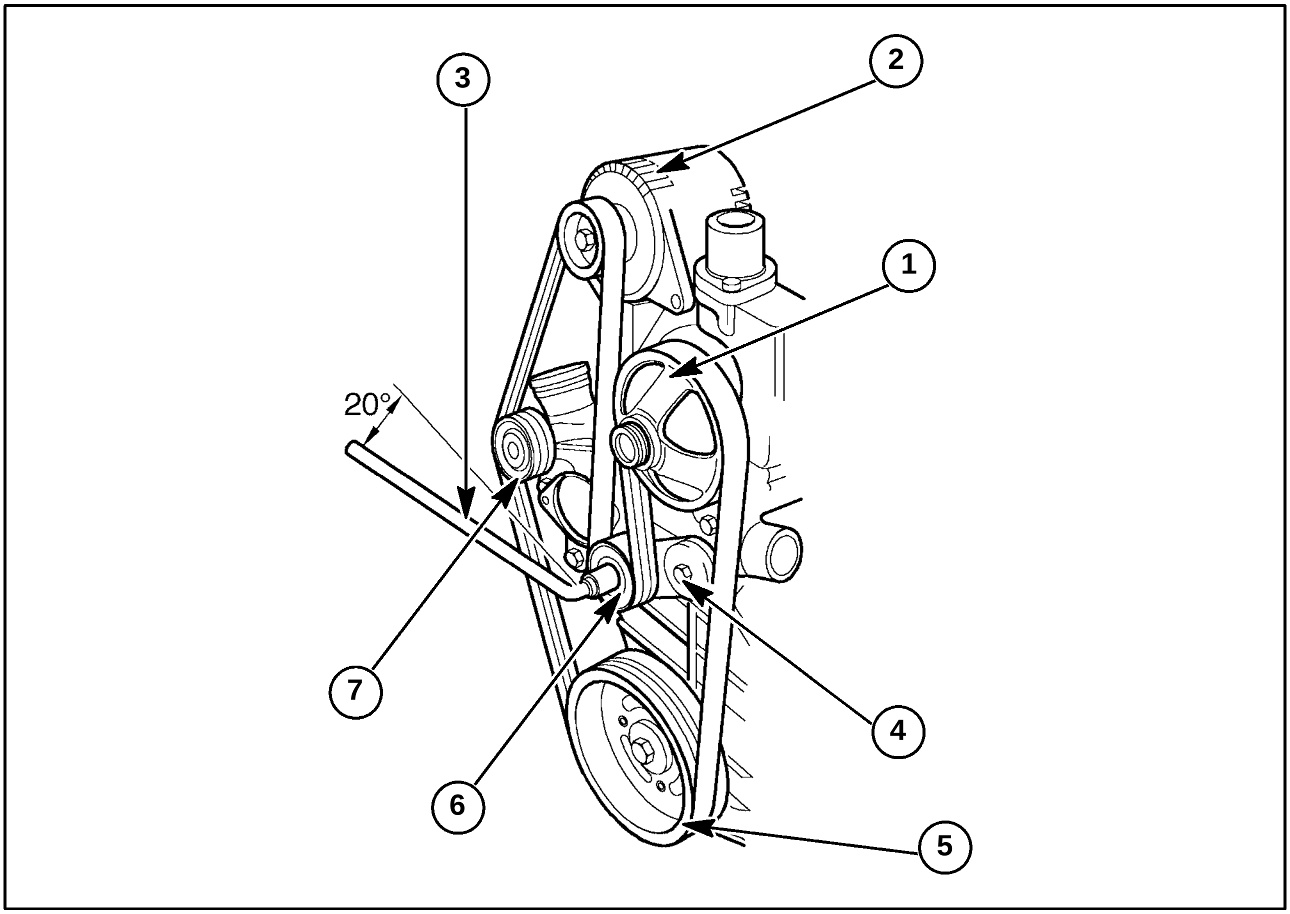


287

Installation

Installation of the thermostat is the reverse of the removal procedure but observing the following:

1. Prior to reassembly, ensure the thermostat housing faces are clean and free of old sealer or gasket material. Clean the faces with a small stone or fine grit paper.
2. Coat a new gasket with sealer 518 Gasket Eliminator® and position in the recess on the thermostat housing, prior to installing the thermostat.
3. Coat the edge of the thermostat with grease and install, with the heat element located in the cylinder head.
4. Refit the thermostat housing and torque the two bolts to 20 - 28 N·m (15 - 21 ft. lbs.).
5. Ensure the correct grade, and quantity of antifreeze, is added to the coolant. Recommended content mixture is Water 50%, with 50% antifreeze.



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Fan Belt Tensioner

1. Water Pump Pulley
2. Alternator
3. Torque Wrench
4. Tensioner Attaching Bolt
5. Crankshaft Pulley
6. Tensioner Assembly
7. Idler Pulley

FAN BELT TENSIONER REMOVAL

1. The fan belt should be removed in the following manner. Place a lever with socket attachment onto the tensioner retaining bolt and gently lever the tensioner up. Remove the fan belt from the pulley and allow the tensioner to return to its un-tensioned position once the belt has been removed.
2. Remove the tensioner from the pump by loosening and removing the center attaching bolt.

Inspection and Repair

1. Checking of the tensioner assembly operation should be carried out with the tensioner assembly still attached to the water pump. To check the spring load, place a “break back” torque bar pre-set to 70 - 85 N·m (52 - 63 ft. lbs.) on to the pulley attaching bolt. Raise the lever up through an arc of 20° maximum. If the torque bar does not “break” within the range, a new tensioner assembly is required.
2. Ensure the tensioner pulley rotates freely by hand. If not, replace with new parts.

Re-Assembly

1. Fit a new pulley to the assembly if required, and torque the attaching bolt to 46.5 - 60 N·m (34.5 - 44 ft. lbs.).
2. To re-assemble the arm assembly, position the tensioner on to the water pump, fit the mounting bolt through the assembly, and torque the bolt to 46.5 - 60 N·m (34.5 - 44 ft. lbs.).
3. Refitment of the fan belt is the reverse of the removal procedure, but ensure the “Poly V” belt is positioned correctly onto all of the pulleys.

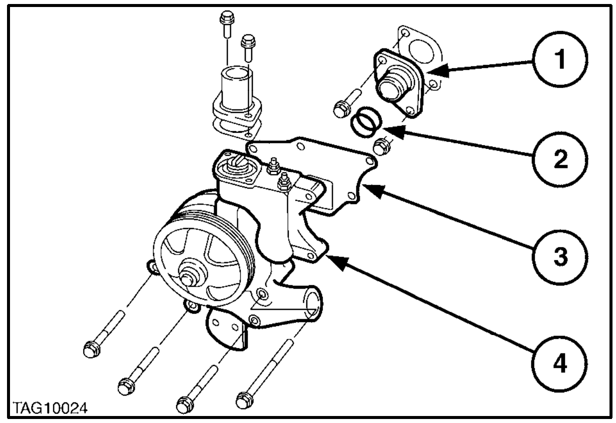
IDLER PULLEY

1. The idler pulley is fitted to the vehicle on the right hand side of the engine front cover, in front of the oil filler cap.
2. Check that the idler pulley rotates freely. If tight or worn, replace with new. Removal and replacement is by the attaching bolts through the center of the bodies. Torque the bolts to 46.5 - 60 N·m (34.5 - 44 ft. lbs.).

Op. 10 402 10

WATER PUMP REMOVAL

1. Drain the cooling system.
2. Remove the radiator.
3. Loosen or lever the fan belt tensioner to ease the tension and remove the fan belt from the vehicle.
4. Withdraw the four bolts which pass through the water pump, 4, and into the block and slide the pump forward and away from its rear connector, 1, removing the two sealing O rings, 2.
5. Alternatively withdraw six bolts, four in the water pump and two in the pump to block connector and remove from the engine as a complete unit, discarding the gaskets, 3.



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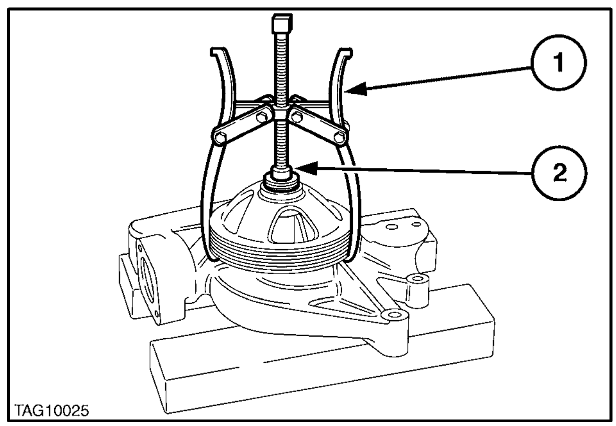
Op. 10 402 28

Disassembly

1. To remove the fan and clutch assembly, hold the pump pulley in a fixed position. Place an open ended spanner on the nut to the rear of the clutch assembly spacer, and loosen the nut in a clockwise direction.
2. Using a puller tool, 1, and a sleeve, 2, slightly smaller than the pulley shaft, ease the pulley from its shaft.



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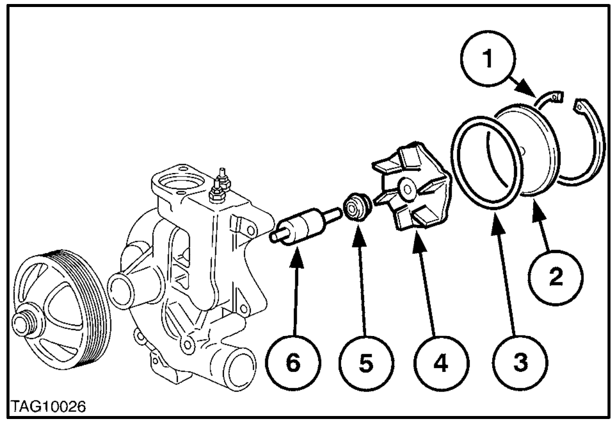
3. Using a pair of heavy snap ring pliers, remove the snap ring, 1, from the rear of the pump body. Carefully ease out the backplate, 2. Remove and discard the O ring, 3.



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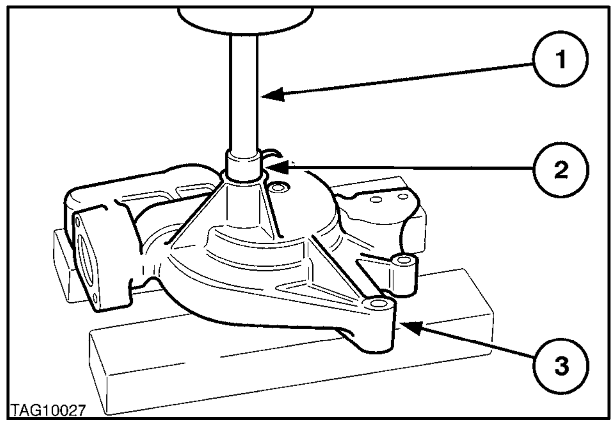
4. To remove the impeller/shaft assembly, place the pump body, 3, impeller side down. Support the pump in a manner to allow the impeller diameter to drop clear of the pump as it is pressed out, 1, from the pump body using the correct tool, 2.

NOTE: *Apply pressure to the outer bearing race and shaft simultaneously to remove, using the correct tool. Do not press the center shaft only because the shaft may move, leaving the outer bearing case in the pump body.*



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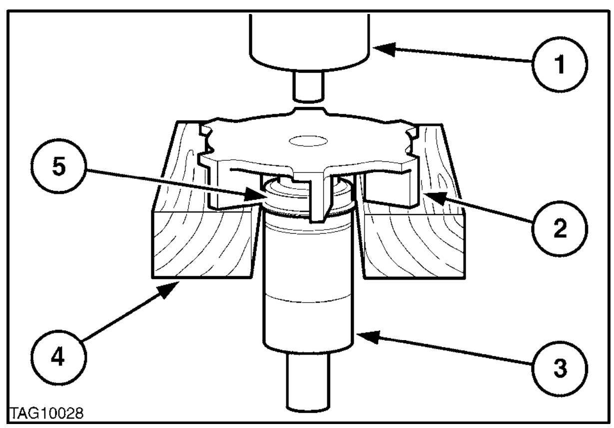
5. With the impeller/shaft assembly, 3, removed from the pump, place the impeller, 2, on supports, 4, and press out the shaft, 3, assembly from the impeller.
6. The seal assembly, 5, attached to the bearing shaft, 3, is not removable or serviceable. During the manufacturing process the seal is pressed onto the shaft and is destroyed on removal, this is to meet pre load conditions and maintain an effective water seal.



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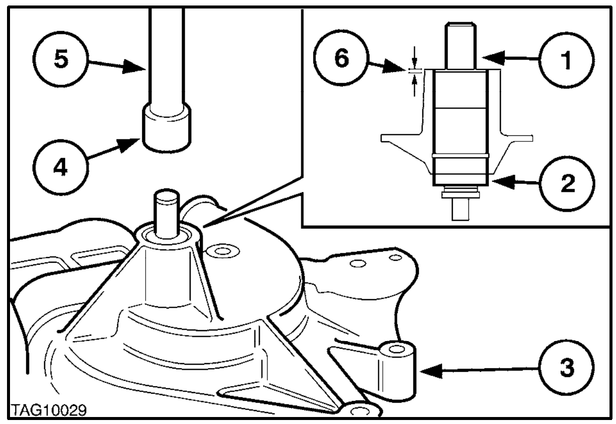
Inspection and Repair

1. Check the bearing shaft and seal assembly for signs of wear or leaks and if evident, the assembly must be replaced with new parts.
2. The impeller should be checked for worn or damaged vanes, and must be replaced if not to an acceptable standard.
3. Clean and check the pump body for signs of cracks, erosion or leaks. If any of these faults are in evidence and likely to cause pump failure at a later date, the pump body must be repaired or replaced with a new one.

Reassembly

1. To install the bearing, 2, into the pump body, 3, place the body rear face down onto a flat surface. Install the bearing with the longer stepped end of the shaft, 1, in the body and using a sleeve, 4, that contacts the bearing outer race only, press, 5, the bearing into the body. Once installed in the body the bearing case end face must be flush with the pump front face without protrusion.



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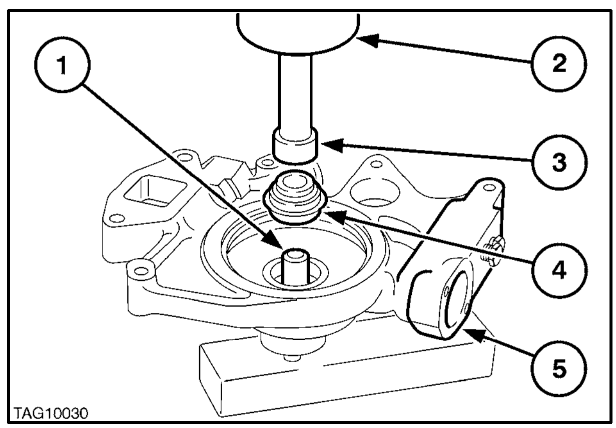
2. With the water pump, 5, placed front face down and the shaft, 1, supported, place the seal assembly, 4, on the end of the shaft, with its smallest diameter uppermost. To insert the seal assembly place Tool # NHT87T - 6312-A, 3, over the seal and press, 2, until the lip on the seal body seats on the pump body.



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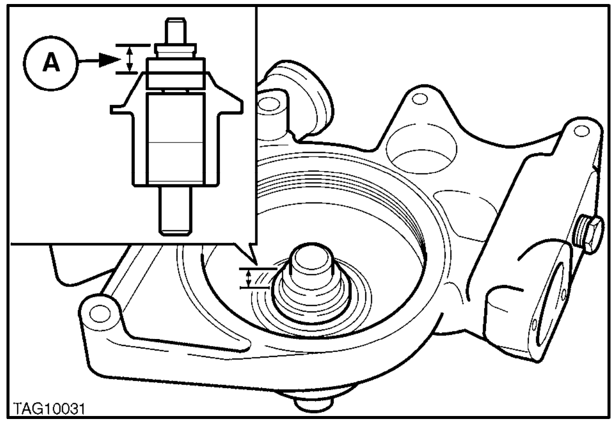
3. With the seal installed correctly, the seal working height should be maintained at 11.9 - 12.4 mm (0.470 - 0.490 in.), Reference “A”.



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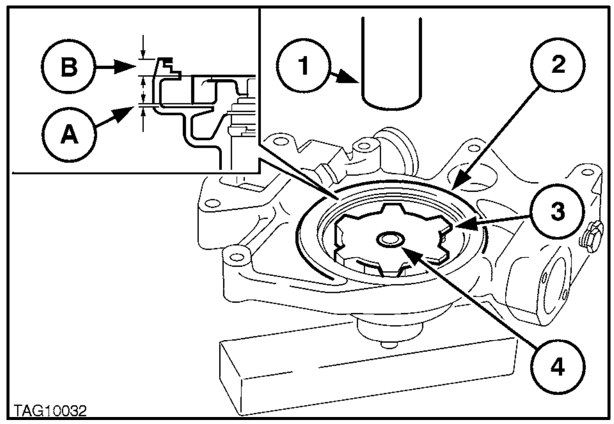
4. With the water pump rear face up, 2, and the shaft, 4, supported, place the impeller, 3, over the shaft and press, 1, the impeller into the water pump body. Installed correctly the face of the impeller fins to the operating face of the water pump should be 0.25 - 0.88 mm (0.010 - 0.035 in.), Reference “A”.
5. Check the dimension from the rear face of the impeller to the rear face of the pump. The dimension should be maintained at 11.6 - 12.2 mm (0.46 - 0.485 in.), Reference “B”.



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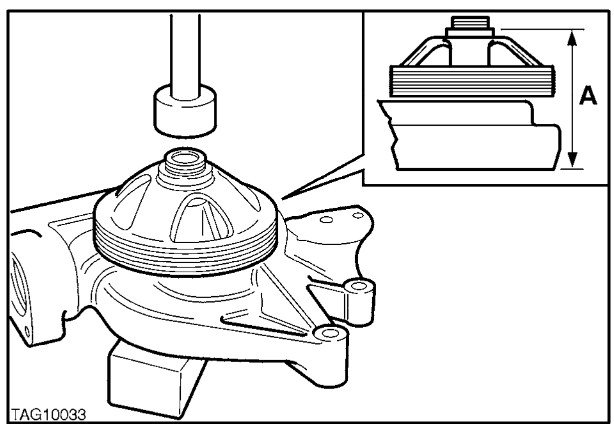
6. With the pump rear face down and the shaft supported, press the pulley onto the shaft ensuring that the pulley front face to the ear face of the pump dimension is, 127 - 129 mm (5.091 - 5.101 in.), Reference “A”.
7. Ensure a new O ring is fitted and place the water pump backplate in position, refitting the snap ring into its groove. Make sure the water pump pulley/ impeller assembly rotates freely by hand prior to reassembly. If not disassemble and recheck the relevant dimensions.



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Installation

1. Installation of the water pump to the engine is the reverse of disassembly, but observing the following requirements.

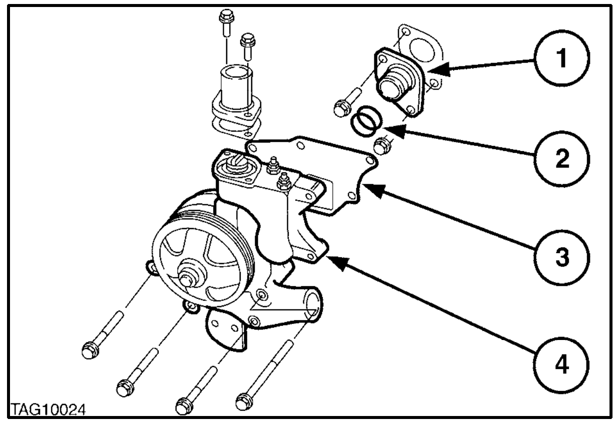
Clean the block face and fit a new gasket, 3, between the connector and block face, then torque the two bolts to 20 - 28 N·m (15 - 21 ft. lbs.).

Fit two new O rings, 2, over the connector outlet port, 1, as required.

Place the water pump, 4, over the connector and install and torque the four pump bolts to 61 - 68 N·m (45 - 50 ft. lbs.).

Ensure the fan belt tensioner pulley rotates freely and the swinging arm of the tensioner returns to rest freely. Gently lever the arm up to enable the fan belt to be seated in the grooves on the pulleys. Refit the fan blade assembly.

After installation of the radiator, refill the cooling system as previously described and run the engine checking for leaks.



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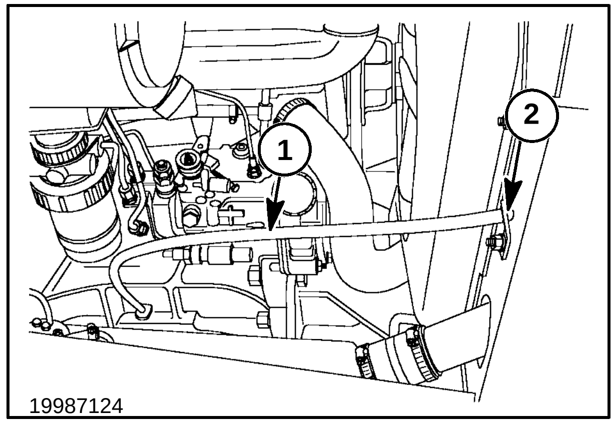
LUBRICATION SYSTEM - LS190

Op. 10 304 06

OIL LEVEL DIPSTICK

The long rubber tube, 1, allows the oil level to be checked from the rear of the loader. The rubber tube must connect correctly to the engine and the back frame for the level reading to be accurate. Check that the rubber tube is completely against the rear frame support, 2.



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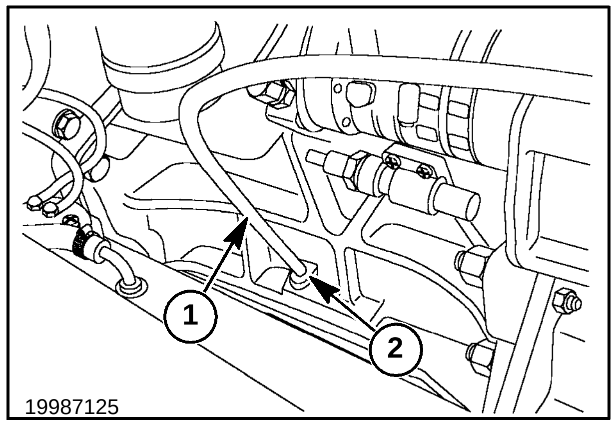
Push the end of the rubber tube, 1, to make sure it contacts the engine block, 2.

If the dipstick problem cannot be fixed by adjusting the tube as described above, remove the hose clamp and remove the long tube from the engine port. Install a replacement short dipstick, part #E9NN6750AA, into the short tube for checking the oil level. The left engine side shield will have to be removed to check the engine crankcase oil when the short dipstick is installed.



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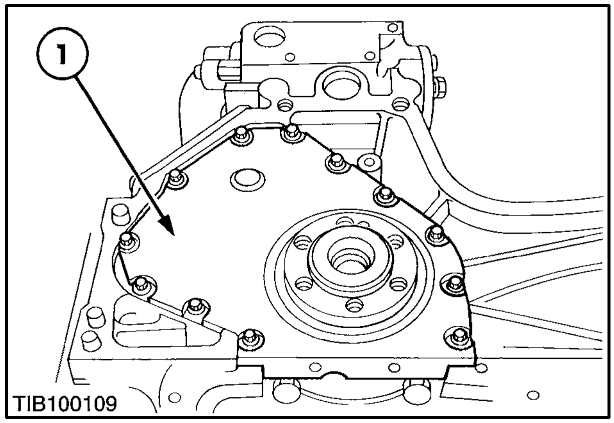
OIL PUMP OVERHAUL

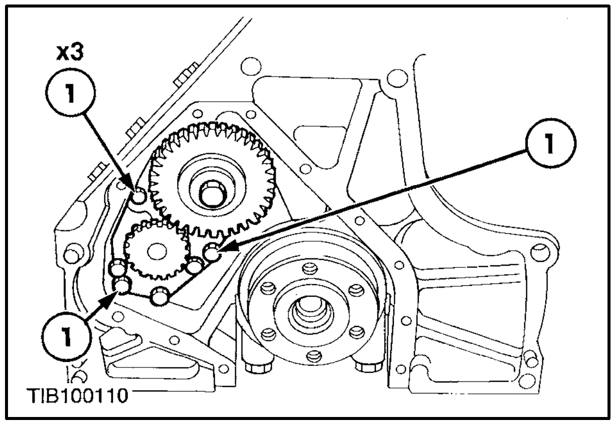
Op. 10 304 34

1. Prior to pump removal check pump gear to camshaft gear backlash does not exceed 0.40 - 0.56 mm (0.016 - 0.022 in.).



302

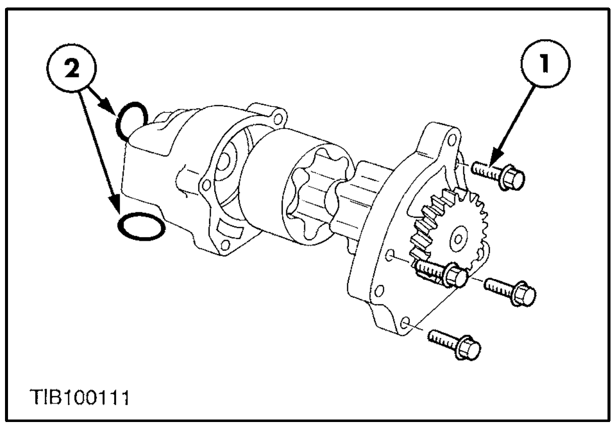
2. Loosen and remove the camshaft gear to expose the oil pump, detach the 3 pump mounting bolts, 1, and withdraw the pump from the block.



303

Disassembly

1. Loosen and remove the pump face plate to body bolts, 1. Disassemble the pump and discard the O rings, 2.



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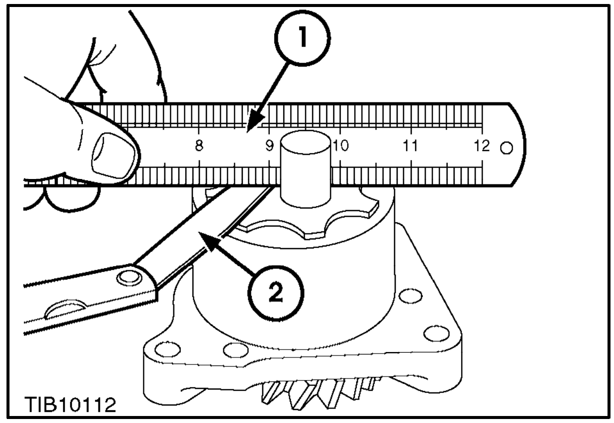
Inspection and Repair

1. Wash all parts in a suitable solvent and inspect inside of pump plate, and body, for excessive wear or damage. If visually okay, check in the following manner.
2. Invert pump plate/rotor assembly, and place outer rotor over inner rotor. Placing a ruler, 1, across top of both, slide a feeler gauge, 2, between ruler and inner rotor. A gap of 0.025 - 0.089 mm (0.001 - 0.0035 in.) is acceptable.

NOTE: *If not to specification, replace the oil pump, as reduced pump pressure through wear could result in reduced engine life.*



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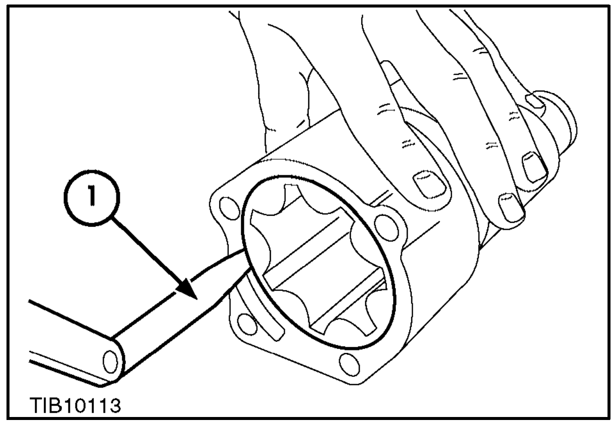
3. Place outer rotor in pump body and check clearance, by inserting a feeler gauge, 1 between the rotor and body. Check to a max of 0.55 mm (0.022 in.). If specification is exceeded, a new pump is required.



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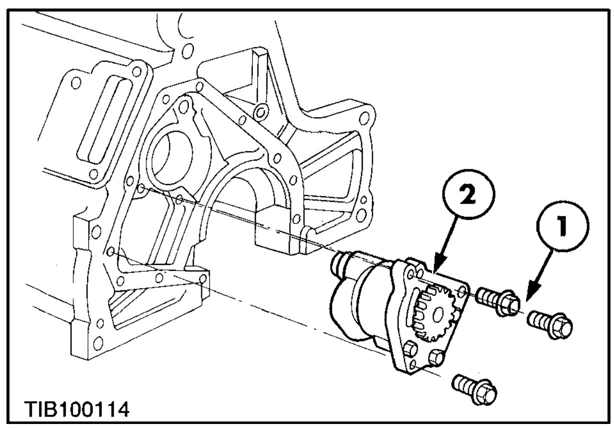
Installation

1. Clean and coat parts in new engine oil. Place outer rotor in pump body, and ensure free rotation. Insert inner rotor and pump plate assembly, into the body and ensure that shaft is fully seated into bushing.
2. Assemble the front plate to the body bolts, and torque to 23.0 - 28.4 N·m (17 - 21 ft. lbs.).

IMPORTANT: *After tightening, ensure the drive gear rotates freely by hand, at least 5 revolutions. If the gear does not rotate freely, disassemble and repeat the exercise.*



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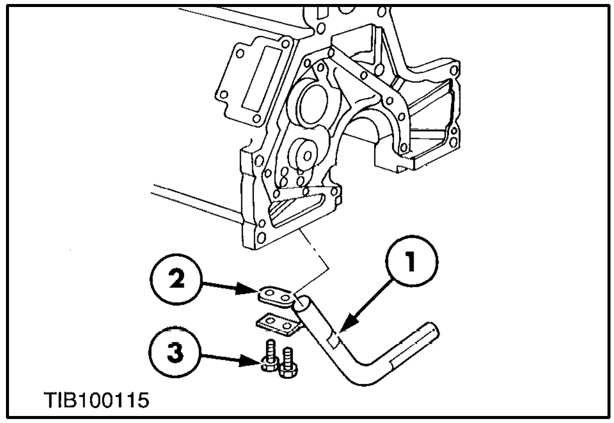
3. Fit a new O ring to the output tube, lubricate and insert the pump into the block tightening to 23.0 - 28.4 N·m (17 - 21 ft. lbs.).
4. Fit a new O ring into suction port. Lubricate and insert tube/screen assembly, 1, into pump through bottom of engine. Fitting a new gasket, 2, torque the attaching bolts, 3, to 27 - 34 N·m (20 - 25 ft. lbs.).
5. Refit gears and check backlash as previously described.



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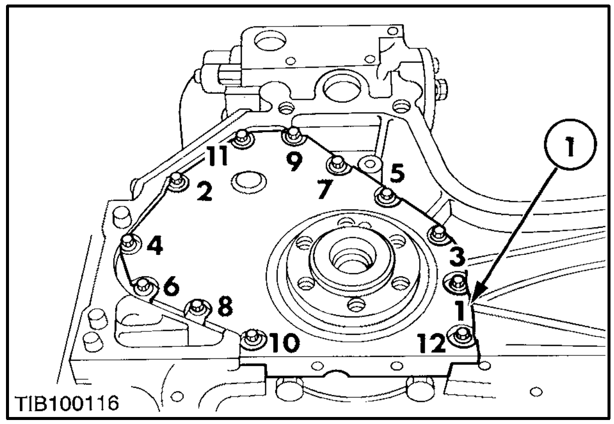
6. Ensure the engine backplate, 1, is fitted correctly and the bolts are torqued up in sequence.



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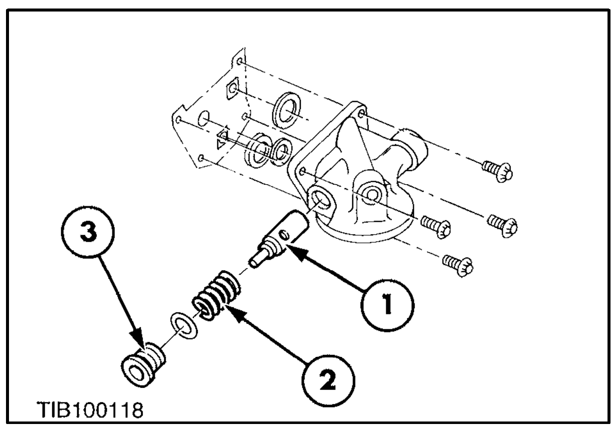
Oil Filter Support Assembly

Op. 10 206 10

Removal

1. Unscrew and discard the old filter. Loosen the 4 attaching bolts and oil connections and remove the filter support assembly from the block. Discard the O rings.
2. Clean the filter support in a suitable solvent.
3. Remove pressure relief valve plug, 3, removing valve, 1, and spring, 2. To ensure correct operation of the pressure relief valve, check spring length:
   Free length = 52.8 mm (2.08 in.).
   Compressed length = 37.0 mm (1.46 in.) using a weight of 15.6 kgs (34.3 lbs).
4. Check the parts for damage, wear, and replace as necessary. Failure to do so could result in premature wear to the engine, due to oil bypassing the filter and returning back to the system.



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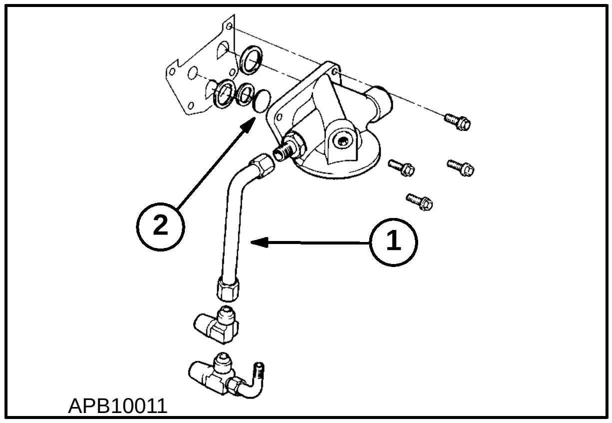
Installation

1. Lubricate the pressure relief valve and spring and insert into housing, ensuring free movement. Fit a new O ring to the plug and torque to, 55 N·m (42 ft. lbs.).

NOTE: *On some models the pressure relief valve "end plug" is replaced by an oil return tube, 1, from the engine block. Where this pipe is fitted a plug, 2, is used to blank the oil return port to the engine block.*

2. Fit tube, 1, to the connector and torque to 27 N·m (20 ft. lbs.).
3. Refit the oil filter head to the engine block with new O rings and plug where required as above and torque the bolts to 34 - 47 N·m (26 - 35 ft. lbs.).



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FUEL SYSTEM - LS190

The diesel fuel system consists of a fuel tank, electric lift pump, fuel filter/sediment separator, DPS 200 series fuel injection pump, fuel injectors and inter-connecting fuel lines. A dry type air cleaner removes dirt and contaminants from the air intake.

DP203

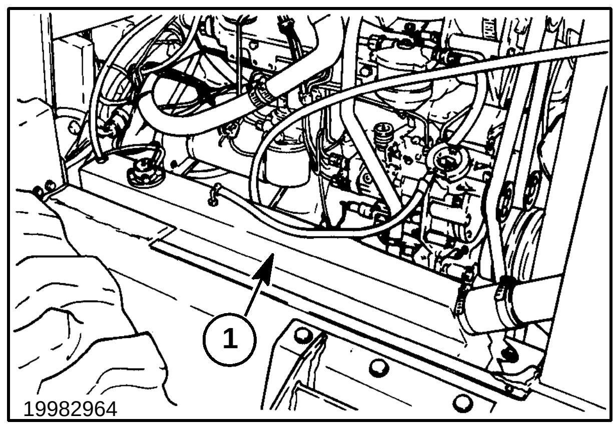
The fuel is drawn from the fuel tank, through the sediment separator and fuel filter by the electric lift pump, and then fed into the injection pump.

The transfer pump delivers fuel to the injection pump to supply fuel at high pressure to each injector and also provides extra fuel which lubricates and cools the injection pump. This extra fuel is recirculated via a fitting on the fuel injection pump governor control housing to the fuel tank by means of the injector leak-off line.

The excess fuel that leaks past the needle valve of the injectors is directed back into the fuel tank at the filler neck by means of the injection leak-off line.

FUEL TANK

A plastic fuel tank, 1, is located on the lower left rear of the machine.



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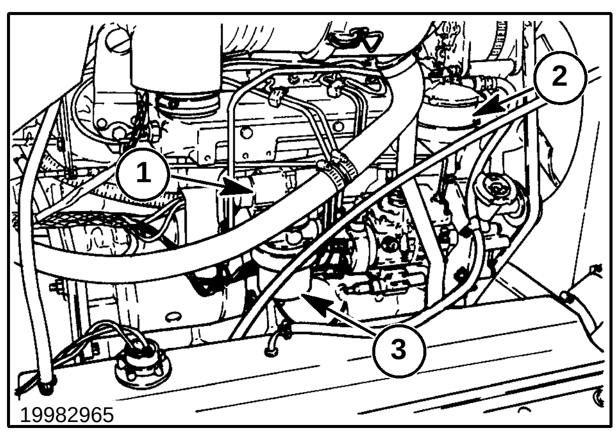
Op. 10 210 21

ELECTRIC LIFT PUMP

Mounted on the left hand side of the engine above the fuel filter is an electrical lift pump, 1. The pump draws fuel through the sediment separator, 2, and the fuel filter, 3. The fuel is then pressurized and fed into the fuel injection pump.



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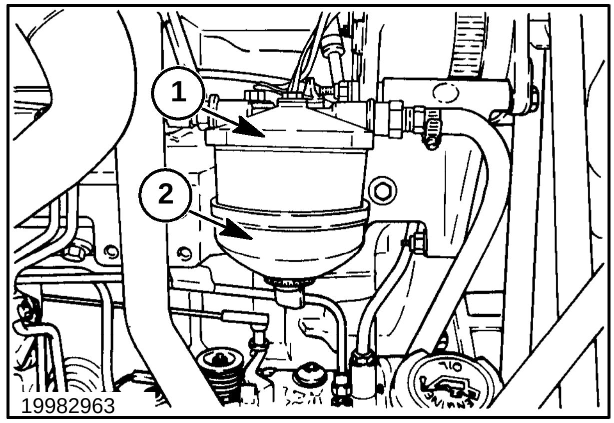
SEDIMENT SEPARATOR

Positioned on the left hand side of the engine is the fuel sediment separator. The assembly consists of a cast head, 1, which is bolted to the engine, and a glass sediment separator, 2.

The fuel is fed into the sediment separator side of the head to be directed down and around the edges of the separator cone, the larger particles of dirt and water (which are heavier than fuel oil) are separated out and sink to the collecting bowl. The cleaned fuel is then fed into the fuel filter.



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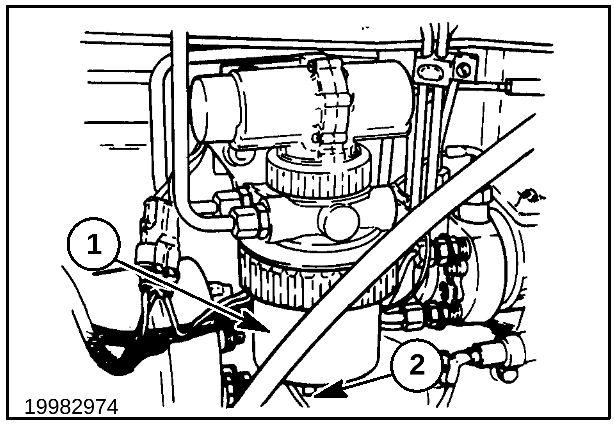
Op. 10 206 10

FUEL FILTER

The filter, 1, positioned on the right hand side of the engine behind the injection pump directs the fuel through the filter head to be directed down through the filter paper into the base chamber. The filtered fuel then flows up the center tube of the element to the filter head outlet and flows onto the injection pump.

The drain plug, 2, permits contaminated fuel to be drained from the filter.



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THERMOSTART

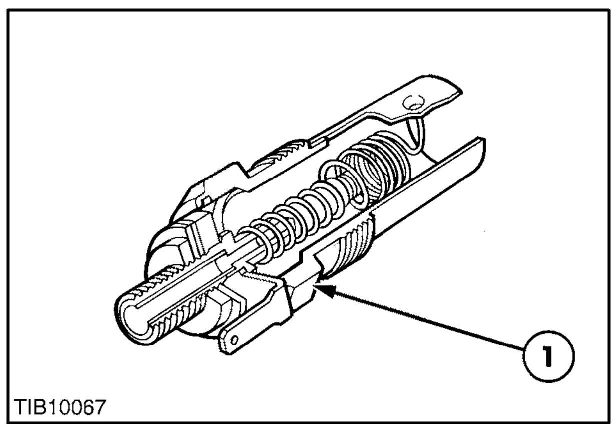
To aid engine starting in cold weather conditions, a thermostart system incorporating an integral reservoir system is available.

The thermostart system is made up of a plug assembly screwed into the intake manifold, a fuel line connected to the injector leak-off tube and an electrical circuit, connected to the ignition switch.

The plug assembly, 1, consists of a check valve and electrically heated element.

Fuel is gravity fed to the plug assembly and, when operating the key start/stop switch and the thermostart switch, the heater and “igniter” coils are both energized. The “heater” coil opens a check valve which allows diesel fuel to flow through the thermostart. The fuel is ignited by the “igniter” coil in the manifold, heating the intake manifold air prior to it entering the combustion chamber.

When the thermostart switch is released to the off position, the electrical current is disconnected from the thermostart and the check valve closes.



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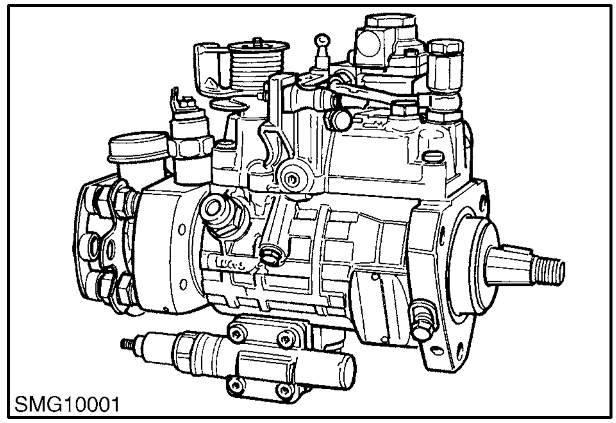
Op. 10 246 14

FUEL PUMP

The fuel injection pump fitted to these vehicles is the DP203 (emissionized) type. The fuel pump, which is fed by an electric lift pump, supplies fuel at high pressure to the fuel injectors.

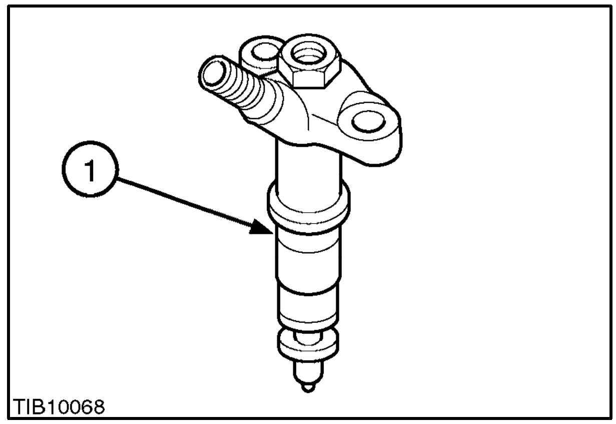


317

Op. 10 218 34

INJECTORS

The fuel injectors, 1, mounted in the cylinder head supply fuel in the form of a spray pattern into the cylinder bores. The controlled amounts of fuel ensure optimum engine performance throughout the operating range.



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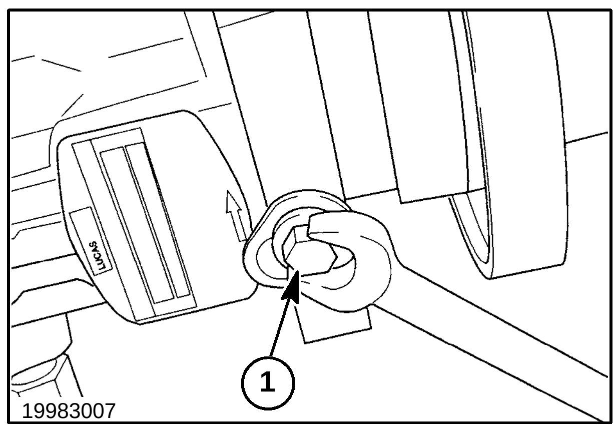
ADJUSTMENTS

INJECTION PUMP LOCK TIMING (ON BENCH)

1. Unlock the pump by loosening the locking screw, 1.



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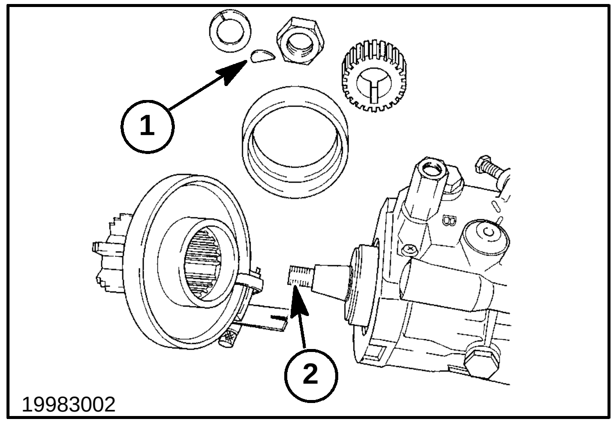
2. Install a key, 1, P/N 74145S, into the slot in the fuel injection pump drive shaft, 2.



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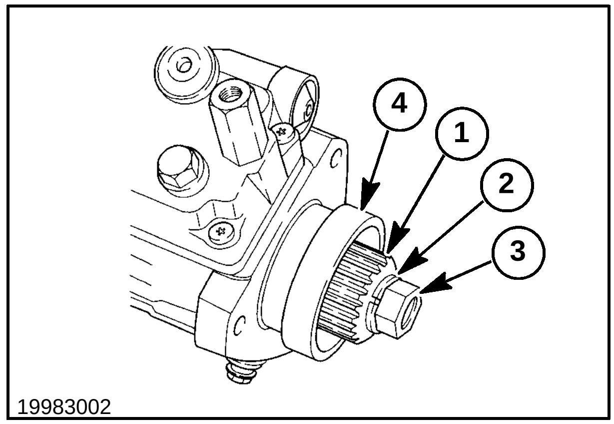
3. Place the small adapter, 1, P/N PD67/3, onto the shaft. Place the key in the slot to make sure the adapter is properly aligned. Use the lock washer, 2, P/N D8NN9G593AA, and nut, 3, P/N D8NN9N904AA. Hold the adapter counterclockwise while tightening the nut to 27 Nm (20 ft lbs).
4. Place the guide, 4, P/N MS67B/8, over the shaft and pilot area of the pump housing, followed by the protractor assembly.

NOTE: *Preset the protractor to the 29 degree mark.*



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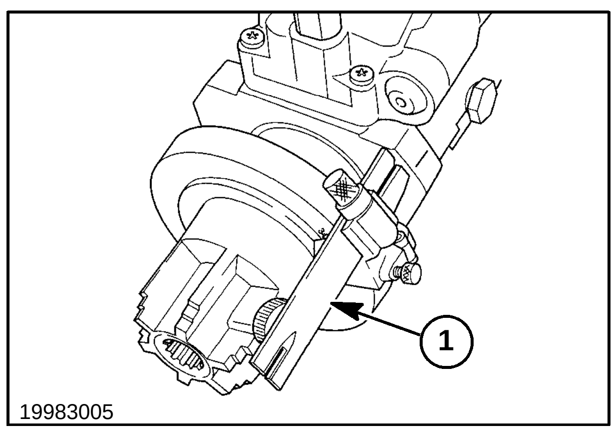
Pump Timing Degree Chart

No. of Cylinders	Engine Timing	Pump Lock Degree	#1 Piston Drop
4 N/A	29° BTDC	29°	10.39 ± 0.025 mm (0.409 ± 0.001 in.)

5. Place the protractor, 1, on the adapter and into the support. The marker (pointer) should extend to allow maximum visibility for the pump timing mark in the slot.



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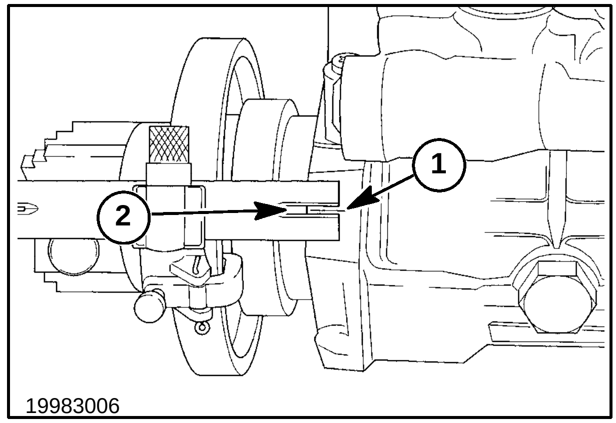
6. Rotate the pump until the timing mark, 1, on the pump flange is centered in the marker (pointer) slot, 2.



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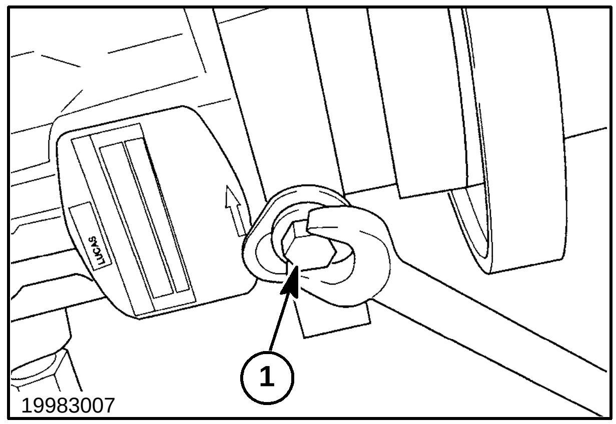
7. Lock the pump shaft as follows: Loosen the locking screw, 1, remove or realign the washer so the large hole fits over the shoulder of the screw, then retighten the screw against the pump shaft to 41 N·m (30 ft lbs).

NOTE: *Verify that the marker aligns with the pump timing mark.*

8. Remove the timing tool, nut and lock washer. Loosen the adapter from the shaft.

IMPORTANT: *Remove the key from the pump.*

9. Install the pump on the engine (refer to Engine Timing Section).



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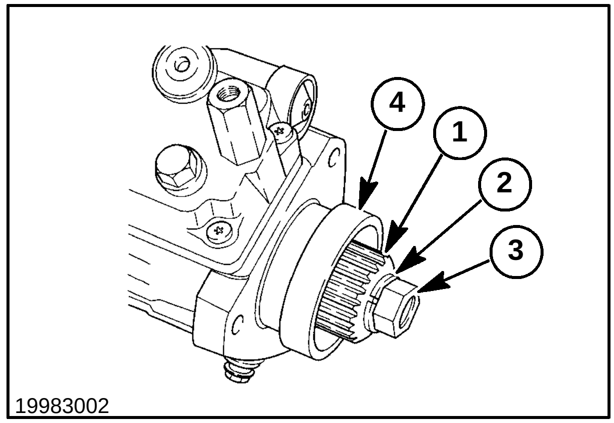
VERIFYING PUMP TIMING

1. Set the engine on its basic timing mark (see chart).
2. Lock and remove the pump (see “Removing the Injection Pump”).
3. Install a key, P/N 74145S, into the slot in the fuel injection pump drive shaft.
4. Place the small adapter, 1, P/N PD67/3, onto the shaft in alignment with the key. Use the lock washer, 2, P/N D8NN9G593AA, and nut, 3, P/N D8NN9N904AA. Hold the gear counterclockwise to prevent the pump from rotating while tightening the nut to 27 Nm (20 ft lbs).
5. Place the guide, 4, P/N MS67B/8, over the shaft and pilot area of the pump housing.



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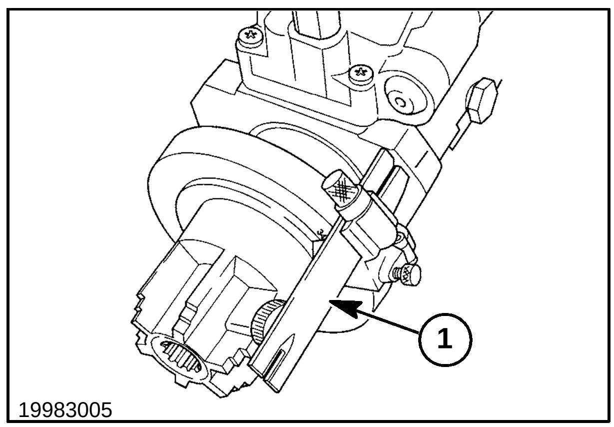
Pump Timing Degree Chart

No. of Cylinders	Engine Timing	Pump Lock Degree	#1 Piston Drop
4 N/A	29° BTDC	29°	10.39 ± 0.025 mm (0.409 ± 0.001 in.)

6. Loosen the marker (pointer) and place the protractor, 1, on the adapter and into the support. The marker should extend to allow maximum visibility for the pump timing mark in the slot.



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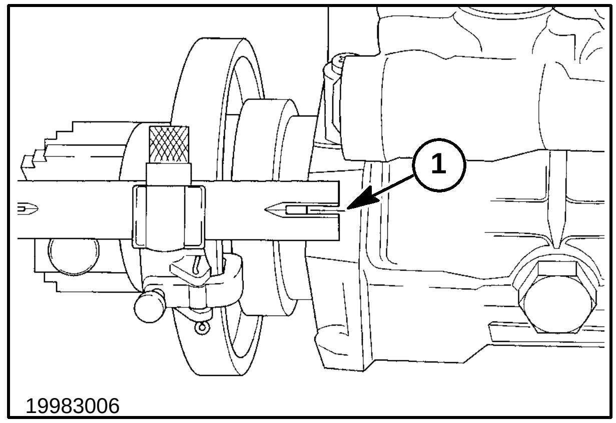
7. Slide the pointer bar until it aligns with the timing mark, 1, on the pump flange.
8. If the reading is 29°, the pump is properly timed. If the reading differs, the pump is out of time. Follow the procedure in “Injection Pump Lock Timing” to retime the pump. Each degree the pump varies from the proper timing equals two engine degrees of timing.



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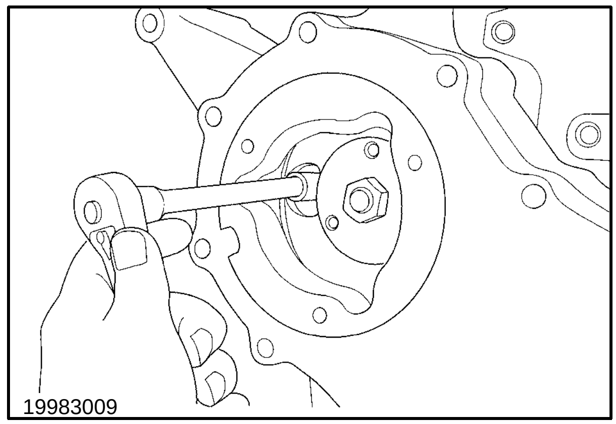
INSTALLING THE INJECTION PUMP

1. Place the locked, pre-timed fuel Injection pump on the engine. The mounting bolts install from inside the front cover. Two bolts thread into the pump flange, while the third bolt uses a nut on the outside of the pump flange. Tighten to 20 - 25 N·m (15 - 18 ft lbs).

IMPORTANT: *Use an O ring, P/N 14437585, on each mounting bolt prior to inserting if through the mounting holes. Failure to install new O rings on the bolts may allow engine lubricant to leak out.*



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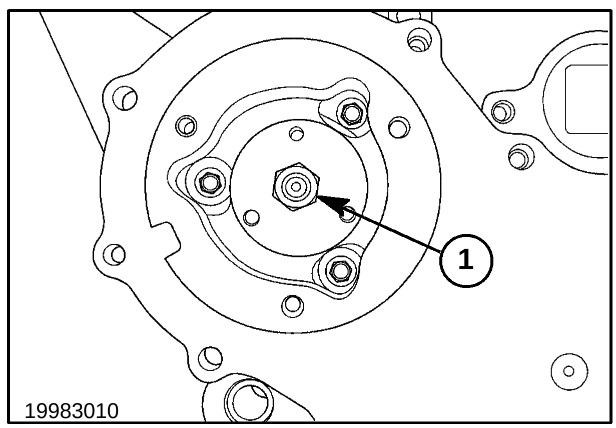
2. Place the washer and retaining nut on the gear, leaving the nut loose for now.
3. Hold the gear counterclockwise to take up any backlash between the pump gear and idler gear. While holding the gear, tighten the nut, 1, to 74.5 - 81.3 N·m (55 - 60 ft lbs). Do not move the gear train.



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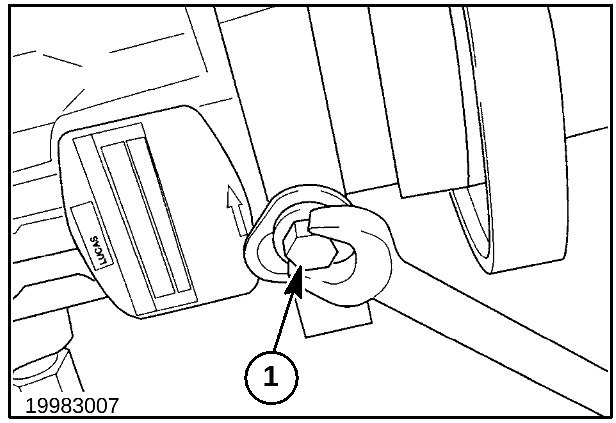
4. Unlock the fuel pump by loosening the lock screw, 1, and installing or realigning the washer so that the small opening is under the screw head. Retighten the lock screw to 11 - 13 N·m (8 - 10 ft lbs). Do not overtighten.
5. Reinstall all fuel lines, tubing, access covers and other hardware that was removed during service. Use proper gaskets or sealants, and tighten all hardware to the appropriate torque.
6. Prime the fuel system and start the engine. Inspect the fuel system and repair any leaks.

NOTE: *Always run the engine and inspect all connections and components to be sure they function properly before returning the unit to service.*



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Priming The Fuel System

NOTE: *The fuel system should be primed whenever fuel system components are removed or disconnected in order to expel any air in the system.*

1. Make sure there is sufficient fuel in the tank and all connections are tight.
2. Operate key start switch to activate the electric fuel pump. An audible difference is dectectable when the system is primed, this may take up to 5 minutes.

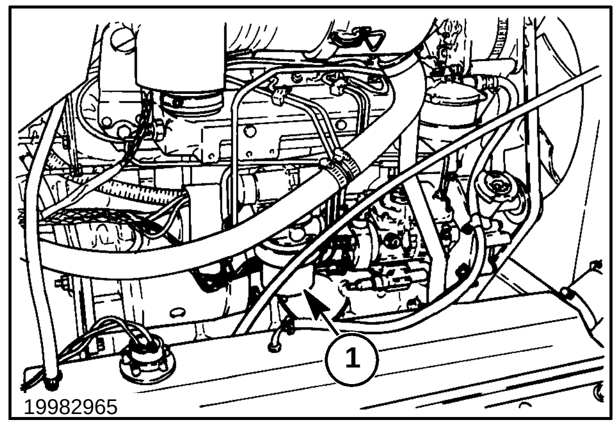
NOTE: *The bleed screw, 1, in the filter head is on the intake side and must be kept closed during priming.*

NOTE: *Attempt to start the engine. If it does not start, continue through Step 4.*

3. With the throttle in the maximum no-load speed position, operate the starting motor to crank the engine. The fuel injection pump is self-venting and does not require bleeding.

IMPORTANT*: Do not crank the starting motor continuously for more than 60 seconds as doing so may cause starting motor failure.*

4. If the engine fails to start after 60 seconds, repeat the priming procedure outlined above.
5. Run the engine and check for leaks.



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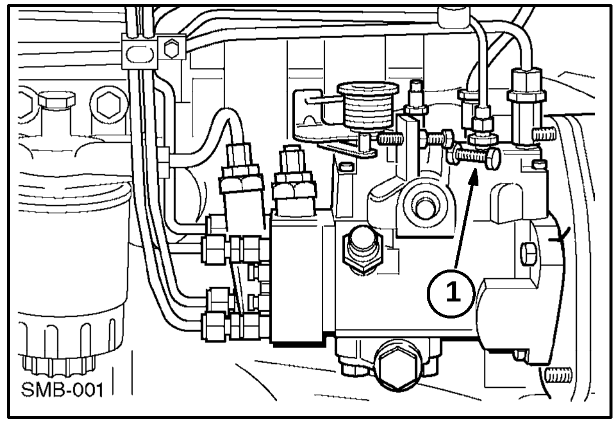
IDLE SPEED ADJUSTMENT

1. With the engine running and at normal temperature, disconnect the throttle cable at the injection pump.
2. Loosen the locknut and adjust the idle speed stop screw, 1, until the specified idle speed of 700 - 800 RPM is obtained. Tighten the locknut and reconnect the throttle cable.
3. Operate the throttle lever several times and check that the idle speed is correct. If excessive free play is felt in either the foot or hand throttle after adjustment, proceed to “Throttle Linkage Adjustments” in this section.



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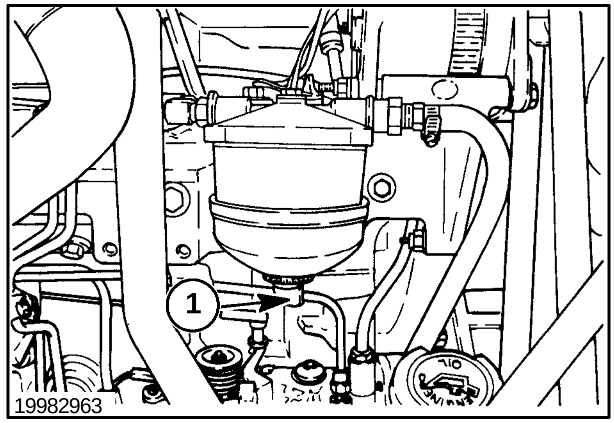
FUEL WATER AND SEDIMENT SEPARATOR



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Removal

1. Drain the water and sediment separator of fuel, by removing the bowl retaining nut, 1.
2. Disconnect and remove the fuel lines from the head of the sediment separator assembly and plug the exposed openings to prevent contamination.
3. Remove the retaining bolts, then remove the assembly from the tractor.

Disassembly

1. Remove the center retaining bolts and separate the filter components.
2. Using clean fuel, wash out the filter bowl and the glass bowl on the sediment separator.

Reassembly

Reassembly of the sediment separator follows the disassembly procedure in reverse. On reassembly, observe the following requirements:

1. Install a new filter element and sealing rings, be sure the sealing rings are correctly positioned.
2. Tighten the center retaining bolts.

Installation

Installation of the sediment separator assembly follows the removal procedure in reverse. On installation, observe the following requirements:

1. Tighten the retaining bolts.
2. Assemble the fuel pipes to the connectors in the head and tighten the nuts until the stop is reached (metal to metal contact).
3. Bleed the fuel system as previously described.

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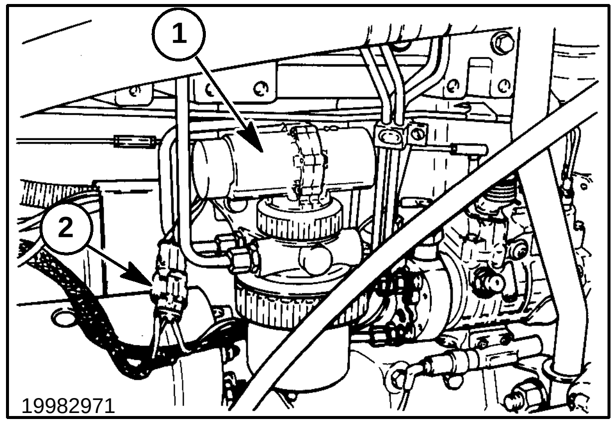
ELECTRIC LIFT PUMP - LS190

The pump, 1, is mounted into the head of the fuel filter and is activated via the key-start switch.

The fuel is drawn up from the tank through the separator and filter assemblies and then out to the FIP inlet.

1. With the key start on - check for 12V at the electrical connector, 2, of the pump. If 12V is not present, check fuses, relay and wiring.
2. If there is no/little delivery, and voltage and fuel are present at the pump, the pump should be replaced.



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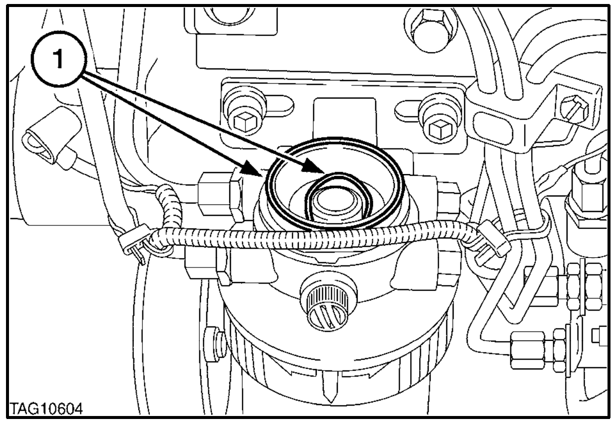
Removal

1. Disconnect battery
2. Disconnect the electrical connector from the pump.
3. Unscrew the filter head/pump assembly connection and lift away from filter assembly.

Installation is reverse procedure, ensure O rings, 1, are serviceable.



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Pump Testing

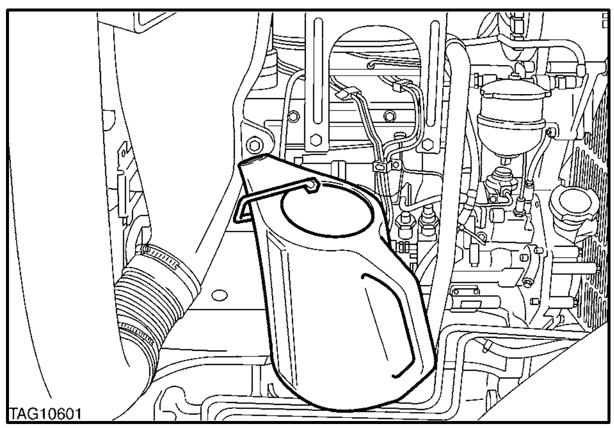
Fuel pump may be checked on the vehicle.

Ensure initially that the filter is serviceable and there are no other restrictions between the fuel tank and filters.

Disconnect the filter outlet to pump tube and reconnect to the filter, allowing the outlet to be positioned into a suitable measuring jar.

Turn the key start to the first position for a measured amount of time and record the fuel delivered.

Compare against specification.



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PUMP TEST CONDITION	POSSIBLE CAUSES	CORRECTION
Low pressure at pump outlet	1. Low or no fuel in tank 2. Blocked filter in lift pump 3. Actuating Shaft Worn 4. Pump Worn	1. Refill tank 2. Clean filter 3. Replace Shaft 4. Replace Pump
Air in the fuel from pump outlet	1. Blocked fuel tank breather 2. Loose fuel connections 3. Fuel Pump Diaphragm Perforated 4. Fuel pump body seam Leaking 5. Pump Worn	1. Clear blockage 2. Check and tighten 3. Replace Pump 4. Replace Pump 5. Replace Pump

INJECTORS

DESCRIPTION AND OPERATION

The engine injector function is to inject fuel into a pressurized cylinder in a fully atomized condition so as to burn efficiently with a minimum of smoke.

Each injector consists of a nozzle assembly, containing a needle valve, and an injector body assembly housing the injector needle valve regulating spring.

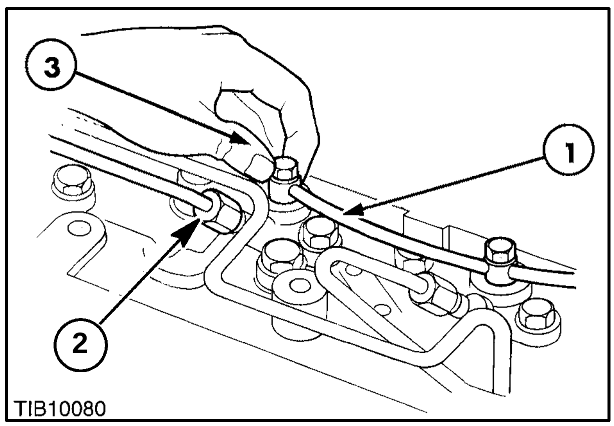
Fuel from the fuel injection pump enters the injector fuel inlet and passes down through a drilling in the injector body to the needle valve seat.

The fuel, pressurized by the injection pump, lifts the needle valve off the seat against the action of a spring. The fuel is then forced, in an atomized state, through the five holes in the nozzle tip. When the pressure from the injection pump drops, the needle valve snaps back onto the seat under pressure from the spring.

To provide lubrication of the injector, a small amount of fuel is permitted to leak up between the needle valve and the nozzle body. The excess fuel rises to the top of the injector and returns to the fuel tank via an injector leak-off line.

OVERHAUL

1. Loosen the high pressure fuel pipe gland nuts at the injection pump.
2. Clean the area around the injectors.
3. Remove the banjo bolts, 3, and discard the two copper washers from each bolt. Remove the leak-off pipe, 1.
4. Unscrew the gland nuts and disconnect the high pressure pipes, 2, from the injectors.
5. Remove the two retaining bolts from each injector and withdraw from cylinder head.
6. If a replacement set of injectors is not immediately available, cover the ends of the pipes and the cylinder head openings to prevent the entry of dirt and foreign material.



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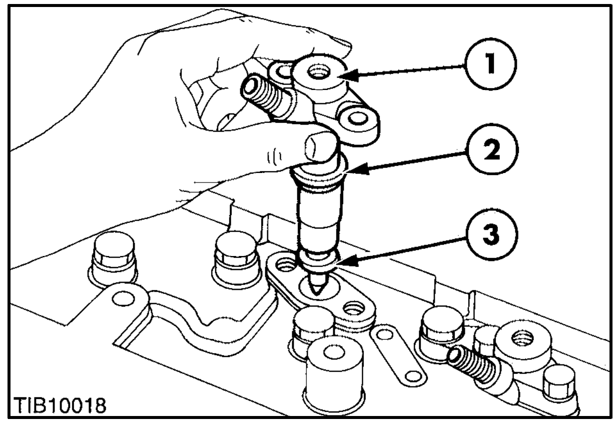
7. Discard the cork dust washer, 2 and the copper sealing washer, 3.

NOTE: *The copper sealing washer may have to be extracted from the bore in the cylinder head.*

8. To establish if overhaul or replacement is necessary, test the injectors according to the following procedure. Before testing, install a protective cap to the inlet union and clean the outside of the injectors with a soft wire brush and a carbon solvent.



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TESTING

WARNING

The spray from a fuel injector tester can pierce human skin with fatal results. when an injector is spraying, the nozzle holder should be turned away from the operator and any other persons.

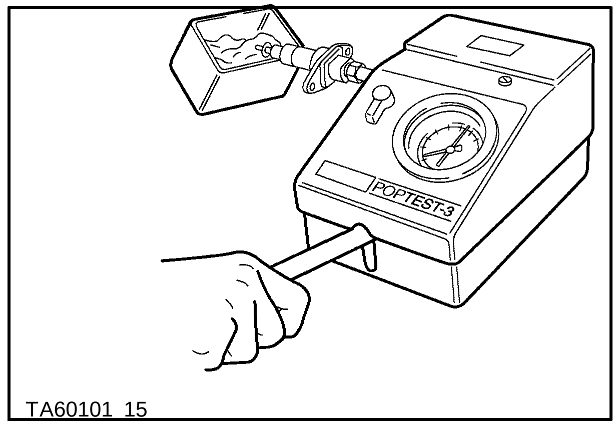
During the Nozzle Opening Pressure and Spray Pattern Tests, collect the spray in a container partly filled with rags to absorb the spray.

When conducting the Nozzle Seat Leakage Test, release the injector tester pump pressure before touching the nozzle tip with a sheet of blotting paper.

WARNING

The spray is flammable. make sure no open flames are in the area of the tester and do not generate excessive vapor.

1. Fill the injector tester with a calibrating type fuel oil and leave the filler cap loose to prevent a vacuum forming during testing.
2. Prime the tester until oil is emitted from the tester line, then connect the injector.
3. Make sure the knob on the right-hand side of the tester is screwed in to prevent the gauge being over-pressurized if the injector nozzle is blocked.
4. Pump the tester and check the nozzle is free to open. Open the pressure gauge valve and begin injector testing. If the nozzle is blocked or the needle jammed, disassemble the injector.



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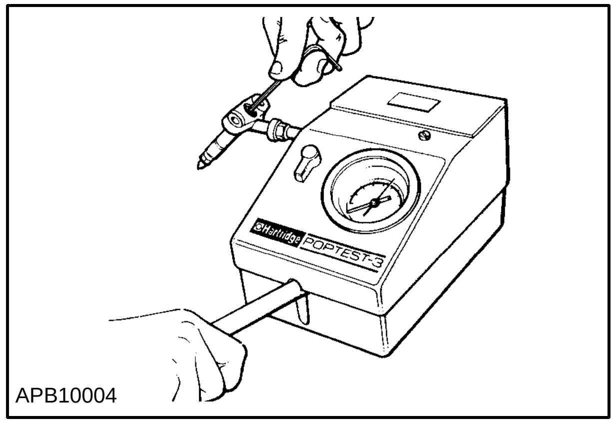
5. Nozzle Opening Pressure Setting - Slowly pump the injector tester and observe the pressure at which the needle valve lifts and fuel is injected from the nozzle tip. By rotating clockwise or counterclockwise the adjuster located in the top of the injector, the pressure setting can be varied. The opening pressure required 290 bar (4200 PSI).
6. Spray Pattern - Pump the tester rapidly (80 to 90 strokes per/min.) and observe the spray pattern from the holes. An atomized spray free from distortion and irregular streaks of fuel should be observed. The tester is not regarded as providing a suitable test for atomization under working conditions, but gives an indication of the working of the nozzle.



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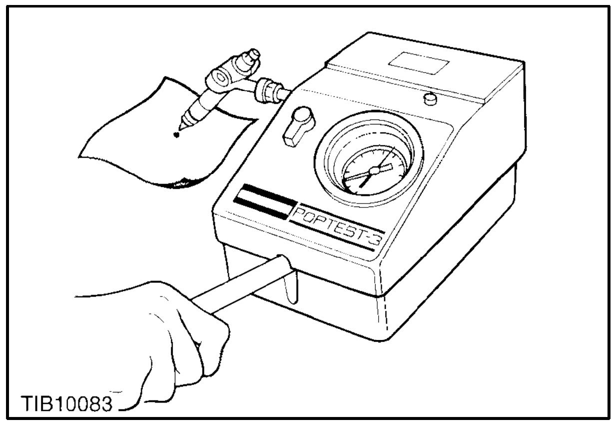
7. Nozzle Seat Leakage - Wipe the nozzle tip dry and apply a pressure to 280 bar (4060 PSI), i.e., 10 bar (145 PSI) below the opening pressure. The nozzle tip and bottom face must remain essentially dry and there must be no tendency for blobs of fuel to collect or drip. A slight dampness can be ignored. If there is any leakage from the nozzle seat, the nozzle assembly must be scrapped.
8. Nozzle Back Leakage - Apply a pressure of 280 bar (4060 PSI), 10 bar (145 PSI) below the opening pressure, then release the handle and the time/pressure drop should be between 148 - 99 bar (2140 - 1430 PSI) within 45 to 6 seconds. If below 6 seconds, the nozzle assembly must be scrapped. If above 45 seconds, check for carbon on the valve and/or blocked back leak drillings.



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NOTE: *If the injectors meet the tests carried out then refit the injectors to the engine.*

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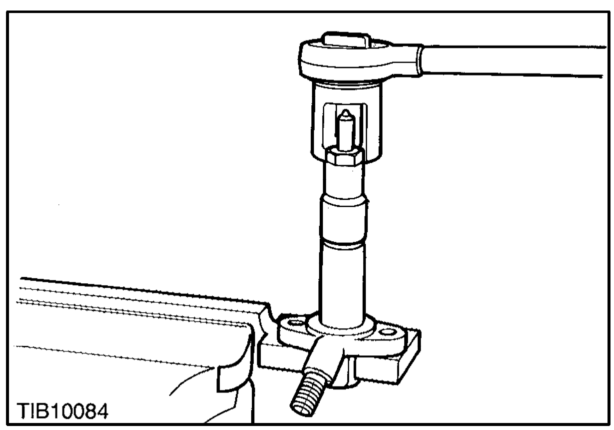
DISASSEMBLY

1. Place the injector in a holding fixture with the nozzle uppermost. Do not clamp the injector body in a vise. Use socket, tool #CT9009 or 8126, to loosen the nozzle retaining nut.
2. Remove the nozzle retaining nut, complete with the nozzle body, needle valve and the dowelled adaptor plate.



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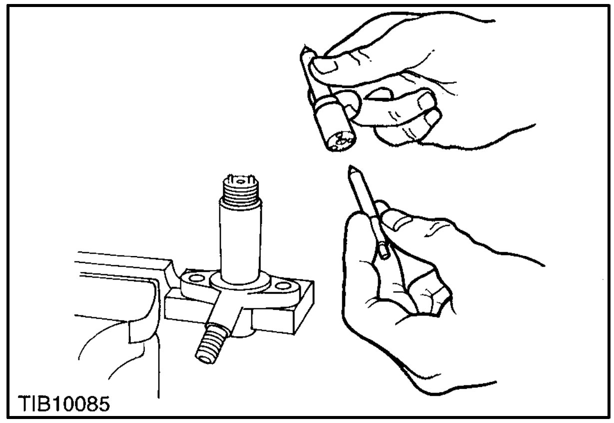
3. Remove the injector body from the holding fixture, invert and carefully remove the spring seat, spring and adjustment shims. To avoid damage, place all dismantled components in suitable baths of clean fuel oil.

NOTE: *To prevent corrosion of injector components after cleaning, rinse in clean fuel oil and place in a suitable bath of clean fuel oil.*



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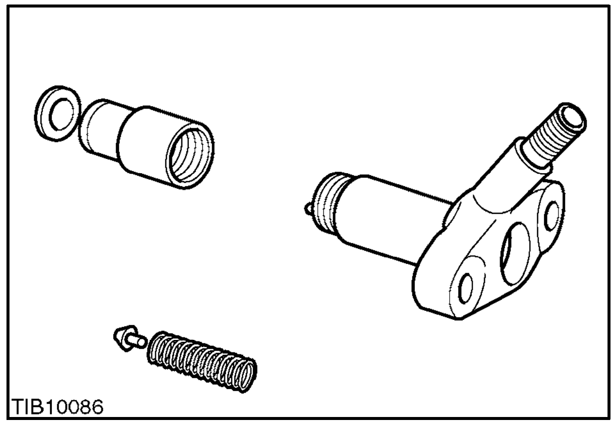
INSPECTION AND REPAIR

1. Clean the injector body by soaking in a carbon solvent and brushing with a brass wire brush. Inspect the body for damaged threads and pressure face, making sure the holes in the injector nozzle are thoroughly clean with no signs of corrosion or pitting.
2. Clean the spring and spring seat using a brass wire brush and check for scoring, pitting or corrosion.



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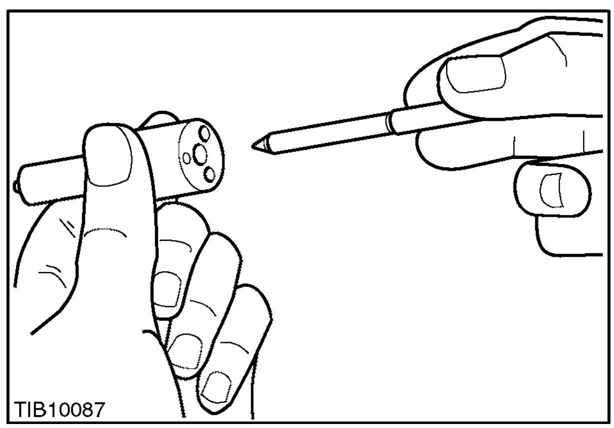
3. Clean the dowelled adaptor plate using a brass wire brush. Inspect the plate for loose or bent dowels, a damaged pressure face or corrosion.
4. Clean the needle valve and body by soaking in a carbon solvent and brushing with a brass wire brush. Using the tools included in the Injector Nozzle Cleaning Kit, Tool #DX730, clean the nozzle as follows:

NOTE: *If the needle valve is in any way damaged or blued, it must be discarded and a new matched needle valve and nozzle body assembly obtained. It is not possible to grind or lap the three special angles on the valve point.*



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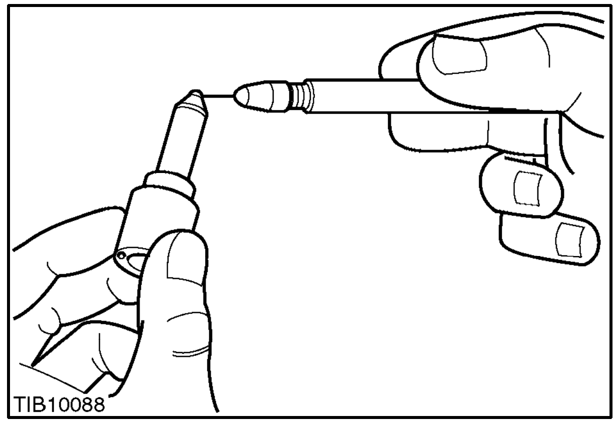
- Clean the spray holes with a nozzle cleaning wire held in a pin vise so that it protrudes for only 1.5 mm (0.06 in.), thereby giving maximum resistance to bending. Insert the wire into each hole, pushing and rotating gently until each hole is cleared.



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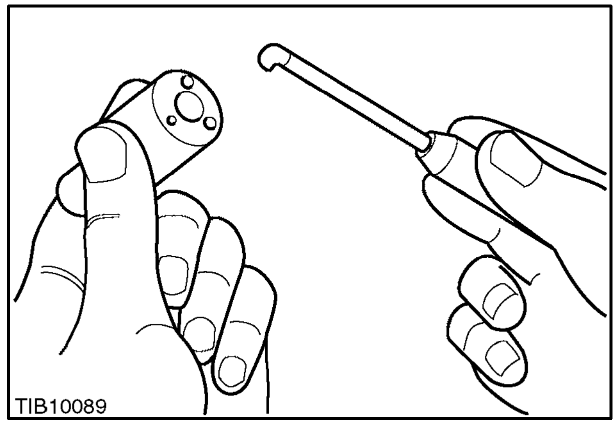
- Clean the needle valve seat using the valve seat scraper by rotating and pushing the tool onto the valve seating.
- Clean the fuel port using the fuel port scraper. Insert the scraper into the port, press hard against the side of the cavity and rotate to clear all carbon deposits from this area.



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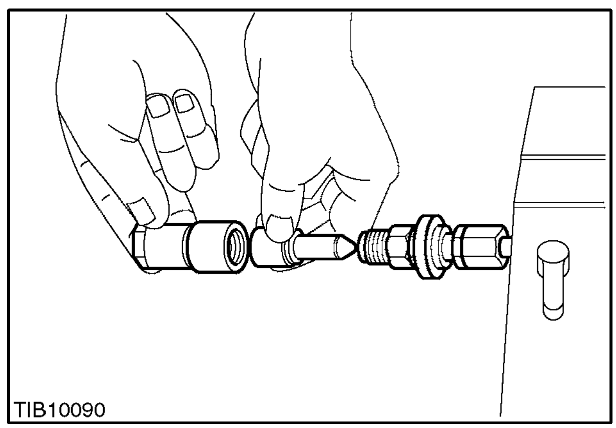
5. Use a Reverse Flush Nozzle Adaptor, Tool #CT9024, on the injector tester and reverse flush the nozzle to remove the carbon loosened during cleaning, Step 4.
6. After flushing the nozzle, polish the valve seat by placing a very small amount of tallow on the end of a polishing stick and rotate in the nozzle.



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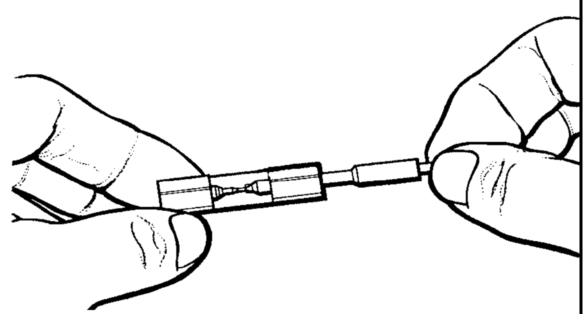
7. Clean the top of the needle valve using a needle valve scraper.
8. Clean the nozzle retaining nut using a brass wire brush and check to see that the threads are not damaged and are free from carbon deposits.



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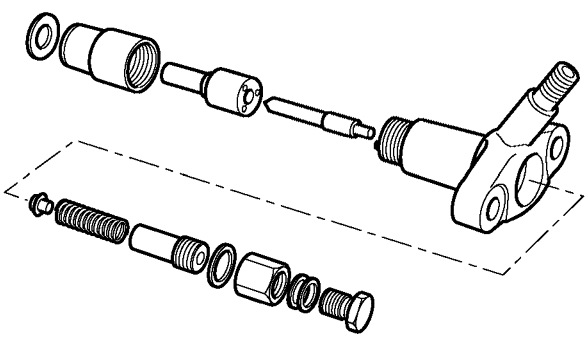
REASSEMBLY

1. Make sure all parts are absolutely clean and undamaged prior to reassembly. Rinse all parts in clean fuel oil and assemble the components while still wet.
2. Place the spring and spring seat into the injector body bore. Place the injector body into the holding fixture.
3. Assemble the needle valve into the nozzle body and then position the dowelled adaptor plate onto the nozzle body. Insert this assembly into the nozzle retaining nut.



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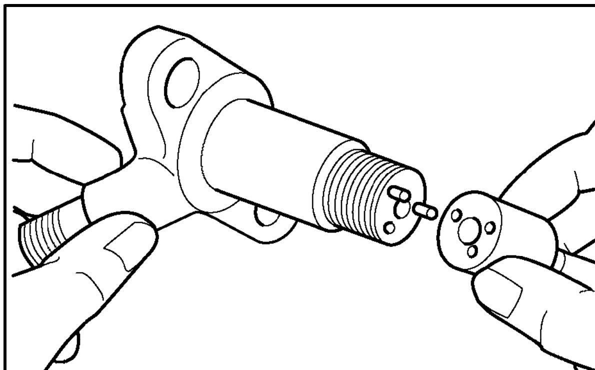
4. Carefully assemble the dowelled adaptor plate and the nozzle retaining nut assembly onto the injector body, tighten the retaining nut to 48 N·m (35 ft. lbs) torque.

To set the nozzle opening pressure, connect the injector to the test rig as described in ‘‘Testing’’ and alter the adjusting nut until the specified opening pressure is achieved.



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INSTALLATION

1. Remove any blanking plugs from cylinder head openings and pipe ends.
2. Insert the new/replacement injector in the cylinder head, having used a new cork dust washer and a new copper sealing washer.
3. Secure each injector with the two retaining bolts and tighten to 22 N·m (17 ft. lbs).
4. Reconnect the leak-off pipe using new washers either side of the banjo fittings and tighten banjo bolts to the 12 N·m (10 ft. lbs).
5. Reconnect high pressure fuel pipes to injectors and tighten gland nuts to 32 N·m (23 ft. lbs).
6. Tighten high pressure fuel pipe gland nuts at the injection pump to 32 N·m (23 ft. lbs).
7. Bleed the fuel system as detailed previously.
8. If the injectors are to be stored before installation, clean in calibrating oil. Storage for longer than 6 months may result in the necessity of disassembling and cleaning the injectors before installation.

FUEL TANK - LS190

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FUEL TANK REMOVAL

1. Securely block the skid steer loader with all four wheels off the ground. Refer to Section 00 for more detailed information on properly supporting the skid steer.

CAUTION

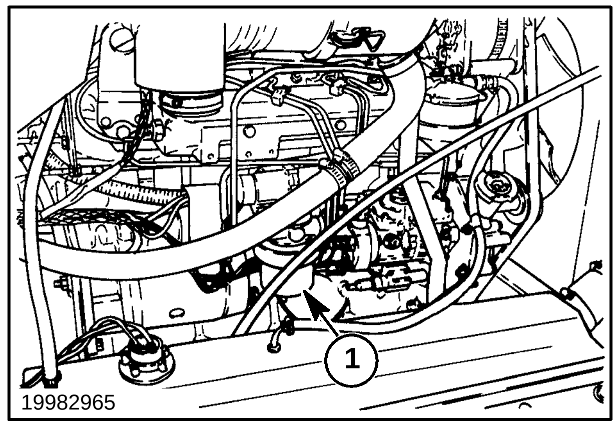
Failure to securely support the skid steer loader could result in movement of the loader causing serious injury or damage to the equipment.

2. Open the rear door and remove the left engine side shield to gain access to the fuel tank.
3. Remove the rear engine belly pan.

CAUTION

Use a floor jack to support the belly pan to prevent serious injury.

4. Drain the fuel tank. Loosen the clamp and remove the fuel tank filler neck.
5. Remove fuel lines, 1 and 2.
6. Disconnect fuel sender wires, 3.



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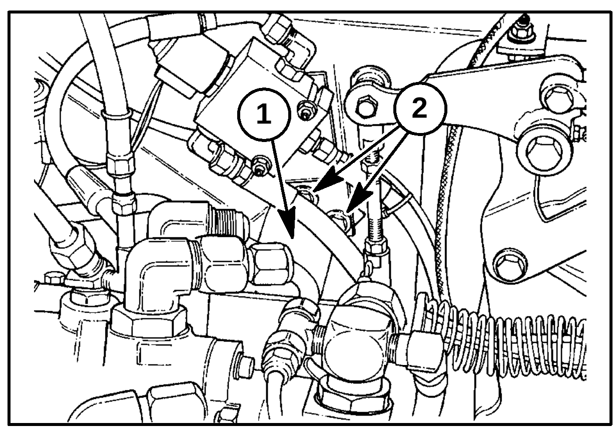
7. Remove cap screws, 2. Remove bracket, 1.



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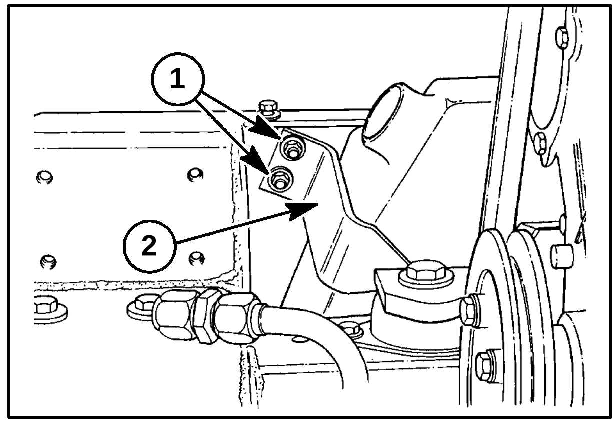
8. Support the fuel tank before removing the rear bracket. Remove the cap screws, washers, and nuts, 1. Remove bracket, 2.
9. Lower the fuel tank and slide rearward.



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FUEL TANK INSTALLATION

1. Install the fuel tank into the loader and secure with retaining hardware.

NOTE: *Use silicone sealant on the two cap screws holding the front retaining bracket to the final drive case.*

2. Install the fuel lines and fuel level sender wires.
3. Install the fuel tank filler neck. Tighten the hose clamp.
4. Fill the fuel tank.
5. Install the engine belly pan and left side shield.
6. Lower the skid steer loader.

AIR INTAKE AND EXHAUST SYSTEM - LS190

AIR CLEANER - LS190

Op. 10 202 40

Removal

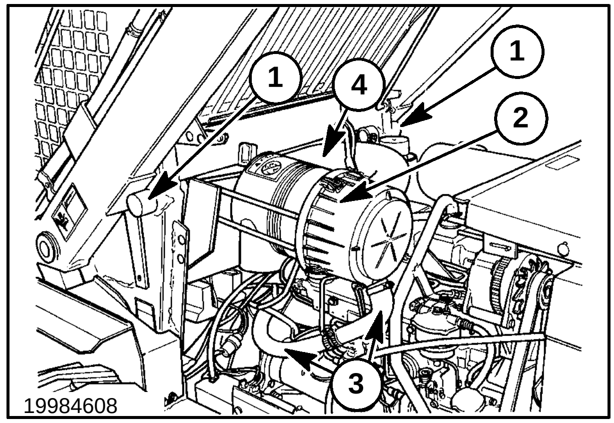
To service the engine air cleaner, the boom must be raised and supported on the boom lock pins, 1.

The air cleaner, 2, is accessed by opening the rear door and top engine cover and left engine side shield. The air cleaner assembly uses two elements, a primary element and a safety element.

Disconnect the outlet hose, 3, and inlet hose, 4.

To access the air filter elements, loosen the three clamps, 1, and unlatching end cap from air cleaner body.

To remove the primary element, remove the end cap, 2. This exposes the primary element, 3.



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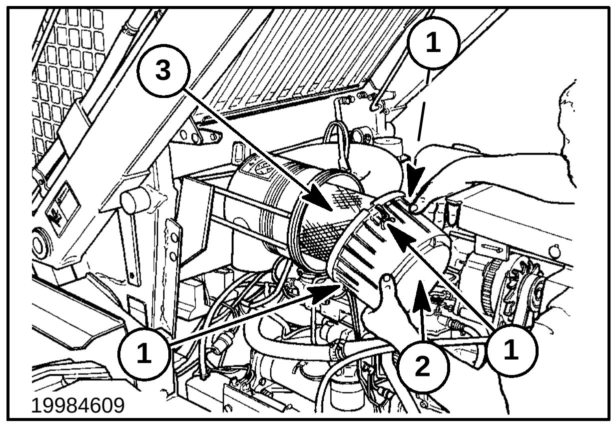

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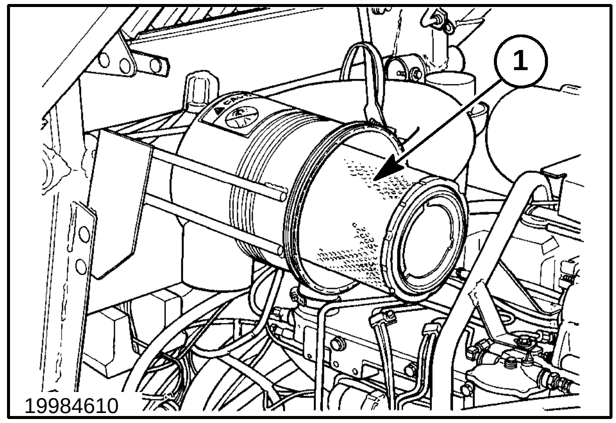
Inspection

1. Pull the primary element, 1, from the canister. Clean any loose dirt from the canister and inspect the end of the canister for dirt that may prevent the new element from sealing properly. Replace the primary element when the EIC indicates air cleaner restriction. Do not attempt to remove the element when the engine is running because dirt will be sucked into the engine. Do not attempt to clean the element by beating or rapping it.



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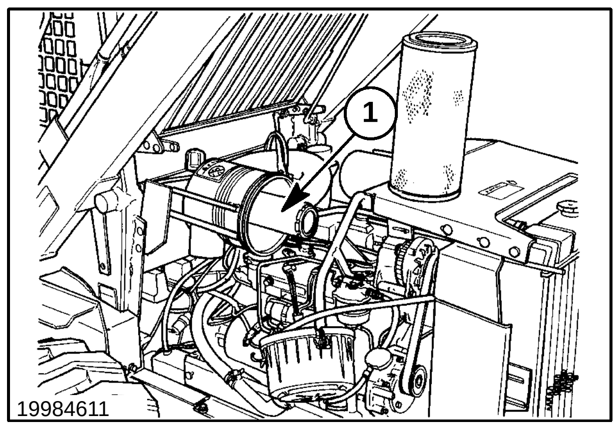
IMPORTANT: *Do not attempt to remove the element when the engine is running because dirt will be sucked into the engine. Change the air cleaner element if a loss of power is noted. When installing a new element make sure it seals properly in the canister.*

IMPORTANT: *Clean any dirt and dust from the canister before reinstalling the cleaner element. Make sure the inner end of the canister is clean and free of dirt to insure the element will seal properly to prevent dirt from entering the intake of the engine. Failure of a good seal between the filter and canister may cause major engine damage.*

2. Do not clean the inner safety filter element, 1. Once the element becomes partially clogged, replace it. To remove safety element pull the element from the canister.

   Visual inspection can be done by placing a light inside the element. If the element is partially clogged, little light will show through the element.

   If the element becomes clogged, it will cause air restriction which will cause loss of engine power or excessive exhaust smoke. For maximum engine protection and air cleaner service life, replace the safety element with a new safety element every third primary element change or 1000 hours - whichever occurs first.



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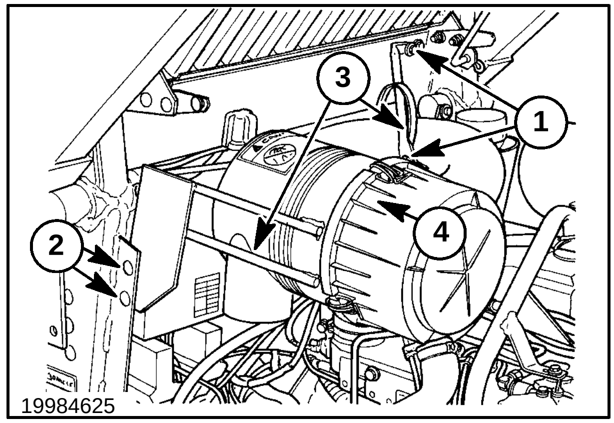
IMPORTANT: *Clean any dirt and dust from the canister before reinstalling the cleaner element. Make sure the inner end of the canister is clean and free of dirt to insure the element will seal properly to prevent dirt from entering the intake of the engine. Failure of a good seal between the filter and canister may cause major engine damage.*

The optional pre-cleaner/aspirator exhaust system can be installed to replace the standard system to extend the air cleaner element life.

3. Inspect the support rod hardware, 1, and the canister support mounting hardware, 2.

   Check that the support rods, 3, are not bent.

   Check that the end cover, 4, fits snugly over the outer canister with no large gaps.



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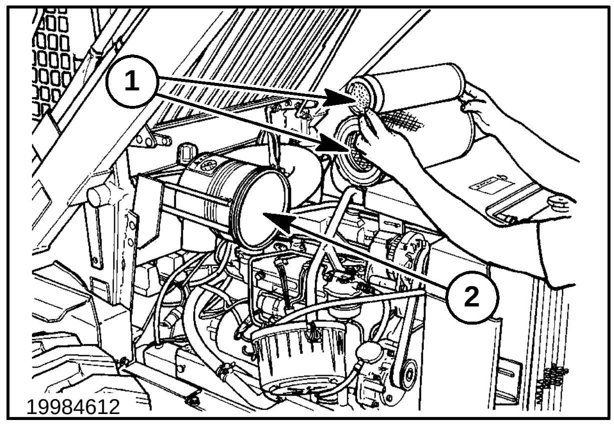
Reinstallation

Install a new primary element and/or safety element by inserting the open end of the elements, 1, into the canister, 2. Push the elements into the canister firmly for proper sealing inside the canister.



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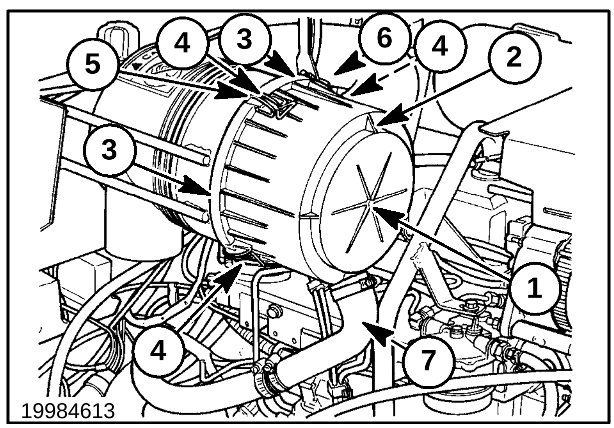
Reinstall the end cap, 1, by positioning the top of the end cap at 2. Seat the end cap into the lip on the canister at 3, pushing the elements and end cap into position.

Relatch the clamps, 4, by catching the top clamp into a slot in the canister lip at 5. Relatch the second two clamps after the top is clamped securely.

Reconnect the inlet hose, 6, and outlet hose, 7, to the canister.



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MANIFOLDS - LS190

The cross flow design aluminum intake and cast iron exhaust manifolds are on opposite sides of the cylinder head. This is designed to maintain balanced heat distribution within the cylinder head. The configuration of the manifolds also ensures minimum heat transfer to the intake manifold.

A hose connects the air cleaner to the intake manifold. In the rear end of the manifold a tapped hole provides for installation of a thermostart cold starting aid.

NOTE: *On tractors where cold start equipment is not installed, make sure the plug in the intake manifold is kept tight at all times. Considerable damage to the cylinder bores may be incurred by entry of grit or other foreign material if the plug is left loose or missing. Also, dirt and grit may be drawn through the air cleaner connections if they are not properly secured.*

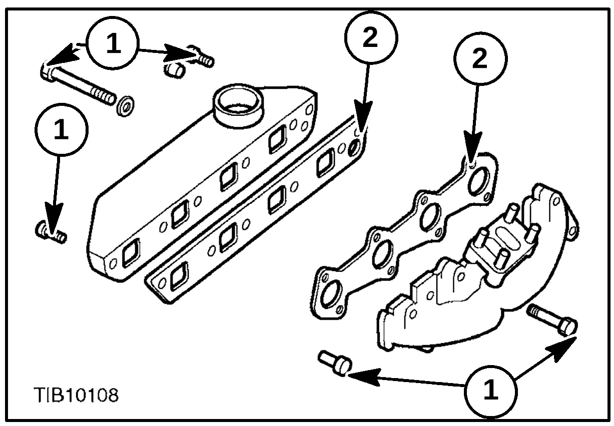
The inlet manifold attached to the right hand side of the engine block is a one piece cast aluminium plenum chamber that directs the air from the air cleaner and into the cylinder head.

The exhaust manifold attached to the right hand side of the engine block is a one piece cast iron unit that channels the spent exhaust fumes into the muffler by way of tubing and clamps.

REMOVAL

IMPORTANT: *Whenever it is necessary to remove the intake or exhaust manifolds from the engine, new sealing gaskets must be fitted upon reassembly.*

1. Remove the securing bolts, 1, for the intake manifold and exhaust manifold. Discard the gaskets, 2.



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Op. 10 254 12

Intake Manifold - Removal

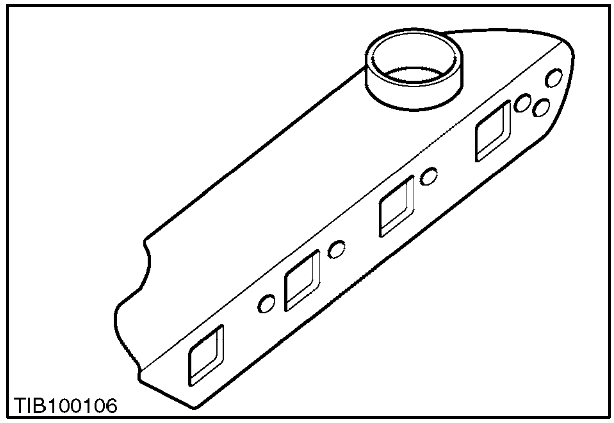
Op. 10 254 14

Exhaust Manifold - Removal

INSPECTION

1. Clean the intake manifold in a solvent that is suitable for aluminum and check for cracks or damage repair where practical. Small imperfections on the joint face can be dressed with a stone, but where they exceed a stone repair the manifold must be changed.

NOTE: *Intake manifold bolts have O ring seals fitted.*



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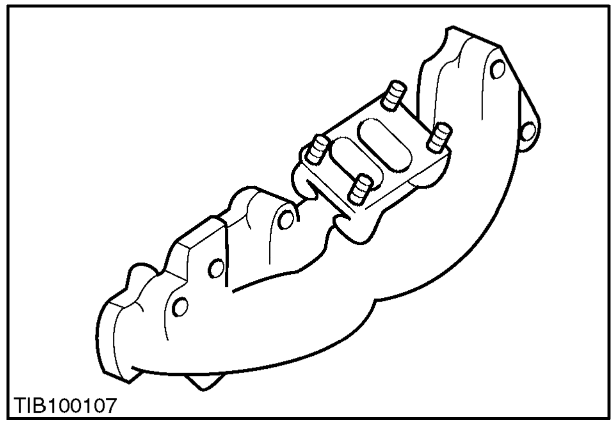
2. Clean the exhaust manifold in a suitable solvent, removing the carbon deposits with a wire brush. Check for cracks or damage to the joint face that could create an air leakage. Small imperfections can be dressed with a stone, but where they exceed a stone repair the manifold must be changed.



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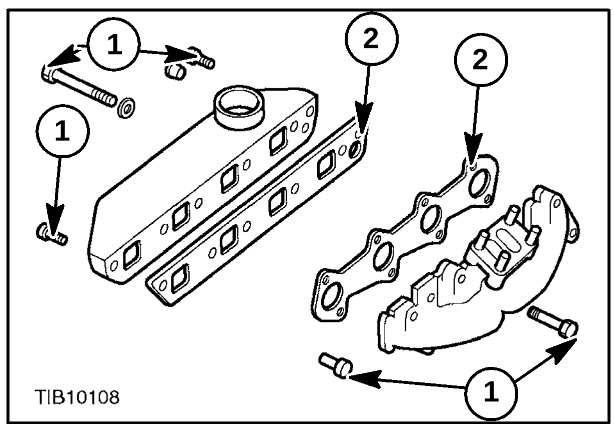
INSTALLATION

1. Prior to refitting the manifolds clean the cylinder head faces with light grit paper to remove any trace of old gaskets that may have remained on the head face during disassembly.
2. Place the bolts, 1, through the manifold to be fitted and through a new gasket, 2. Attach the manifold and gasket onto the cylinder head and torque the bolts on the:
   Intake manifold to 35 N·m (26 ft. lbs.)
   Exhaust manifold bolts to 38 N·m (28 ft. lbs.)



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ENGINE INSTALLATION - LS190

ENGINE ASSEMBLY SEQUENCE

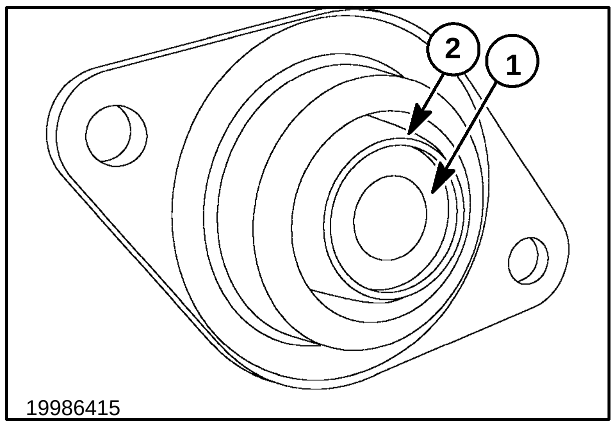
The following assembly procedure is suggested for installing external components onto the engine. Refer to the appropriate section when installing engine components.

1. Install crankshaft pulley.
2. Install oil pan.
3. Install transmission housing and flywheel. (See Section 27.)
4. Install water pump.
5. Install fuel filter, fuel supply pump, and fuel line.
6. Install oil filter, engine oil cooler and hoses.
7. Install coolant outlet connection with thermostat and new gasket.
8. Install rocker arm cover with vent tube.
9. Install turbocharger and exhaust manifold.
10. Fill coolant and engine oil to proper level.

INSTALLATION INTO LOADER

1. Before installing the engine into the skid steer, check the condition of the engine (isolator) mounts and replace if necessary.

   Examine the three isolation mounts (part #9803221) for wear or damage to the inner steel bushing. Damage may be in the form of wear or crushing to the end bushing surface, 1, on either end of the inner steel bushing. Severe damage may result in cracking of inner bushing, 2. If damaged, replace all three bushings.



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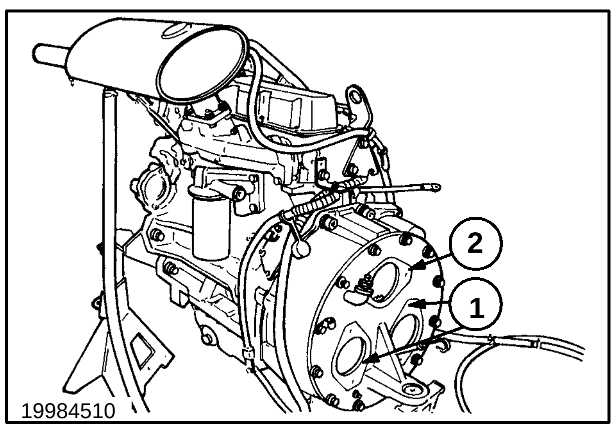
2. Prepare the motor for reassembly by ensuring that the hydrostatic pump mounting flanges, 1, and high-flow hydraulic pump mounting flange, 2, are clean. Ensure that there is no dirt or debris in the transmission gear case housing. Clean the mounting flanges on both hydrostatic pumps and install new mounting flange O rings.



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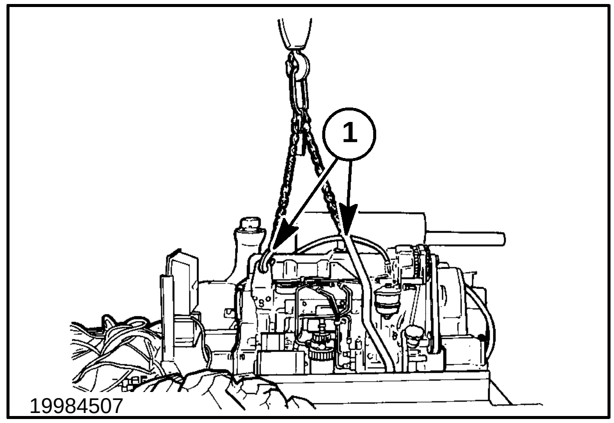
3. Install the engine assembly into the skid steer by slowly lowering the engine into the engine compartment. It will be necessary to slide the engine forward as it is lowered into the engine compartment.

   If the hydrostatic pumps were left in the skid steer, take care to lift the hydrostatic pumps into the transmission gear housing as the engine is being lowered into the engine compartment.

   Once the engine is aligned over the engine isolation mounts completely, lower the engine into the skid steer.



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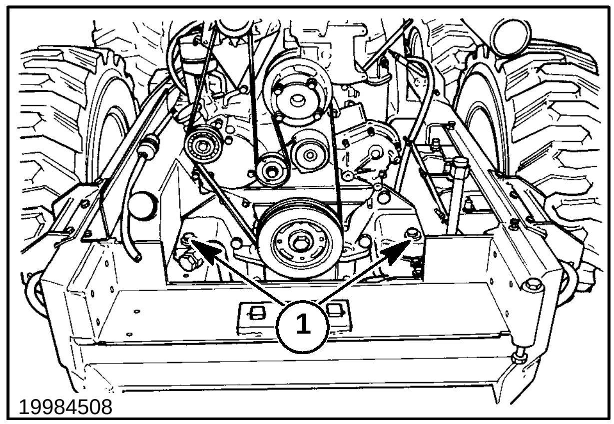
CAUTION

If the batteries remained in the skid steer loader, take extreme care to protect the batteries from damage during engine replacement.

4. Install the engine mounting bolts, 1, and forward engine mounting bolt. Torque the mounting capscrews to 172 N·m (127 ft. lbs.).



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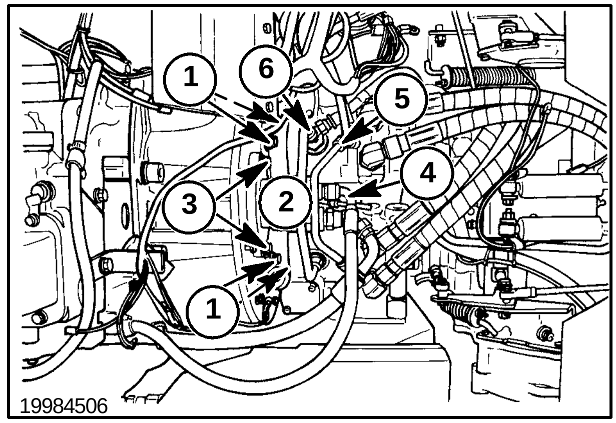
5. Reattach the hydrostatic pumps to the transmission gear housing by installing the upper and lower mounting bolts, 1, on each of the hydrostatic pumps. Tighten the mounting bolts.
6. High-Flow Hydraulics - If the unit was fitted with a High-Flow Hydraulic Kit, reinstall the hydraulic pump, 2, by first cleaning the mounting surfaces, placing a bead of silicone sealant around the pump mounting flange and bolting it to the transmission gear housing at 3. Tighten the mounting bolts.
7. Reconnect the high-pressure (line to selector valve) hydraulic line, 4, from the High-Flow pump and its engine mounting support bracket. Tighten the fittings at this time.

   Reconnect the hydrostatic pump charge pressure crossover tube, 5, and case drain tube 6. Tighten the fittings at this time.



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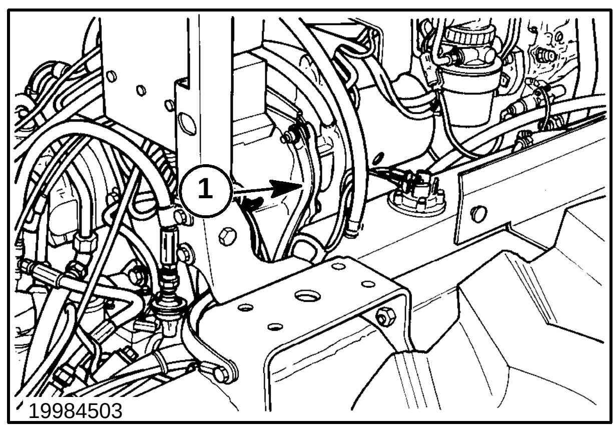
NOTE: *Detailed information for connecting the hydrostatic pumps can be found in Section 29 - Hydrostatic Transmission, if needed. Information concerning the High-Flow Hydraulic Kit, if installed, can be found in Section 88 - Accessories.*

8. Install the engine ground strap, 1, ground wires and harness clamps to the transmission gearbox. Install the engine wiring harness and reattach to engine components:
   - Fuel compensator solenoid
   - Fuel shut off solenoid
   - Electric fuel pump
   - Starter
   - Engine pre-heater
   - Alternator
   - Engine coolant temperature element
   - Oil pressure switch
9. Install the fan blade assembly onto the water pump shaft.



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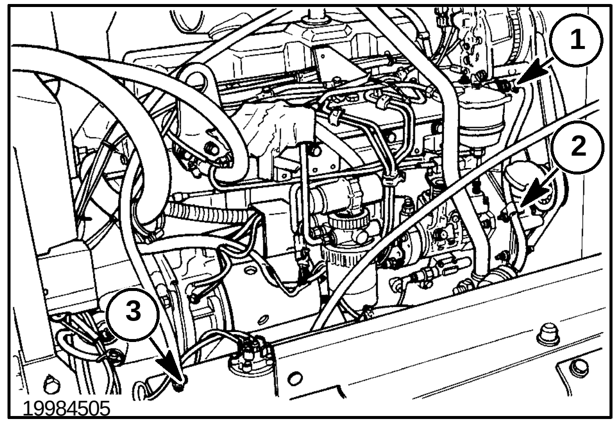
10. Install the engine fuel supply line, 1, at the engine connection. Install the retaining clip, 2, and the fuel return line, 3, at the fuel tank connection.



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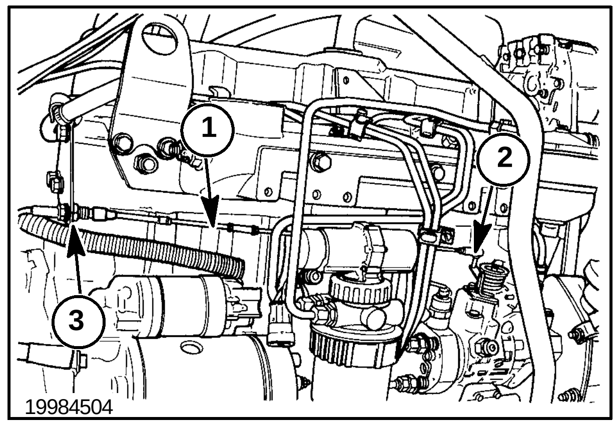
11. Connect the throttle cable, 1, to the throttle body plate, 2, and the cable to its mounting bracket, 3.



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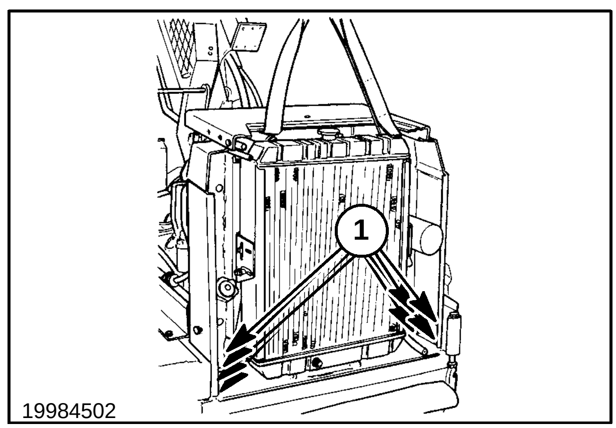
12. Place the engine fan shroud over the fan in preparation for installation of the radiator housing assembly. Install the radiator housing assembly onto the skid steer loader and secure in place with eight (four per side) capscrews, 1.

NOTE: *Drain the oil from the cooler prior to installing the radiator assembly onto the skid steer loader to make connecting the oil cooler lower fitting easier.*



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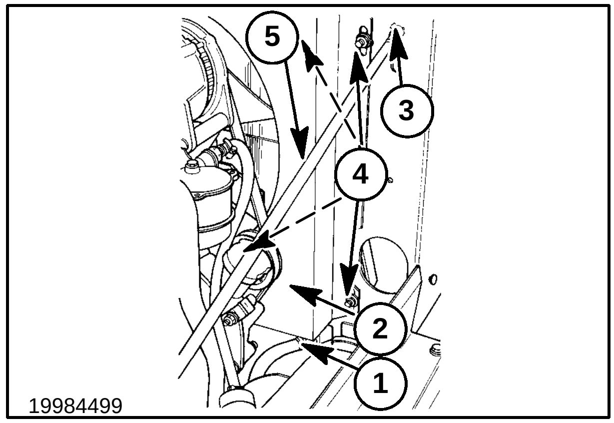
13. Connect the oil cooler bottom left line, 1, and tighten.
14. Install the fan shroud, 2, onto the radiator housing 3, by installing the four (two per side) capscrews, 4, and tightening. Install the engine oil dipstick line, 5.
15. Install the upper and lower radiator hoses. If the unit is fitted with a Cab Heater/Defroster Kit, also reconnect the heater hose to the "T" connection in the lower radiator hose.



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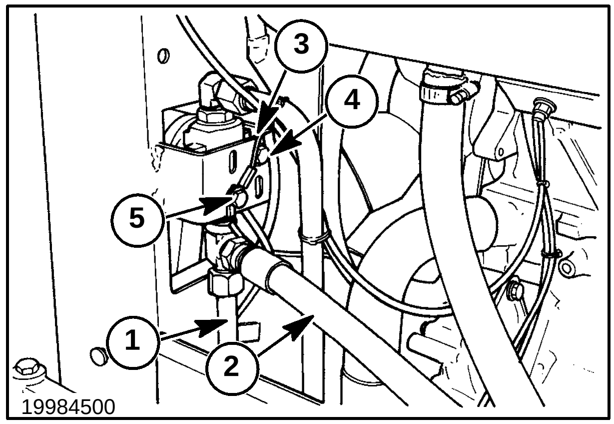
16. Connect the hydraulic line, 1, to the oil filter base. If the unit is fitted with a High-Flow Hydraulic kit also connect the high flow hydraulic line, 2, to the "T" connection at the hydraulic oil filter base. Tighten all fittings.
17. Connect the hydraulic oil filter restriction switch wires, 3, harness clamp, 4, and ground wire connections, 5.



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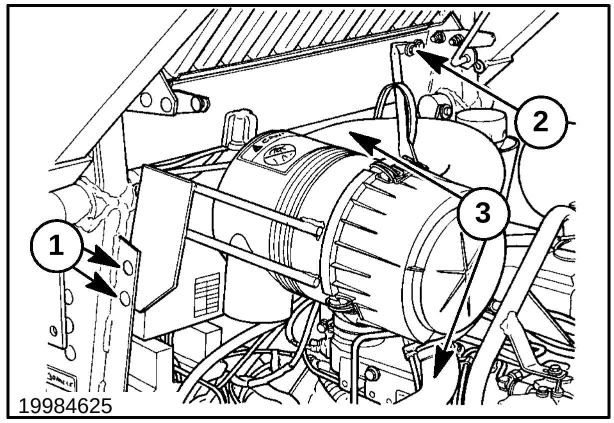
18. Install the air cleaner canister support hardware, 1. Install the support rod hardware, 2. Connect the air hoses at the air cleaner, 3, and tighten the hose clamps.
19. Install the fuel tank filler neck and tighten the hose clamps.
20. Install the rear door latch bracket.
21. nstall the engine oil dipstick tube to the radiator housing and insert the dipstick.
22. Install the radiator housing rear door and adjust the latch bracket to achieve proper closing and latching of the door. Tighten all latch bracket and door hinge hardware.
23. Attach the radiator overflow hose to the radiator. If the skid steer was fitted with a Backup Alarm kit, connect the alarm module wires. Connect the pink/gray wire to the module positive (+) terminal and the black wire to the negative (-) terminal.
24. If the batteries were removed, install the batteries and connect the positive cable and then the negative cable to the batteries. Attach the engine compartment side skirt that was previously removed to facilitate battery removal.
25. Install the skid steer loader center belly cover plate and tighten the bolts.
26. Check the following fluid levels and refill or top off as necessary:
    - Transmission gear case level
    - Engine oil level
    - Hydraulic oil level
    - Engine/radiator coolant level



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OPERATING THE ENGINE AFTER OVERHAUL

1. Check level of engine oil, coolant and fuel.
2. Disconnect the wiring harness connector at the engine stop solenoid.
3. Crank the engine until the oil pressure lamp is extinguished.
4. Connect the wiring harness connector to the engine stop solenoid.
5. Move the hand throttle to the 1/3 or 1/2 open position and start the engine. Operate at no more than 1500 RPM.
6. Run the engine at 1500 RPM for about 30 minutes to allow it to fully warm up and begin the ring seating process. During warmup observe the following:
   - Listen for abnormal sounds.
   - Monitor engine temperature.
   - Check for fluid leaks (oil, coolant, fuel).

ELECTRICAL COMPONENT MAINTENANCE - LS190

CRANKING CIRCUIT (STARTING MOTOR)

Op. 55 201 50

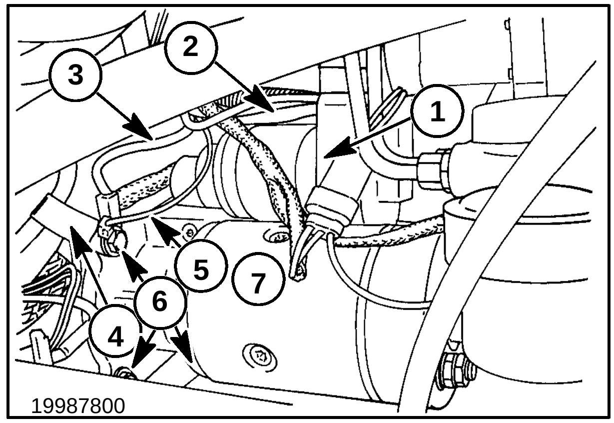
Removal

IMPORTANT*: Always disconnect the negative (-) battery cable before removing the starter or a short circuit could result.*

1. Disconnect the negative (-) battery cable.
2. Remove solenoid cover, 1, from rear of solenoid.
3. Disconnect the positive battery cable, red wiring leads and WHT/RED wiring lead, 2, from the starter solenoid.
4. Remove the oil dipstick cap screws and lower for starter removal clearance.
5. Remove the negative battery cable, 3; ground strap, 4; and black wiring lead, 5.
6. Remove three cap screws, 6. Remove starting motor, 7.

Installation

1. Reverse the removal procedure previously outlined.



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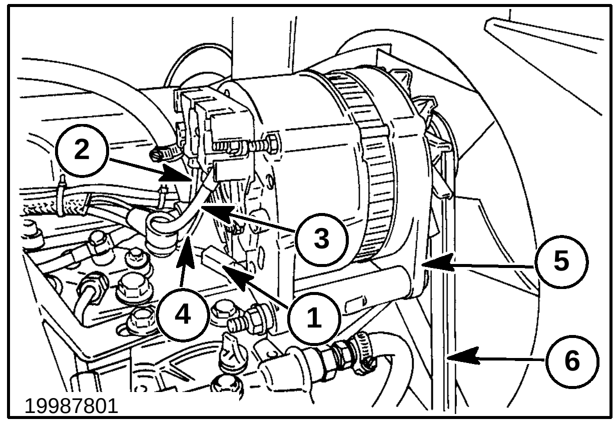
CHARGING CIRCUIT

Op. 55 301 10

Alternator Removal

IMPORTANT: *Always disconnect the negative (-) battery cable before removing the alternator or a short circuit could result.*

1. Disconnect the negative (-) battery cable.
2. Disconnect the RED/DK BL wiring lead, 3, from terminal B+ and PUR/RED wiring lead, 2, from terminal W.
3. Disconnect BLK wiring lead, 1, and YEL/DK BL electrical connector, 4.
4. Remove the three cap screws, 5. Remove belt, 6. Remove the alternator.



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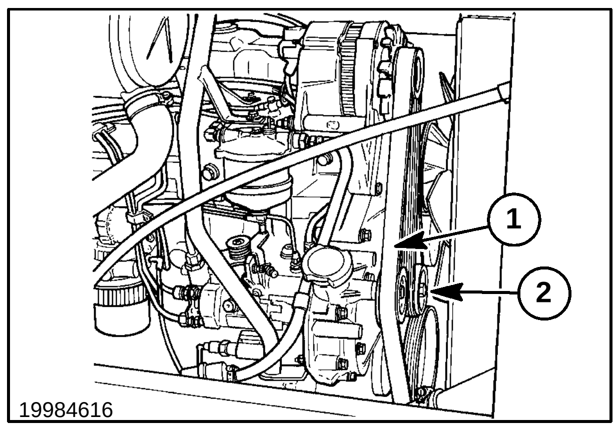
Installation

1. Reverse the removal procedure previously outlined.
2. Adjust belt tension.

ADJUST BELT TENSION

Check the alternator belt, 1, for proper tension. The alternator drive belt has a spring loaded idler, 2, to automatically maintain proper belt tension.



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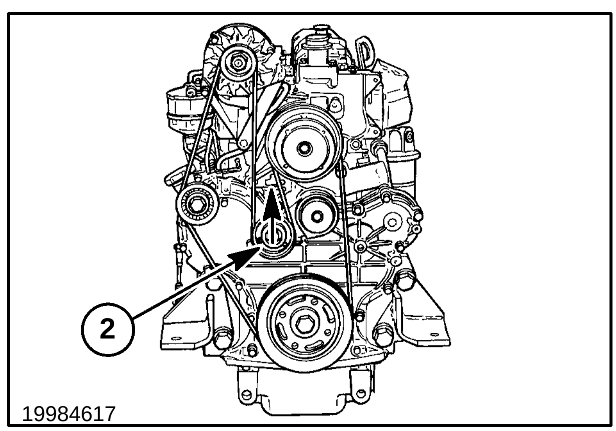
To replace the drive belt, lift the spring loaded idler, 2, up to release tension on belt and remove belt. Refer to this figure for proper belt routing. The fan and shroud is removed for clarity.

IMPORTANT: *To prevent possible damage to the alternator when replacing a belt, disconnect the (-) negative, ground cable from the battery.*



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SPECIAL TOOLS - LS190

DESCRIPTION	TOOL NO.
Adjustable Bridge Puller	FNH09539
Shaft Protectors	FNH09212
Step Plate Adapters	FNH09210
Bushing Kit	FNH09514
Crankshaft Gear Remover/Installer Adapter/Insert	 FNH02134 FNH01237
Valve Guide Reamer Kit	FNH02136
Camshaft Bearings Remover/Installer Handle	 FNH01225 FNH01442
Water Pump Seal Replacer	FNH04672
Reverse Flush Adapter	FNH08124
Crankshaft, Seal Replacer Front Seal Rear Seal	 FNH10103 FNH01301
Fuel Injector Pump Timing Gauge, Splined Shaft and Slotted Arm	NH01341

LABOR GUIDE - LS190

The following labor amounts are listed as a guide only. Machine and working conditions and experience will vary the actual time required to perform a repair operation.

Op. 10 001 10

ENGINE REMOVAL FROM SKID STEER LOADER
(5.0)

Includes tilting the cab, removal of the oil cooler and filter and radiator as an assembly. Disconnecting hydrostatic drive pumps.

ENGINE OVERHAUL

Op. 10 001 53

Major overhaul (16.0)
Engine removed from machine.

Steam clean and completely dismantle, clean all parts, flush all oil and water passages and replace plugs, check crankshaft for wear and inspect all parts.

Deglaze cylinder bores as required. Does not include rebore or fitting new sleeves.

Replace or repair pistons with new rings.

Replace crankshaft main and rod bearing liners, camshaft bearings. Does not include regrind of crankshaft.

Recondition cylinder head including reseating valves, repair/replace valve guides, overhaul rocker shaft assembly. Service fuel injectors.

Inspect and replace timing gears as necessary. Inspect and repair water pump and oil pump as required.

Reassemble engine completely using new gaskets and seals and tighten to specifications. Set valve clearances. Run engine and check for leaks. Reset valve clearances.

Minor overhaul (oil consumption rectification)
Engine in machine. (9.0)

Engine removed from machine. (8.0)

Remove cylinder head, oil pan and oil pump.

Remove all pistons and connecting rods.

Deglaze all cylinder bores.

Clean and check pistons for wear. Repair as necessary and replace piston rings.

Strip and clean cylinder head. Reseat valves and service fuel injectors.

Inspect oil pump and repair/replace as necessary.

Reassemble all parts using new gaskets and seals.

Run engine and check for leaks. Reset valve clearances.

CYLINDER BLOCK

Op. 10 001 54

Replace bare block (12.5)
Engine removed from machine.

Steam clean complete engine, dismantle, clean and inspect all parts to be reused.

Reassemble engine complete into new bare block with same or new pistons using new rings, crankshaft main and rod bearings, camshaft bearings, gaskets and seals. Reinstall cylinder head. Tighten to specifications.

PISTON ASSEMBLY

Op. 10 105 10

Connecting rod
Replace one. (4.0) Engine in machine.

Includes remove and replace cylinder head, oil pan, piston and rod assembly. Clean, reinstall with new gaskets. Run engine, check for leaks. Reset valve clearances.

Small end bushing
Replace one. Engine in machine. (4.2)

Each additional (0.5)

Includes remove and replace connecting rod.

Op. 10 105 12

Piston
Replace one. Engine in machine. (4.5)

Each additional (0.3)

Includes remove and replace cylinder head, oil pan, piston and rod assembly. Clean, fit new rings, reinstall with new gaskets. Run engine, check for leaks. Reset valve clearances.

CYLINDER HEAD

Valve Rocker Arm Cover
Remove and replace. (0.4)

Cylinder Head Overhaul
Engine in machine. (6.5)

Engine removed from machine. (5.5)

Remove cylinder head and gasket. Clean head and block surface.

Reseat all valves. Grind all valve seats, reface all valves.

Additional time: Replace valve seat - each (0.2)

Clean and inspect valve guides. Ream and fit new valves as necessary.

Inspect and shim valves springs.

Install head, set valve clearances. Run engine and check for leaks. Reset valve clearances.

Op. 10 101 20

Cylinder Head Remove and Replace
Engine in machine (2.5)

Includes remove and replace valve rocker cover and shaft assembly. Adjust valve clearances. Install new gaskets.

Valve Spring
Change one. (0.8)

Head not removed.

Includes remove and replace rocker arm cover.

Change all. (1.3)

Head not removed.

Includes remove and replace rocker arm cover.

CAMSHAFT, TIMING GEARS AND COVER ASSEMBLY

Camshaft
Remove and replace. Engine removed from machine. (3.1)

Includes remove and replace rocker shaft assembly, timing gear cover.

Valve Lifters
Remove and replace all. Camshaft removed from engine. (0.7)

Includes remove and replace oil pan.

Timing Gear Cover
Remove and replace. Engine in machine. (2.0)

Remove and replace. Engine removed from machine. (0.7)

Includes remove and replace radiator support (in machine) and crankshaft pulley.

FUEL SYSTEM

Injection Pump
Remove and replace. (2.4)

Includes remove and replace starter, high-pressure and low-pressure pipes, bleed system.

High-Pressure Pipes
Remove and replace one (0.2)

Remove and replace all. (0.4)

Fuel Injector
Remove and replace one (0.5)

Remove and replace set (1.2)

Includes injector test.

Dismantle and clean one injector (0.7)

Includes remove and replace and retest.

Dismantle and clean all injectors (2.0)

Includes remove and replace and test.

Fuel filter element (0.2)
Change
Includes bleeding system.

Fuel pump stop solenoid (0.2)
Remove and replace.

Fuel tank (1.0)
Remove and replace.

Fuel level sender (0.1)
Remove and replace.

Fuel pickup tube (0.1)
Remove and replace.

Fuel lines (supply & return) (0.1)
Remove and replace.

Electric lift pump (1.0)
Remove and replace.

AUXILIARY EQUIPMENT

Alternator (0.3)
Remove and replace.

Oil filter (0.1)
Remove and replace.

Starter motor (0.4)
Remove and replace.

Starter solenoid (0.7)
Remove and replace.

With starter removed from engine.

Thermostat (0.8)
Remove and replace.

Engine fan (0.8)
Remove and replace.

Fan belt (0.2)
Remove and replace.

Water pump (1.6)
Remove and replace.

Radiator (0.5)
Remove and replace.

Manifolds (2.0)
Remove and replace.

SECTION 27 – REAR DRIVE AXLE (GEARBOXES)

Chapter 1 – Gearboxes

CONTENTS

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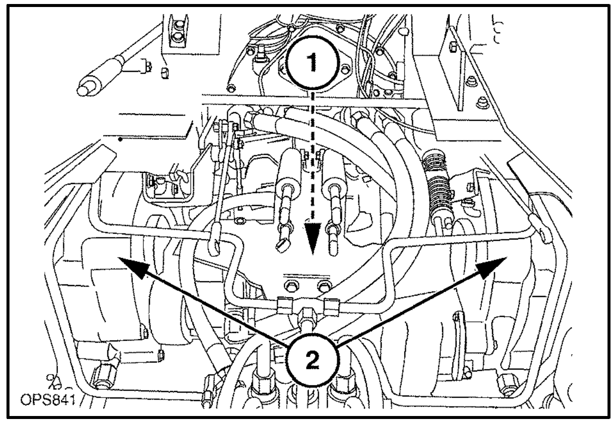
GENERAL INFORMATION

Each of the two hydrostatic pumps is driven by the engine through a spur gear configuration located in the engine-to-transmission gearbox. The hydrostatic pumps then transmit hydraulic power to the hydrostatic motors, 1, which are connected to gearboxes, 2, located on the inside of the final drive cases. The left and right drives are separate from each other and are operated independently.



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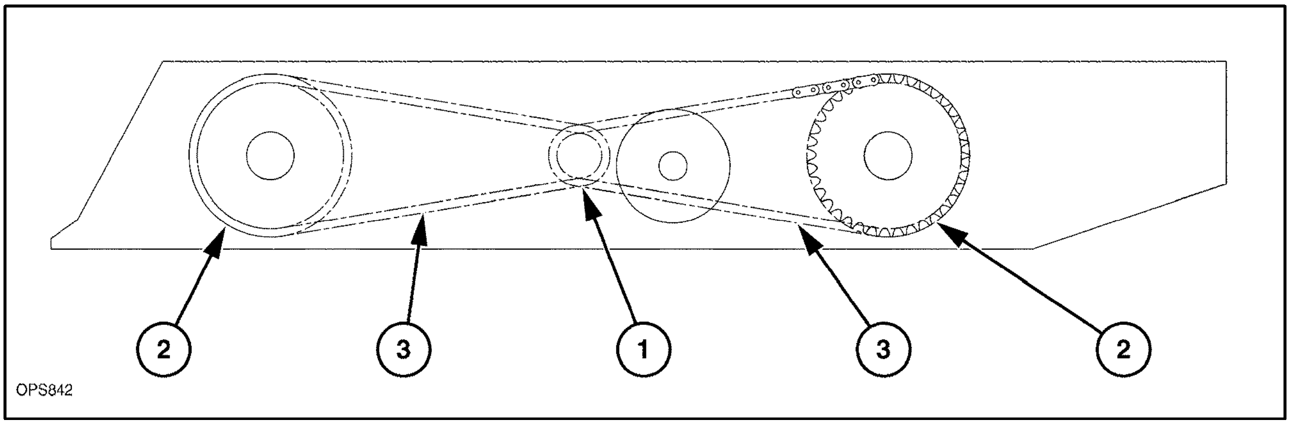

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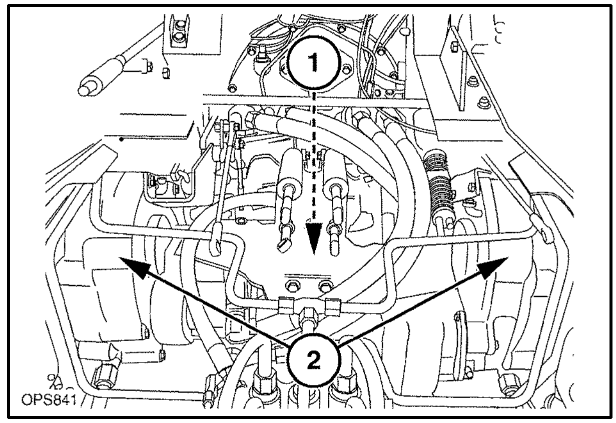
Power is then transmitted through gears to a drive sprocket, 1, in the final drive case. The drive sprocket is connected to the axle sprockets, 2, with chains, 3, one endless chain to the front axle and one endless chain to the rear axle.

The right and left gearboxes, 2, are located under the operator’s seat. Hydrostatic motors, 1, drive the gearboxes, and power is transmitted through the gearboxes to the final drive chains and axles.



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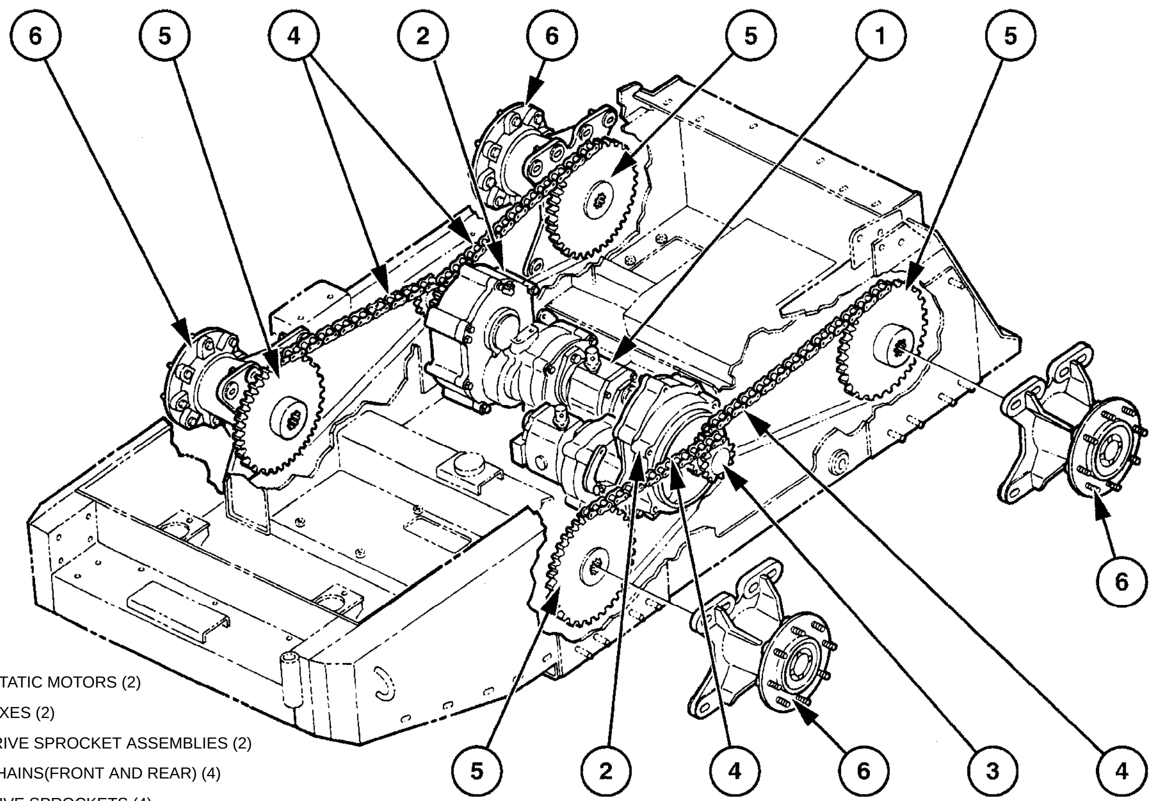

1 - HYDROSTATIC MOTORS (2)
2 - GEARBOXES (2)
3 - FINAL DRIVE SPROCKET ASSEMBLIES (2)
4 - DRIVE CHAINS(FRONT AND REAR) (4)
5 - AXLE DRIVE SPROCKETS (4)
6 - AXLES ASSEMBLIES (4)

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SPECIFICATIONS

Chain Case and Gearbox

Side Cover Bolt Torque . . . . 15 N·m (11 ft. lbs.)

Drive Chain . . . . #100

Front Chain Length (64 links) . . . . 80″ (2032 mm)

Rear Chain Length – LS180 (58 links) . . . . 72.5″ (1841.5 mm)

Rear Chain Length – LS190 (64 links) . . . . 80″ (2032 mm)

Chain Tension . . . . 0 to 6 mm (0″ to 1/4″) movement at tire tread

Gearbox Mounting Bolt Torque . . . . 233 ft. lbs. (316 N·m)

Drive Motor Mounting Bolt Torque . . . . 63 ft. lbs. (85 N·m)

Front Cover Plate Bolt Torque . . . . 15 ft. lbs. (20 N·m)

Lubrication . . . . 9.5 liters (2.5 gal.) each side - 80W-90 API Service GL-5 Gear Oil

Other Materials

Description	Use
Ultra/Blue Silicone Sealer	Gearbox mounting bolts Axle housing bolts Chain case cover bolts Gearbox to chain case Gearbox cover and bolts
Sealing Material	NH Ultra Blue silicone sealer NH #L81724 - 3.35-oz. tube (cord) NH #L82519DS - 8-oz. tube NH #L58775 - 10.2-oz. cartridge
Gear Oil	80W-90 API Service GL-5 Gear Oil NH #9613295 - 1 qt. NH #9613294 - 5 gal. NH #9613375 - 4 L
Grease	High viscosity lithium base NH #9613310 - tube

NOTE: *Always use a noncorrosive silicone sealer to seal where required to prevent corrosion during the silicone curing process.*

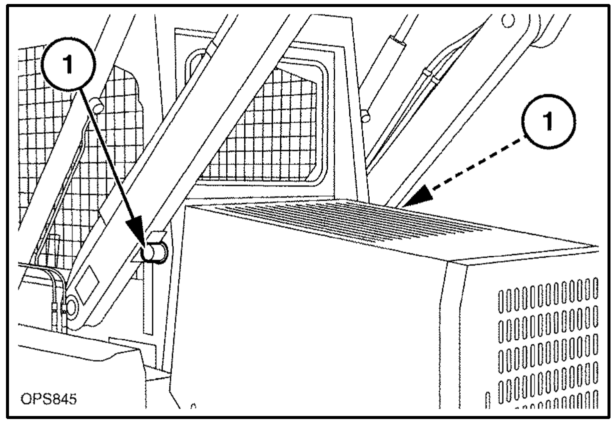
TROUBLESHOOTING

FINAL DRIVE SYSTEM

Before servicing or adjusting the final drive system, the skid steer should be jacked up with the wheels off the ground.

Remove any attachment from the skid steer; boom, bucket, etc. Lower the boom to the lowered position or, if servicing requires the boom to be in the raised position, support the boom on the boom lock pins.

Raise the boom and lower onto the boom lock pins, 1.



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1. Raise the boom above the boom lock pins.
2. Engage the boom lock pins.
3. Stop the engine; ignition key in the “OFF” position.
4. Turn the ignition key to the “ON” position.
5. Lower the boom onto the boom lock pins.
6. Turn the ignition key to the “OFF” position.

CAUTION

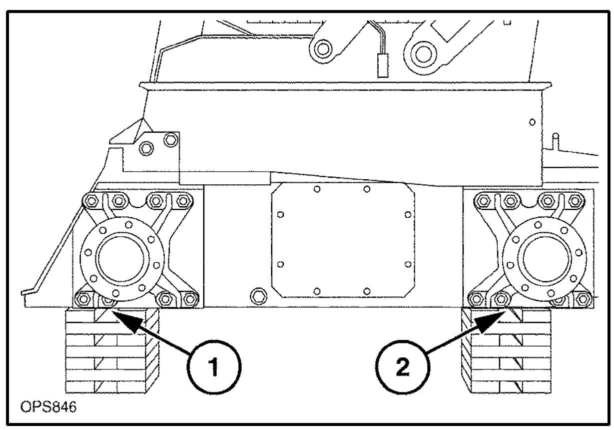
Never exit the loader with the boom in the raised position unless the boom is supported on the boom lock pins.

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment mounted. Always remove the attachment from the loader.

Jack up the loader and support the loader with the wheels off the ground. Use adequate jack stands or blocks to securely support the loader.

Support the loader at the front of the final drive cases at 1, and at the rear at 2.



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CAUTION

Never service a raised loader unless it is securely supported with adequate jack stands or blocks.

FINAL DRIVE SYSTEM

PROBLEM	POSSIBLE CAUSES	CORRECTION
Both drive wheels on one side not powered	No hydrostatic motor shaft rotation	Check for pump to motor oil flow and repair
	No gearbox output drive	Check gearbox shaft rotation and repair
	Broken drive chains	Check chains and repair
One drive wheel not powered	Broken drive chain	Check chain and repair
	Axle or drive sprocket splines worn	Check axle and sprocket; replace
Chain case noise	Loose drive chains	Check and adjust chains
	No oil in final drive	Check oil level
	Worn drive sprockets	Check sprockets and repair
	Bearing failure	Check axle and gearbox bearings and repair
Excessive axle play	Bearing failure on axle shaft	Check bearings and repair
	Snap ring failure on axle shaft	Check axle bearing preload; repair
Noise in gearbox	No or low oil in gearbox	Check oil level
	Bearing failure	Check shafts and bearings; repair
	Bearing or shaft failure in drive motor	Check drive motor and repair
	Gears in gearbox worn	Check and replace
	Parking brake not released	Release parking brake
Final drive case leaking	Oil escaping past case side sheet and reinforcing plate	Reinstall with sealant as described in Service Bulletin (7/95-I7)
	Oil escaping past studs	Remove and reseal studs
	Oil escaping around center inspection plate	Remove plate and reseal

TESTING

Pretest instructions:

* Operator in seat with seat belt buckled.

* Engine running at high idle (full throttle).

* Park brake in disengaged position.

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Push both drive controls forward equally and loader should move in a straight line.	YES NO	Drive system OK. Engine stalls, wheels appear locked, check parking brake for engaged. If OK, go to step 2. Slow or no power; refer to hydrostatic drive section.
2			Check final drive chain; if broken, repair.
3	Pull both drive controls rearward equally and loader should move in a straight line.	YES NO	Drive system OK. Engine stalls, wheels appear locked, go to step 1. Wheels rotate slow or no power, go to step 1. One side of loader drags, go to step 2.

Pretest instructions:

* Lower boom and attachment to the ground.

* Stop engine.

* Jack loader with wheels off the ground.

* Release parking brake.

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Rotate each tire by hand, tires move less than 1/4″ at tread.	YES NO	Drive system OK. Tires move more than 6 mm (1/4″) at tread; check chain tension.
2			One tire rotates freely, broken chain, or axle spline worn.
3			Both tires on one side rotate freely together, inspect drive gearboxes. If OK, check drive motor.
4	Tires rotate but are noisy.	YES NO	Check drive chains, axle bearings. Drive system OK.

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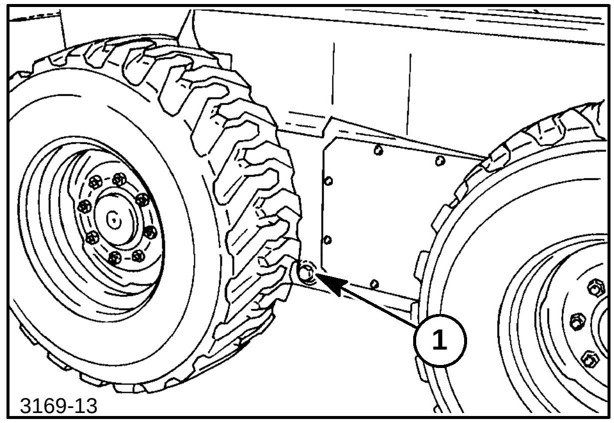
GEARBOXES

Two gearboxes are used to provide speed reduction and transmit power from the hydrostatic drive motors to the final drive chains. The parking brake assemblies are located in the gearboxes.

FINAL DRIVE AND GEARBOX FILL/CHECK PLUG (2)

The final drive fill/check plug, 1, is located on each side of the loader frame. Remove plug and oil should just begin to run from plug. Fill each final drive to the bottom of check plug with SAE 80W-90 API Service GL-5 gear oil.



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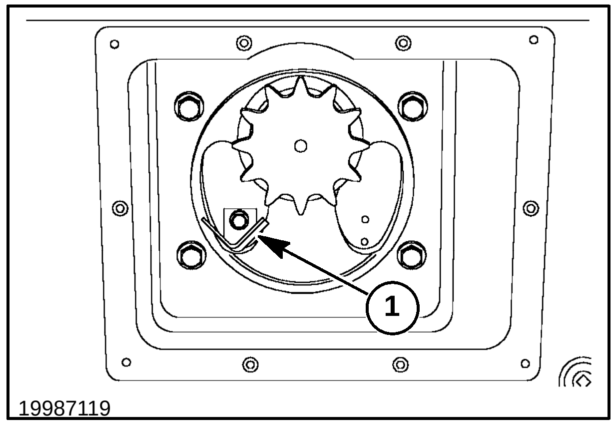
The shared oil configuration circulates oil through holes in the gearbox gear cover. A funnel, 1, takes oil into the gearbox, and the oil returns through the opposite hole.



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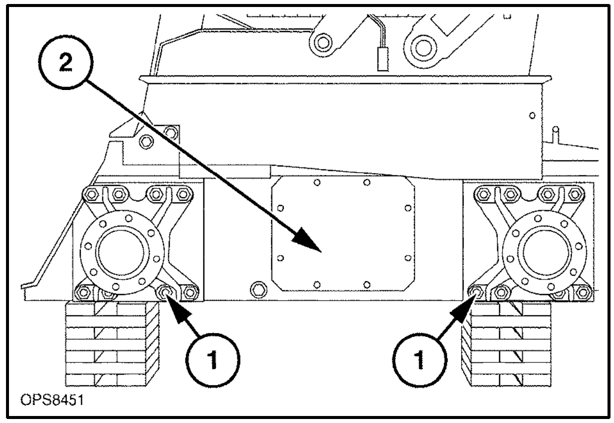
REMOVAL

1. Securely block the skid steer with all four wheels off the ground. Refer to Section 00 for more detailed information on properly supporting the skid steer.

CAUTION

Failure to securely support the skid steer could result in movement of the loader causing serious injury or damage to the equipment.



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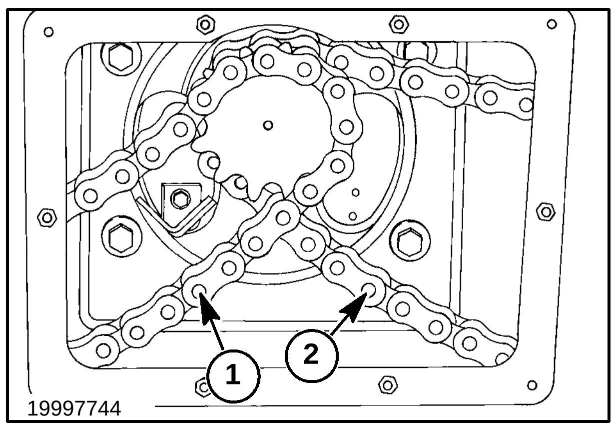
2. Tilt the cab and boom forward. Refer to Section 00 for more detailed information on this procedure.
3. Remove the drive control lever assembly. Refer to Section 29 for the drive control lever removal procedure.
4. Remove the tires and wheels from the final drive being serviced.
5. Clean the axle and final drive area to prevent debris from entering the final drive case.
6. Remove the eight axle housing retaining nuts, 1, on each axle. Remove the final drive axles from the frame.
7. Remove the final drive case cover, 2.



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8. Remove drive chains, 1 and 2, from the final gearbox sprocket.
9. Remove the transmission centering assembly. Refer to Section 29 for the removal procedure.
10. Remove the hydrostatic motor two-speed control linkage and hydraulic cylinder. Refer to Section 29 for this procedure.
11. Remove the hydrostatic motor. Refer to Section 29 for the hydrostatic motor removal procedure.

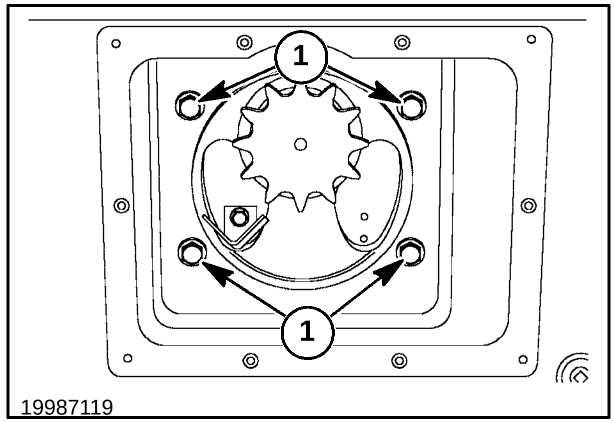
NOTE: *For clearance, the high-pressure lines may require removal. If the lines are removed, cap the lines and fittings to prevent loss of oil and contamination of the hydrostatic system.*

12. Disconnect the gearbox filler tube, hose, and wire clamps as required.
13. Remove the four mounting cap screws, 1, holding the final gearbox housing to the drive case.

CAUTION

The gearbox is heavy and a suitable hoist/lift should be used.

14. With a suitable hoist, lift the gearbox from the loader.



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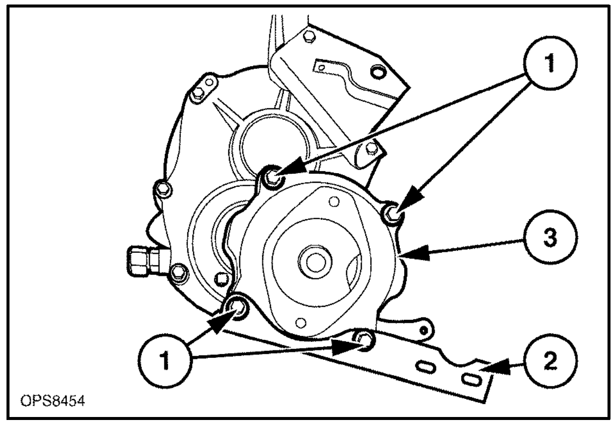
DISASSEMBLY

1. Thoroughly clean the gearbox.
2. Remove the four cap screws and washers, 1. Remove bracket, 2, and the parking brake cover, 3.



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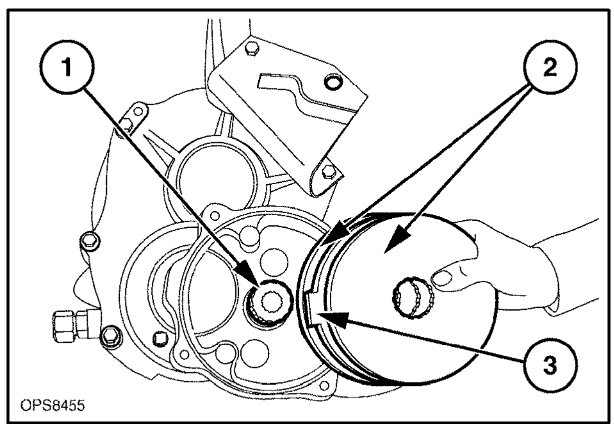
3. Remove the two brake discs, 2, and separator plate, 3, from drive coupling, 1.



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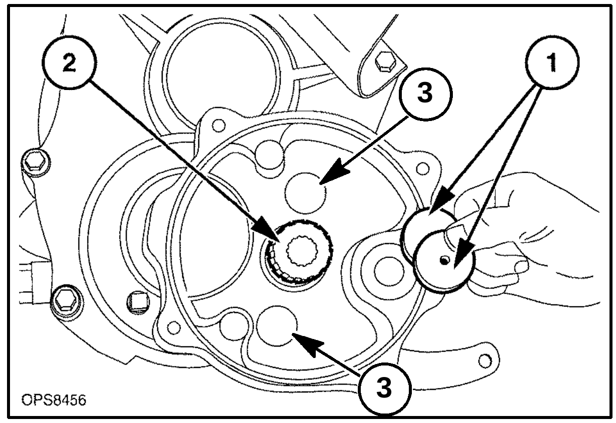
4. Remove the brake friction pad and spacer plate, 1, and drive coupling, 2.

NOTE: *There are two magnets located at 3. Remove the magnets from the housing.*



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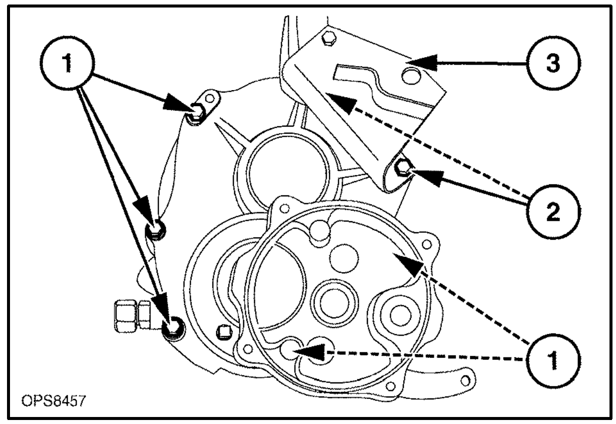
5. Remove two cap screws, 2. Remove bracket, 3. Remove the remaining five cap screws, 1. Separate the gearbox halves.



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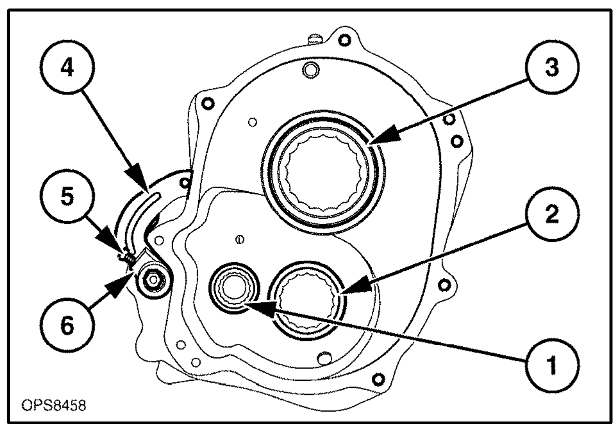
6. Inspect roller bearings, 1, 2, and 3. If worn or rough, they must be removed and replaced.

NOTE: *Roller bearings have some interference in housing and may require a bearing puller to remove.*

7. Loosen jam nut, 6, and cap screw, 5. Remove park brake lever, 4.



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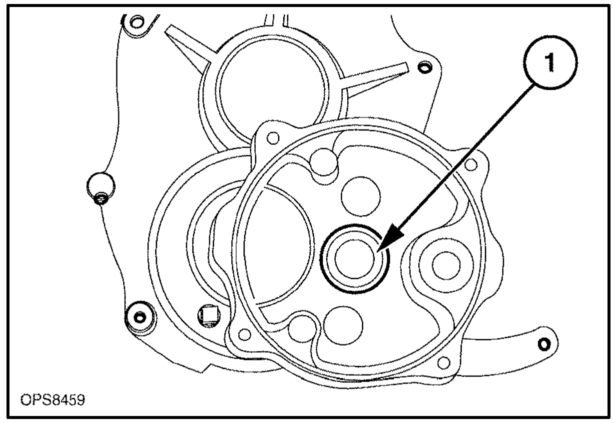
8. Remove oil seal, 1.

NOTE: *The oil seal will be destroyed when removed. Replace it with a new seal.*



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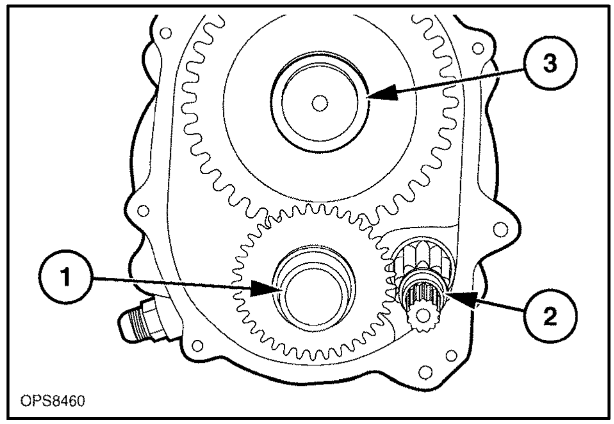
9. Remove pinion gear, 2, and gear, 1, by sliding them from the housing.
10. Remove snap ring, 3.



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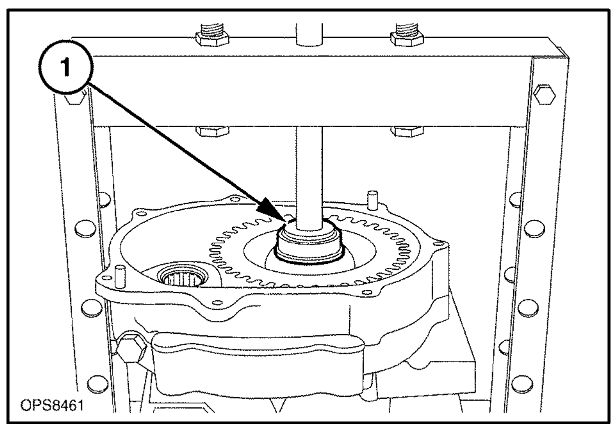
11. Place the gearbox in a press and support housing as close as possible to the drive sprocket.
12. Using an appropriate size shaft protector, press the shaft assembly, 1, from the bearings and remove from the housing. Do not allow the shaft assembly to drop to the floor when it breaks free of the housing.



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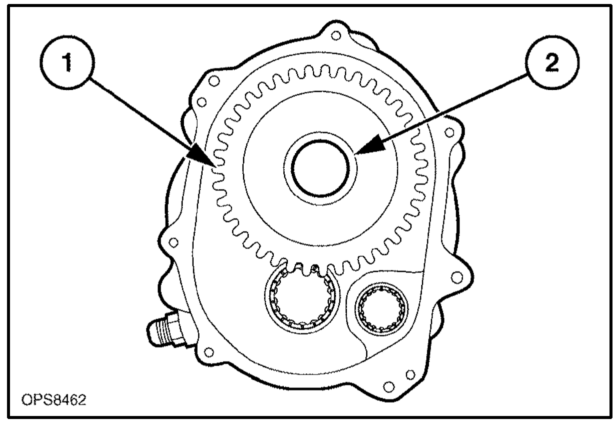
13. Remove gear, 1, and two bearing races, 2.



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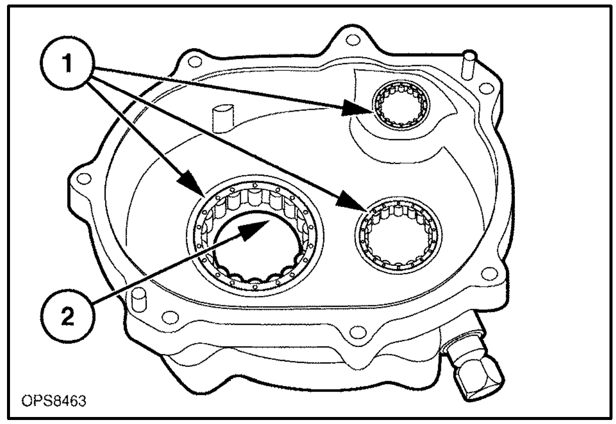
14. Remove roller bearings, 1.

NOTE: *Roller bearings have some interference in housing and may require a bearing puller to remove.*

15. Remove oil seal, 2.

NOTE: *The oil seal will be destroyed when removed. Replace it with a new seal.*



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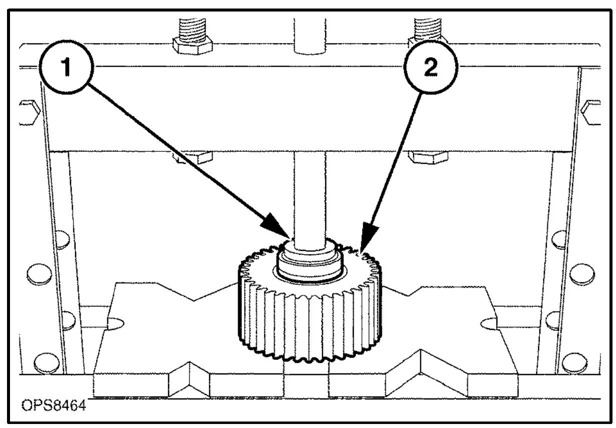
16. Support gear assembly in press as shown. Remove bearing race, 1, and gear, 2.

    Do not allow the shaft to drop to the floor when it breaks free of the gear.



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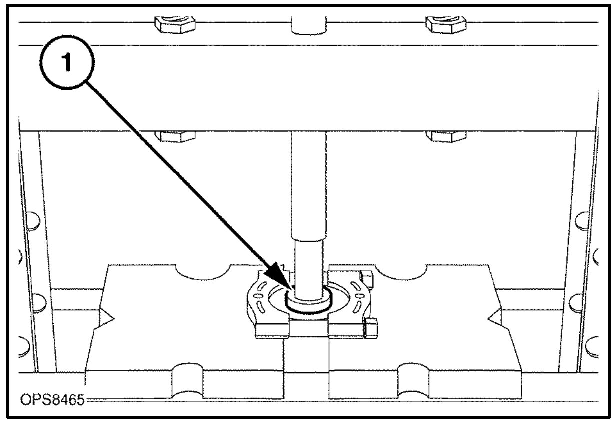
17. Install a bearing separator as shown. Press on pinion shaft to remove bearing race, 1.

    Do not allow the pinion shaft to drop to the floor when it breaks free of the bearing.



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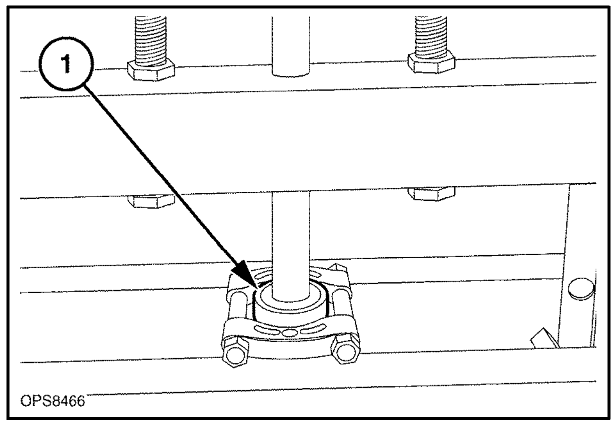
18. Invert the pinion shaft assembly in the press. Support the shaft assembly with a bearing separator as shown. Remove bearing race, 1.



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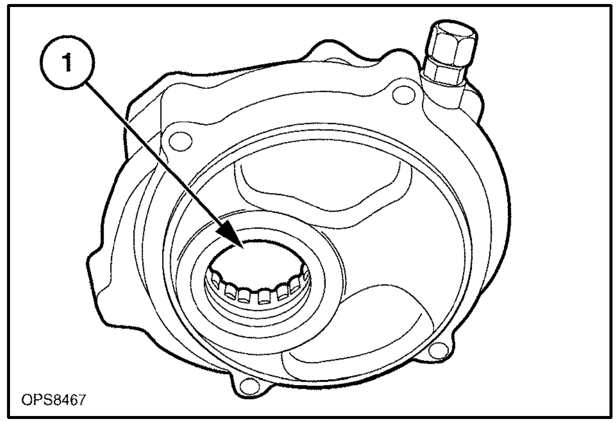
PARTS INSPECTION

1. Thoroughly clean all parts of old sealant, oil, etc. before inspection.
2. Examine the shaft bearing surfaces for wear.
3. Check the shaft splines for wear.
4. Check the operation of the gearbox breather.
5. Check the gearbox housing for any cracks, etc.
6. Inspect the gearbox housing bearing areas for wear.
7. Examine the mounting bolt threads for damage.

REASSEMBLY

Reassemble the final drive gearbox in the reverse of the disassembly procedures previously outlined while observing the following precautions.

1. Install oil seals, 1, with the seal lips facing the gearbox.



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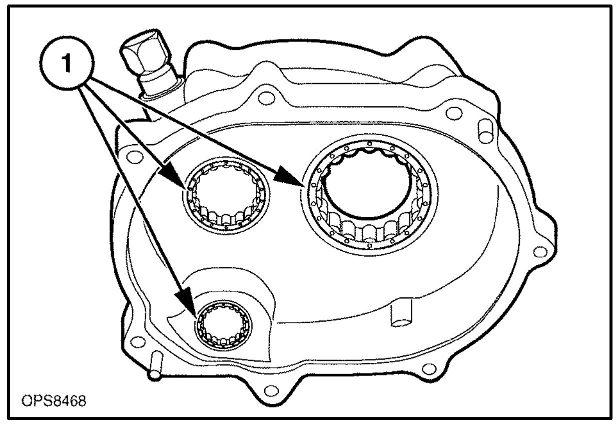
2. Install roller bearings into the housing until bearing face, 1, is flush with the housing. DO NOT bottom the bearings in the housing.



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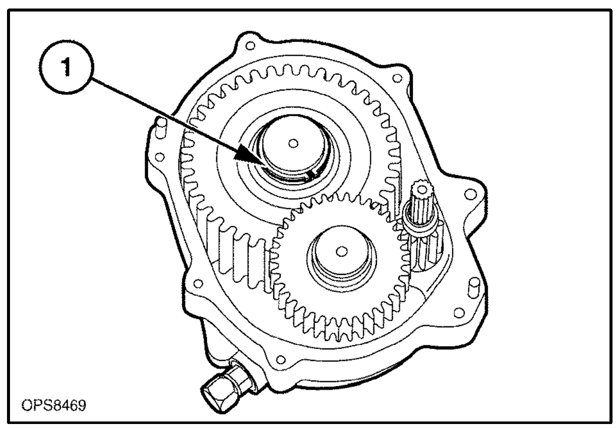
3. Install snap ring, 1, onto the drive shaft making sure it is seated properly in its groove.



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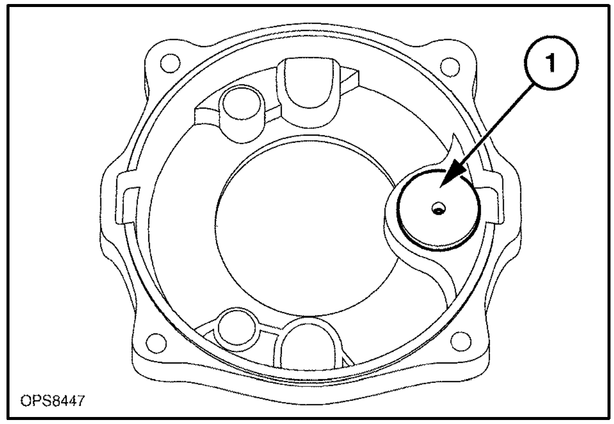
4. Install the parking brake friction pad, 1, into the end cap, 2.



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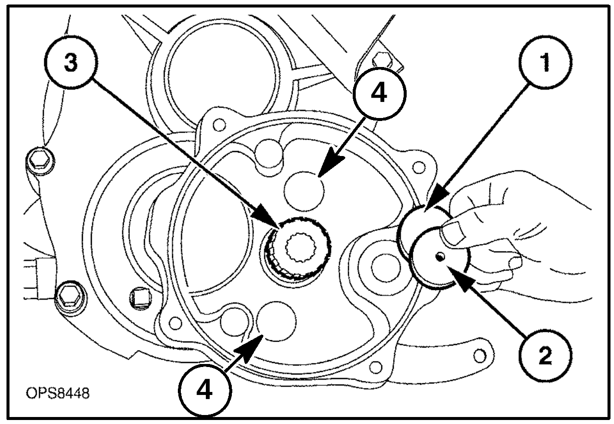
5. Install the parking brake pad spacer, 1, (thin disc) into the inner brake housing. Install the friction pad, 2, (thick disc) into the inner brake housing.
6. Install the splined coupler hub, 3, onto the gearbox input shaft.
7. Reinstall the two magnets in holes, 4. One each side.



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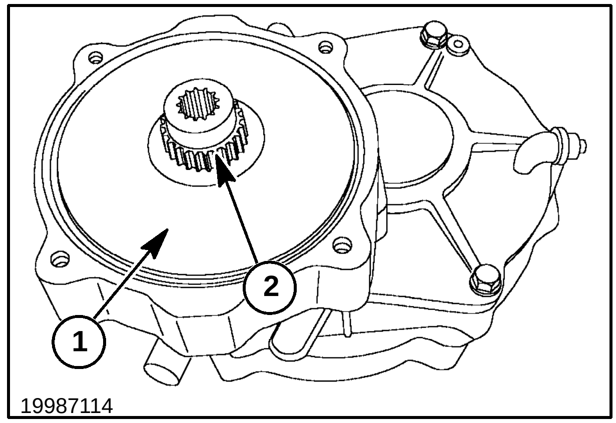
8. Install the first brake disc, 1, over the splines of the drive coupler, 2.



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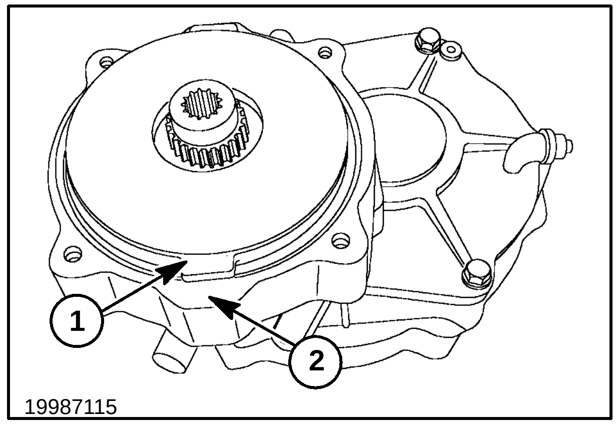
9. Install the separator plate on the drive coupler, with the lugs, 1, over the extended tabs, 2, on the gearbox case.



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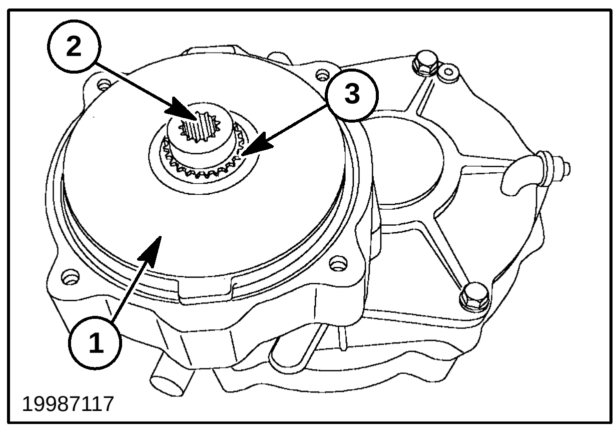
10. Install the second brake disc, 1, on the drive coupler, 2. The splines, 3, of the drive coupler should be visible above the brake disc.



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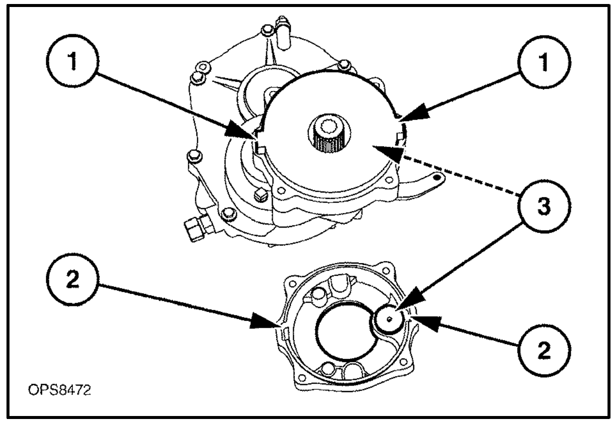
11. Apply noncorrosive silicone sealer to the mating surfaces of the housing and end cap.
12. Install the end cap onto the brake housing making sure the lugs, 1, on the separator plate fit in the notches, 2, on the end cap and the brake friction pads, 3, line up opposite each other across the brake and separator plates.



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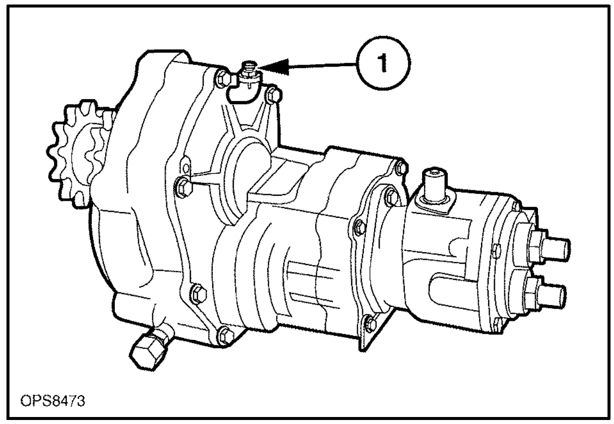
13. Reinstall the gearbox breather, 1, if removed, using pipe sealant on the fitting threads.



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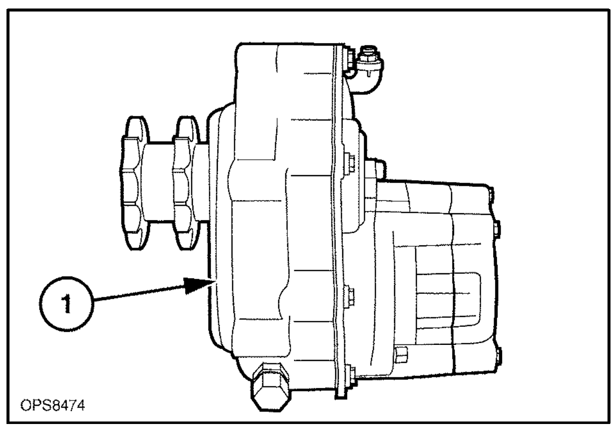
REINSTALLATION

1. Thoroughly clean the mating surfaces between the chain case and the final drive gearbox to provide a good sealing surface.

NOTE: *When resealing, use a noncorrosive silicone sealer to prevent rusting and corrosion of parts after assembly.*

2. Apply a bead of silicone sealer to the corner of the pilot OD on the final drive gearbox at 1.



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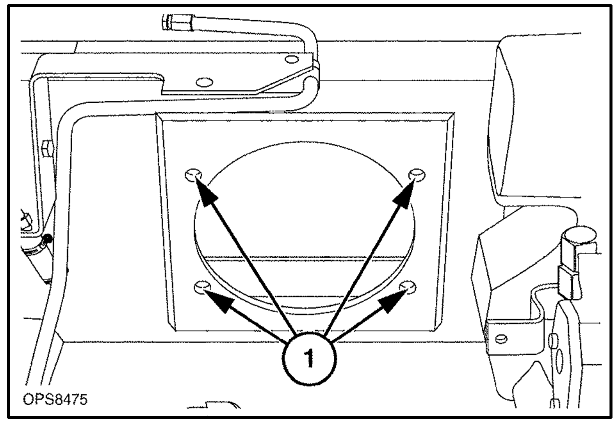
3. Apply a circular bead of silicone sealer around the four gearbox mounting holes, 1, on the chain case mounting surface.



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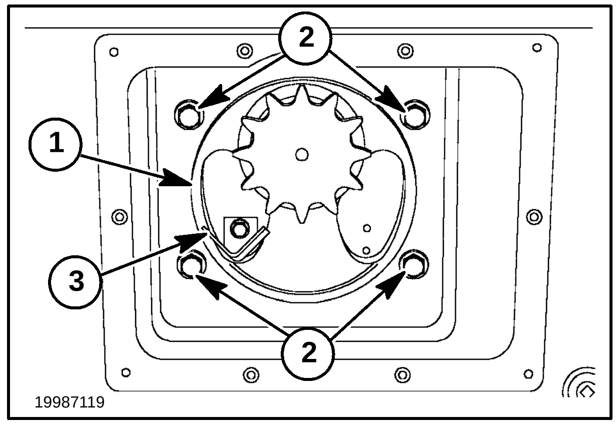
4. Using a hoist, lower the gearbox into position and pilot into the chain case mounting hole, 1.
5. Apply a bead of silicone sealer under the heads and washers of the gearbox retaining bolts, 2, and install. Torque the bolts to 233 ft. lbs. (316 N·m). Check that the plastic funnel, 3, is not cracked or broken, and reinstall if removed.



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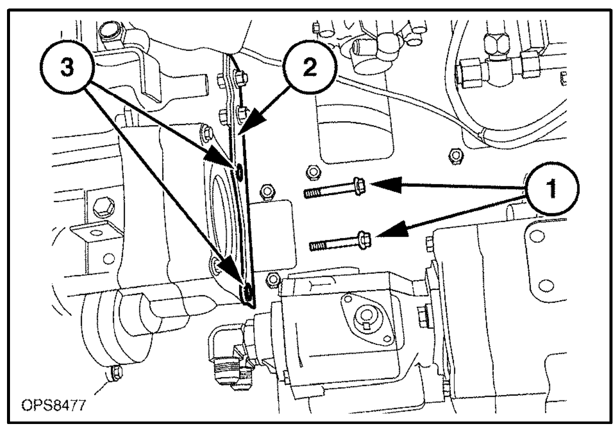
6. Install the two lower gearbox mounting bolts, 1, through mounting plate, 2, and into the gearbox at 3. Torque to 34 ft. lbs. (46 N·m).



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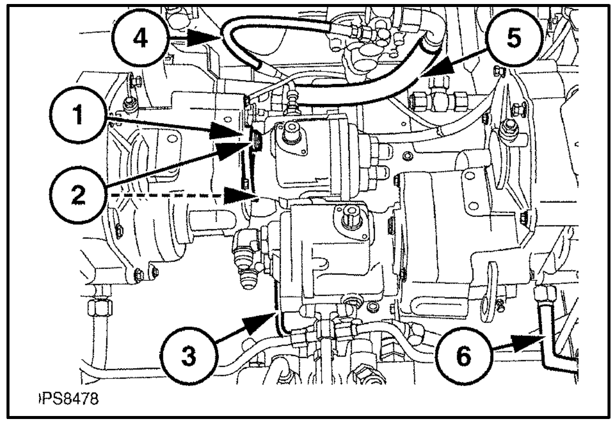
7. Apply a bead of silicone sealer around the OD of the hydrostatic motor pilot and on the mounting surface of the gearbox at 1. Install the motor onto the gearbox and retain with two attaching bolts, 2. Apply a bead of silicone sealer under the head of the bolt and washer prior to tightening. Torque to 45 ft. lbs. (61 N·m).
8. Install the motor case drain tube, 3, and the case drain hose, 4, from the right motor to the hydraulic gear pump. Reinstall the gear pump suction hose, 5, if removed.
9. Install the gearbox oil level/filler tubes at 6.



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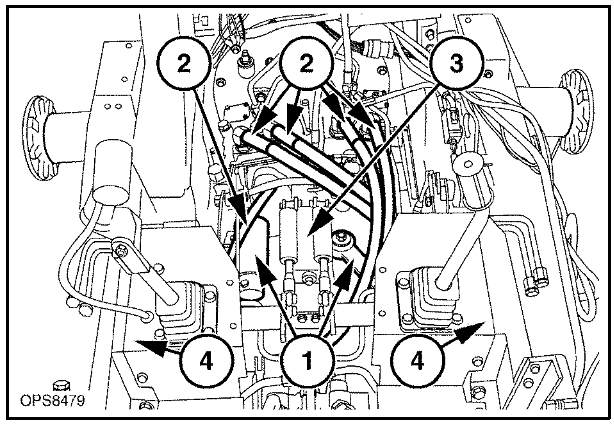
10. Install the remaining hoses and control linkages:
    - Neutralizer support bracket, connects the right and left hydrostatic motors.
    - Two-speed control linkage and shift cylinder, 1 (if applicable).
    - High-pressure hydraulic and hydrostatic hoses, 2.
    - Neutralizer assembly, 3.
    - Control handle assemblies and linkages, 4.



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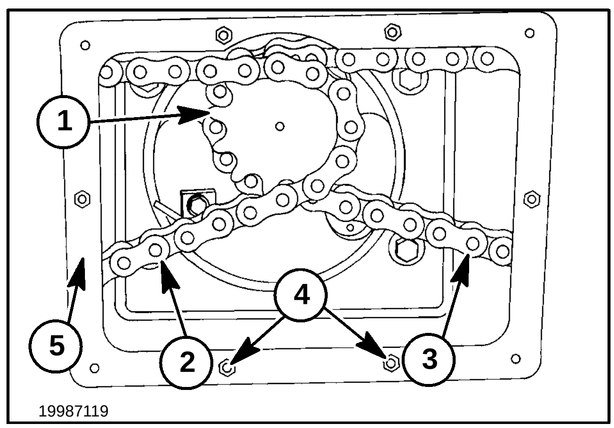
11. Install the drive chains onto the gearbox drive sprocket, 1 with the front chain, 2, to the inside and the rear chain, 3, to the outside.
12. Fill the chain case with SAE 80W-90 API service GL-5 gear oil to the bottom edge of the lower two threaded holes at 4.
13. Clean all sealer and oil from the chain case cover mating area at 5.



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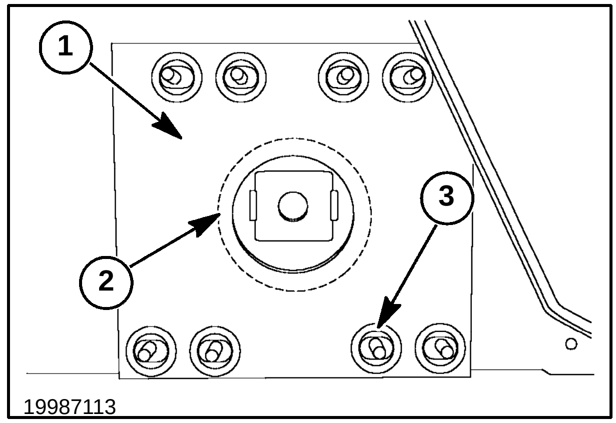
14. If there are signs of oil leaking out of the bottom of the axle housing, the oil may be escaping between the final drive case sheet and the outer reinforcing plate. The reinforcing plate, 1, has a narrower opening than the drive case sheet, 2. If the loader frame is welded between the reinforcing plate and drive case sheet, the case should not leak.

    To seal off this area and prevent leaks, clean the final drive case around the pilot mating area, 2, and around the studs, 3, with an appropriate cleaner. Place a bead of silicone sealant (such as part #L58775), around the side sheet mating area, 2, and the studs, 3.



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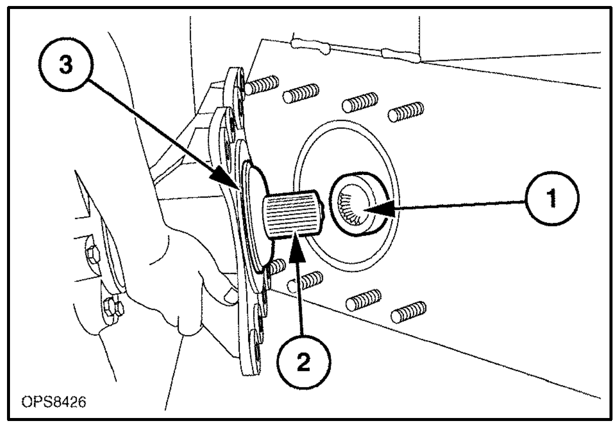
***NOTE:** When installing the final drive case, the case must lay flat against the frame and the pilot must rest on the edge of the frame opening.*

15. Position the drive sprocket, 1, in the axle opening. Make sure the drive sprocket is placed in the drive chain properly.
16. Lift the axle housing assembly and mate the splines on the axle shaft, 2, and the drive sprocket and slide together. Lifting the axle housing assembly over the retaining studs, pilot the center of the housing, 3, into the hole in the case and slide the housing tight against the case.

***NOTE:** When installing the rear final drive case, the rear drive sprocket will stay in place better with the front of the loader raised.*



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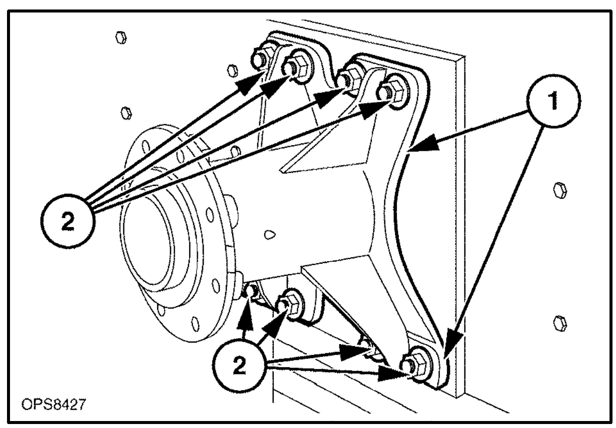
17. With the axle housing, 1, tight against the case, install the retaining nuts and flat washers, 2, to hold the housing against the case.
18. Slide the axle housing assembly to tighten the drive chains.

***NOTE:** The chains are properly tensioned when there is 0 to 6 mm (0″ to 1/4″) movement at the outer edge of tire tread.*

19. Torque the axle retaining hardware to 140 ft. lbs. (190 N·m).



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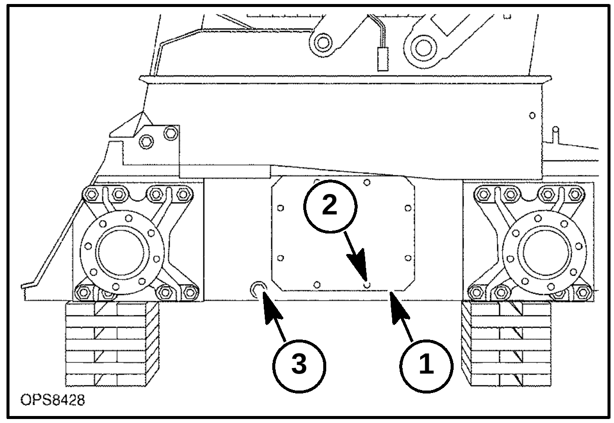
CAUTION

When tightening the axle retaining hardware, the axle housing must be tight against the case at 1, or damage to the case may occur.

20. Apply silicone sealer to the perimeter of the opening for the chain case cover, 1, and to the bottom of the heads on the cover retaining bolts, 2. Install the cover and eight retaining bolts. Torque to 11 ft. lbs. (15 N·m).

    Check the final drive oil level at the check plug, 3. Add SAE 80W-90 API Service GL-5 gear oil as required.

21. Replace any shields that were removed for the repair.



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22. Refer to “Start-Up Procedure” at the end of this section, and complete the procedure prior to machine operation.

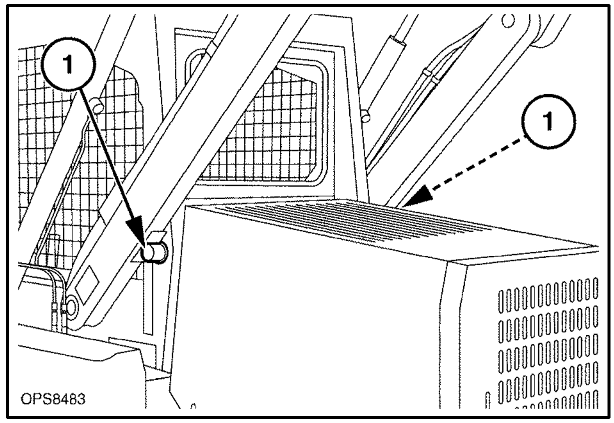
    Start-Up Procedure Summary

    - Connect charge pressure gauge.
    - Remove fuel solenoid wire.
    - Crank engine for up to 30 seconds until a charge pressure of more than 50 PSI (3.4 bar) is obtained.
    - Reconnect the fuel solenoid wire and start engine. Operate for 30 min., observe charge pressure gauge, and check for leaks. Repair leaks if necessary.
    - Stop engine, check oil level, and add if necessary.
    - Restart engine, operate at 1500 RPM and slowly operate the control levers. Monitor charge pressure.
    - Stop engine, check oil level.
    - Remove gauge, start engine, run for 30 min. to filter oil. Stop engine, change oil filter.

23. Tilt cab back to operating position and install tires.
24. Recheck the final drive chain adjustment. Rotate each tire and check for movement: 0 to 6 mm (0″ to 1/4″) movement at the tire tread is acceptable.
25. Reinstall all shields removed for repair.
26. Lower the skid steer to the ground and operate.

ENGINE-TO-TRANSMISSION GEARBOX

The engine-to-transmission gearbox transfers power from the engine to the hydrostatic pumps through an internal gear set. The gearbox is also equipped to accept the optional hydraulic, high flow kit pump assembly.



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REMOVAL - DISASSEMBLY

The transmission gearbox should be removed with the cab and boom tilted forward.

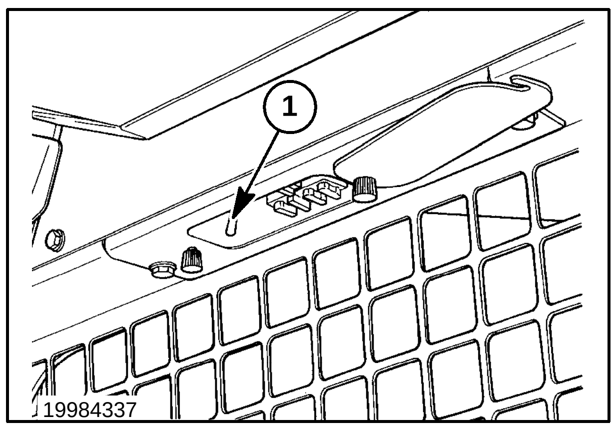
1. Remove any attachment, bucket, etc. from the boom quick-attach plate
2. Raise the boom and lower it onto the boom lock pins, 1.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. always remove the attachment from the loader.

3. Stop the engine, turn the key to the run position and operate the boom and bucket pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
4. Put the Service/Run switch, 1, in the “SERVICE” position.



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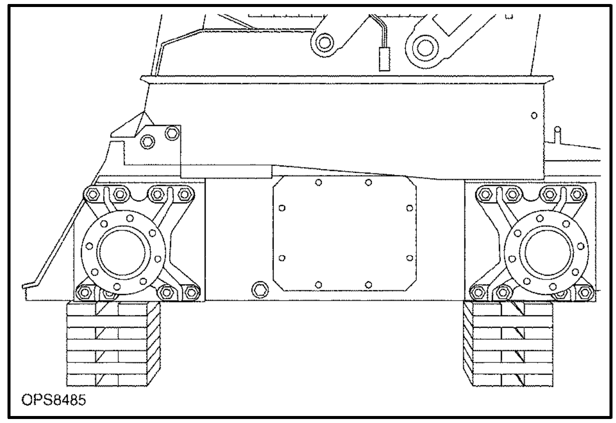
5. Securely block the skid steer with all four wheels off the ground. Refer to Section 00 for more detailed information on properly supporting the skid steer.

CAUTION

Failure to securely support the skid steer could result in movement of the loader during testing causing serious injury or damage to the equipment.

WARNING

Never attempt to tilt the skid steer cab over unless the loader is securely supported.



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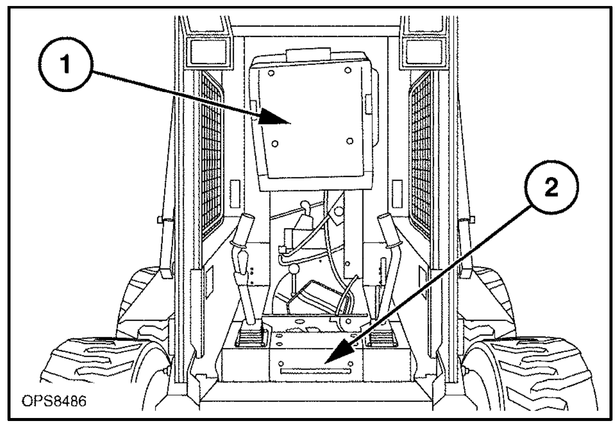
6. Raise the operator's seat and latch in the raised position, 1.
7. Remove the step shield, 2.
8. Relieve all pressure in the hydraulic and hydrostatic systems.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

Never loosen any hydraulic lines without first relieving all pressure in the systems to avoid serious injury.



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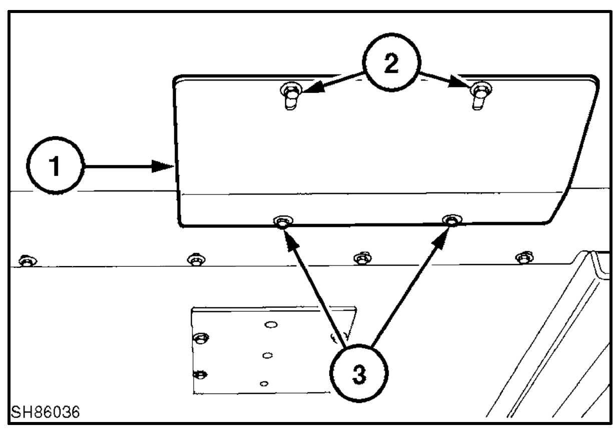
9. To drain the system, remove the small access door, 1, at the front right corner of the engine belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



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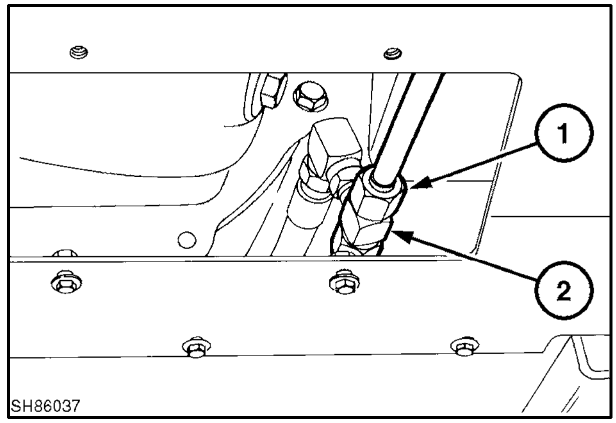
10. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.



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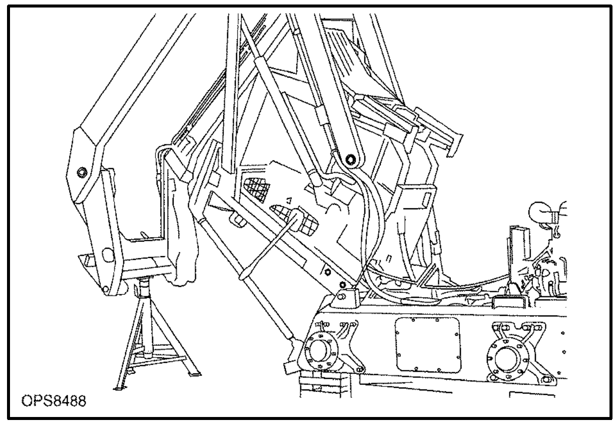
11. Tilt the cab and boom forward. Refer to the “Cab Tilting Procedure” in Section 0 of the operator’s manual for additional information.



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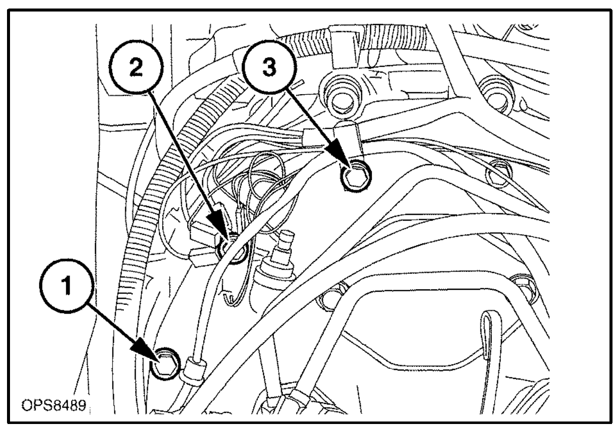
12. Remove the wiring harness attaching clips, 1 and 3. Mark their locations for reassembly.
13. Remove the ground wire cap screw at 2. Keeping the wires on the bolt and threading a nut onto the end of the bolt will ensure that all ground wires are reconnected during reassembly.



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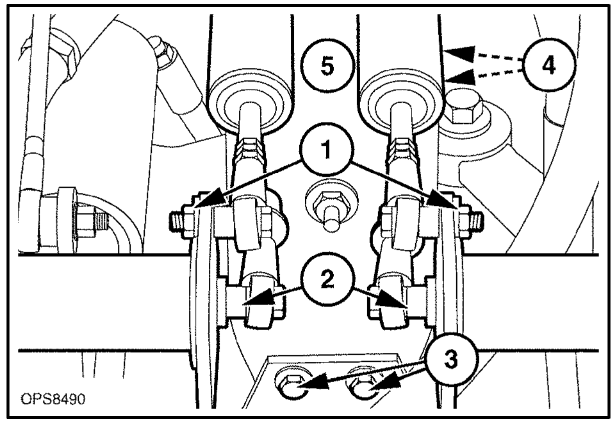
14. Disconnect the dampener shocks at 1 and the neutralizer assembly at 2.
15. Remove the four neutralizer attaching bolts - two at the front, 3, and two at the rear, 4. Lift the entire neutralizer assembly, 5, out in one piece.



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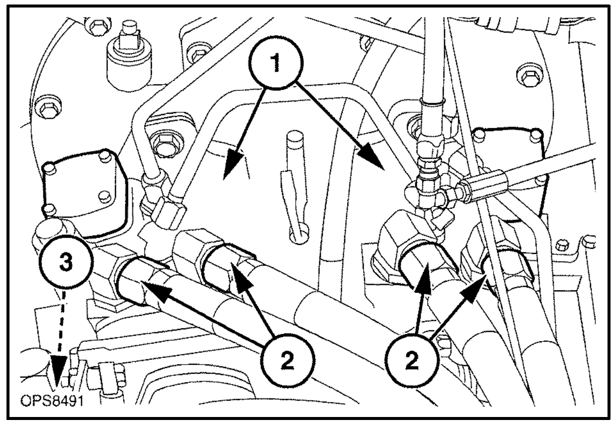
NOTE: *Clean the pumps thoroughly and mark the hose locations to aid in reassembly.*

16. To remove the right and left hydrostatic pumps, 1, disconnect the high-pressure hoses, 2, and cap the hose ends and pump ports.
17. Disconnect the supply hose to the charge pump at 3.



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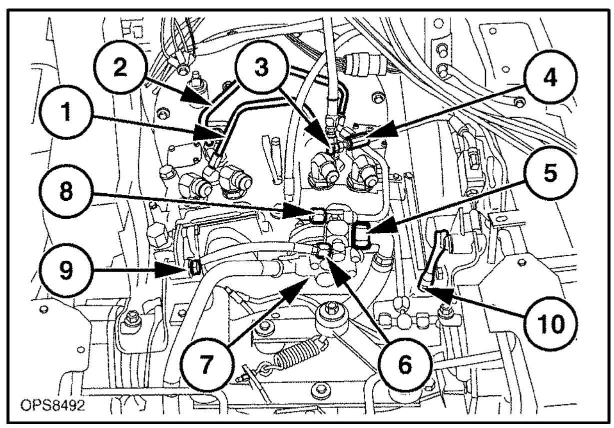
18. Remove the charge pressure cross tube, 1, and the case drain cross tube, 2. Disconnect the charge pressure sender hose at 3.
19. Disconnect the hydraulic gear pump suction line at 5, the motor case drain hose at 6, and the main control valve supply hose at 7.
20. Disconnect the two-speed control valve supply hose at 4, and the return hose at 8, (if applicable).
21. Disconnect the rear hydrostatic control rods from the pump control arms at 9 and 10.
22. Plug all hoses and pump ports to prevent the entry of dirt and contaminants.



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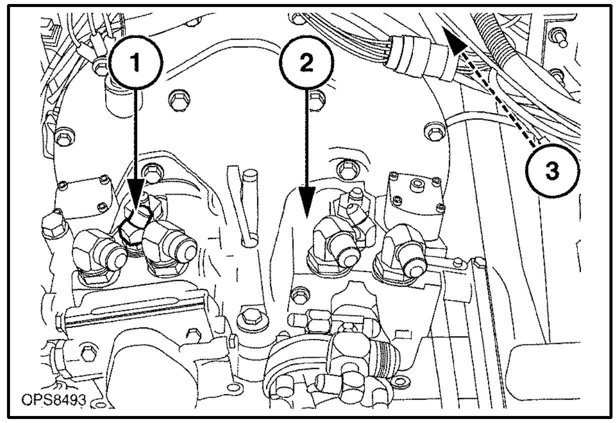
23. Remove the upper and lower pump attaching bolts and remove the right-hand pump/charge pump assembly, 1, and the left- hand pump/gear pump assembly, 2. Remove the O rings if stuck to the bellhousing cover.
24. If the entire flywheel housing is to be removed, unbolt and remove the engine starter assembly, 3.



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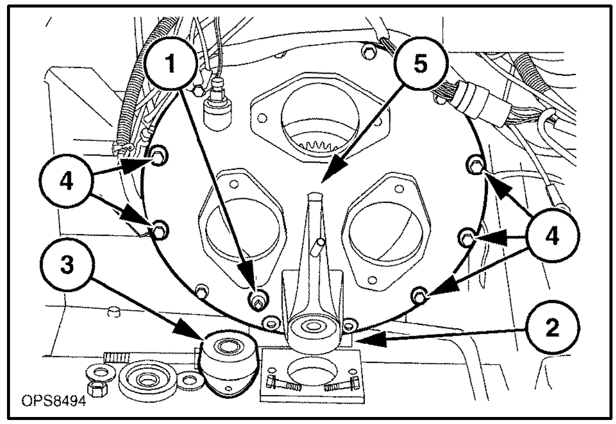
25. Drain the oil from the gearbox at drain plug, 1.
26. Support the front of the engine block with a piece of wood or other device at 2. Remove the front engine mount, 3, along with the retaining hardware.
27. Remove the gearbox cover retaining bolts, 4, and the gearbox cover, 5.



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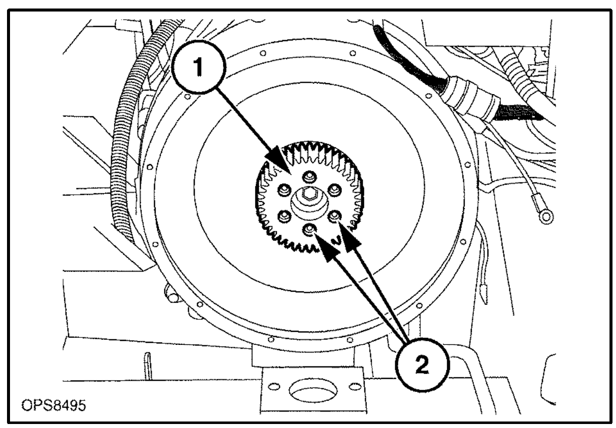
28. Remove the drive gear, 1, by removing the six socket-head attaching bolts, 2.



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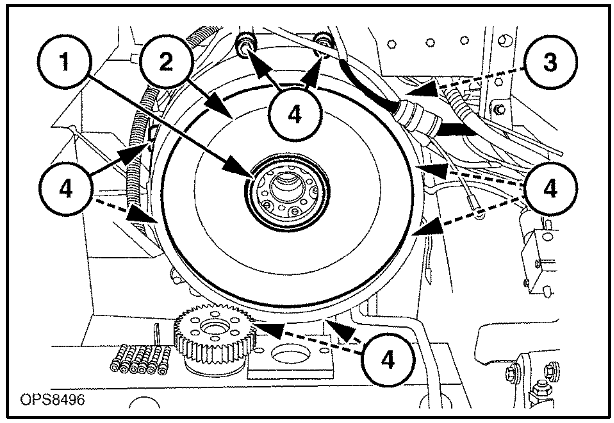
29. Remove the drive gear oil seal, 1, using a seal removal tool or puller arrangement.
30. Replacement of the drive gear oil seal, 1, can be done without removing the flywheel housing, 2. If for some reason the flywheel housing needs to be removed, do the following:
    - Support the engine at the engine block.
    - Remove the engine starter assembly at 3.
    - Remove the eight flywheel housing attaching bolts, 4 (two at both the top and bottom, and two at each side).
    - Remove the flywheel housing.



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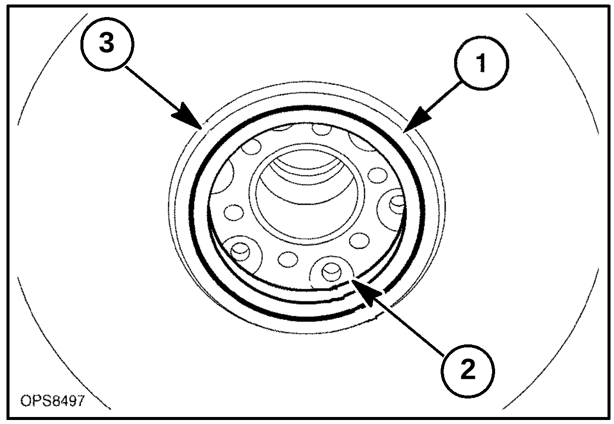
PARTS INSPECTION

1. Inspect the drive gear seal, 1, for damage to the inside diameter sealing surfaces, 2, or for looseness in the flywheel housing, 3, outside diameter of seal.
2. Look for signs of oil on the engine flywheel side of the housing. This could indicate a leaking seal.
3. Replace the seal if necessary. Install the seal with the spring-loaded seal lip toward the flywheel cover side. Use the proper tools to press fit the seal into the flywheel housing so damage to the seal does not occur.



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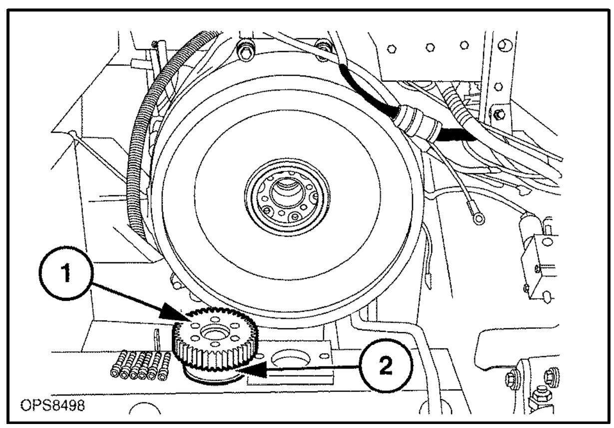
4. Inspect the drive gear teeth, 1, for damage or uneven wear patterns.
5. Inspect the seal contact surface, 2, for damage or wear.
6. Replace the gear if necessary.



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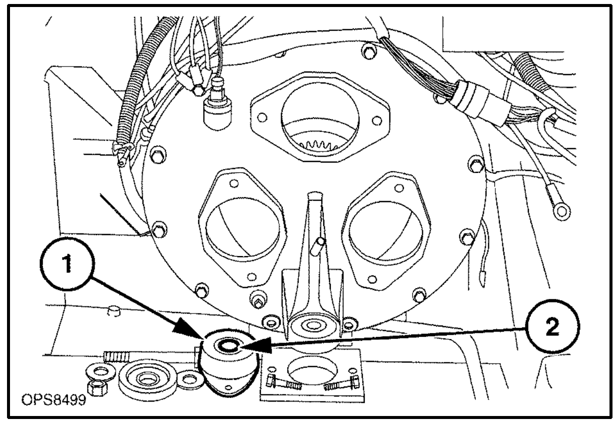
7. Inspect the engine isolator mount, 1, for damage or deformation. Be sure the center tube, 2, is not crushed from over tightening of the mounting hardware.
8. Replace the engine isolator mount if necessary.



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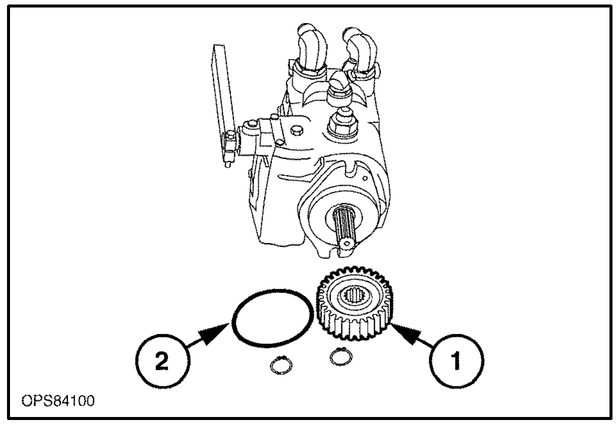
9. Inspect the hydrostatic pump drive gears, 1, on both the right- and left-hand hydrostatic pumps (left-hand pump shown). Check for tooth wear or damage.
10. Check for damage to the O ring, 2.
11. Replace parts as required.



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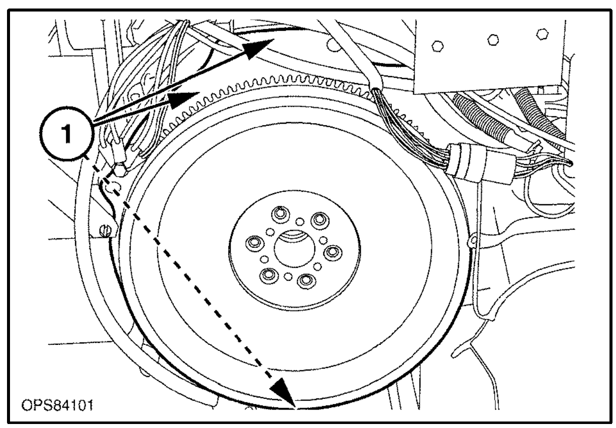
REASSEMBLY - INSTALLATION

1. Clean all previously sealed surfaces, flywheel housing to engine, flywheel cover to flywheel housing, and drive gear retaining bolts.

   When resealing, use a noncorrosive silicone sealer to prevent rust and corrosion of parts after assembly.

2. Apply a bead of silicone sealer along the engine plate, 1, to seal any gap between the plate and the flywheel housing.
3. Align the dowel pins and install the flywheel housing. Attach with the previously used hardware and torque to 290 ft. lbs. (394 N·m).
4. Reinstall the starter motor assembly.



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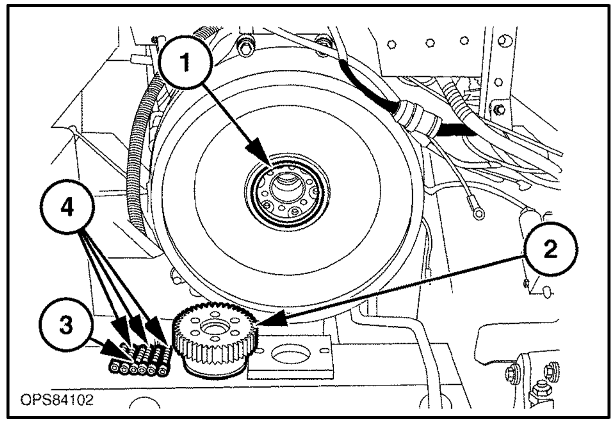
5. Lubricate the seal lip, 1, with 80/90 gear oil.
6. Install the drive gear, 2, making sure not to damage the seal.
7. Apply silicone sealer to the bottom of the bolt heads at 3, and reinstall the six drive gear attaching bolts, 4. Torque the bolts to 50 ft. lbs. (68 N·m).



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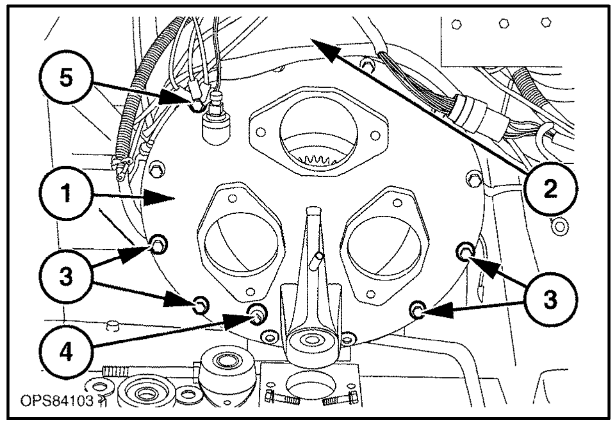
8. Apply a bead of silicone sealer along the contact surface of the flywheel cover, 1, align correctly, and install onto the flywheel housing, 2.
9. Install attaching hardware, 3, and torque to 34 ft. lbs. (46 N·m).
10. Install drain plug, 4, and tighten.
11. Install the ground wire bundle, 5, and harness retaining clips where removed.

NOTE: *Properly stack the ground wires according to wire size and number of wires to single spade. Starting with largest first and wire size and multiple wire spades to single wire spades last.*



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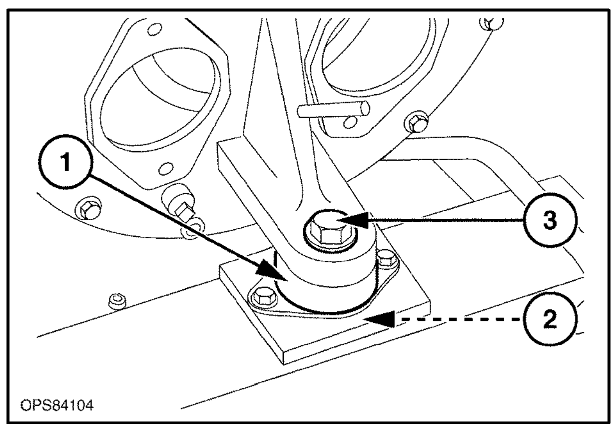
12. Install the isolator mount, 1, hardware, and snubber plate, 2, in the order previously removed. Tighten the main mounting bolt, 3, to 165 ft. lbs. (225 N·m).



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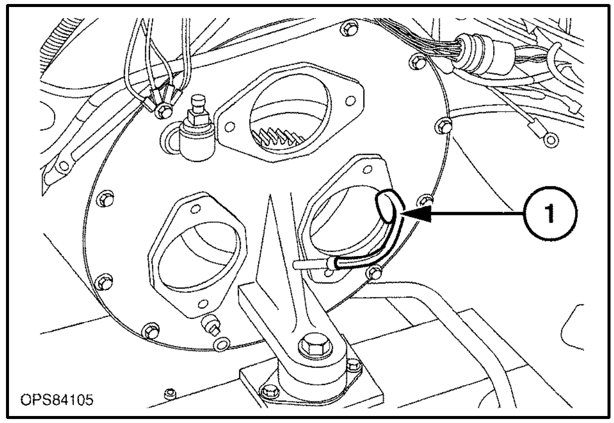
13. Fill the gearbox with 80/90 gear oil to the proper level as indicated on the gearbox dipstick, 1.



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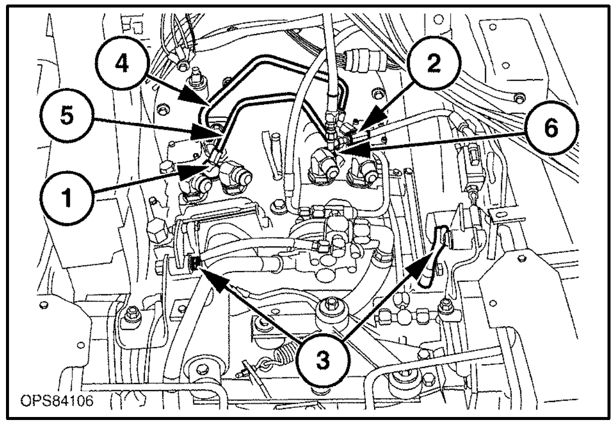
14. Reinstall the right and left hydrostatic pumps, 1 and 2, and secure with 1/2″ x 1-1/4″ cap screws and washers. Torque the bolts to 64 ft. lbs. (87 N·m).
15. Reconnect the rear control rods, 3, to the hydrostatic pump control arms.
16. Reinstall the case drain cross tube, 4, and the charge pressure cross tube, 5. Reconnect the charge pressure sender hose at 6.



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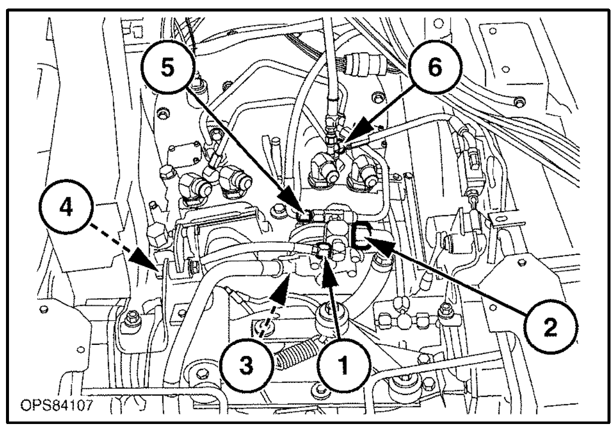
17. Reconnect the motor case drain hose, 1; the hydraulic gear pump suction hose, 2; and the main control valve pressure hose, 3.
18. Reconnect the charge pump suction hose to the fitting at 4.
19. Connect the two-speed control valve return hose at 5, and the control valve supply hose at 6, (if applicable).



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20. Reconnect the hydrostatic system high- pressure hoses to their correct positions on the hydrostatic pumps.

    Hose 1 (RH Pump) to bottom port, RH Motor

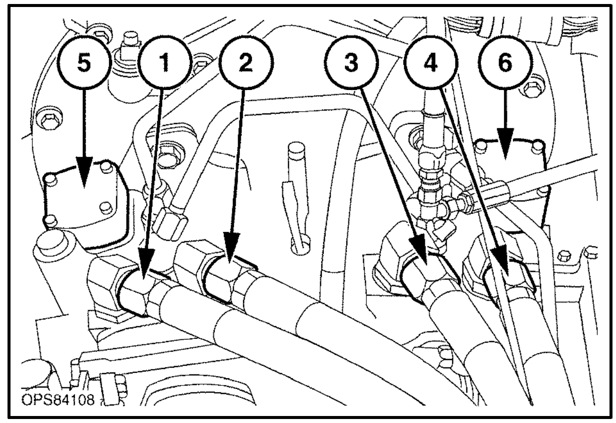
    Hose 2 (RH Pump) to top port, RH Motor

    Hose 3 (LH Pump) to top port, LH Motor

    Hose 4 (LH Pump) to bottom port, LH Motor

    RH Pump - 5

    LH Pump - 6



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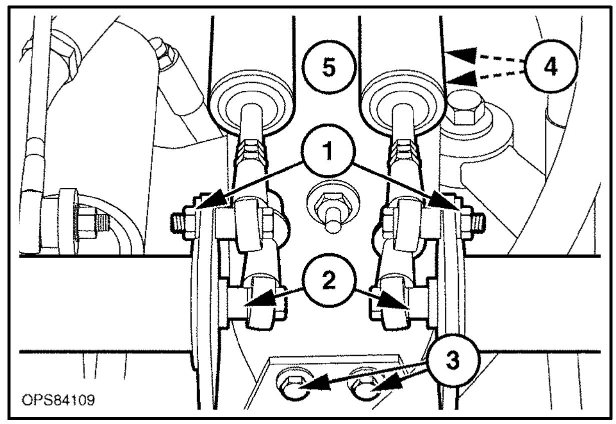
21. Reinstall the neutralizer assembly, 5. Retain with two bolts at the front, 3, and two bolts at the rear, 4. Reconnect the neutralizers at 2, and the dampener shocks at 1.



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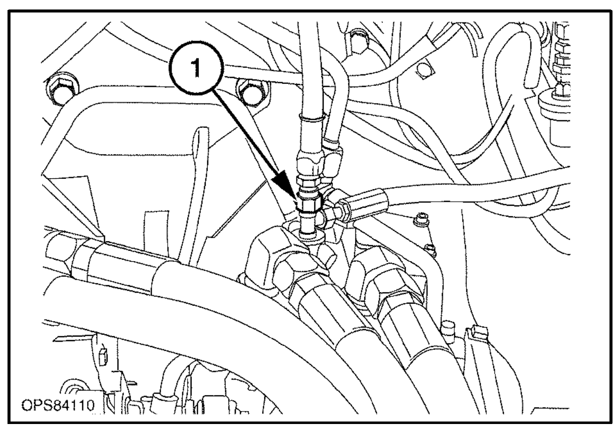
START-UP PROCEDURE

1. Recheck all hydraulic/hydrostatic lines to be sure they are tight.
2. Fill the hydraulic reservoir with API Service SH/CG-4 10W-30 oil to the proper level, as indicated on the back of the reservoir.
3. Install a 600 PSI (0 - 50 bar) gauge in the charge pressure line at 1.



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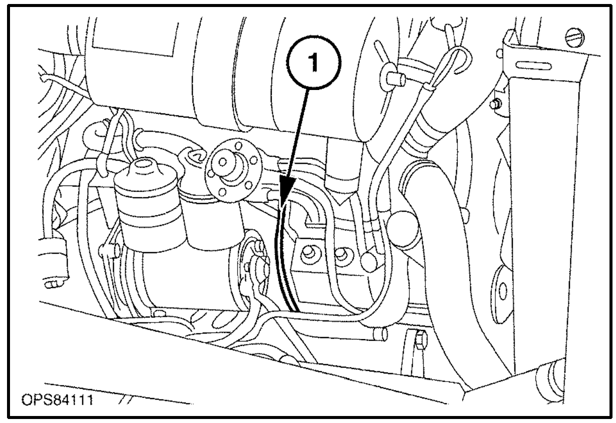
4. Remove the fuel solenoid power wire, 1, to prevent the engine from starting.
5. Put the steering control levers in the neutral position.



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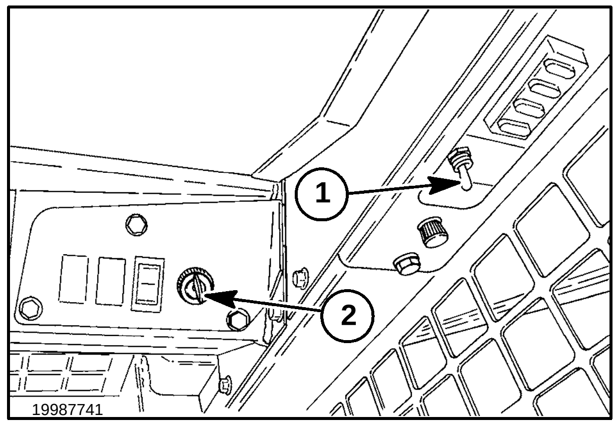
6. Put the Service/Run switch, 1, in the “SERVICE” position.
7. Turn the ignition key, 2, to the start position, and allow the engine to crank for 30 seconds at a time, until the pressure gauge starts to move. If after trying three times the gauge does not move, loosen the gear pump pressure line at the control valve to bleed the air from the hydraulic system.

   Recrank the engine until the gauge moves. After the gauge moves, stop cranking and reconnect the fuel solenoid wire.



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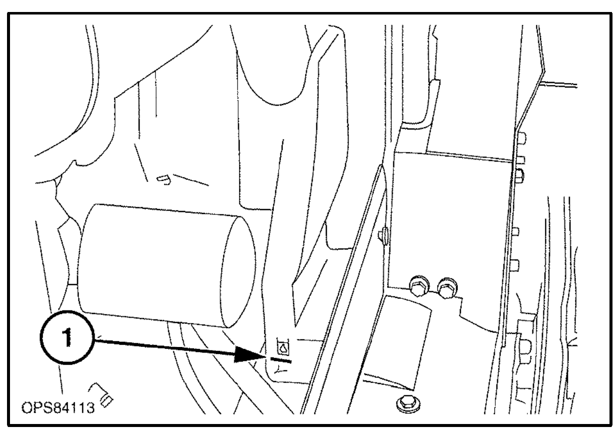
8. Start the engine and monitor the charge pressure gauge to insure charge oil to the hydrostatic system. The pressure reading should be 250 - 300 PSI (17.2 - 20.7 bar).

IMPORTANT*: If the charge pressure remains below 50 PSI (3.4 bar) for more than 10 seconds, stop the engine and locate the cause. If the unit is operated with low or no charge pressure, severe damage will occur to the hydrostatic system.*

   Do not stroke the hydrostatic controls at this time.

9. Start the engine and operate at 1500 RPM for approximately 30 minutes. Stop the engine; check the oil level at 1, and fill as required.



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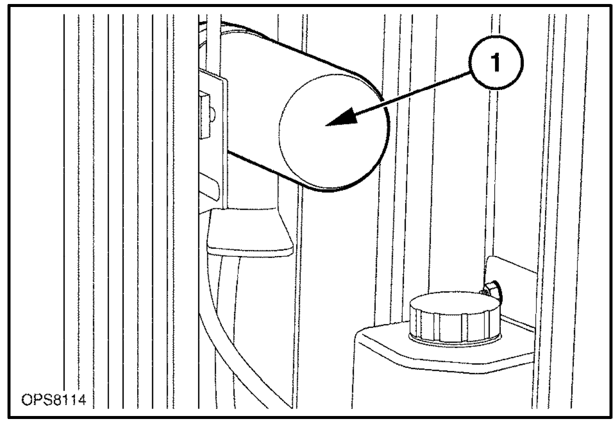
10. Restart the engine and operate at 1500 RPM. Slowly operate the hydrostatic controls to remove the air trapped in the system; monitor the charge pressure.
11. Stop the engine; recheck the hydraulic oil level and add as required.
12. Remove the charge pressure test gauge.
13. Adjust the neutral control linkage if required; refer to neutral adjustment procedures.
14. Run the engine at 1500 RPM for an additional 30 minutes to filter the oil.

    Stop the engine, allow the hydraulic oil to cool, and change the oil filter, 1.



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15. Check for oil leaks and repair as required.
16. Tilt the cab back to the operating position.
17. Reinstall all shields removed for repair.
18. Lower the skid steer to the ground and operate.

LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Man-Hours
General	
Jack up machine and secure on blocking	0.5 hr.
Final Drive Gearboxes	
R&R one side. Includes tilting cab, R&R two wheels, transmission centering assembly and hydrostatic motor.	9.0 hrs.
R&R both sides. Includes tilting cab, R&R all wheels, transmission centering assembly and hydrostatic motors.	14 hrs.
Additional time for R&R two-speed control	1.5 hrs.
Rebuild - each	2.5 hrs.
Engine-to-Transmission Gearbox	
R&R includes tilting cab and pump removal.	6.0 hrs.

SECTION 29 – HYDROSTATIC TRANSMISSION

Chapter 1 – Neutralizer, Pumps, Motors, Two-Speed

CONTENTS

Op. 29 100

GENERAL INFORMATION

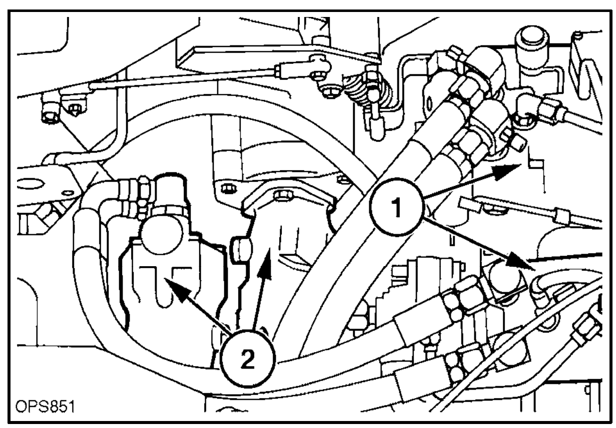
The hydrostatic system provides a means to transfer power from the engine to the final drives and wheels. It provides an infinite number of operator speed selections for both forward and reverse directions. The hydrostatic system also furnishes a means to steer the loader.

Each of the two hydrostatic pumps receive power from the engine through a spur gear drive configuration located in the engine to transmission gearbox. The pumps convert rotary power, developed by the engine, to variable pressure/flow fluid power. Fluid power is then transferred to the hydrostatic motors where it is transferred back to rotary motion. The rotary motion from the hydrostatic motors is transferred to the final drive gearboxes, axles, and finally to the wheels.

Hydrostatic pump flow and fluid direction is operator-controlled by levers. Both left and right side pump and motor configurations are operated independently of each other and power each side separately.

OPERATION

The hydrostatic system is a closed loop, fluid power system that provides a smooth transition of power from the engine to the wheels. The hydrostatic system is made up of two piston pumps, 1 and two piston motors, 2. Hydrostatic charge pressure is supplied to the pumps by a gerotor charge pump, which is attached to the right hand hydrostatic pump. This provides replenishing oil for the oil that is lost due to leakage for lubrication and cooling purposes.



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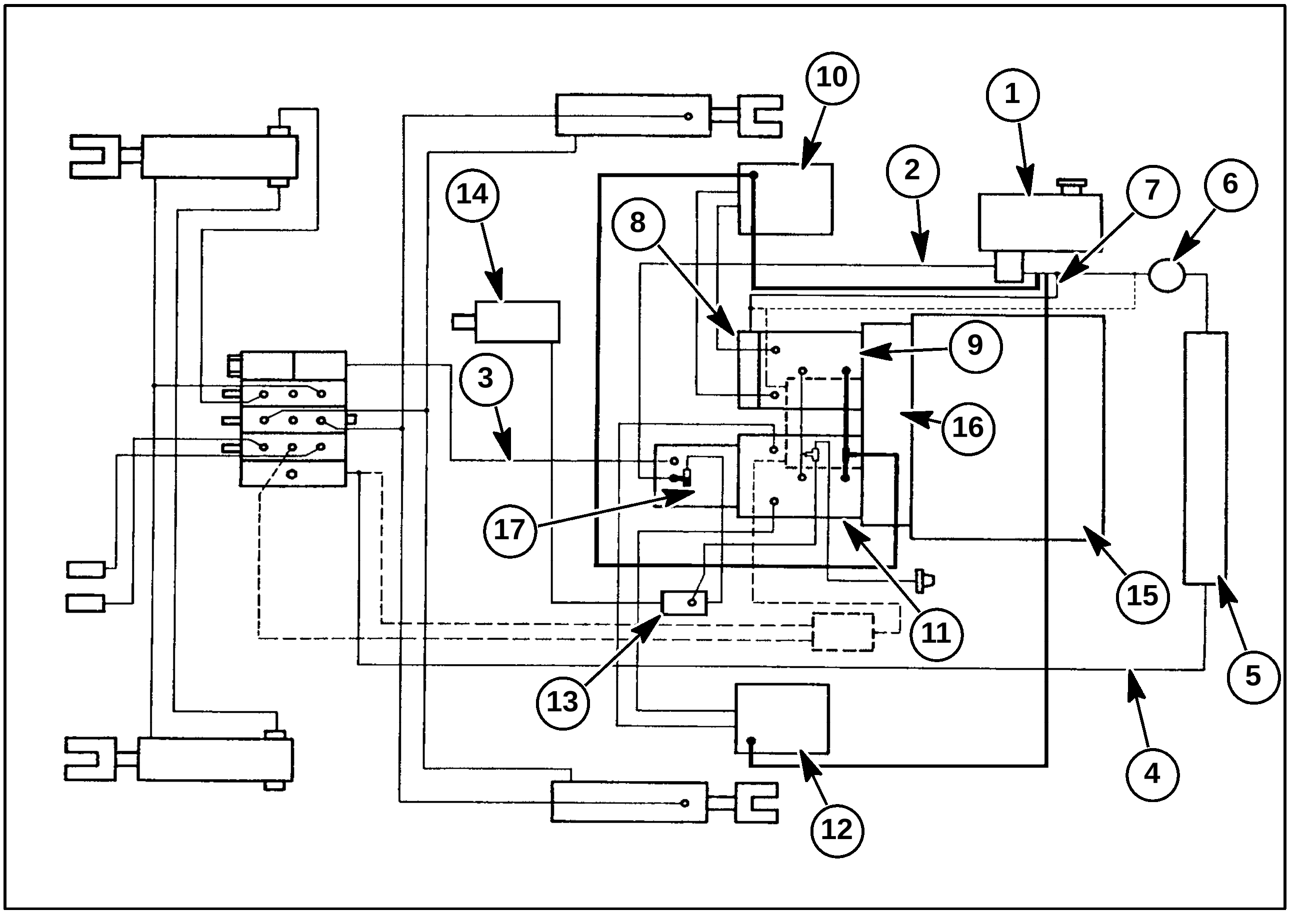
Steering is controlled by two hand levers located in the operator's cab. These hand levers control the forward and reverse direction and the amount of oil flow for speed of the skid steer. The variable oil flow from the pumps is a result of the rotation of the pump camplates within the individual pumps. The further the control levers are pushed from neutral, the greater the camplate angle. More oil is then pumped to the motors, resulting in an increase in wheel speed. The greatest wheel torque is when the control levers are closest to neutral. When operating the skid steer, more power (torque), is available by destroking the control levers, thus increasing the skid steer efficiency.



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The hydrostatic system consists of the following components:

19. Hydraulic reservoir - Right front of engine compartment.
20. Suction line - From the reservoir to the gear pump under the operator's seat.
21. Pressure line - From the gear pump to the control valve.
22. Return line - From the control valve to the oil cooler.
23. Oil cooler - Engine side of radiator in engine compartment.
24. Oil filter - After the oil cooler at the engine compartment rear door.
25. Charge pump suction line - From tee in the line from the oil filter to the hydrostatic charge pump.
26. Hydrostatic charge pump - Attached to the front of the right hydrostatic pump.
27. Hydrostatic pump for right drive - Under operator's seat.
28. Hydrostatic motor for right drive - Attached to the right gearbox assembly.
29. Hydrostatic pump for left drive - Under operator's seat.
30. Hydrostatic motor for left drive - Attached to the left gearbox assembly.
31. Two-Speed high/low control valve, if equipped.
32. Two-Speed high/low shift cylinder, if equipped.
33. Engine.
34. Engine to transmission gearbox.
35. Hydraulic gear pump.

SPECIFICATIONS

HYDROSTATIC PUMPS

Type . . . . Variable Displacement Piston Pump

Displacement . . . . 82.3 l/min. (21.47 GPM) @ 2000 RPM

Pressure Relief Setting . . . . 345 bar (5000 PSI)

Minimum Pump Efficiency . . . . 80 %

Maximum Pump Case Drain . . . . 5.7 l/min. (1.5 GPM) per pump

Maximum Pump Case Pressure . . . . 1.7 bar (25 PSI)

HYDROSTATIC MOTORS

LS180, Single-Speed Transmission . . . . Fixed Displacement Piston Type
Displacement . . . . 40.6 cc (2.48 cubic in.)

LS180 and LS190, Two-Speed Transmission . . . . Variable Displacement Piston Type
Displacement . . . . 21.0 - 40.6 cc (1.28 - 2.48 cubic in.)

Minimum Motor Efficiency . . . . 80 %

Maximum Motor Case Pressure . . . . 3.8 L (1 GPM) per motor

CHARGE PRESSURE SYSTEM

Charge Pump Relief Valve Setting . . . . 17.2 - 20.7 bar (250 - 300 PSI)

Relief Valve Torque Specifications . . . . 37 - 41 N·m (27 - 30 ft. lbs.)

OIL REQUIREMENTS

Type and Specifications . . . . API Service SH/CG-4 10W-30

TORQUE SPECIFICATIONS

PUMPS

Relief Valves Caps . . . . 136 N·m (100 ft. lbs.)

Backplate and Charge Pump Adaptor . . . . 37 N·m (27 ft. lbs.)

Servo Control Assembly . . . . 4.5 N·m (40 in. lbs.)

Gear Pump to Backplate . . . . 37 N·m (27 ft. lbs.)

Pump Mount to Engine Gearbox . . . . 61 N·m (45 ft. lbs.)

MOTORS

Backplate (Fixed Displacement) . . . . 20 N·m (15 ft. lbs.)

Backplate (Variable Displacement) . . . . 37 N·m (27 ft. lbs.)

Gearbox Attaching Bolts . . . . 61 N·m (45 ft. lbs.)

OTHER MATERIALS

Hydraulic Oil . . . . API Service SH/CG-4 10W-30
NH #9613313 - 1 qt.
NH #9613314 - 5 gal.
NH #9613385 - 1 L
NH #9613360 - 20 L

Sealing Material . . . . NH Ultra Blue silicone sealer
NH #L81724 - 3.35 oz. tube (cord)
NH #L82519DS - 8 oz. tube
NH #L58775 - 10.2 oz. cartridge

NOTE: *Always use a noncorrosive silicone sealer to prevent damage to the components being sealed during the silicone curing process.*

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TROUBLESHOOTING

When performing tests on the hydrostatic system, use the proper test procedures and test equipment.

Before testing, lower the attachment to the ground or remove attachment from the skid steer.

If testing is to be performed with a raised boom, make sure the boom is raised above and resting on the boom lock pins, attachment removed.

Before opening the hydraulic system, clean the area thoroughly to prevent contaminating the system.

Before opening the hydraulic system, relieve all pressure from the system.

Before testing the hydraulic system, check the hydraulic oil level.

Before testing the hydraulic system, the oil must be at normal operating temperature.

If testing requires the skid steer to be raised, use adequate blocking and/or jack stands to securely support the skid steer.

CAUTION

When connecting test equipment to the hydrostatic system, relieve the pressure in the system. Stop the engine, with the seat belt fastened, turn the ignition switch to the "on" position and operate all hydraulic control valve circuits to relieve pressure. Turn the ignition switch to the "off" position.

WARNING

Gauges, gauge fittings, and hoses must have operating pressure ratings of at least 25 percent higher than the highest pressures of the system.

Never adjust or replace the relief valves to get higher pressures than those specified by the equipment manufacturer.

Fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Always protect the skin and eyes from escaping fluid under pressure.

Before disconnecting lines or fittings, be sure to turn off the skid steer engine and relieve all pressure. Before applying pressure to the system, be sure all connections are tight and that lines, pipes, and hoses are not damaged.

If injured by escaping fluid, obtain medical assistance at once. Serious infection or reaction can develop if medical treatment is not administered immediately.

Remove any attachment from the mounting plate before loosening or disconnecting any hydraulic lines.

CAUTION

Use adequate blocking and/or jack stands to ensure that the skid steer is safely supported with all four wheels off the ground.

PROBLEM	POSSIBLE CAUSE	REMEDY
Machine will not move either direction	Parking brake engaged	Release parking brake
	Low hydraulic oil	Check oil level
	Low charge pressure	Check charge pressure/repair
	Incorrect oil	Drain and replenish with proper oil
	Air in system	Purge air and repair system
	Water in system	Drain, clean, and replace oil
	Output pressure too low	Check pressure replace relief valve
	Internal pump or motor damage	Check pump/motor case drain flow
	Linkages loose or broken	Check and repair
One side moves, other side does not	Relief valve stuck open	Check and repair
	Internal pump or motor damage	Check pump/motor case drain flow
	Brake engaged on one side	Check parking brake system and repair
	Linkage loose or broken	Check and repair
	Broken drive chain	Check and repair
	Gearbox damaged	Check and repair
Noisy pump or motor	Air in system	Purge air and repair system
	Wrong kind of oil	Drain, clean system and replace oil
	Water in system	Drain, clean, and replace oil
	Internal pump or motor damaged	Check pump/motor case drain flow
	Linkage loose or broken	Check and repair
	Parking brake engaged	Release parking brake
Low power	Low hydraulic oil	Check oil level
	Low charge pressure	Check charge pressure/repair
	Relief valve stuck open	Check and repair
	Air in system	Purge air and repair system
	Output pressure too low	Check pressure replace relief valve
	Internal pump or motor damage	Check pump/motor case drain flow
Sluggish response to changes in speed	Relief valve stuck open	Check and repair
	Air in system	Purge air and repair system
	Output pressure too low	Check pressure replace relief valve
	Linkage loose or broken	Check and repair
	Oil too heavy, cold weather	Allow unit to warm up before operating
	Wrong kind of oil	Drain, clean system and replace oil

LOW POWER THROUGH THE ENGINE/ TRANSMISSION SYSTEM

Perceived low power has been noted in certain heavy power demand applications. Possible causes include:

- Machine overloaded - The bucket or attachment is too large for the material being handled.
- Engine concerns.
- The operator is not properly trained and is over-steering the servo-controlled transmissions.

1. Match the correct attachment for the material being handled. Use the bucket chart and material density chart found in the attachment section of the operator’s manual. It may be necessary to weigh a bucket of material to determine the weight being handled.
2. Engine Concerns:
   a. Check fuel quality and grade and replace fuel if necessary.
   b. Check for plugged fuel filters and drain water trap.
   c. Check engine timing.
   d. The injection pump calibration has not been found out of range on any complaint machines. However, it could still be a factor.

   In most cases, engine performance has been found acceptable, with the exception of bad fuel or plugged fuel filters.
3. Machine operation has been the most significant contributing factor. Operators tend to over-steer the servo-controlled transmission in heavy power demand situations, resulting in the engine lugging down or stopping.

Operators must be instructed to reduce the wheel speed (ground speed) by positioning the steering levers closer to the neutral position in heavy digging, backing out of steep inclines, or turning on pavement-type surfaces with heavy loads.

LS180 - Adjustable steering links

Hole 1 - Gives maximum linkage travel and wheel speed.

Hole 2 - Reduces linkage travel and wheel speed when steering levers are fully stroked.

Hole 3 - Maximum reduction in linkage travel and corresponding wheel speed.

Factory assembly of linkage is in hole, 2, as shown in Figures 3 through 5. If an operator is in a less power-demanding operation and needs maximum ground speed, the linkage can be moved to hole, 1.

For maximum wheel torque, use hole, 3.

NOTE: *Left and right linkage must be in the holes for machines to operate in a straight line of travel and with the same power.*

Wheel speed on LS180 (in low range, if two-speed) and engine speed at high idle (2350 $\pm$ 25 RPM) is:

Hole 1 - 80 RPM $\pm$ 5

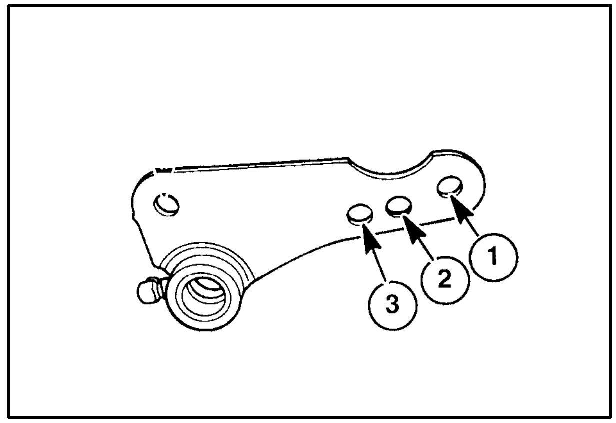
Hole 2 - 67 RPM $\pm$ 5

Hole 3 - Seldom used (use only when 67 RPM cannot be reached using hole 2)

Axle speeds should be set as close as possible to maximize straight travel in the forward direction.

When moving the linkage between holes 1, 2, and 3, neutral positioning may have to be reset.

NOTE: *When changing linkage position, have the skid steer up on blocks, securely supported with all four wheels off the ground so neutral can be adjusted, if needed, on engine start-up. This also aids when using a tachometer to adjust wheel speed.*



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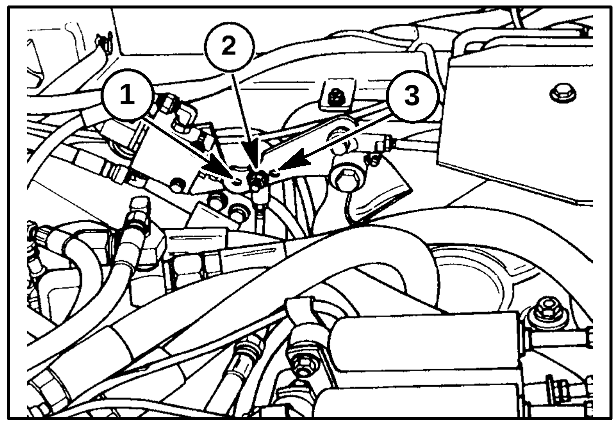

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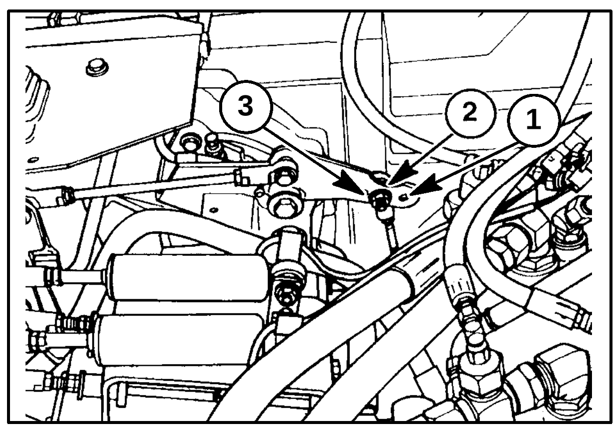

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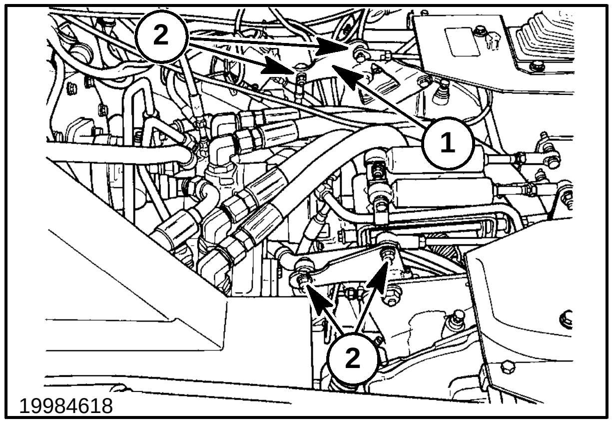
LS190 - Nonadjustable steering links

The steering links, 1, on LS190 skid steers have only two pivot holes, 2, and the link cannot be adjusted. Refer to the LS190 Operator's Manual for proper transmission speed adjustment.

IMPORTANT: *DO NOT EXCEED the 67 RPM, low range, or 106 RPM, high range, to prevent transmission overspeed and transmission damage.*



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HYDROSTATIC DRIVE SYSTEM TESTING

Hand controls - forward and reverse

Pre-test instructions:

* Operator in seat
* Seat belt buckled
* Service/Run switch in “RUN” position
* Key switch in the “OFF” position

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Levers should move freely	NO YES	Check control linkage from levers to the pumps. System OK
2	Stroke both levers forward or reverse, the levers should return to neutral position	YES NO	System OK Check neutralizer system for binding or adjustment.
3	Stroke both levers forward or reverse and release one lever, both levers should stay in direction stroked	YES NO	System OK Check neutralizer system for binding or adjustment

Hand controls - forward and reverse

Pre-test instructions:

* Operator in seat
* Seat belt buckled
* Service/Run switch in “RUN” position
* Parking brake disengaged
* Key switch in the “RUN” position
* Engine operating at low idle speed

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Control levers in neutral, unit should not move	YES NO	System OK Check and adjust for neutral
2	Stroke both levers forward or reverse, unit should accelerate smoothly	YES NO	System OK Check for loose or damaged control linkage, if OK go to next step.
3			Check hydraulic oil level and add as required, if OK go to next step.
4			Check hydrostatic hoses, tubing, and connections for leaks, if OK go to next step.
5			Check parking brake for being engaged or correct adjustment, if OK go to next step.
6			Check hydrostatic charge pressure, if OK go to next step.
7			Check forward or reverse relief valve operation and pressure settings.
8	Control levers in neutral park brake engaged, pumps should be quiet	YES NO	Control System OK Check and adjust for neutral, if OK go to next step.
9			Check for loose or damaged control linkage, if OK go to next step.
10	Control levers in full forward, machine should go in straight line	YES NO	Control System OK Reset control lever stops

Before performing any hydraulic tests, operate the skid steer to get the hydraulic oil to operating temperature (approximately 55° C [100° F] above the ambient temperature).

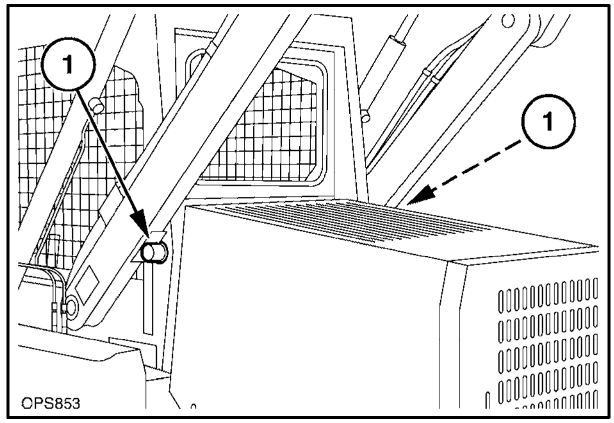
For access to the hydrostatic system, remove any attachment from the skid steer attaching face plate and support the boom on the boom lock pins.

1. Raise the boom, extend the boom lock pins, 1, and rest the boom on the boom lock pins.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.



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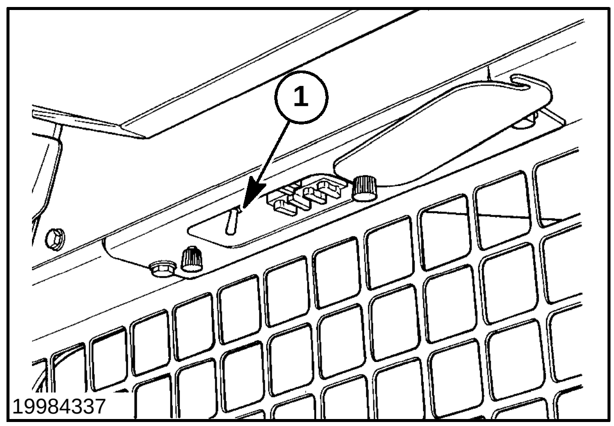
2. Stop the engine, turn the key to the run position and operate the boom and bucket pedals to relieve pressure in the boom and bucket circuits.

3. Put the Service/Run switch, 1, in the “SERVICE” position.



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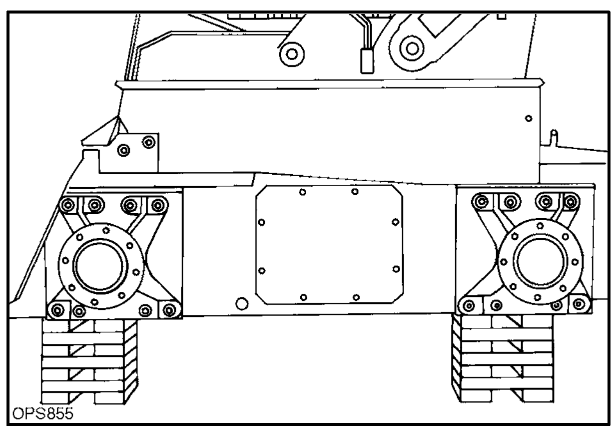
4. Securely block the skid steer with all four wheels off the ground. Refer to Section 00 for more detailed information on properly supporting the skid steer.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer causing serious injury or damage to the equipment.



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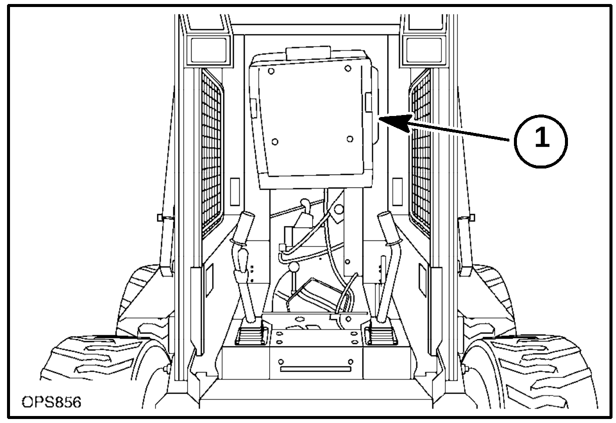
5. Raise the operator's seat and latch, 1, in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.



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6. Check the hydraulic oil level, 1, and add if required to the proper level.

WARNING

Gauges, gauge fittings, and hoses must have operating pressure ratings of at least 25% higher than the highest pressures of the system.

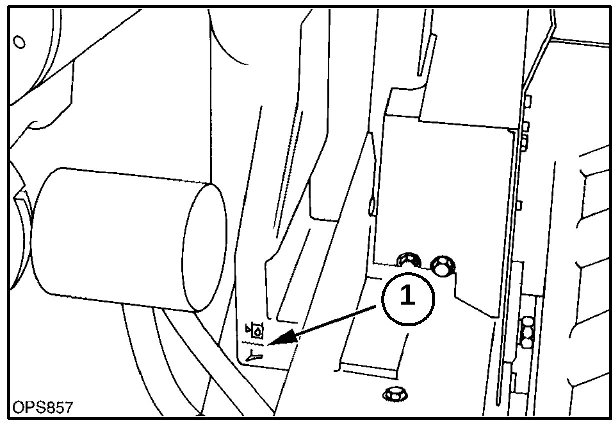
Never adjust or replace the relief valves to get higher pressures than those specified by the equipment manufacturer.

Fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Always protect the skin and eyes from escaping fluid under pressure.

Before disconnecting lines or fittings, be sure to turn off the skid steer engine and relieve all pressure. Before applying pressure to the system, be sure all connections are tight and that lines, pipes, and hoses are not damaged.

If injured by escaping fluid, obtain medical assistance at once. Serious infection or reaction can develop if medical treatment is not administered immediately.

Remove any attachment from the mounting plate before loosening or disconnecting any hydraulic lines.



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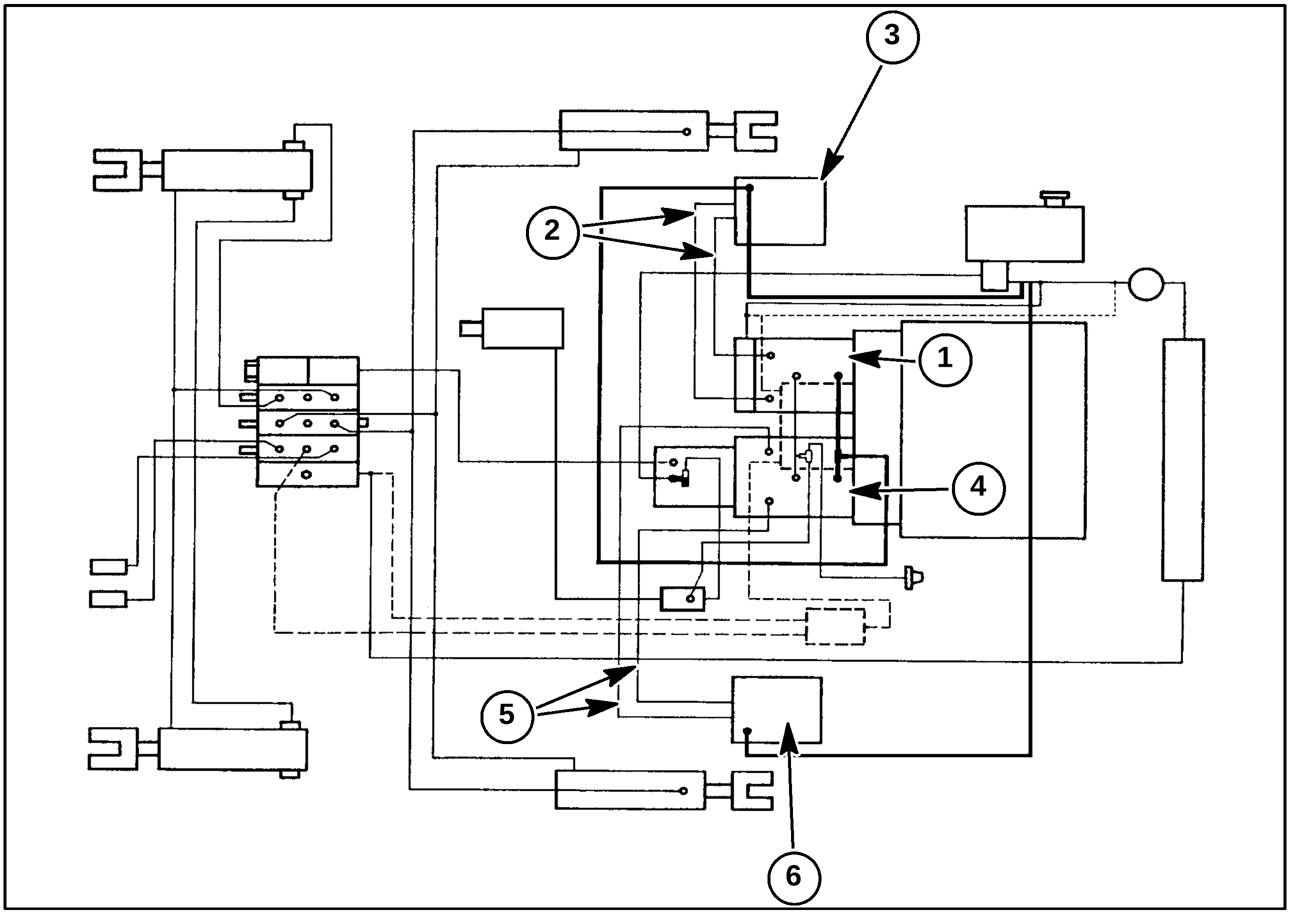

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HYDROSTATIC SYSTEM OIL FLOW

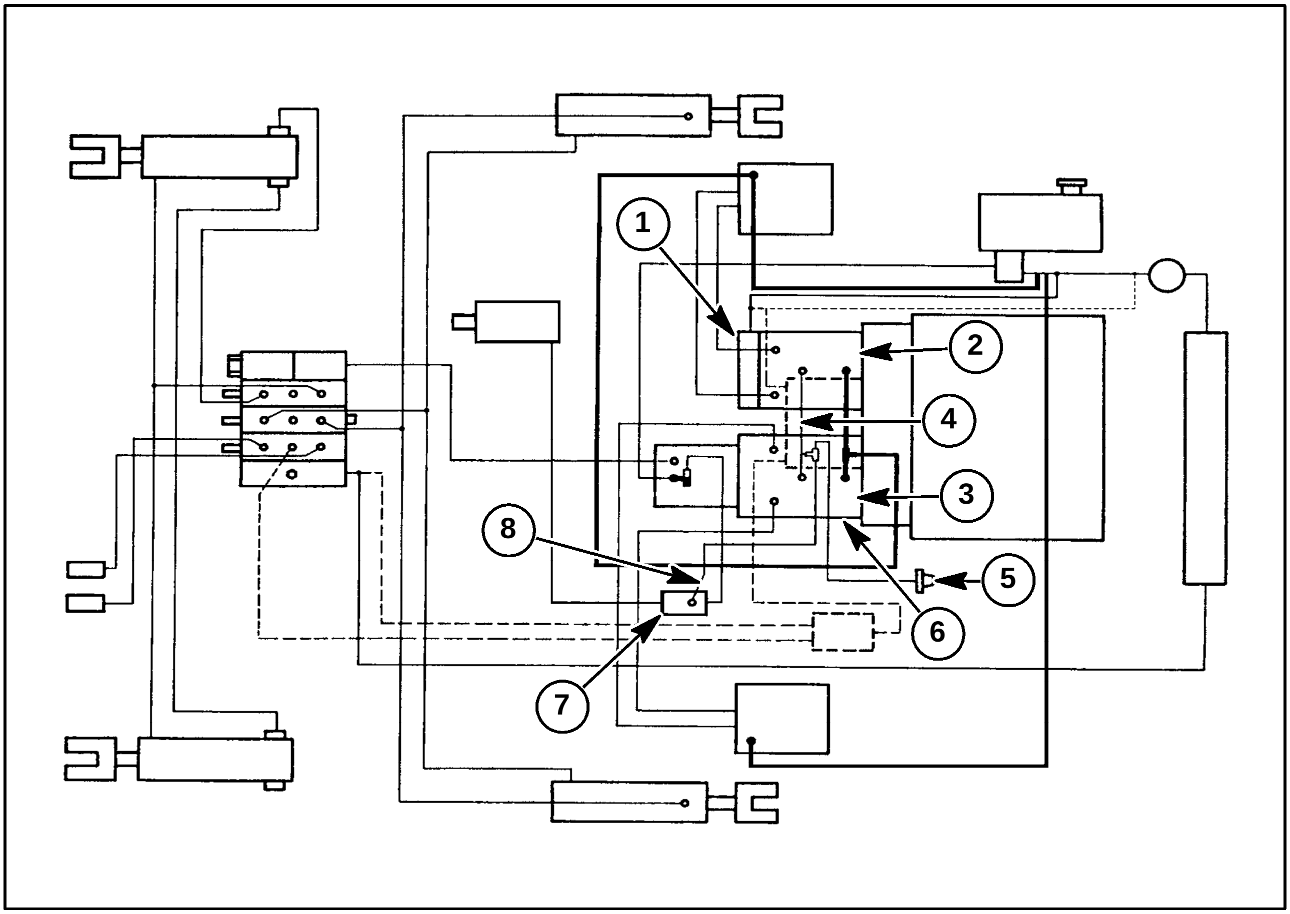
Hydrostatic Pumps and Motors High-Pressure Flow

The hydrostatic pumps are driven by the engine through a spur gear configuration in the transmission gearbox.

The right hand hydrostatic pump, 1, supplies high-pressure oil through high-pressure lines, 2, to the right hand hydrostatic motor, 3, when the right forward/reverse control lever is stroked in either direction.

The left hand hydrostatic pump, 4, supplies high-pressure oil through high-pressure lines, 5, to the left hand hydrostatic motor, 6, when the left forward/reverse control lever is stroked in either direction.

The hydrostatic system is protected by four high-pressure relief valves, two in each pump, one for forward and one for reverse. All four high-pressure relief valves are the same and are factory set at 345 bar (5000 PSI). Do not try changing the pressure setting of these relief valves. If during testing the relief valves are found to be incorrectly set, replace the complete valve cartridge.



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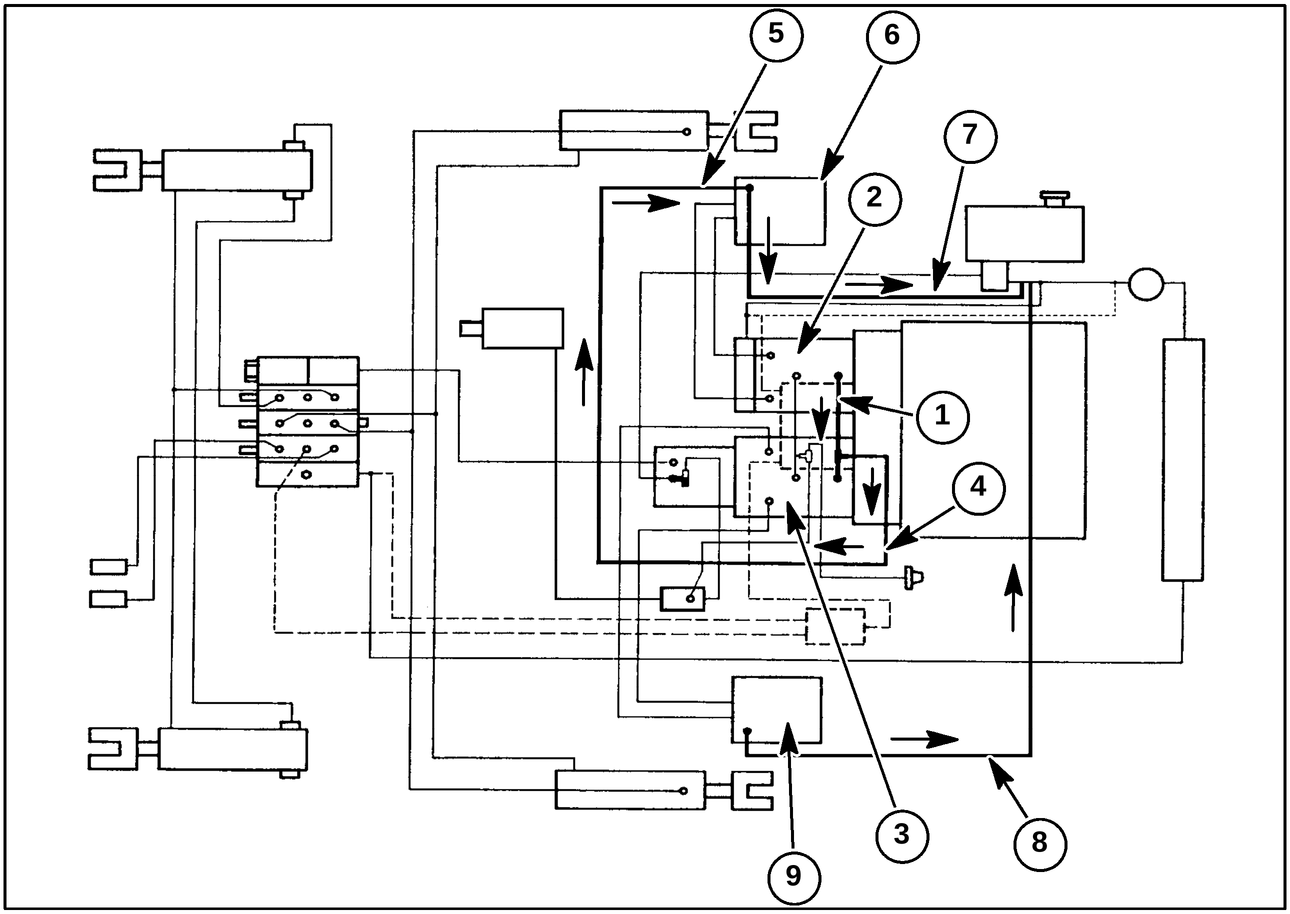
Hydrostatic Pump Charge Pressure Oil Flow
A gerotor charge pump, 1, is attached to the right hand hydrostatic pump, 2, and provides charge pressure oil to both the right and left hand hydrostatic pumps, 2 and 3. Oil is supplied to the left hand hydrostatic pump through line 4. This charge oil replaces oil in the high-pressure circuit that was used for lubrication and cooling of the internal rotating parts of the pumps and motors.

Charge oil is also supplied to the Transmission Charge Pressure switch, 5, through hose 6. This hose tees into the charge pressure circuit at the left hand hydrostatic pump.

On the two-speed skid steers, charge oil is used to supply oil to the Hi/Low Control Valve, 7, through hose 8. This hose also tees into the charge pump circuit at the left hand hydrostatic pump.



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Hydrostatic Pump and Motor Case Drain Flow (LS180 and LS190 Two-Speed Shown)

NOTE: *LS180 Models with fixed displacement motors operate the same, without the two-speed selector valve and shift cylinder.*

During operation of the hydrostatic pumps and motors, oil from the high-pressure circuits used for lubrication drains into the pump and motor housings.

The lubrication oil will fill the housings approximately half full. This oil then becomes cooling oil and will drain from the pump and motor housings (cases) through the case drain lines.

On the hydrostatic pumps, the case drain line, 1, connects the right and left pumps 2 and 3. Line 4 tees into the case drain port, 5, at the rear of the right-hand hydrostatic motor, 6. The hot case drain oil is returned to the hydraulic system (to be cooled and filtered) through the return line, 7.

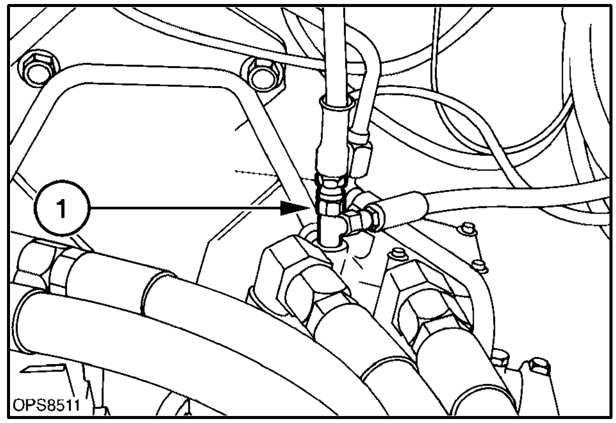
Tube, 8, from the front case drain port on the left hand hydrostatic motor, 9, tees into the case drain port at the hydraulic reservoir.

HYDROSTATIC CHARGE SYSTEM PRESSURE TEST

The hydrostatic charge pump provides charge pressure oil to the right and left hand hydrostatic pumps. This oil replenishes the hydrostatic system for lubrication and cooling of the hydrostatic pumps and motors.

The charge pressure can be checked at the charge pressure port on the top of the left hand hydrostatic pump, 1.

The charge system pressure is regulated by the charge pump relief valve and can not be adjusted. If there is some reason to suspect incorrect pressure, check the pressure as follows:



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Checking Charge System Pressure

Fittings and gauge required:

1. 0 - 50 bar (0 - 600 PSI) gauge (minimum)
2. 7/16 - 20, 37° (JIC) swivel nut run tee and hose to gauge

Test Procedure

1. Raise the boom and rest on the boom locks.
2. Put the SERVICE/RUN switch in the SERVICE position.
3. Disengage the parking brake.
4. Securely block the skid steer with all four wheels off the ground. Support the front of the skid steer at 1, to the front of the final drive case and at 2, to the rear of the case (tires removed for clarity).

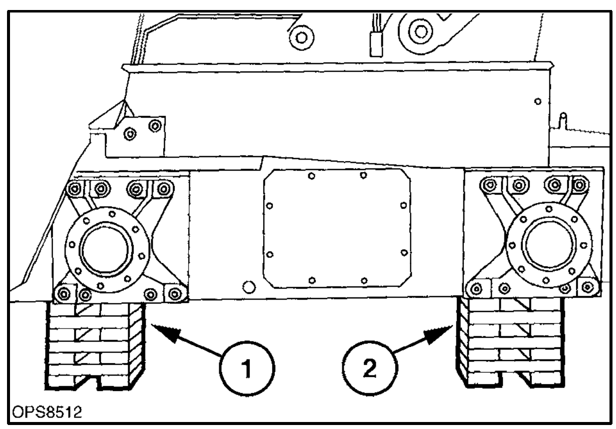
CAUTION

Failure to securely support the skid steer could result in movement of the skid steer causing serious injury or damage to the equipment.

5. Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.



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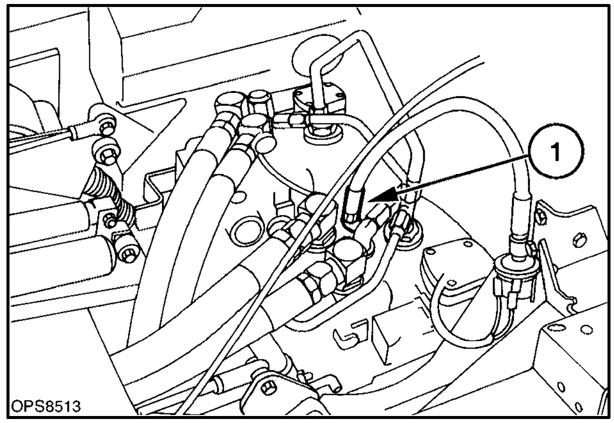
6. Disconnect the hose to the Transmission Charge Pressure switch at 1, install a swivel nut run tee, hose and pressure gauge, and reinstall the hose to the charge pressure switch.

IMPORTANT: *Check the oil level in the hydraulic oil reservoir and add SAE 10W-30 oil (if required) to make sure there is sufficient oil for the test.*



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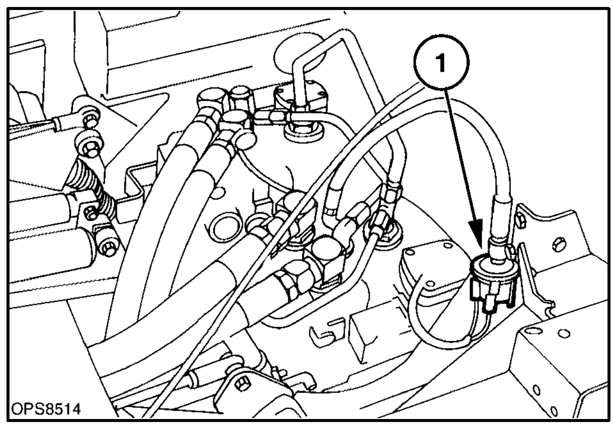
7. Start the engine, run at full throttle (2225 - 2275 RPM), and take a pressure reading. The pressure should be within the 17.2 - 20.7 bar (250 - 300 PSI) allowable range.
8. Operate the hydrostatic control levers in forward and reverse until the system bypasses and take a pressure reading. Return the controls to neutral. The pressure should remain within the range of 17.2 - 20.7 bar (250 - 300 PSI).

CAUTION

Always stay clear of moving parts during testing or serious injury could occur.

9. If the charge pressure is within the specified range, but the EIC warning light is on indicating low charge pressure, replace the Transmission Charge Pressure sending unit, 1.
10. If charge pressure is low, refer to the Hydrostatic Pump section for disassembly instructions and check the following:
    a. Charge pressure relief valve damage:
        1. Broken spring
        2. Damaged poppet seat
        3. Dirt or debris under poppet seat
    b. Remove charge pump assembly and check:
        1. Gerotor ring wear, both inner and outer
        2. Drive key failure
11. Low charge pressure could also be a result of excess case drain flow from the hydrostatic pumps/motors. This is a result of worn or damaged internal components. Refer to the test procedures outlined in this section to determine the case drain flow. If case drain flow is the problem, refer to the Hydrostatic Pump/Motor Section for service instructions.



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HYDROSTATIC PUMP CASE DRAIN TEST

The hydrostatic pump case drain oil flow should be checked to determine if wear and possible damage to the internal rotating components has occurred.

Checking Pump Case Drain Flow

Fittings and other equipment required:

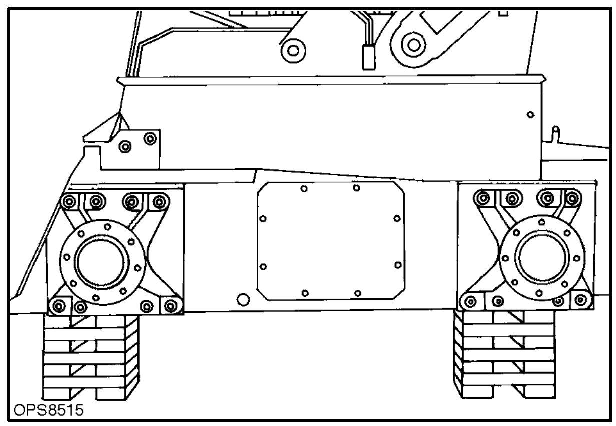
1. Misc. 37° JIC fittings for case drain tubes: Plugs, elbows and adapters.
2. Drain hose
3. 5 gallon bucket
4. Stop watch

Test Procedure

1. Raise the boom and rest on the boom locks.
2. Put the SERVICE/RUN switch in the SERVICE position.
3. Engage the parking brake.
4. Securely block the skid steer with all four wheels off the ground.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer during testing causing serious injury or damage to the equipment.



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5. Raise the operator’s seat and latch in the raised position.

CAUTION

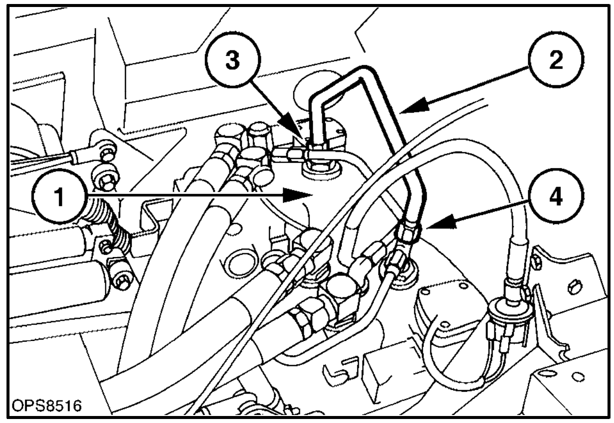
Never work under a raised seat unless it is securely latched in the raised position.

Right Hand Hydrostatic Pump, 1

6. Remove the case drain cross tube, 2, at the right and left pump housing outlet ports, 3 and 4. Cap the open fitting at 4, on the left pump. Connect a hose to the case drain fitting at 3, on the right pump, and run into a suitable container.

IMPORTANT: *Check the hydraulic oil level and add if required to ensure sufficient oil for the test.*

7. Start the engine and run at full throttle (2225 - 2275 RPM). Take a flow reading. The maximum flow should be 5.7 l/min. (1.5 gal./min.).
8. Stroke the hydrostatic control levers forward and reverse and take a flow reading in both directions. If the flow exceeds the 5.7 l/min. (1.5 gal./min.), there is excessive leakage from the forward and/or reverse high pressure loops.



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CAUTION

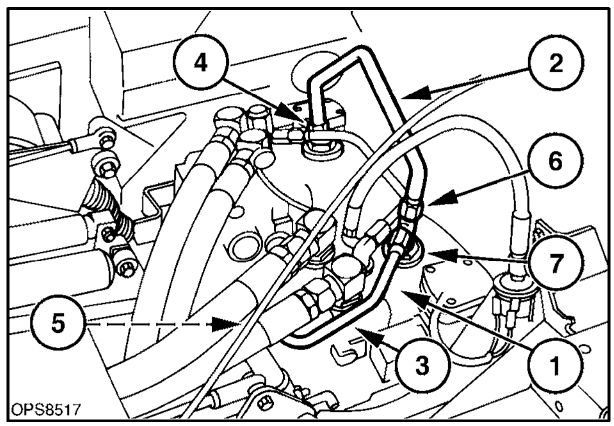
Always stay clear of moving parts during testing or serious injury could occur.

Left Hand Hydrostatic Pump, 1

9. Remove the case drain cross tube, 2, and case drain tube, 3. Connect a hose from the case drain port on the right pump at 4, to the open inlet port on the hydraulic gear pump at 5. Remove the tee fitting, 6, connect a hose to the case drain port at 7, on the left pump, and run the hose into a suitable container.

IMPORTANT: *Check the hydraulic oil level and add if required to ensure sufficient oil for the test.*

10. Start the engine and run at full throttle (2225 - 2275 RPM). Take a flow reading. The maximum flow should be 5.7 l/min. (1.5 gal./min.).
11. Stroke the hydrostatic control levers forward and reverse and take a flow reading in both directions. If the flow exceeds the 5.7 l/min. (1.5 gal./min.), there is excessive leakage from the forward and/or reverse high pressure loops.



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CAUTION

Always stay clear of moving parts during testing or serious injury could occur.

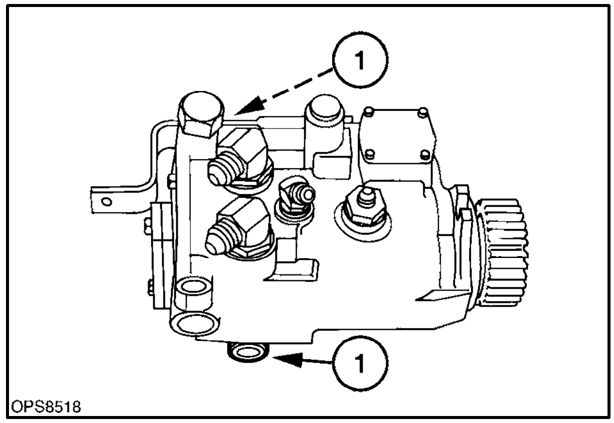
12. If the flow from the hydrostatic pumps is less than 5.7 l/min. (1.5 gal./min.), the problem may be in the motors. Refer to the Hydrostatic Motor Case Drain Test in this section for further details.

HYDROSTATIC PUMP HIGH-PRESSURE TEST

The hydrostatic drive system is protected by four high-pressure relief valves; two in each pump, one for forward and one for reverse. All four valves are the same and are factory set at 345 bar (5000 PSI).

The valves are located opposite each other at the bottom of the backplate section of the pumps. Right hand pump at 1, and left hand pump at 2.

If one relief valve is in question, the valve can be switched with a known good valve; if the problem follows the switched valve, replace the suspect valve. Switching forward and reverse relief valves on the same pump should reverse the problem if the relief valve is defective. If the problem remains, internal wear or damage in the pump or motor is the likely cause. Refer to the pump case drain test for further testing to locate the problem.



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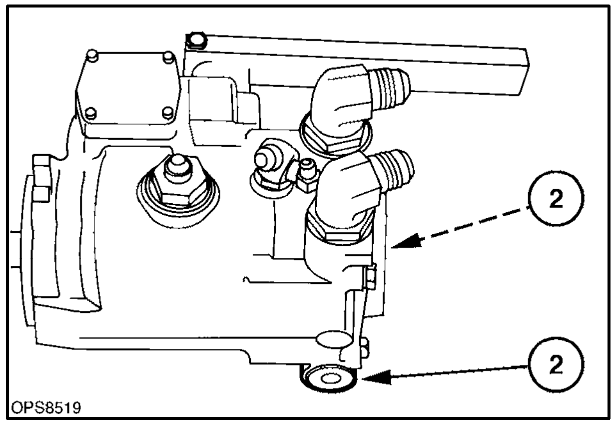

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Gauge Required

0 - 690 bar (0 - 10,000 PSI)

Relief Valve Test Procedure

1. Raise the boom and rest on the boom locks.
2. Put the SERVICE/RUN switch in the SERVICE position.
3. Engage the parking brake.
4. Securely block the skid steer with all four wheels off the ground.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer during testing causing serious injury or damage to the equipment.

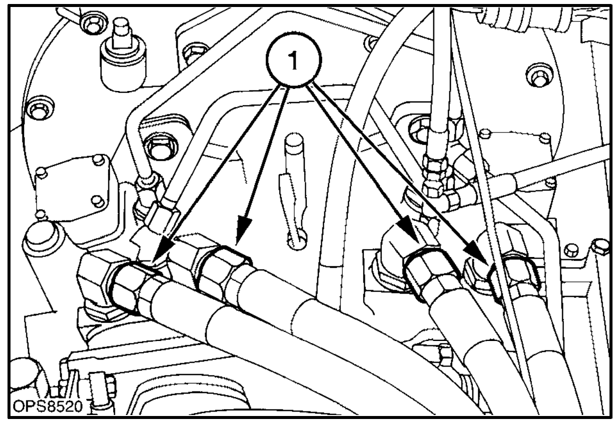
5. Raise the operator’s seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

6. Install a tee fitting, in the high-pressure loop being tested, at the pump outlet, 1.

IMPORTANT: *Check the hydraulic oil level and add if required to ensure sufficient oil for the test.*



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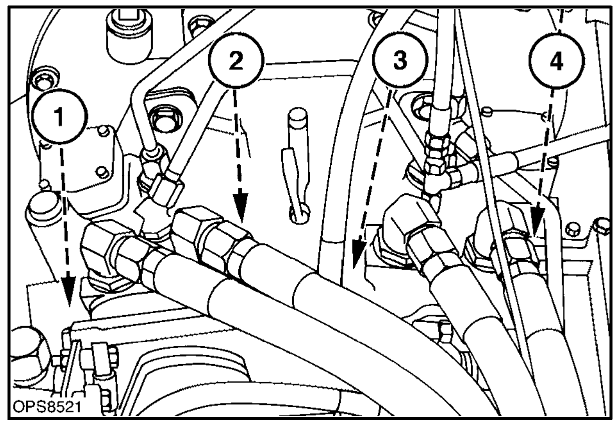
The following hydrostatic pump relief valves protect the forward and reverse direction of the hydrostatic drive motor (tire) rotation.

Right pump controls the right motor

1 - Forward
2 - Reverse

Left pump controls the left motor

3 - Reverse
4 - Forward



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7. Start the engine and run it at full throttle (2225 - 2275 RPM).
8. Stroke the hydrostatic lever on the side being tested and in the direction being tested, and take a pressure reading. The pressure should be 345 bar (5000 PSI). If the pressure is not at specification of 345 bar (5000 PSI), replace the suspect relief valve.

CAUTION

Always stay clear of moving parts during testing or serious injury could occur.

NOTE: *All four directional relief valves can be tested in this manner.*

If the pressure is within specification, refer to the pump/motor case drain test for further testing to locate the problem.

HYDROSTATIC MOTOR CASE DRAIN TEST

The hydrostatic motors should be checked for excessive internal leakage if one or both of the ground drive systems appears weak. The excessive leakage is caused by wear or damage to the motors internal rotating groups, thus allowing high-pressure oil to leak into the case.

Checking Motor Case Drain Flow

Ideally, case drain to each motor should be checked individually to properly evaluate their condition. But due to the inaccessibility of the hydrostatic motor and case drain lines, the following procedure should be used.

Fittings and other equipment required:

1. Misc. 37° JIC fittings
2. Drain hose
3. 5 gallon bucket
4. Stop watch

Test Procedure

1. Raise the boom and rest on the boom locks.
2. Put the SERVICE/RUN switch in the SERVICE position.
3. Engage the parking brake.
4. Securely block the skid steer with all four wheels off the ground.

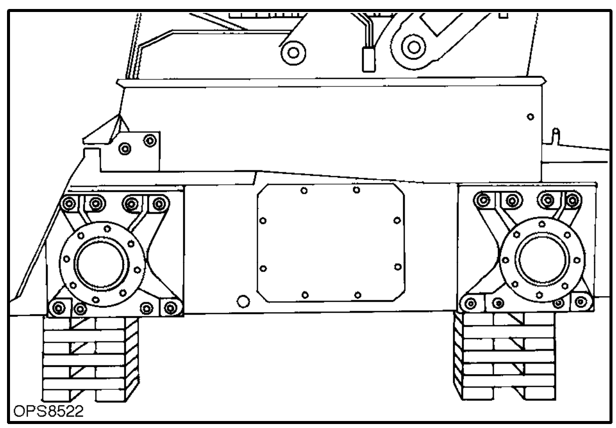
CAUTION

Failure to securely support the skid steer could result in movement of the skid steer during testing causing serious injury or damage to the equipment.

5. Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.



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6. Verify that the hydrostatic pumps are in good condition by performing a case drain test on the pumps. Refer to the pump case drain test procedure as outlined earlier.
7. If either the right or left hand side was appearing weak, and the pump case drain test was within specifications, a check of the total case drain flow from the motors should be performed.
8. Disconnect the hydrostatic motor case drain hose at the hydraulic gear pump at 1, and cap the fitting at the pump.
9. Connect another hose to the end of the motor case drain hose, and run into a suitable container.

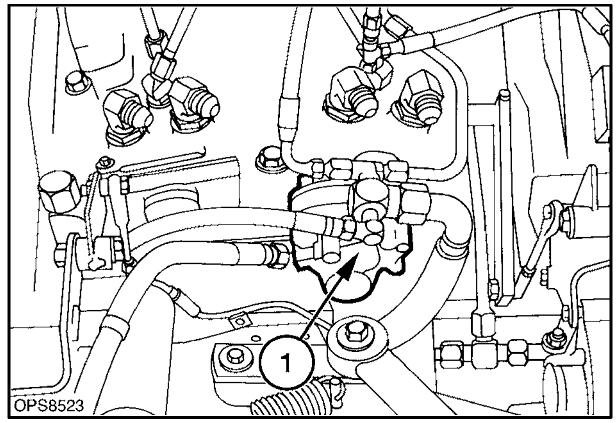
IMPORTANT: *Check the hydraulic oil level and add if required to ensure sufficient oil for the test.*

10. Start the engine and run at full throttle (2225 - 2275 RPM).
11. Stroke the control lever for the side being tested, both forward and reverse, and take a flow reading. Flows in excess of 5.7 l/min. (1.5 GPM) indicate excessive leakage in the motor. This will also indicate the need for either repair or replacement of the motor.

NOTE: *Even though the case drain flow is for both motors, flow from the unstroked side is not enough to affect the results.*

CAUTION

Always stay clear of moving parts during testing or serious injury could occur.



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HYDRAULIC, HYDROSTATIC SYSTEM AIR INGRESS TEST

Hydraulic system air ingress, causing oil aeration, can affect performance of the hydraulic oil. This may be evident on a machine by jerky or uneven movement of the skid steer boom or bucket.

To assist in testing and finding leaks, a tool has been developed (part #FNH22ESS95). This tool comprises a cap which replaces the reservoir filler breather for testing purposes, a pressure gauge and a relief valve. The cap has fittings for air pressure to be applied to the hydraulic reservoir.

CAUTION

Do not start the engine with the test tool installed, as the hydraulic system must be able to breathe.

Test Procedure

1. Remove the filler/breather cap.
2. Remove the self-tapping screws around the cap base and screen assembly.
3. Remove the base, screen and gasket assembly, clean all sealing surfaces.
4. Re-install new gaskets and base, taking care not to overtighten the screws.
5. Make sure the tank has 10W-30 oil visible.
6. Pressurize the tank using an air pressure line. The tool is equipped with a 3 PSI relief valve and a pressure gauge. The reservoir should not be pressurized beyond 4 PSI.

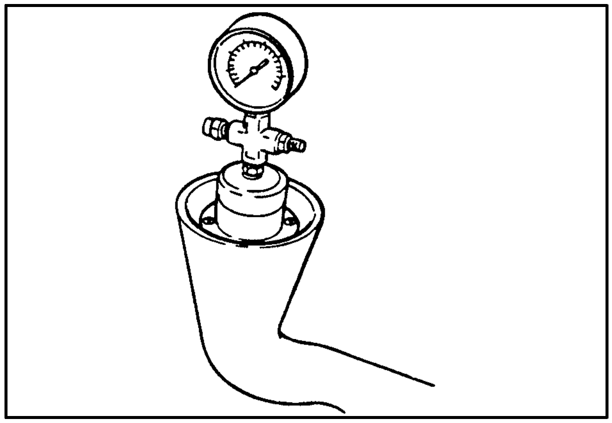
The following checks should then be performed to trace the source of the air ingress.

- Examine the suction tubes and fittings to the hydraulic gear pump and the return tubes from the filter to the reservoir.
- Examine the transmission case drain tubes/hoses and fittings from the hydraulic motors and pumps to the suction side of the hydraulic pump. Also check the cam plate shaft seals and the pump and motor casing gaskets.
- Potential leakage areas could also be input shaft seals in the engine bell housing, gearbox or output shaft seals in motors and gearboxes and the chain case.

- It may be necessary in some instances (where leakage is occurring on shaft seals into gearboxes or bell housing), to pressurize the reservoir for 2 to 4 hours and monitor the oil level in the gearboxes.
- If the prior checks do not locate the source of the leak, it may be necessary to pressurize each hydrostatic component individually.

  To do this it will be necessary to disconnect each case drain line in turn and pressurize using an air line to a maximum pressure of 10 PSI.

NOTE: *A check valve can be installed in the case drain tube which maintains a 5 PSI pressure in the pump and motor cases. This helps prevent air ingress into the system.*



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HYDROSTATIC AND CHARGE PUMPS

HYDROSTATIC PUMPS

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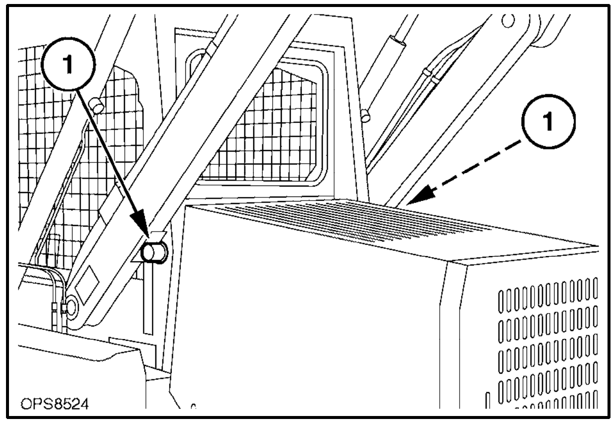
REMOVAL

The hydrostatic pump assemblies can be removed from the top and front, or the cab and boom can be tilted forward for more access. Refer to Section 00 for the cab tilting procedure.

To remove the hydrostatic pump assembly without tilting the cab forward:

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1.



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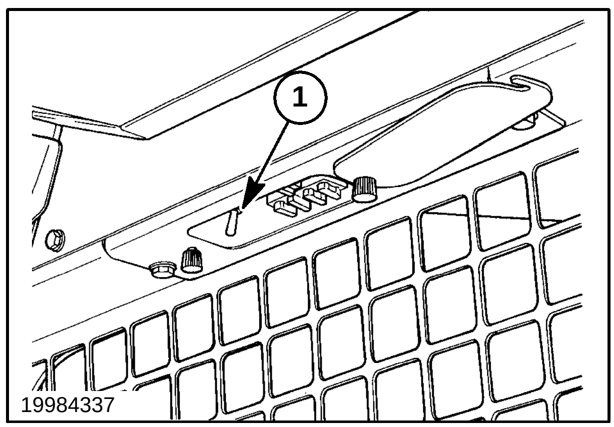
CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. always remove the attachment from the skid steer.

2. Stop the engine, turn the ignition key to the run position, and operate the boom and bucket pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the “SERVICE” position.
4. Engage the parking brake.



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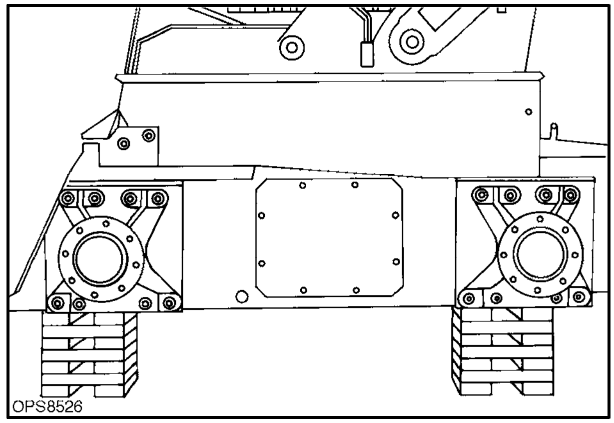
5. Securely block the skid steer with all four wheels off the ground. Refer to Section 00 for more detailed information on properly supporting the skid steer.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer during testing causing serious injury or damage to the equipment.



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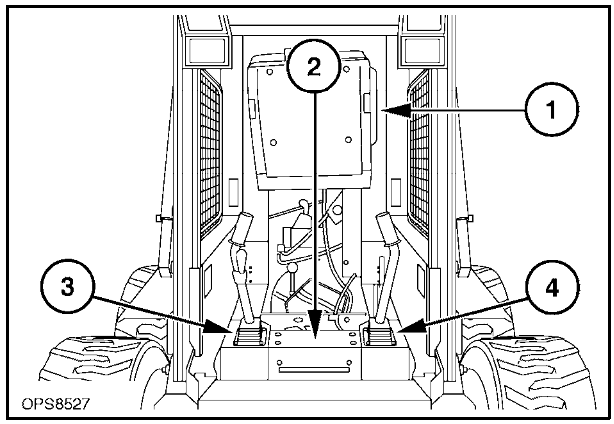
6. Raise the operator's seat and latch in the raised position, 1.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.



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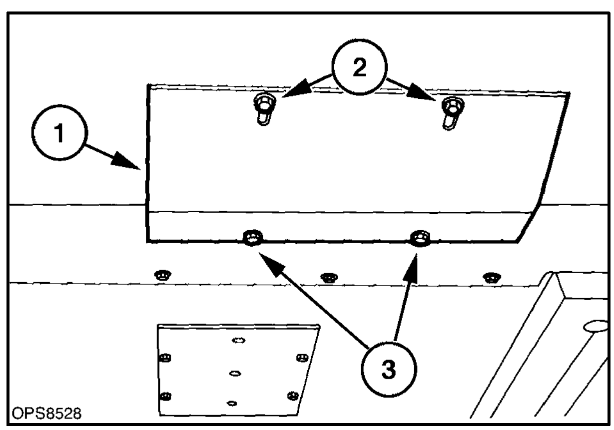
7. Remove the step shield, 2, to access the hydrostatic pump and motor area. For more access, remove the right or left hydrostatic control handle assembly, 3 or 4.
8. Relieve all pressure in the hydraulic and hydrostatic systems.

CAUTION

Never loosen any hydraulic lines without first relieving all pressure in the system to avoid serious injury.

Unless the hydraulic system requires cleaning, draining of the hydraulic oil reservoir is not required. Make sure the suction and return lines are capped to prevent loss of oil.

9. To drain the system, remove the small access door, 1, at the front right corner of the engine belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



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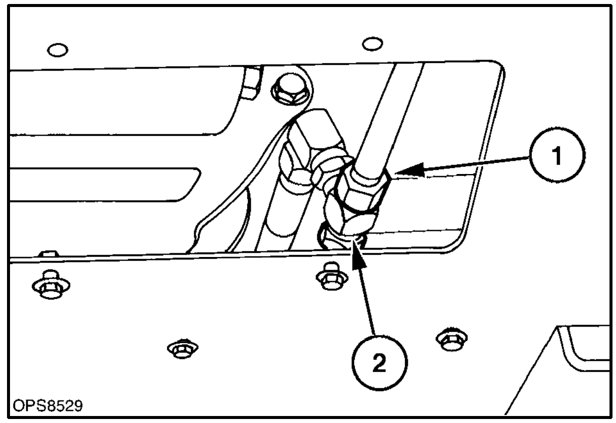
10. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.



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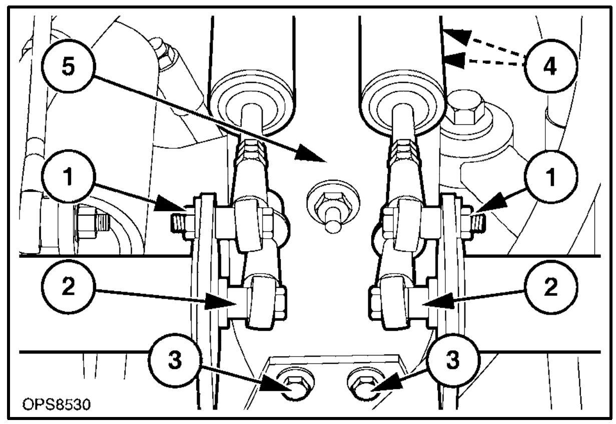
11. Disconnect the dampener shocks at 1, and the neutralizer assemblies at 2.
12. Remove the four neutralizer assembly attaching bolts, two at the front, 3, and two at the rear, 4. Lift the entire neutralizer assembly, 5, out in one piece.



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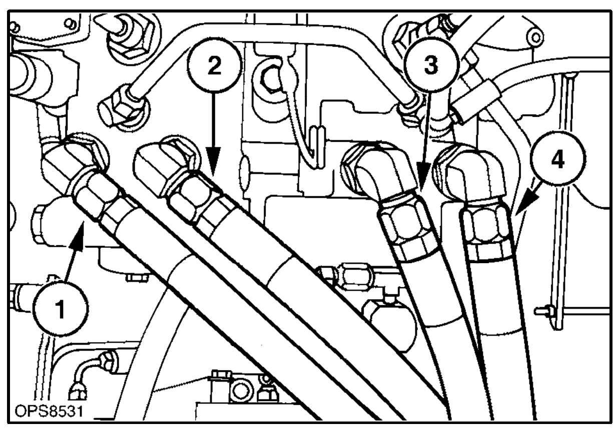
***NOTE:** Clean the pumps thoroughly and mark the hose locations to aid in reassembly.*

13. Disconnect hydrostatic lines, 1 and 2, and cap the ends.
14. Disconnect hydrostatic lines, 3 and 4, and cap the ends.



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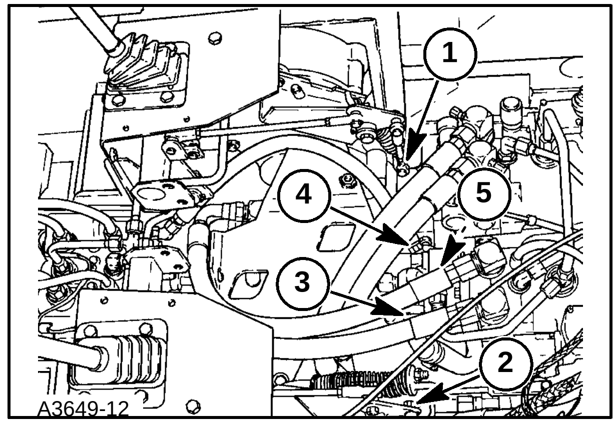
15. Disconnect the rear control rods, 1 and 2, at the pump control arms.
16. Disconnect the hydraulic suction hose, 3, the hydraulic high pressure hose, 4, and if equipped, the two-speed slave cylinder supply hose at 5.



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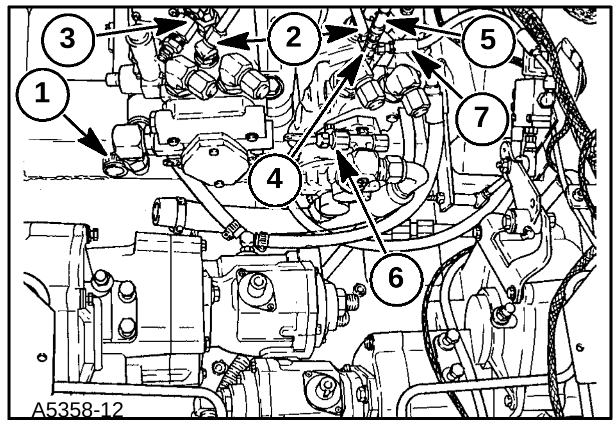
17. Disconnect the charge pump suction line at 1. Remove the charge pressure cross tube, 2, and the case drain tubes, 3 and 5. Disconnect the charge pressure sender line at 4. Cap all lines.

    Two-speed skid steers - If equipped, remove the two-speed solenoid valve supply line, 6, and the solenoid valve return line, 7. Cap lines.



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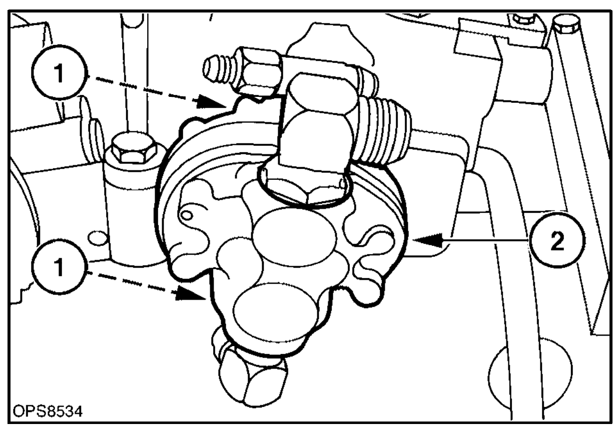
18. Remove the two 3/8″ gear pump attaching bolts, 1, and the gear pump assembly, 2, set aside. Refer to Section 6, “Hydraulic Gear Pump”, for repair information.



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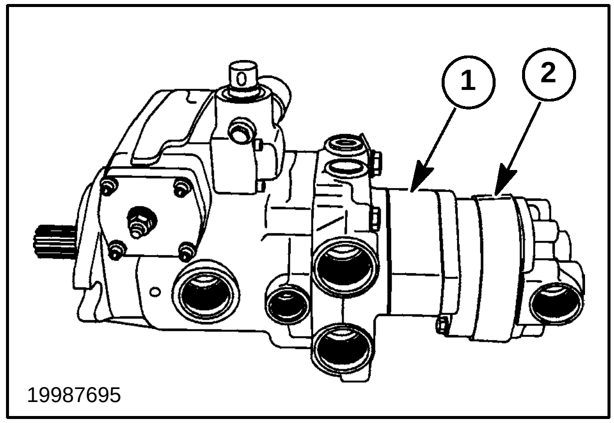
a. LS190 skid steers only - A wide spacer, 1, separates the gear pump, 2, from the hydrostatic pump on LS190 skid steers.



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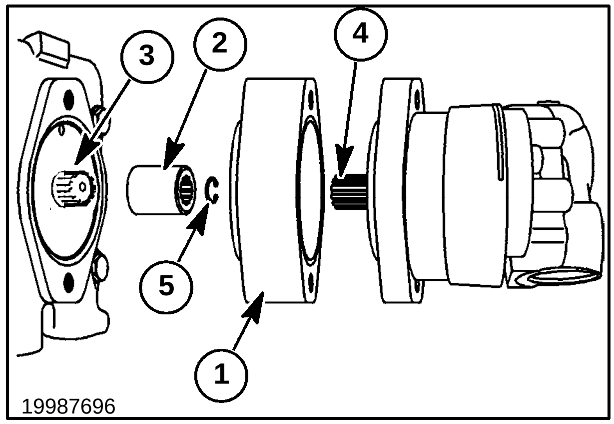
b. LS190 skid steers only - Remove the spacer, 1, and coupler, 2. Discard the O rings on the gear pump and spacer. The hydrostatic pump on LS190 skid steers has a splined male shaft, 3. The coupler connects the hydrostatic pump male shaft to the gear pump splined male shaft, 4. A snap ring, 5, inside the coupler keeps the coupler from shifting position during operation. The spacer allows for the extra space the coupler requires.



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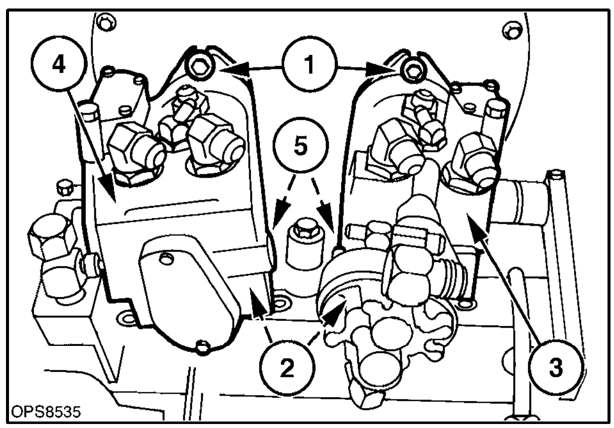
NOTE: *To access the lower mounting bolts on the hydrostatic pumps, remove the inspection cover on the underside of the machine.*

19. Securely support the hydrostatic pumps.
20. Remove the upper pump mounting bolts, 1, and the lower pump mounting bolts, 2.
21. Remove the left hydrostatic pump, 3, and the right hydrostatic pump, 4.
22. Remove the O rings, 5, between the hydrostatic pumps and the engine bell housing.



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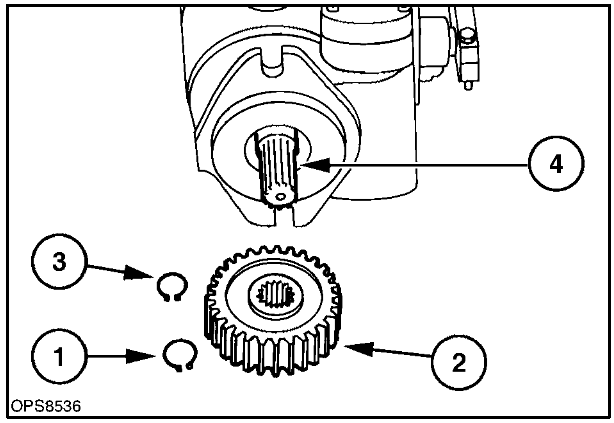
23. Remove the outer retaining ring, 1, pump drive gear, 2, and inner retaining ring, 3, from the hydrostatic pump drive shaft, 4.



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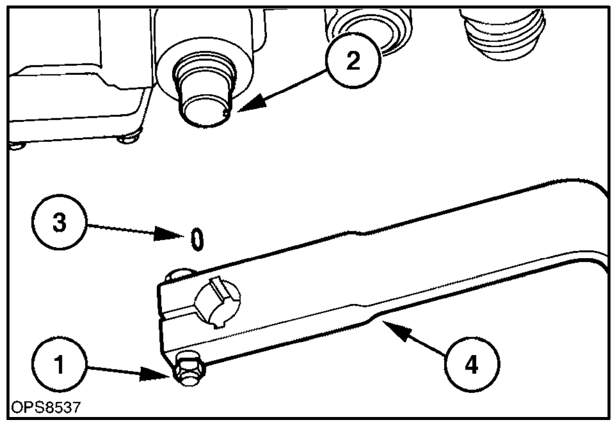
24. Loosen clamp bolt, 1, and remove control arm, 4, and key, 3, from the servo control shaft, 2.

The right hand pump and control arm are shown. Repeat steps 23 and 24 for the left hand pump and control arm.



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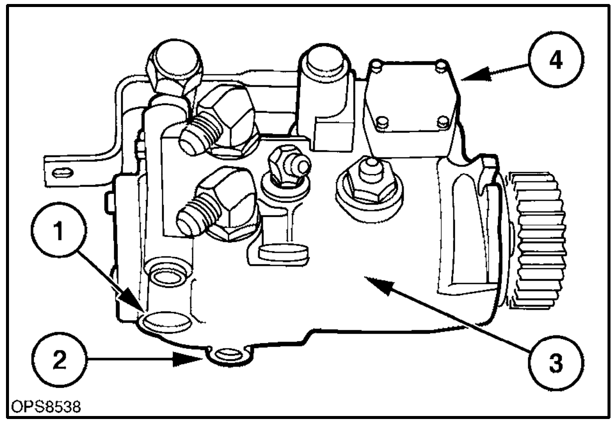
DISASSEMBLY

1. Thoroughly clean the complete pump assembly before teardown. Plug all ports so dirt and solvent do not enter the pump.

   The right hand hydrostatic pump consists of these main components; charge pump adaptor assembly, 1, backplate, 2, main pump housing, 3, and servo control assembly, 4.



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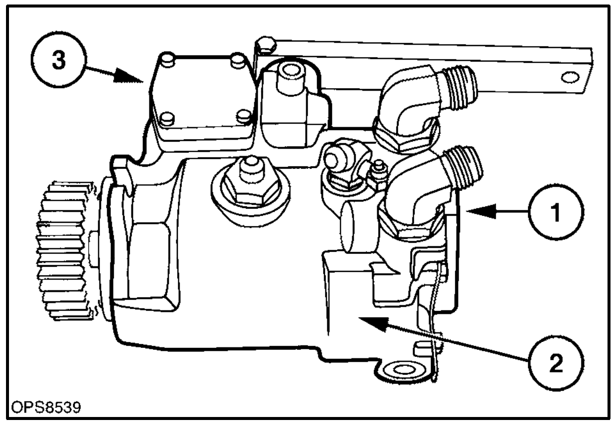
   The left hand hydrostatic pump consists of the backplate, 1, main pump housing, 2, and servo control assembly, 3.



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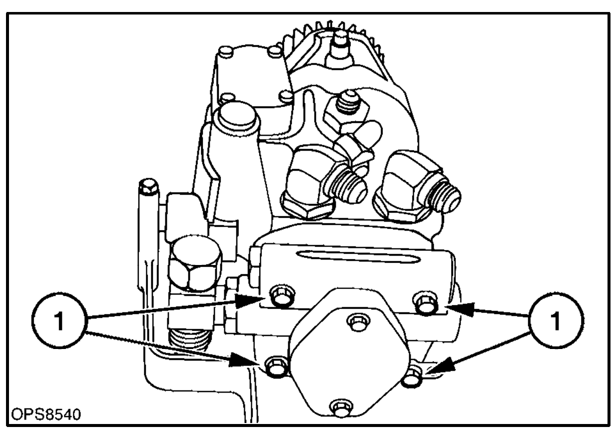
NOTE: *Dealer warranty adjustment requests for any hydrostatic component repair must include the machine model, serial numbers, transmission model number, and date codes. These codes are stamped into the servo control end cap.*

   The following disassembly instructions apply to the right hand hydrostatic pump, with gerotor charge pump. When disassembling the left hand pump, disregard steps concerning the charge pump.

2. To ensure proper reassembly, mark the relationship between the servo control assembly, charge pump adaptor assembly, and main pump housing with a marker or scribe.
3. As the pump is being overhauled, lay the parts on a clean wooden bench top or heavy cardboard to prevent damage to the machined surfaces.
4. Position the pump into a protected jaw vise, clamping onto the outer portion of the mounting flange with the cap screws of the gerotor charge pump facing up.
5. Remove the four cap screws, 1, and tap the housings with a plastic or rubber mallet to separate the two pumps. Lift the charge pump adaptor assembly straight up off the shaft and backplate. The gerotor may stay in the adaptor or on the backplate.



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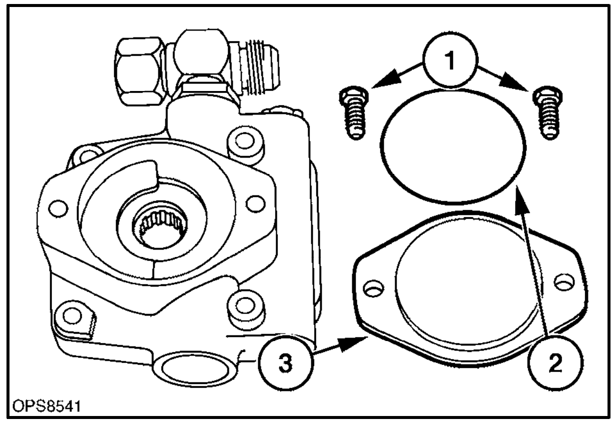
HYDROSTATIC CHARGE PUMP

DISASSEMBLY

1. Thoroughly clean the charge pump to prevent contamination of internal parts.
2. Remove two cap screws, 1, cover plate, 3, and O ring, 2.



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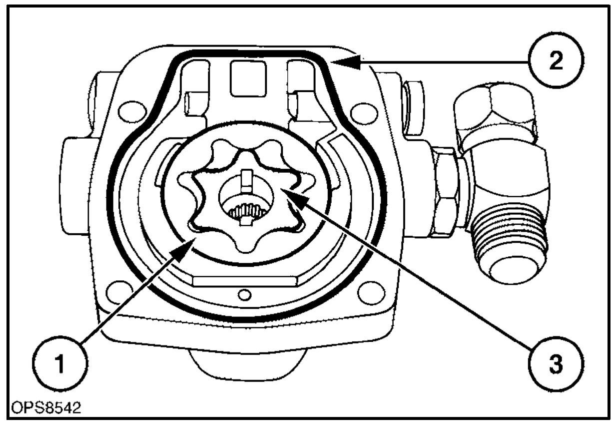
3. Remove the inner gerotor ring, 3, the outer gerotor ring, 1, and molded O ring, 2.

   If the inner gerotor ring, 3, stays on the shaft, remove it and the drive key. If not, remove the drive key and set with the charge pump assembly.



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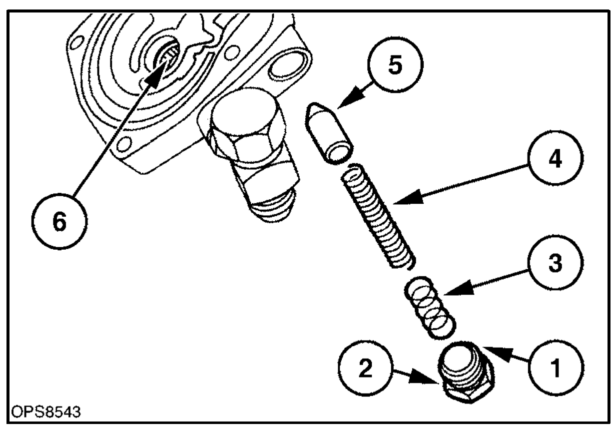
4. Remove the relief valve assembly which consists of: plug, 1, O ring, 2, shims, 3, spring, 4, and poppet, 5.
5. The needle bearings, 6, are a press fit in the adapter housing. Do not remove at this time unless the bearing is loose in the housing or if there are loose, damaged or missing needles.



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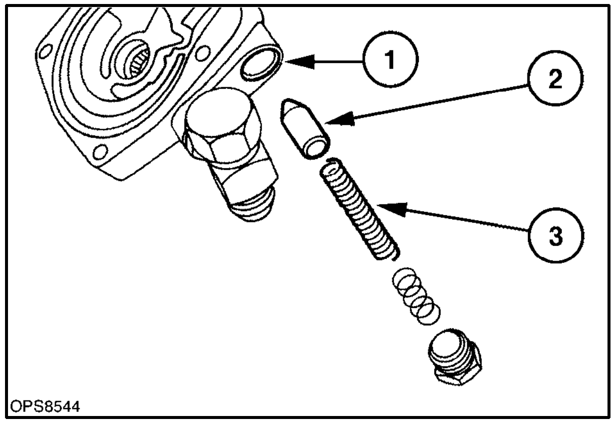
PARTS INSPECTION

1. Clean all parts with a suitable solvent.
2. Inspect the relief valve seat inside the charge pump adaptor housing at 1. Check to make sure that the seat is smooth and free from burrs or other defects.
3. Inspect the relief valve poppet, 2, for damage and scratches in the seat contact area. Also check to make sure the relief valve spring, 3, is not broken.



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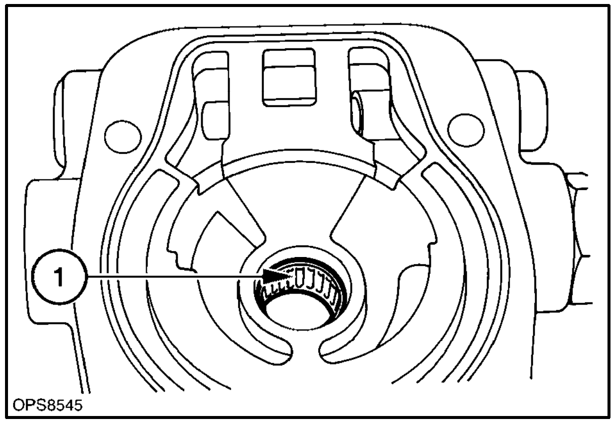
4. The shaft needle bearing assembly, 1, is a press fit in the charge pump adaptor housing and should not be loose. Inspect for looseness. Check for loose or missing needles in the bearing housing.

   Remove bearing assembly if any problems are found.



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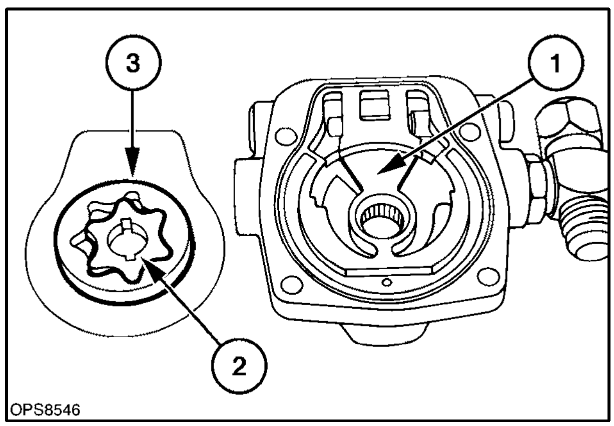
5. Check the gerotor pocket, 1, inside the charge pump adaptor assembly, the inner gerotor ring, 2, and the outer gerotor ring, 3, for scoring and excessive wear.
6. All seals should be replaced upon reassembly.
7. Inspect the drive key for wear or partial shearing.



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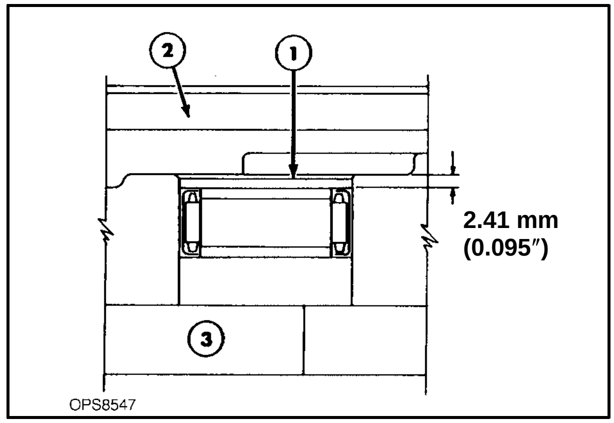
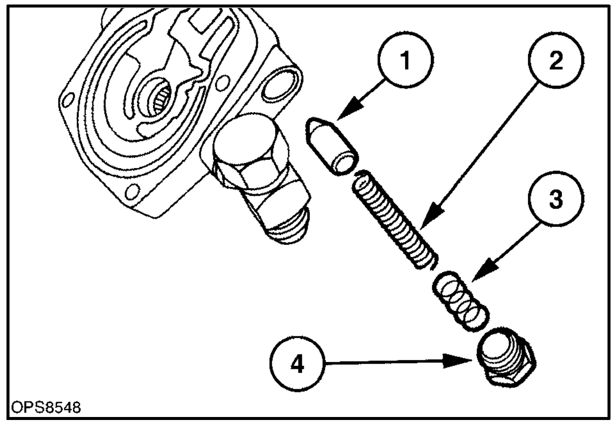
REASSEMBLY

1. Use a suitable solvent to thoroughly clean all parts. Lay the parts on a clean cardboard and air dry.
2. Use a clean 10W-30 oil to lubricate all moving parts as they are reassembled.
3. If necessary, press a new bearing into the adaptor assembly. The bearing should be installed with the numbered end, 1, facing outward and closest to the mounting flange, 2. The gerotor pocket is located at 3. Install to a dimension of 2.41 mm (0.095″).



54

4. Install the relief valve poppet, 1, spring, 2, shims, 3, and plug, 4, with new O ring, into the adaptor assembly. Torque the plug to 37 - 41 N·m (27 - 30 ft. lbs.).



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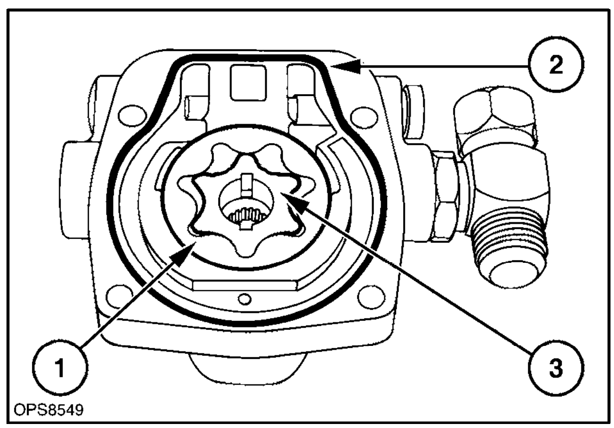
5. Lubricate both a new molded O ring, 2, and the outer gerotor ring, 1; install in adaptor assembly.

   Upon reassembly to the main pump housing, the inner gerotor ring, 3, and drive key will be installed on the pump shaft prior to installing the charge pump adaptor assembly.

6. The four retaining cap screws are torqued to 37 - 42 N·m (27 - 31 ft. lbs.).



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Op. 29 100 46

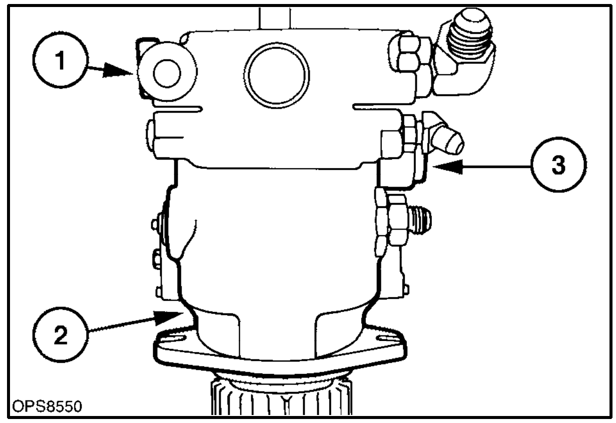
HYDROSTATIC PUMP

DISASSEMBLY

1. Thoroughly clean the complete pump assembly prior to teardown; plug ports so dirt and solvent do not enter the pump.

   After removal of the charge pump adaptor assembly, described earlier, the main pump consists of these main components: charge pump backplate, 1, pump body, 2, and servo control assembly, 3.

   The backplates carry high-pressure oil from the pumps to the motors via high-pressure hoses. The low-pressure return oil from the motors flows back to the pumps through the backplates to complete the closed loop circuit.



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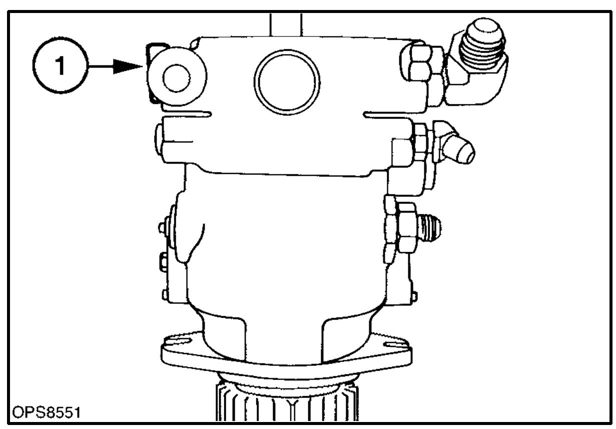
***NOTE:** Dealer warranty adjustment requests for any hydrostatic component repair must include the machine model, serial numbers, transmission model number, and date codes. These codes are stamped into the servo control end cap.*

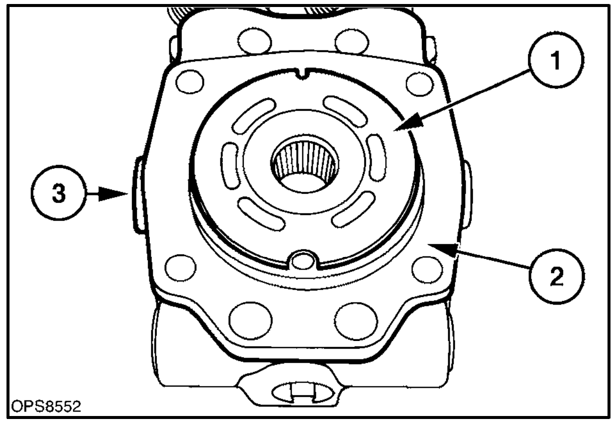
2. To ensure proper reassembly, mark the relationship between the backplate, pump body and servo control assembly with a marker or scribe.
3. As the pump is being overhauled, lay the parts on a clean wooden bench top of heavy carboard to prevent damage to the machined surfaces.
4. With the pump still clamped in a protected jaw vise and the charge pump adaptor assembly removed, lift the backplate, 1, straight up and off the shaft and housing.



58

5. Remove valve plate, 1, and housing gasket, 2, from backplate, 3.

   Valve plate may stick to the rotating group in housing when backplate is removed.



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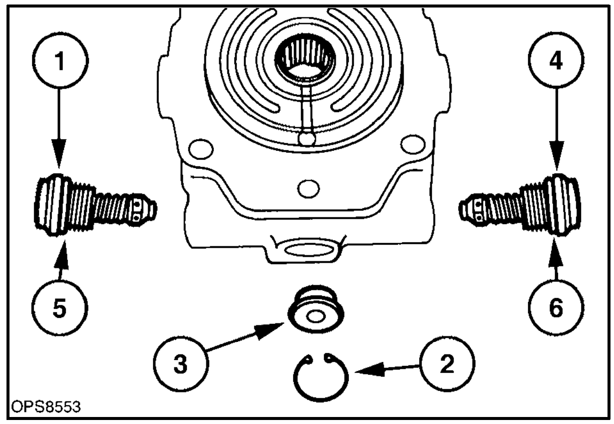
6. Mark the position of the two relief valves to aid in reassembly.
7. Remove the relief valve assemblies, 1 and 4. O rings, 5 and 6, on the relief valves, should be removed and replaced on reassembly.
8. Remove retaining ring, 2, and plug, 3, from the backplate assembly.



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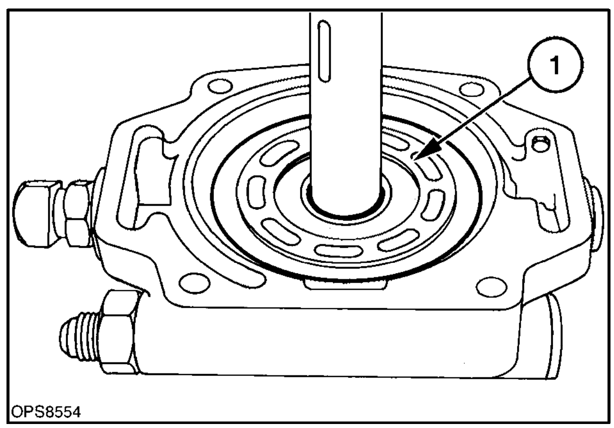
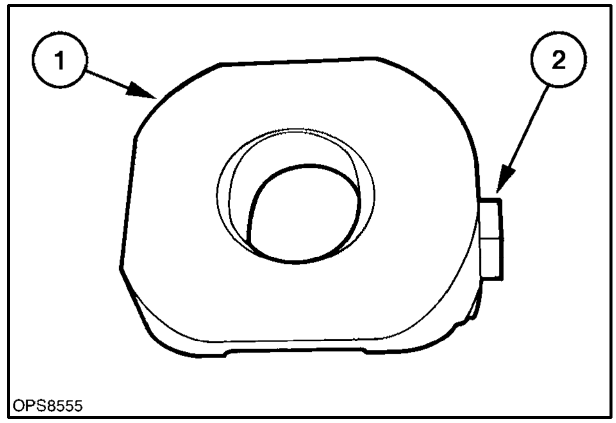
9. To remove the rotating group, 1, from the housing, set the edge of the housing on a 2 x 4 or 4 x 4 block and tilt the open end of the housing down. Turn the rotating piston block and pull it out as a complete unit without scratching or burring the parts.

NOTE: *Keep the rotating group as an assembly at this time.*



61

10. Remove the camplate, 1, from the pump housing by tilting the open end of the housing down and guiding the camplate to the opening. With the long end of the shaft pointing down and supporting the pump housing, rotate the camplate until the servo piston follower, 2, aligns with the notch in the housing, and remove.



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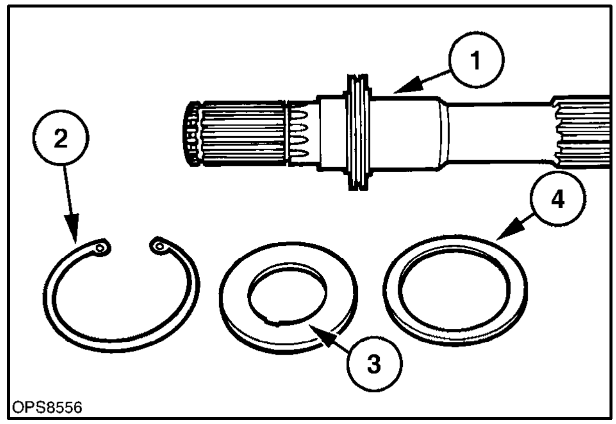
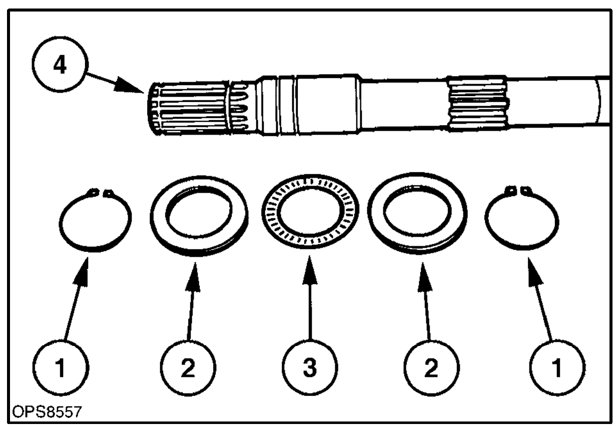
11. The pump drive shaft, 1, can be removed by doing the following:
    a. Remove the large retaining ring, 2.
    b. Use an arbor press or tap the internally splined end of the shaft with a soft faced mallet to remove the drive shaft.
    c. Remove seal, 3, and washer, 4. The seal may be damaged during removal.



63

12. Remove both retaining rings, 1, thrust washers, 2, and thrust bearing, 3, from drive shaft, 4.

    Set all drive shaft components aside for inspection.



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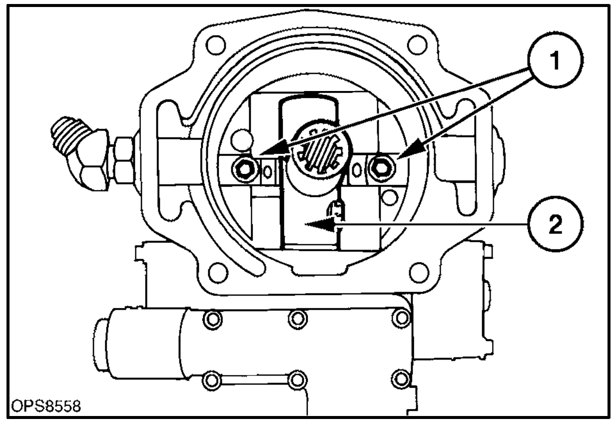
13. Remove the cradle assembly attaching bolts, 1, and move the cradle back and forth to release it from the dowel bushings. Remove the cradle assembly, 2.



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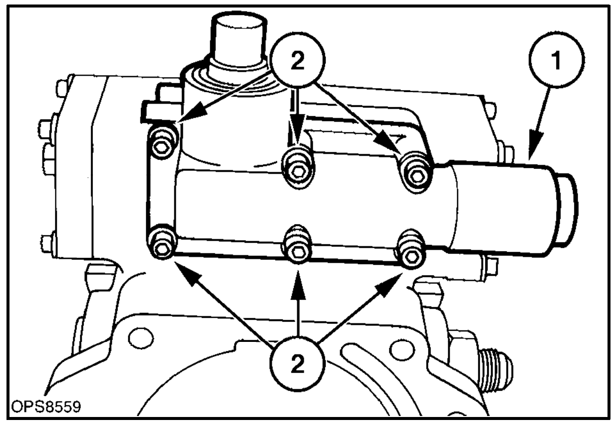
14. Remove the six socket head cap screws, 2, and the manual servo control assembly, 1.



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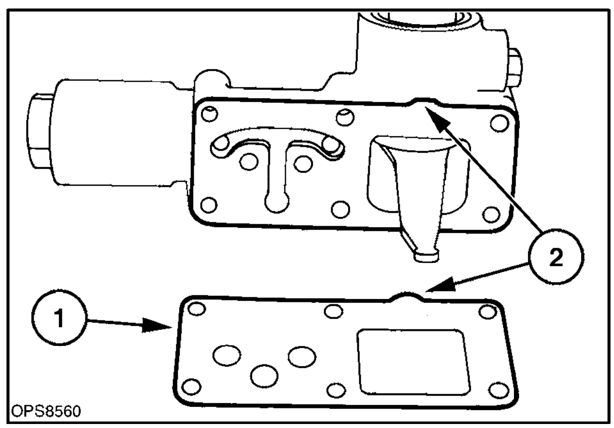
15. Remove the servo control assembly gasket, 1. Note the position of the alignment tab, 2, on both the gasket and the servo control housing, for proper installation of the gasket during reassembly.



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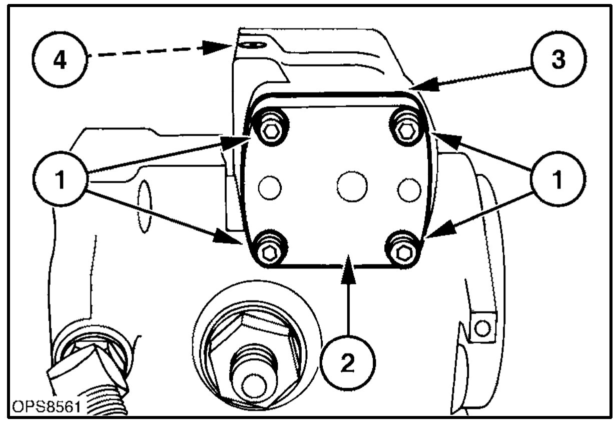
16. Remove the four socket head cap screws and flat washers, 1, from the servo piston cover plate. Remove the cover plate, 2, and gasket, 3. Remove the four remaining socket head cap screws and washers from the cover plate at the opposite end of the servo piston at 4.



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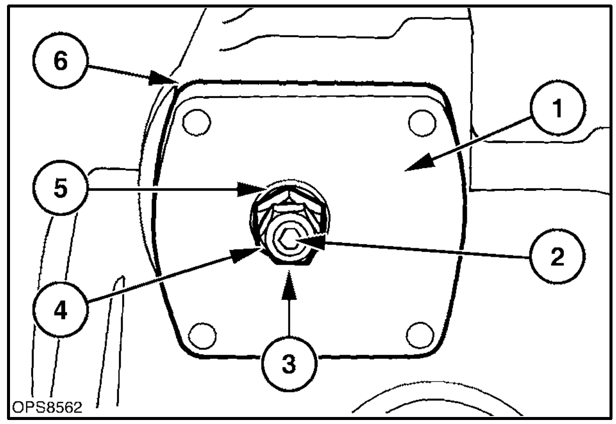
17. To remove the cover plate, 1, from the servo piston bolt, 2, remove jam nut, 3, washer, 4, and seal washer, 5. Hold the servo piston bolt, 2, with an allen wrench and unscrew the cover plate off the bolt. Remove gasket, 6.



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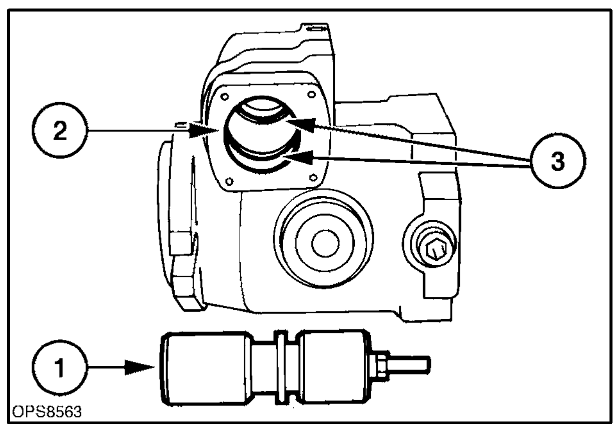
18. Use a wooden hammer handle to push the servo piston, 1, from the pump housing, 2.

    Remove the two servo piston seal assemblies, 3, from the pump housing, 2.

    Disassembly of the servo piston assembly is not required.

CAUTION

Do not disassemble the servo piston, personal injury may occur. An internal spring inside the piston assembly is under pressure.



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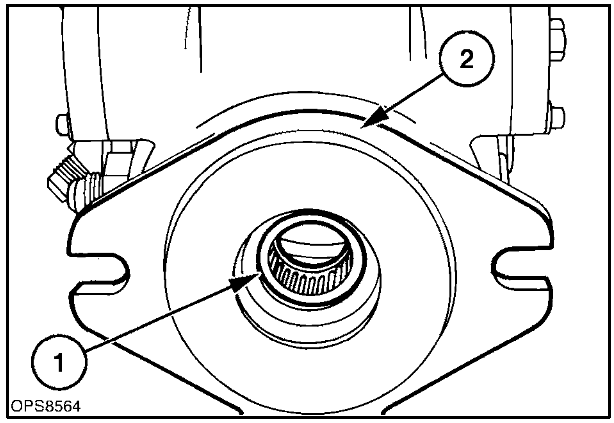
PARTS INSPECTION

Clean all parts in a suitable solvent and air dry.

Pump Housing

1. The shaft needle bearing assembly, 1, in the pump housing, is a press fit, and should not be loose. Inspect for looseness. Check that all needles are in the cage and move freely. Inspect the needles for wear or damage.

   The bearing is shown with the numbered end, 1, facing out toward the flange end of the housing, 2.



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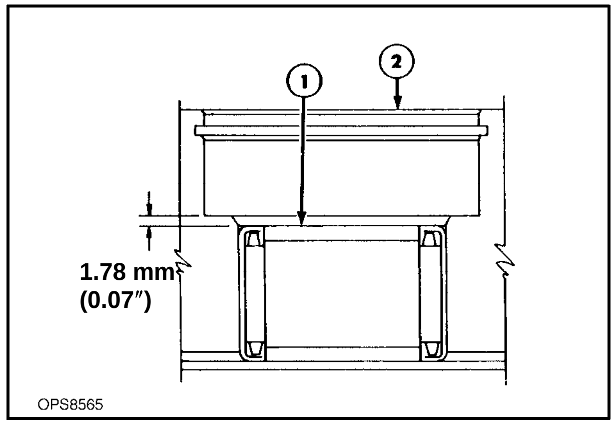
2. Verify that the bearing is positioned correctly and to the dimension shown.
3. Remove the shaft needle bearing assembly if any problems are found. Install a new bearing in the housing with the numbered end, 1, facing out toward the flange end of the housing, 2. Install to the dimension shown.



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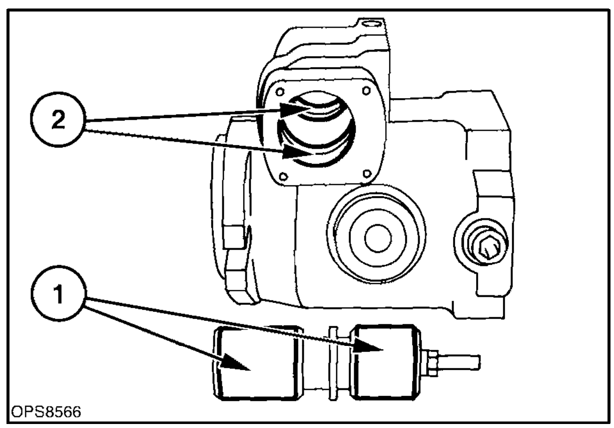
Servo Control and Piston

1. Inspect the servo piston, 1, and housing, 2, for scratches. All seals and gaskets should be replaced at reassembly.



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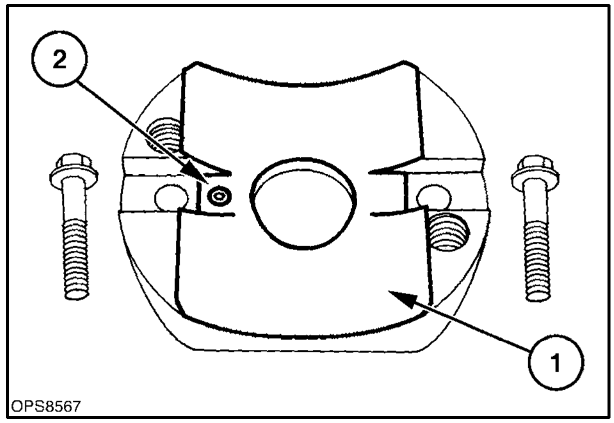
Cradle Assembly

1. Inspect the cradle bushing, 1, for contamination embedded in the bushing surface from contact with the camplate.
2. If contamination is found, remove button head cap screw, 2, and remove cradle bushing. Replace bushing.
3. If bushing is replaced, torque the button head cap screw to 1.6 - 1.8 N·m (14 - 16 in. lbs).



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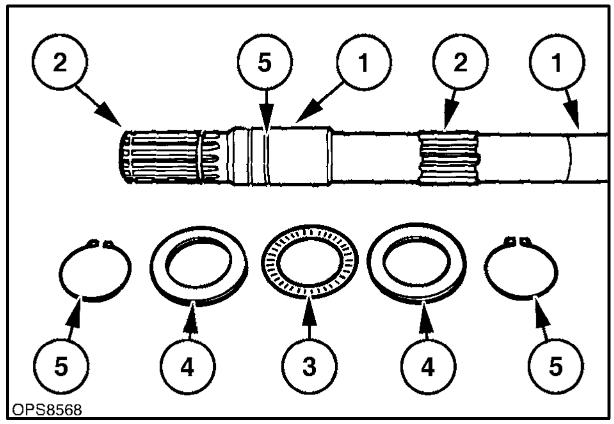
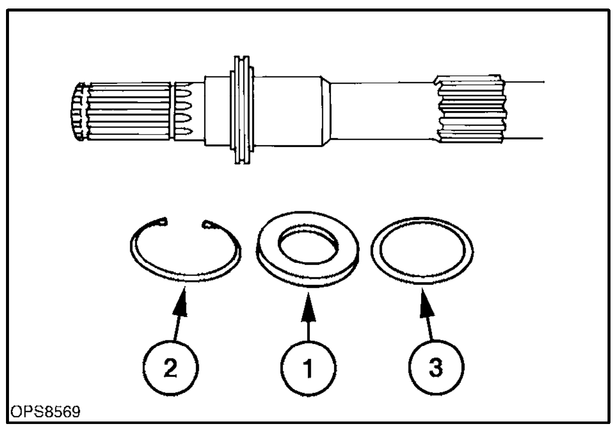
Pump Shaft

1. Inspect the areas that contact the shaft needle bearings, 1, for wear or a rough bearing surface.
2. Check for a bent or worn shaft.
3. Check the spline areas, 2, for wear or twist.
4. Check the thrust bearing, 3, races, 4, and retaining rings and grooves, 5. If bearing or races show wear or roughness, they must be replaced.



75

5. Input seal, 1, will be replaced upon reassembly.
6. Inspect retaining ring, 2, and washer, 3.



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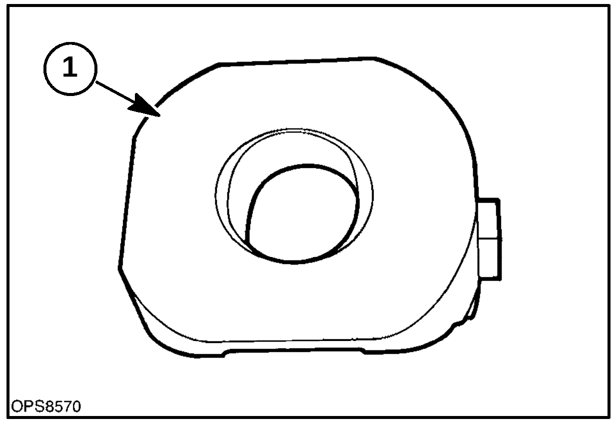
Camplate

1. Shoes of the pump pistons rotate at high speeds against the camplate surface, 1. The surface must be smooth with no metal flaked away and no scoring. Circular scratches centered on the machined surface are due to contamination. If scratches can be felt with your thumbnail, replace the camplate.
2. Check the camplate surface for smearing. The surface must be smooth and bright with no discoloration or brass color on the flat surface.



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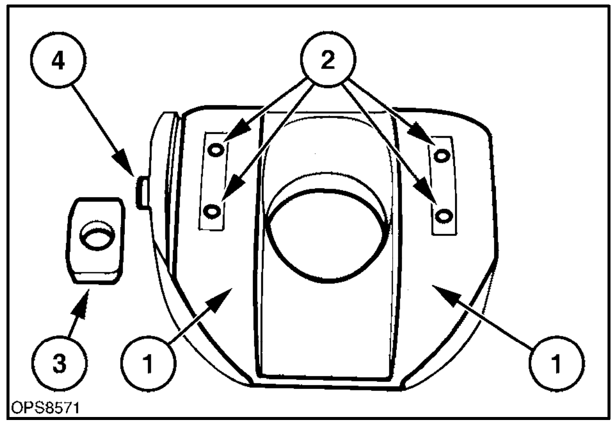
3. Check the camplate bushing surface, 1, for wear and transfer of coating from the cradle bushing. Replace if necessary.
4. Inspect the lubrication ports, 2, for blockage. Clean thoroughly.
5. Inspect the servo piston follower, 3, and aligning pin, 4, for wear.



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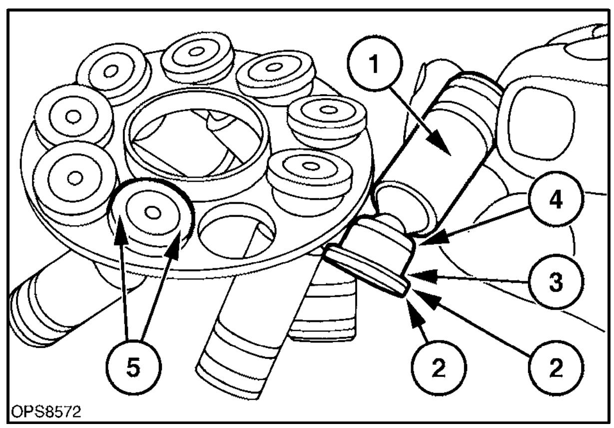
Shoe and Piston Assemblies

Replace the rotating group if:

6. 1. The piston skirt area, 1, shows signs of scratches or wear.
7. 2. The edges of the shoes, 2, are worn (shoe roll) from contact with the camplate.
8. 3. There is wear on the underside of the slipper, between the slipper and shoe plate at 3.
9. 4. The shoes have a loose, sloppy fit on the ball end of the piston at 4.
10. 5. The flat surfaces of the shoes, 5, show metal flaking or are deeply scratched. Light or shallow scratches in the shoes will not cause any harm. Do not lap the shoes.



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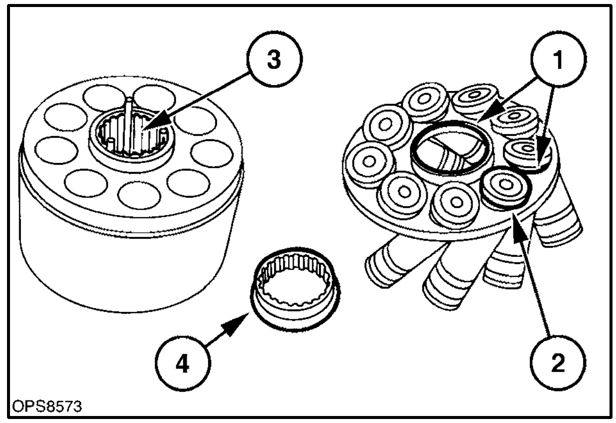
Shoe Plate

11. 1. Check for cracks and wear at the holes for the spherical washer and shoes at 1. The shoe plate is only available as part of the rotating group.
12. 2. Check for wear in the area of the slippers, 2. This area should be flat, smooth, and have no grooves.
13. 3. Check the internal splines of the piston block, 3, for wear.

Spherical Washer (pivot), 4.

14. 1. Check for wear on the top surface where the shoe plate fits. The spherical washer is only available as part of the rotating group.
15. 2. Check the sides, rolled area for cracks.



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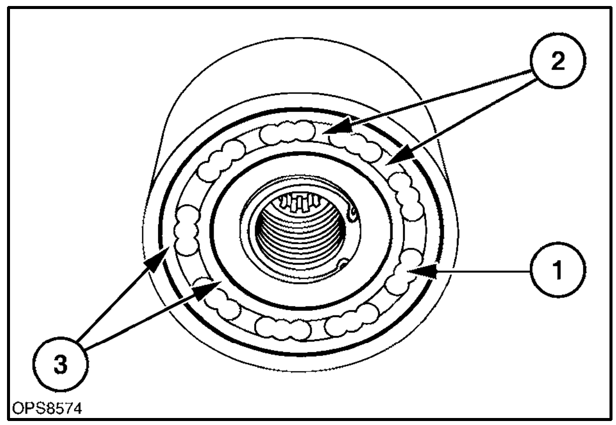
Rotating Piston Block

Replace the rotating group if:

16. 1. Cylinders, 1, are worn or scored so the pistons do not move freely.
17. 2. Surface, 2, is worn or grooved or shows metal buildup. Nicks must not extend from the cylinders to the edge of the raised area, 3.
18. 3. The pistons have side play in the piston block.

19.



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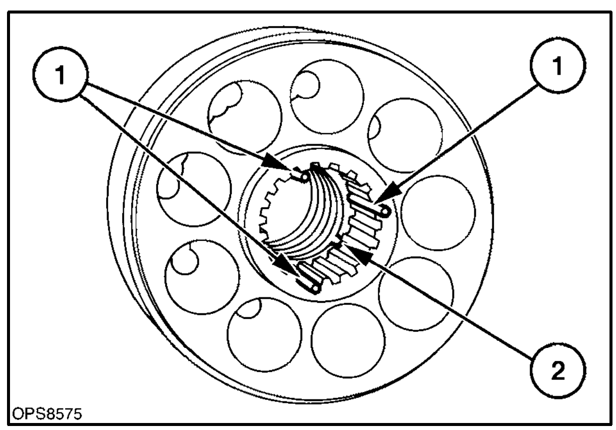
Loading Pins

The three block loading pins, 1, are spring loaded and are held in place by the pin keeper (split bushing), 2.

20. 1. The pins should be the same height.
21. 2. The pins should be seated in the special grooves.
22. 3. The head of the pins should be seated between the washer and the block.



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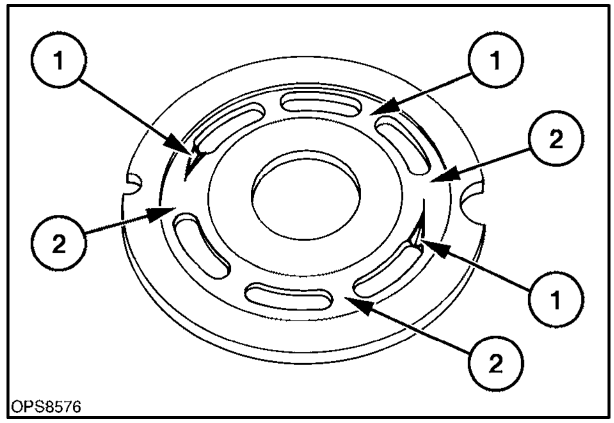
Replaceable Bearing Plate

23. 1. Check for flatness.
24. 2. Check for scratches on the brass side of the plate, extending outward across the area where the raised area of the piston block contacts the plate at 1.
25. 3. Check for scratches between the kidney ports at 2.



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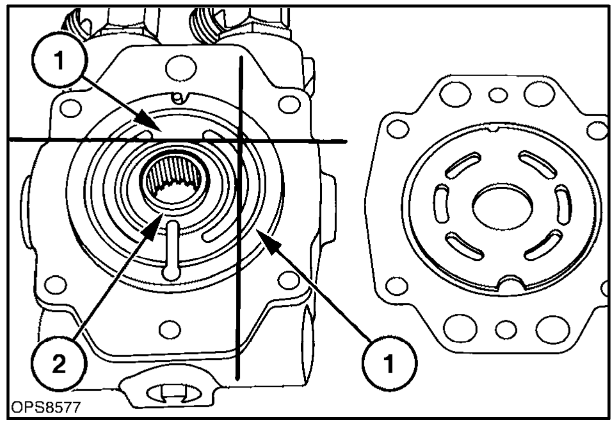
Back Plate

26. 1. Check the back plate for flatness, 1.
27. 2. The back plate needle bearing assembly, 2, is a press fit and should not be loose. Inspect for looseness and wear. Check that all needles are in the cage and move freely.



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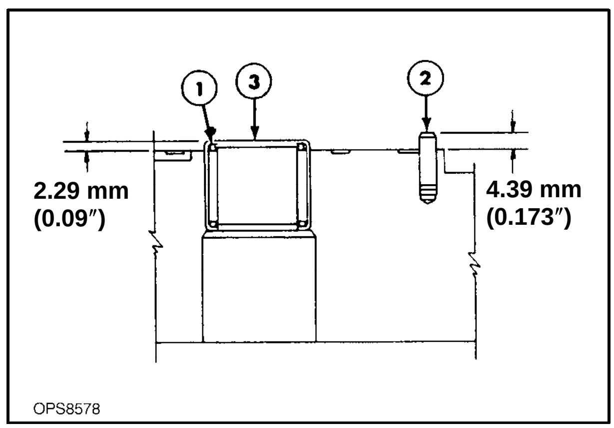
28. 3. Verify that the needle bearing, 1, is positioned correctly and to the dimension shown.
29. 4. Remove the needle bearing if any problems are found. Install a new bearing in the housing with the numbered end, 3, toward the valve plate. Install to dimension of 2.29 mm (0.09″) above the surface of the back plate as shown. The bearing is used as a pilot for the valve plate.
30. 5. Check the back plate roll pin, 2. If the pin is tight and set to the dimension shown, replacement is not required.



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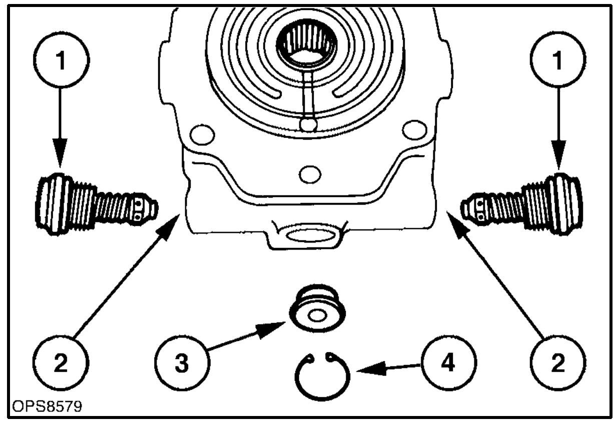
31. 6. Two directional relief valves, 1, are located in each transmission. These relief valves limit the maximum system pressure to 345 bar (5000 PSI). Relief valve pressures are factory set and should not be changed.

32. 7. Check the seat area, 2, in the back plate for scratches that could prevent the relief valves from sealing properly.

33. 8. Inspect the end plug, 3, and retaining ring, 4.



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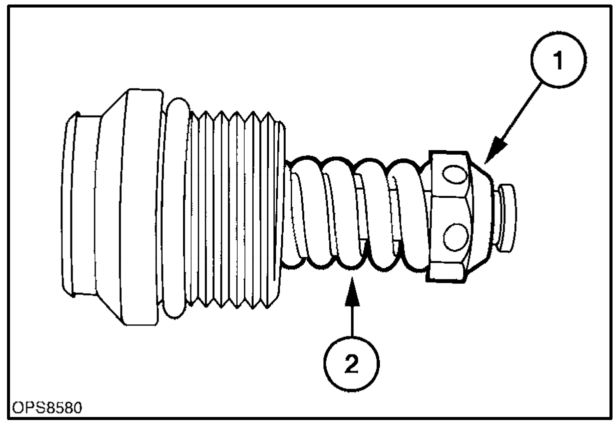
34. 9. Check the relief valves for scratches in the seat areas, 1. Also check for broken springs, 2. If problems are found, the complete relief valve must be replaced.



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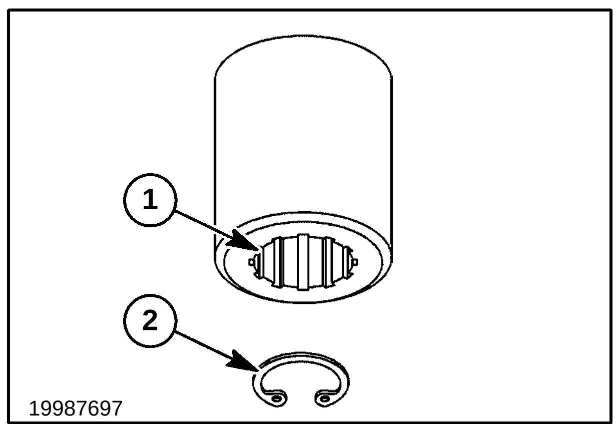
LS190 skid steers only - Inspect the splines, 1, of the coupler for wear or damage. Remove the inside snap ring, 2, and inspect for damage. Replace if necessary. (The coupler is part #86566800 and the snap ring is part #49894.)



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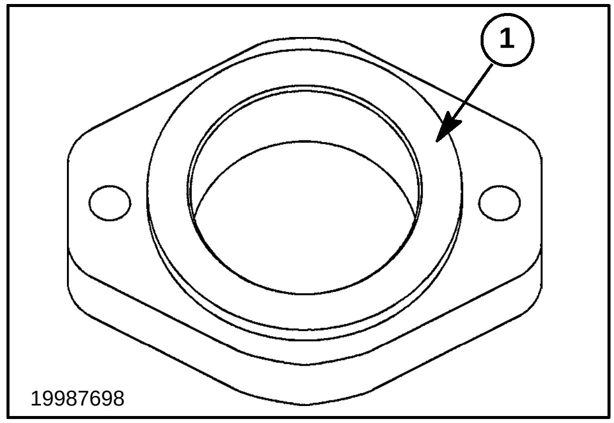
LS190 skid steers only - Inspect the mating areas, 1, of the spacer for chips or scores that could cause a leak. Replace if necessary.



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REASSEMBLY

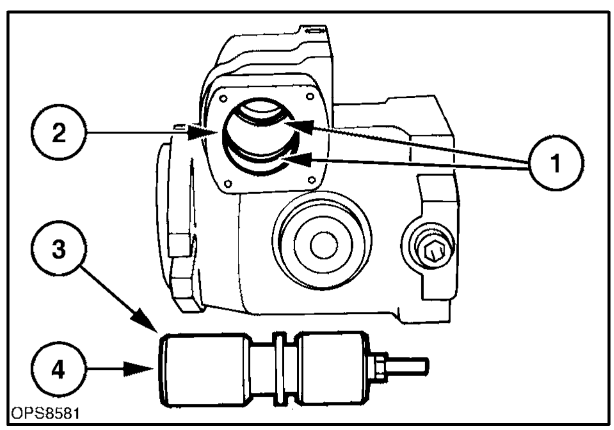
1. Use a suitable solvent to thoroughly clean all parts. Lay the parts on a clean cardboard and air dry.

IMPORTANT: *Due to tight tolerances and finish of internal pump surfaces, it is very important to maintain absolute cleanliness during reassembly.*

2. Use clean SAE 10W-30 oil to lubricate all moving parts as they are being reassembled. Fill the transmission cases with oil through the case drain hole after completing assembly of the component.

IMPORTANT: *Lubrication of the pump components during assembly is required to ensure lubrication oil for start-up.*

3. Install the new O rings, seals, gaskets, and retaining rings provided with the repair kit.
4. If required and not done during inspection, install new needle bearings in the pump housing and backplate. Installation details are shown in the inspection area.
5. Install two new seal sub-assemblies, 1, into the servo piston housing at 2.
6. Install the servo piston assembly, 3, into the right hand side of the housing by inserting end, 4, first. Roughly center the piston in the housing.



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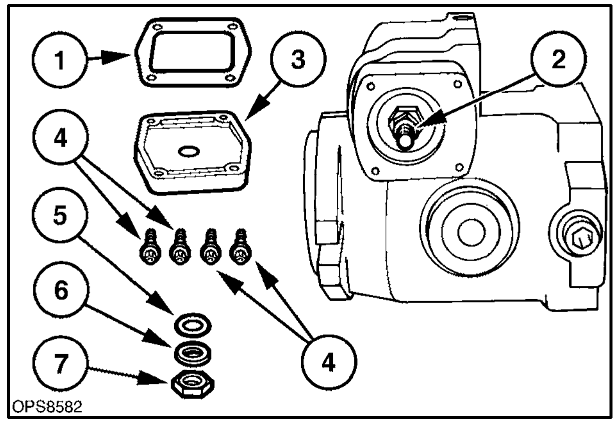
7. Install a new cover plate gasket, 1, over the end of the servo piston bolt, 2, and screw on the cover plate, 3. Align the gasket with the cover plate and retain with four flat washers and socket head cap screws, 4. Tighten all bolts to 4.5 - 5.4 N·m (40 - 48 in lbs.). Install seal washer, 5, washer, 6, and jam nut, 7. Do not tighten at this time.



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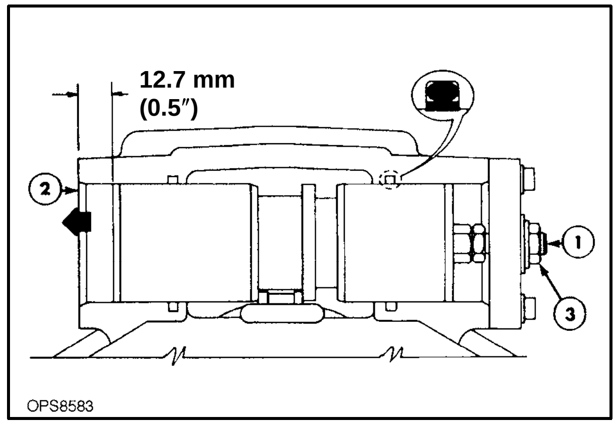
8. To obtain neutral, centering of the servo piston is required.
   a. Insert an allen wrench into the servo piston bolt, 1, on the right hand side.
   b. Measure in from the left hand side of the housing, 2, and turn the servo piston bolt, 1, either in or out to obtain a measurement from the face of the housing to the servo piston of 12.7 mm (0.5″).
   c. While holding the bolt steady, tighten jam nut, 3, to 17 - 18 N·m (150 - 160 in lbs.).



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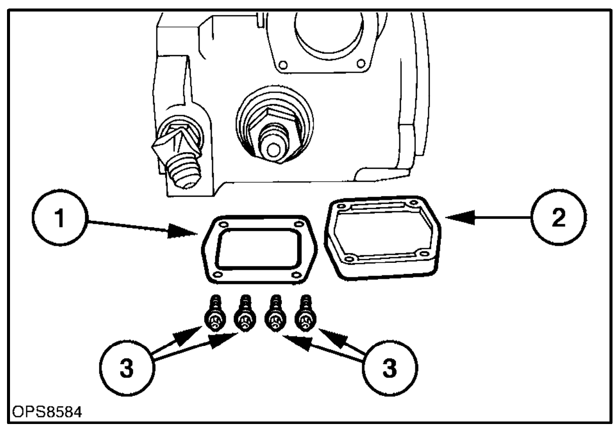
9. Install a new LH servo piston cover plate gasket, 1, and cover plate, 2. Align the gasket with the cover plate and retain with four flat washers and socket head cap screws, 3. Torque to 4.5 - 5.4 N·m (40 - 48 in lbs.).



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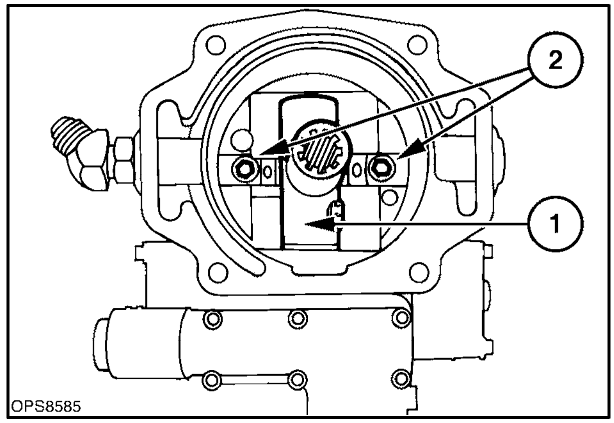
10. Press the cradle assembly, 1, into the pump housing making sure that the cradle and dowel bushings are firmly seated. Apply Loctite® 262 to the threads of the cradle assembly retaining bolts, 2, and torque to 34 - 38 N·m (25 - 28 ft. lbs.).



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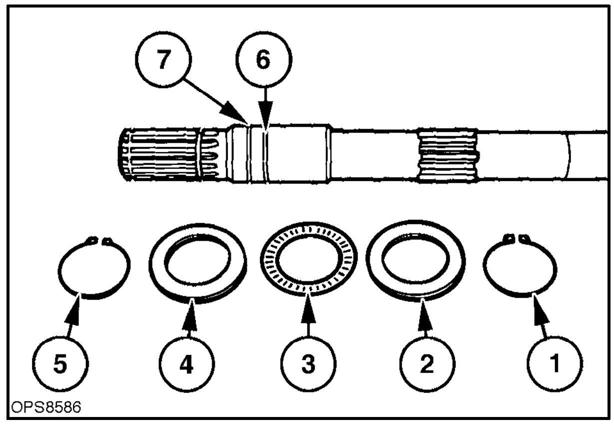
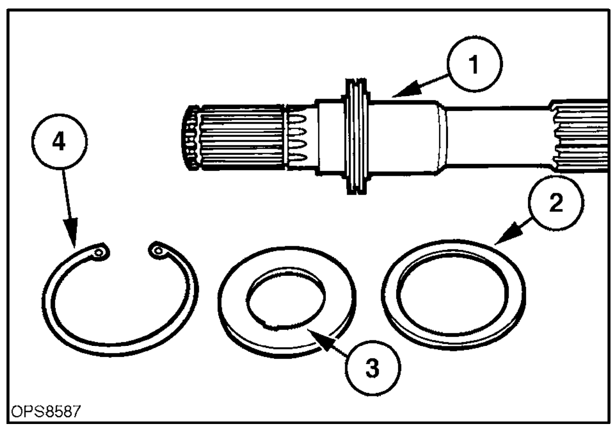
11. Reassemble the pump drive shaft bearing assembly by installing retaining ring, 1, in groove, 6. Next install thrust washer, 2; thrust bearing, 3; and second thrust washer, 4. Secure assembly with second retaining ring, 5, in groove, 7.



95

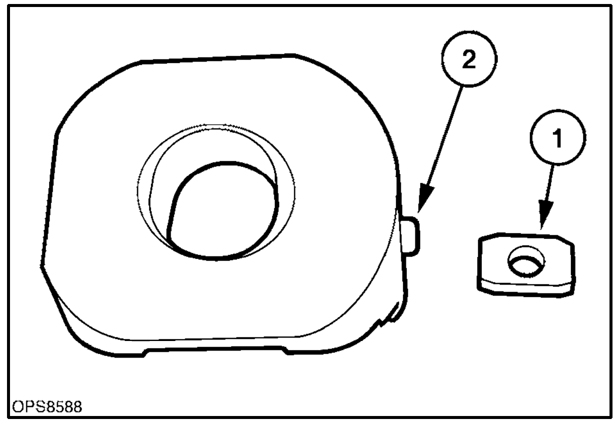
12. Install the shaft and bearing assembly, 1, into the pump housing. Install washer, 2, and new shaft seal, 3. Seat seal into position with a seal driver and secure with retaining ring, 4.



96

13. Camplate

    a. Reinstall the servo piston follower, 1, onto the camplate aligning pin, 2.

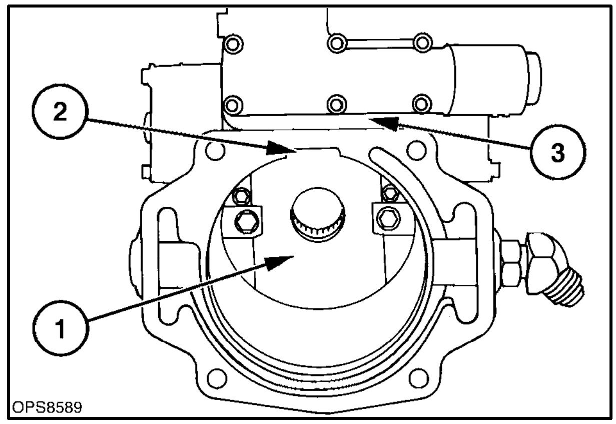


97

    b. Coat the cradle bushing, 1, previously installed with the cradle assembly in the pump housing, with SAE 10W-30 oil.

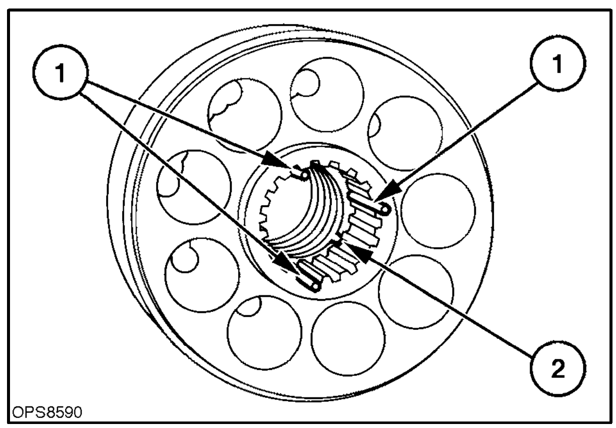
    c. Carefully align the servo piston follower with the notch in the pump housing opening, 2, and slide the camplate into the pump housing.

    d. Make certain that the servo piston follower, 1, Figure 97, on the camplate is aligned with the large groove in the servo piston assembly, 3, to ensure correct positioning of the camplate.



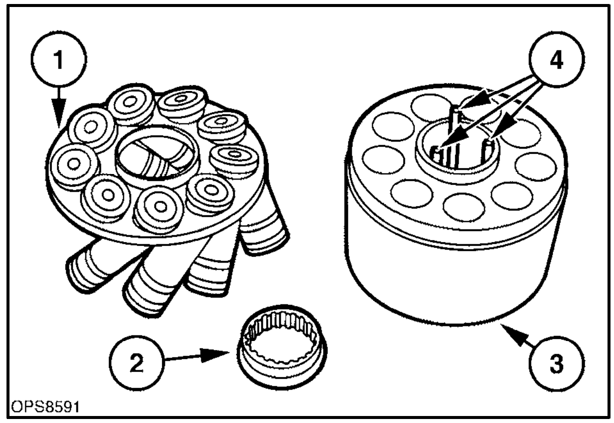
98

14. Check the three piston block loading pins, 1. Make sure they are seated properly in the over-size grooves in the splines and held in place by the retaining ring, 2.



99

15. Reinstall the pistons and piston plate, 1, and pivot, 2, into the piston block, 3, at the locations they were removed. Check to be sure that the pivot is resting on the loading pins, 4.



100

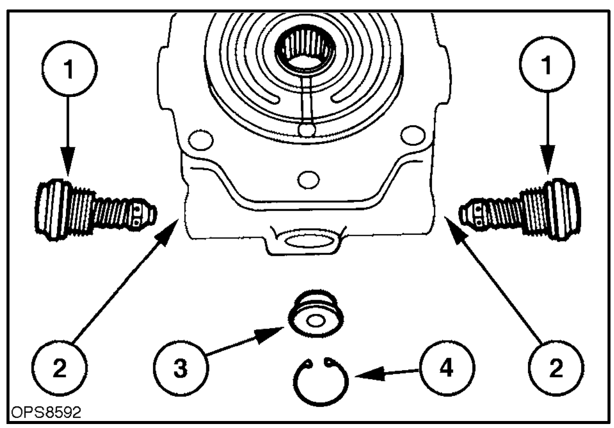
16. With the pump housing resting on its side, insert the piston block assembly into the housing. Rotate the piston block slowly to align the splines and slide together.

NOTE: *Check to be sure that the camplate is still positioned correctly in the housing and that the piston shoes contact the camplate before proceeding.*

NOTE: *If the rotating group assembly will not easily slide over the splined shaft, DO NOT FORCE. One or more of the three loading pins may be out of their groove or the pin head is not seated properly between the washer and block. Forcing the rotating group may cause pin failure and early transmission failure.*

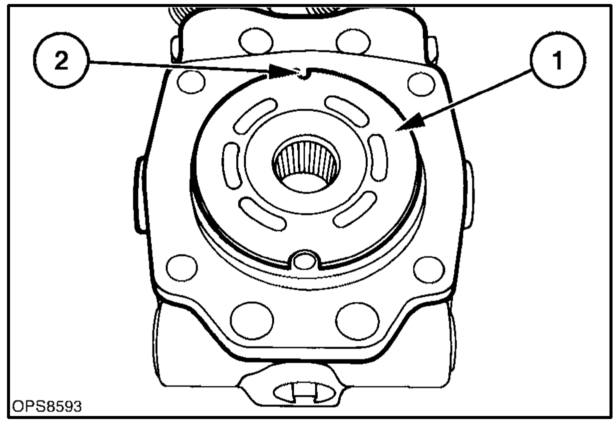
IMPORTANT: *Make sure all mating surfaces are well lubricated with SAE 10W-30 motor oil to insure proper lubrication for start-up.*

17. Install new O rings on the relief valve assemblies, 1, and install the valves at their original positions in the backplate at 2.
18. Install a new O ring on plug, 3; install plug, and secure with retaining ring, 4.



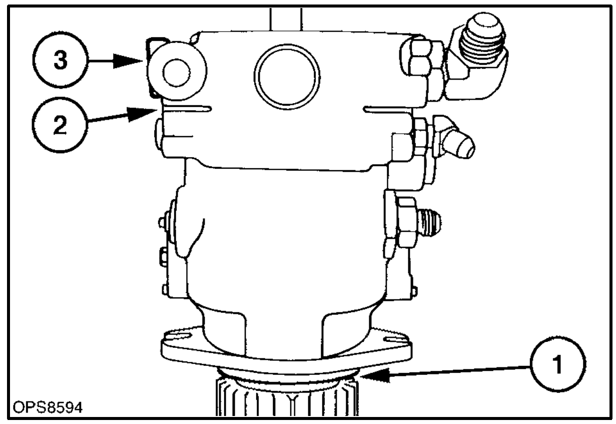
101

19. Apply a small amount of petroleum jelly to the steel side of the valve plate, 1, to hold it in place during assembly. Align the small notch on the outer edge of the valve plate with the backplate indexing pin, 2, and install with the steel side toward the backplate. The brass side of the valve plate should be next to the piston block when assembled.



102

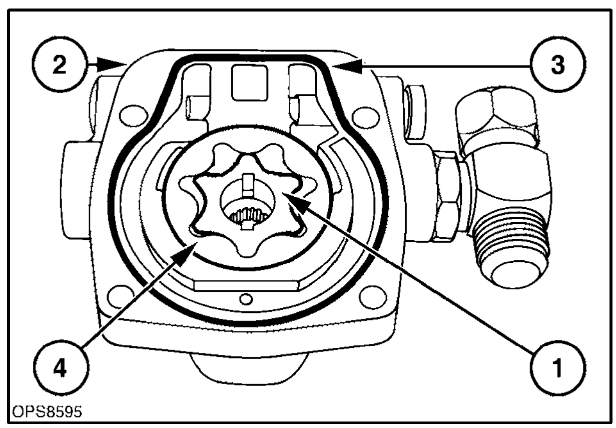
20. Clamp the pump assembly in a protected jaw vise at the pilot flange, 1, with the open end up. Install a new gasket, 2, between the pump housing and backplate, and slide the backplate, 3, down over the shaft. Make sure the ports are positioned correctly and the gasket and valve plate are aligned.



103

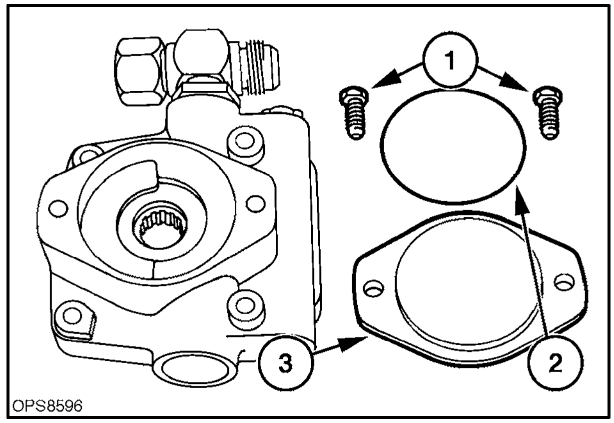
NOTE: *With no gerotor pump, go to step 23.*

21. Install the gerotor pump drive key and inner gerotor ring, 1, onto the pump shaft. Lubricate the inner gerotor ring.
22. Install the charge pump adaptor assembly, 2, onto the pump housing. Make sure the molded O ring, 3, stays in place and that the inner and outer gerotor rings, 1 and 4, are properly aligned.



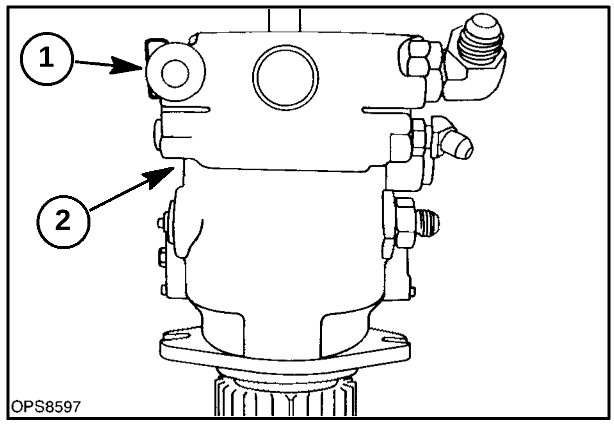
104

23. Install cover plate, 3, new O ring, 2, and attaching bolts, 1. Torque bolts to 37 - 42 N·m (27 - 31 ft lbs).
24. Retain the backplate and charge pump adaptor (when used) with four cap screws. Torque to 37 - 42 N·m (27 - 31 ft. lbs.).



105

NOTE: *When the backplate assembly, 1, is in place, and prior to inserting bolts, a small gap (approx. 1/8″) will be noticed between the pump housing gasket and backplate at 2. This is normal. Tightening the bolts brings the housing against the rotating group spring, resulting in an internal spring load to the valve plate and slippers. After torquing the retaining bolts, the shaft should turn easily with a pair of 8″ pliers. The shaft should have some rolling resistance but should not be tight (locked down) or rotate easily. If it is locked down or rotates freely, the pump is assembled incorrectly and requires teardown and reassembly.*



106

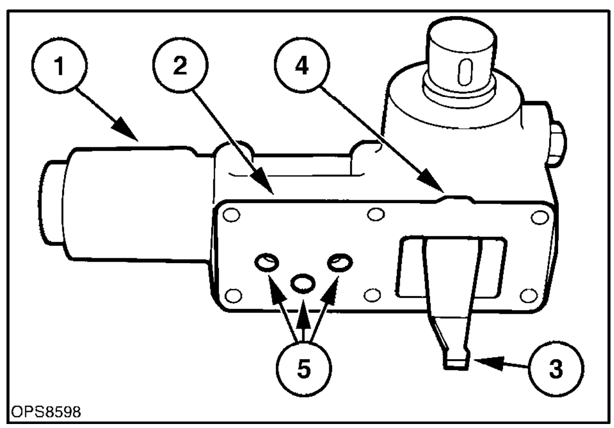
25. Install the servo control assembly, 1, and new servo control gasket, 2, onto the pump housing, making sure the feedback link, 3, aligns with the small groove in the servo piston.

NOTE: *Make sure the tabs, 4, on both the servo control housing, 1, and gasket, 2, are aligned. Also note the position of the gasket over the control ports, 5.*

26. Retain the servo control assembly with six (6) socket head cap screws. Torque to 5 - 8 N·m (4 - 6 ft lbs).
27. Install new O rings on all pump plugs. Install plugs into pump housing. Torque to the following specs:

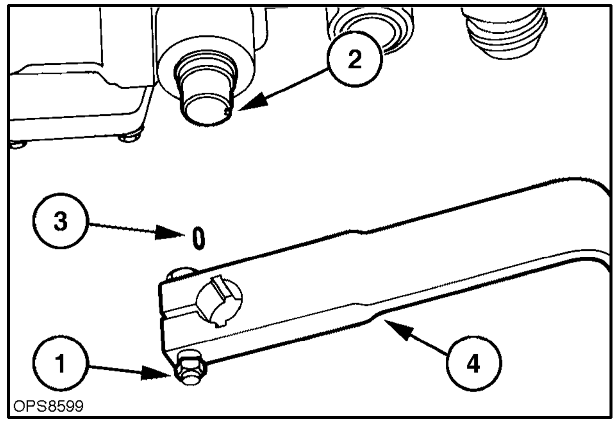
    3/4″ Plugs: 28 - 32 N·m (21 - 24 ft. lbs.)

    1-1/4″ Plugs: 54 - 61 N·m (40 - 45 ft. lbs.)



107

28. Install key, 3, into slot in trunnion shaft, 2, and install control arm, 4, onto shaft. Secure with 5/16″ x 2″ cap screw and locknut, 1. Torque to 20 N·m (15 ft. lbs.). Right side shown.



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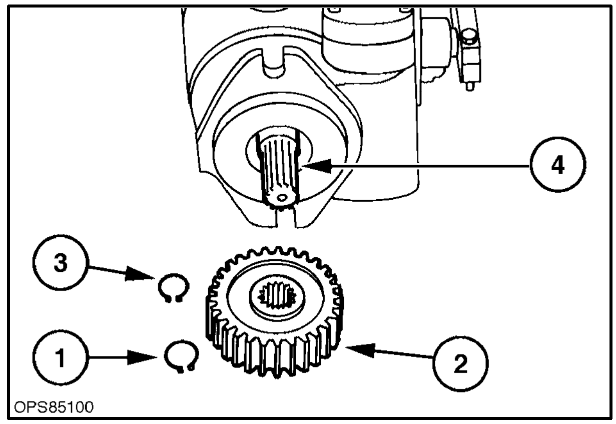
29. Install inner retaining ring, 3, drive gear, 2, and outer retaining ring, 1, onto pump drive shaft, 4.
30. Install the pumps onto the engine bell housing attaching plate, using 1/2″ x 1-1/4″ cap screws and washers. Torque to 87 N·m (64 ft. lbs.).



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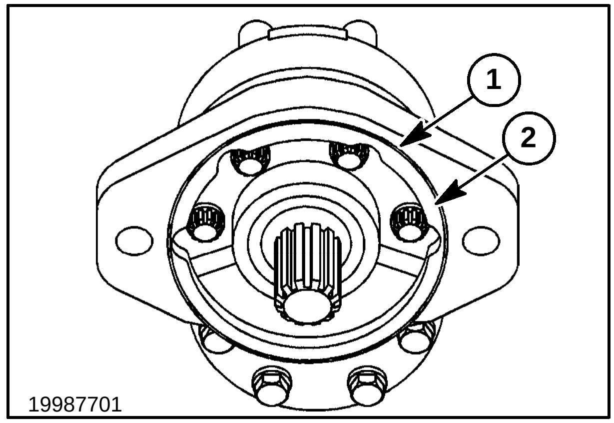
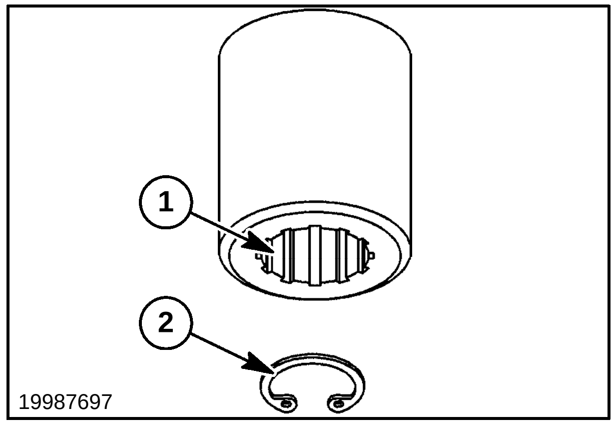
REINSTALLATION

1. Install a new O ring, 1, on the gear pump pilot, 2. For LS180 skid steers, install the gear pump onto the hydrostatic pump, mating the splines on the input shaft.



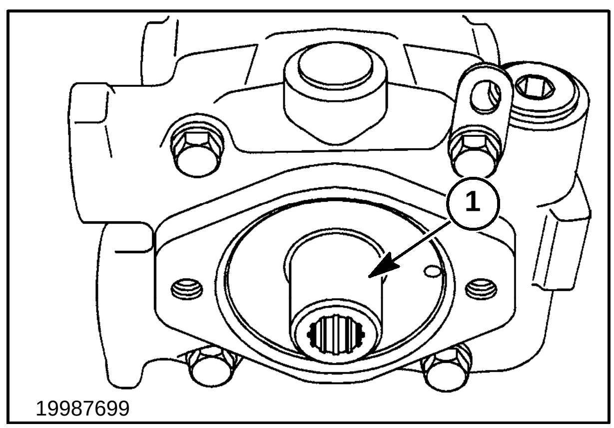
110

2. LS190 skid steers only - Install the snap ring, 1, into the groove in the center of the coupler, 2. Make sure the snap ring is secure inside the coupler.



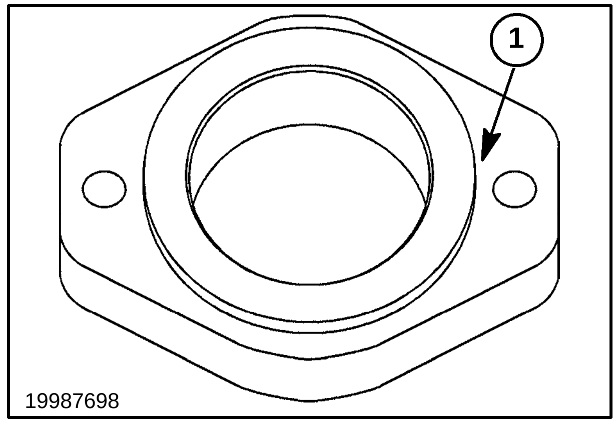
111

3. LS190 skid steers only - Install the coupler, 1, on the hydrostatic pump shaft.



112

4. LS190 skid steers only - Install an O ring, 1, on the spacer.



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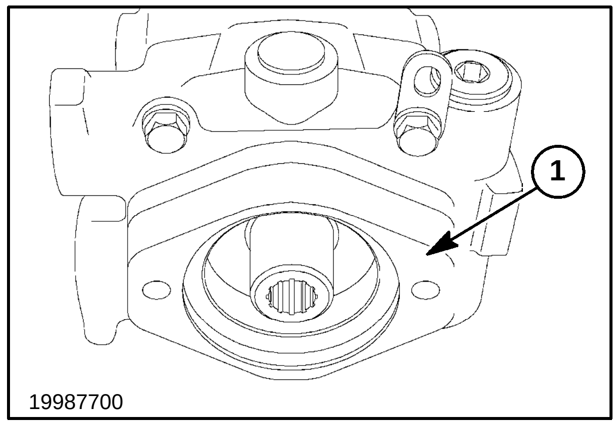
5. LS190 skid steers only - Place the spacer, 1, in place on the hydrostatic pump pilot.



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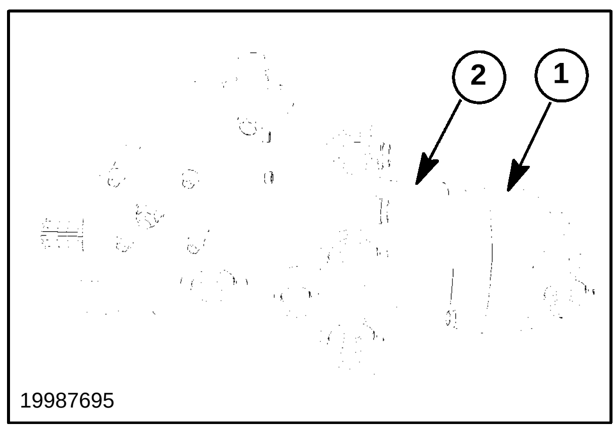
6. LS190 skid steers only - Place the gear pump, 1, with O ring on the spacer, 2. The assembly should be tight when assembled. The O rings on the pump pilots should form a solid seal to the spacer. Install the pump capscrews and tighten to 37 - 42 N·m (27 - 31 ft. lbs.).



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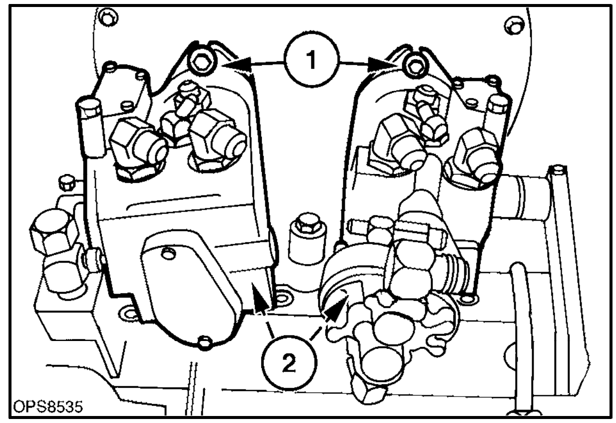
7. Install new O rings on the hydrostatic pump pilot. Support each pump assembly properly and lower them into place. Install the upper pump mounting bolts, 1, and the lower pump mounting bolts, 2. Tighten all the mounting bolts to 101 N·m (75 ft lbs).



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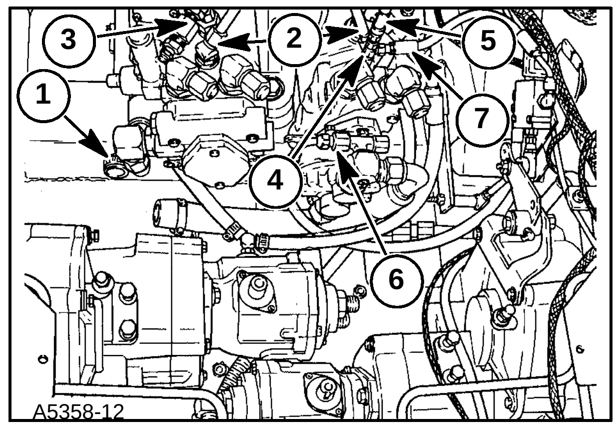
8. Connect the charge pump suction line, 1, the charge pressure cross tube, 2, the case drain tube, 3, the charge pressure sender line, 4, and the case drain tube, 5.

   If equipped, connect the two-speed solenoid valve supply line, 6, and the solenoid valve return line, 7.

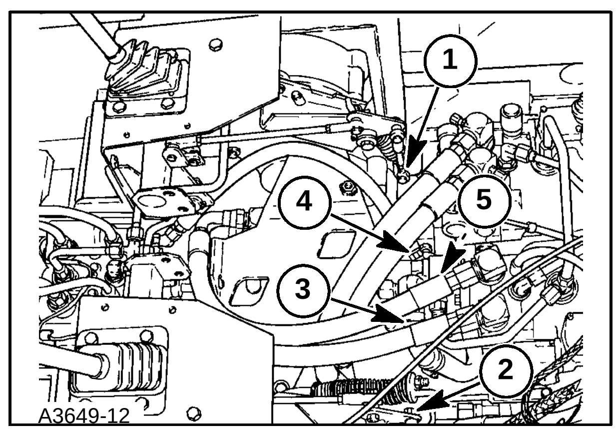


117

9. Connect the rear control rods, 1 and 2, at the pump control arms.

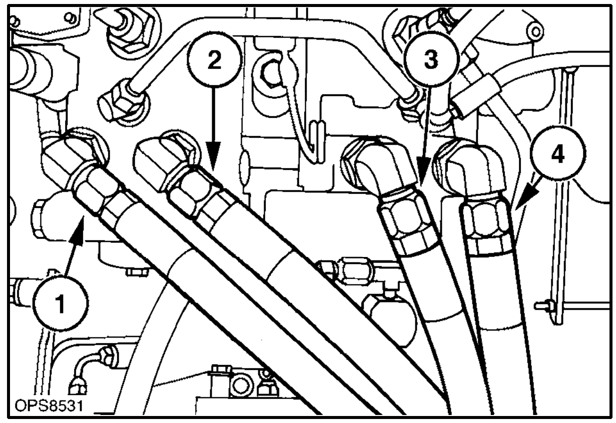
   Connect the hydraulic suction hose, 3, the hydraulic high pressure hose, 4.

   If equipped, connect the two-speed slave cylinder supply hose, 5.



118

10. Connect the hydraulic lines, 1 through 4, referring to the identification marks made during removal.

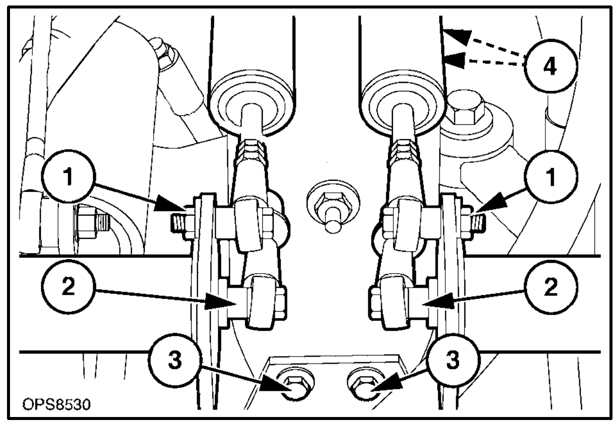


119

11. Lower the entire neutralizer assembly into place.

    Reconnect the dampener shocks, 1, and neutralizer assemblies, 2.

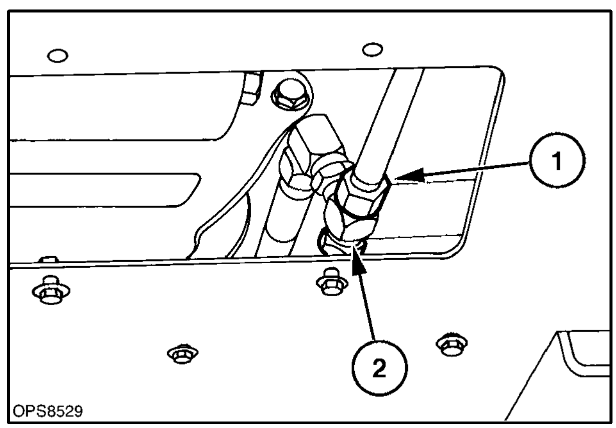
    Install the four neutralizer assembly attaching bolts, 3 and 4.



120

12. Make sure the return line, 1, is installed into the tee, 2, connecting to the hydraulic reservoir.

    Reinstall all shields and fittings removed during hydrostatic pump removal.



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Op. 29 100 60

MOTORS

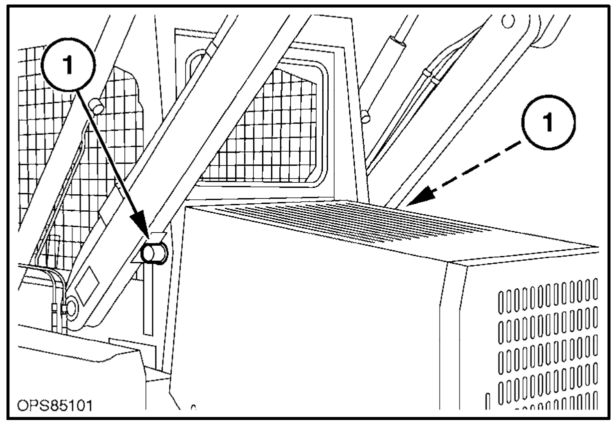
HYDROSTATIC MOTOR - SINGLE SPEED

REMOVAL

The hydrostatic motor assembly can be removed from the top and front or the cab and boom can be tilted forward for more access, refer to Section 00 for the cab tilting procedure.

To remove the hydrostatic motor assembly without tilting the cab forward:

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1.



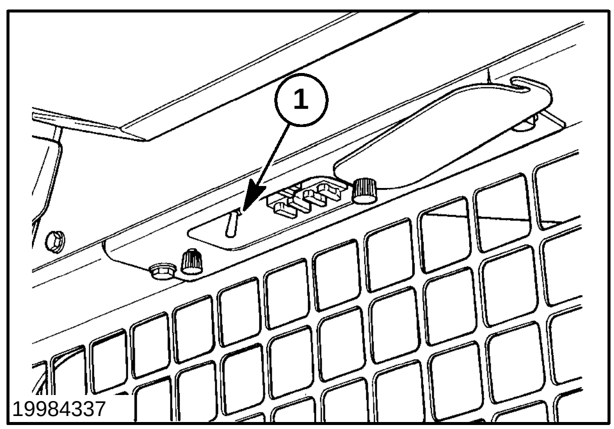
122

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. always remove the attachment from the skid steer.

2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the “SERVICE” position.
4. Engage the parking brake.



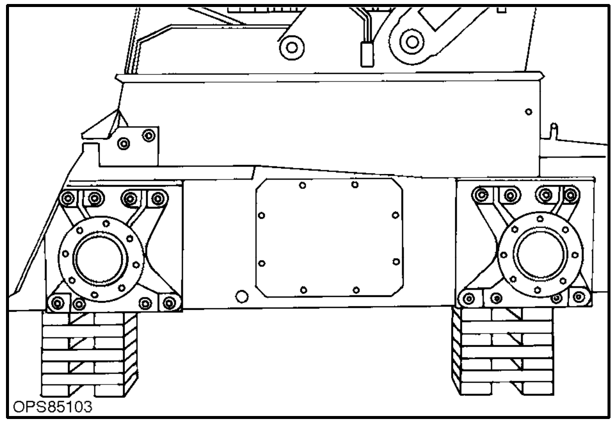
123

NOTE: *Engaging the parking brake during removal of the hydrostatic motors will hold the brake assembly components (discs, pads, coupler) in place for easier reassembly.*

5. Securely block the skid steer with all four wheels off the ground. Refer to Section 00 for more information on properly supporting the skid steer.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer causing serious injury or damage to the equipment.

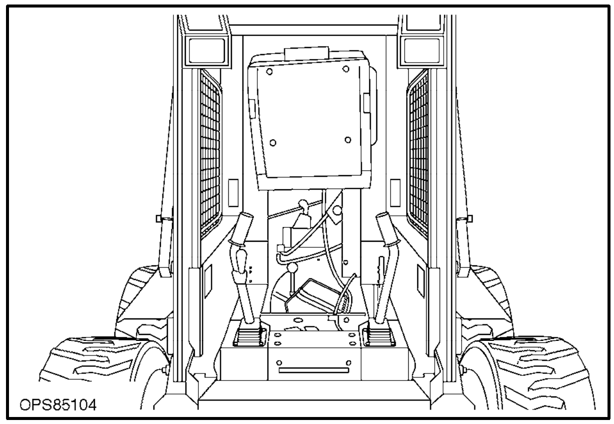


124

6. Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

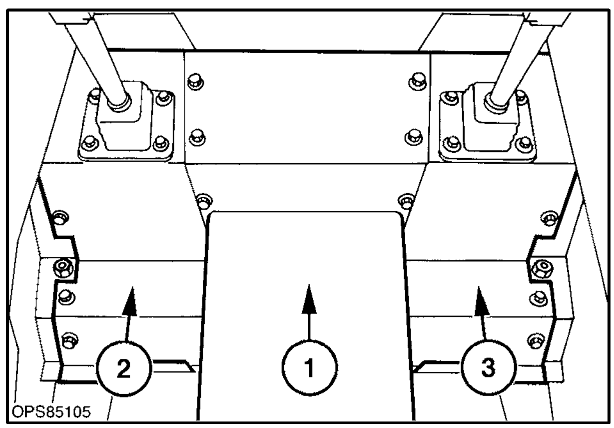


125

7. Remove the step shield, 1, to access the hydrostatic pump and motor area. For more access, remove the right or left hydrostatic control handle assembly, 2 or 3.
8. Relieve all pressure in the hydraulic and hydrostatic systems.

CAUTION

Never loosen any hydraulic lines without first relieving all pressure in the system to avoid serious injury.



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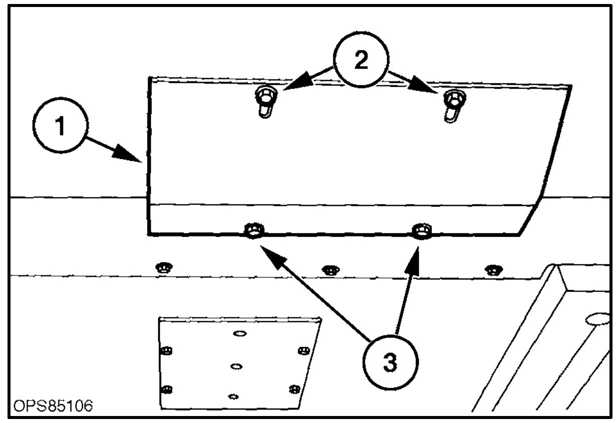
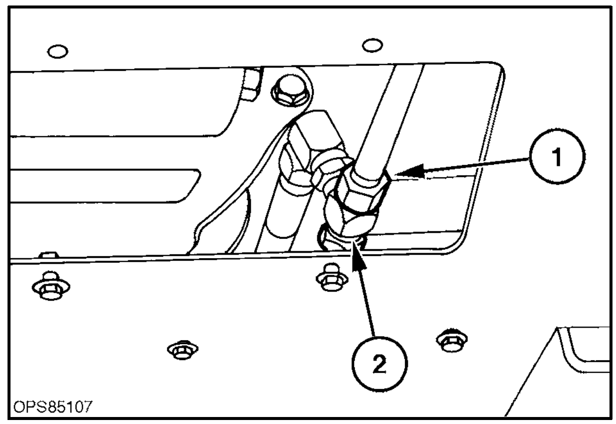
Unless the hydraulic system requires cleaning, draining of the hydraulic oil reservoir is not required. Make sure the suction and return lines are capped to prevent loss of oil.

9. To drain the system, remove the small access door, 1, at the front right corner of the engine belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



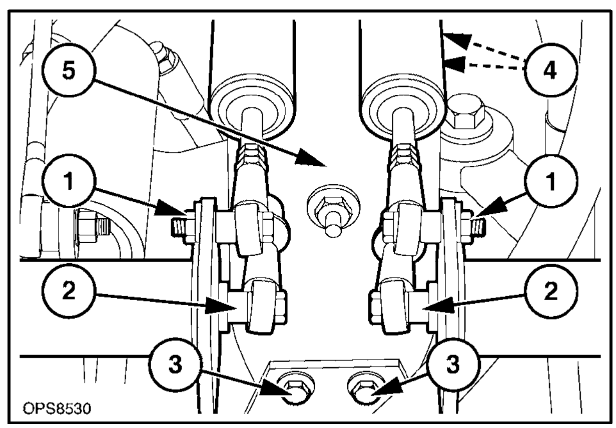
127

10. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.



128

11. Disconnect the dampener shocks at 1, and the neutralizer assemblies at 2.
12. Remove the four neutralizer assembly attaching bolts, two at front, 3, and two at rear, 4. Lift the entire neutralizer assembly, 5, out in one piece.



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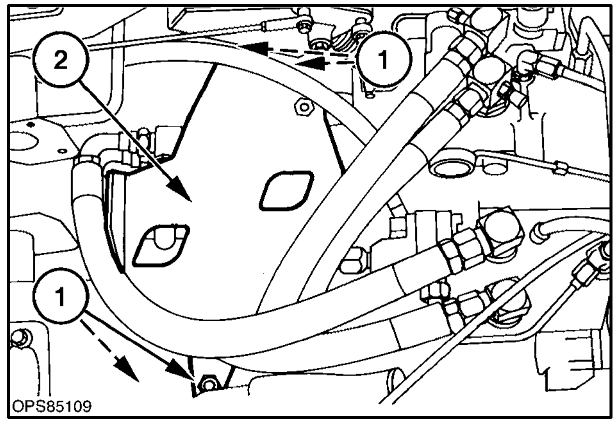
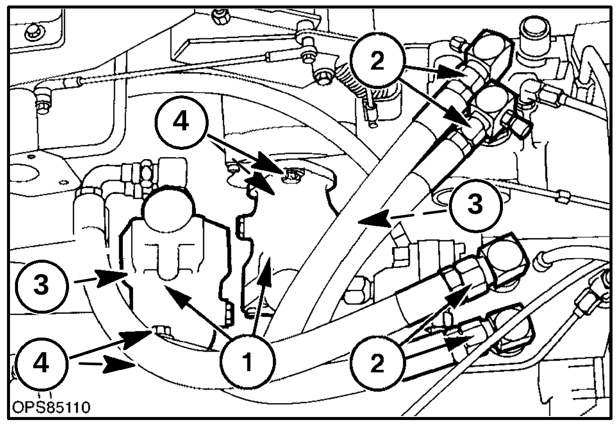
13. Remove the four neutralizer support bracket attaching bolts, 1, and remove the neutralizer support bracket, 2.



130

14. Clean the motors, 1, high-pressure hoses, 2, and case drain tube, located under the motors, and mark their positions to aid in reassembly.
15. Remove the high-pressure hoses, 2, and case drain lines, 3, from the motor and cap to prevent loss of oil. Plug the motor ports to prevent dirt from entering the motor housing.
16. Unbolt and remove the motor from the gearbox assembly, 4. Make sure the parking brake is engaged. This will hold the brake components in place for easier reassembly.



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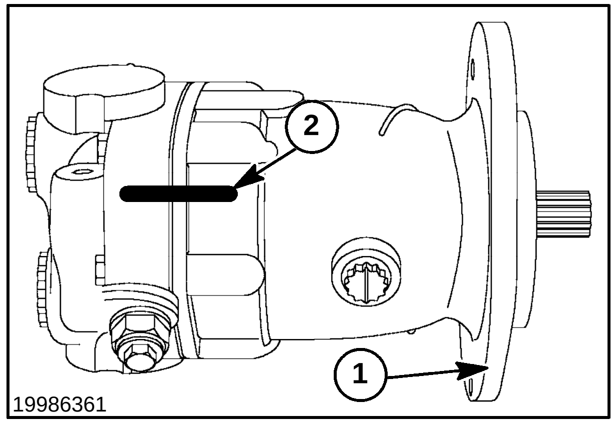
Op. 29 100 66

DISASSEMBLY

NOTE: *Dealer warranty adjustment requests for oil leak repairs, other repairs, or overhaul of the motor must include the model number of the motor and date code. These are stamped into the mounting flange of the motor housing at 1.*



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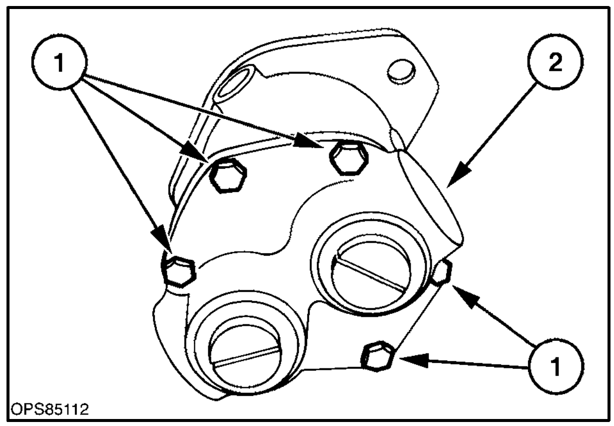
1. Thoroughly clean the outside of the motor housing before disassembly. Plug the ports to prevent dirt and solvent from entering the motor housing.
2. To ensure proper reassembly, mark the relationship between the motor housing and backplate with a marker or scribe, 2.
3. As the motor is being overhauled, lay the parts on a clean wooden bench or heavy cardboard to prevent damage to the machined surfaces.
4. Clamp the motor in a protected jaw vise at the mounting flange. Remove the six cap screws, 1, from the backplate assembly, 2, and lift the backplate straight up from the housing to prevent damage to the shaft and bearings.



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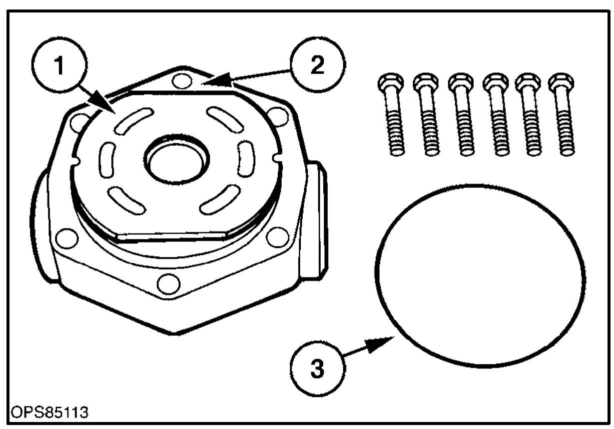
NOTE: *The backplate assembly should pop up with the removal of the six cap screws. If the plate does not pop up, use a plastic mallet and tap on the backplate to remove.*

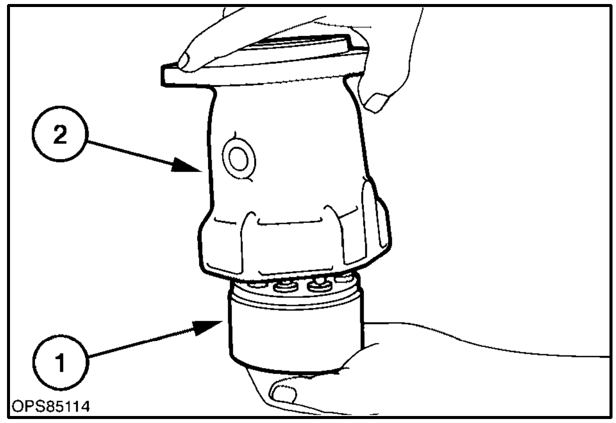
IMPORTANT: *The motor housing is aluminum and can be easily damaged. Do not use sharp objects to pry the backplate from the housing or damage to the machined surfaces may occur.*

5. Remove valve plate, 1, and O ring, 3, from the backplate, 2. Note the position of the valve plate for reassembly.



134

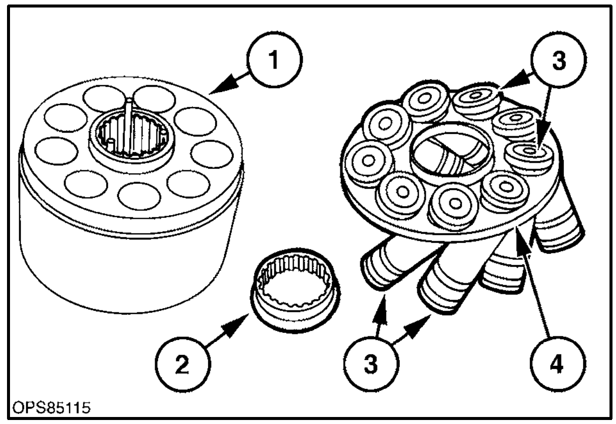
6. Hold the rotating piston block, 1, in one hand and tilt the open end of the motor housing, 2, down. Rotate the piston block and pull it out as a complete unit without scratching or burring the parts.



135

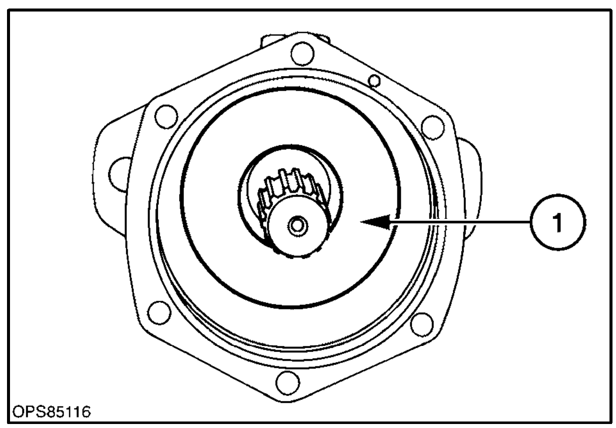
7. The rotating group consists of the following parts:
   a. Piston block, 1.
   b. Spherical washer, 2 (spider pivot).
   c. Piston assemblies, 3.
   d. Piston plate, 4 (spider).

   Carefully disassemble these parts and lay them on cardboard to avoid damage.



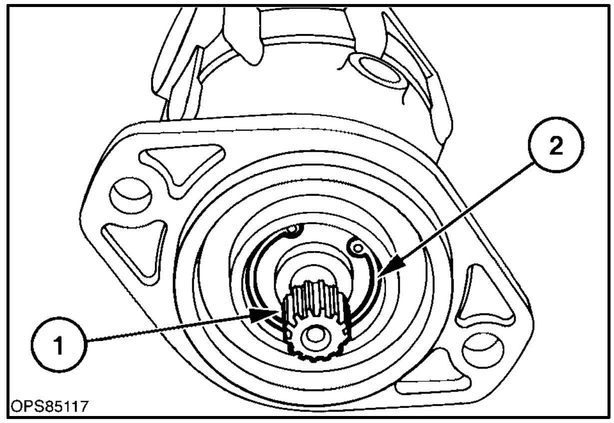
136

8. Remove camplate, 1.



137

9. To remove the motor drive shaft, 1, from the motor housing, remove retaining ring, 2, and tap the opposite end of the shaft with a soft mallet. The seal may be damaged during removal.



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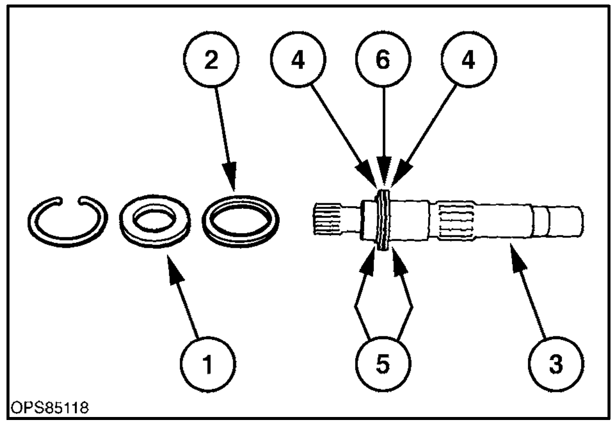
10. Remove shaft seal, 1, and washer, 2, from motor shaft, 3. The motor shaft, thrust bearing assembly, consists of two retaining rings, 4, two thrust washers, 5, and thrust bearing, 6. Disassemble these parts for inspection.



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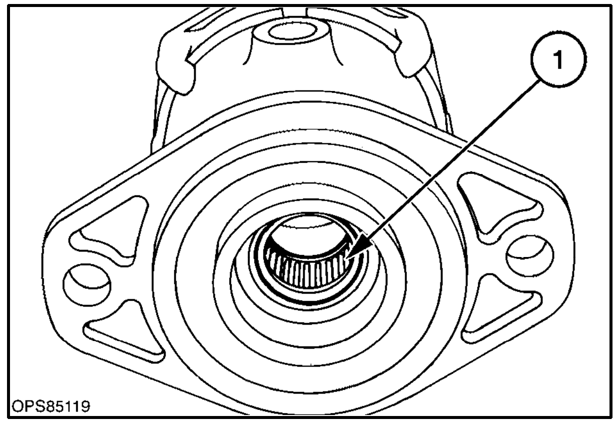
PARTS INSPECTION

Clean all parts in a suitable solvent and air dry prior to inspection.

IMPORTANT: *Due to close tolerances and finish of motor internal surfaces, it is important to maintain absolute cleanliness during inspection and reassembly or damage to the components may occur.*

Motor Housing

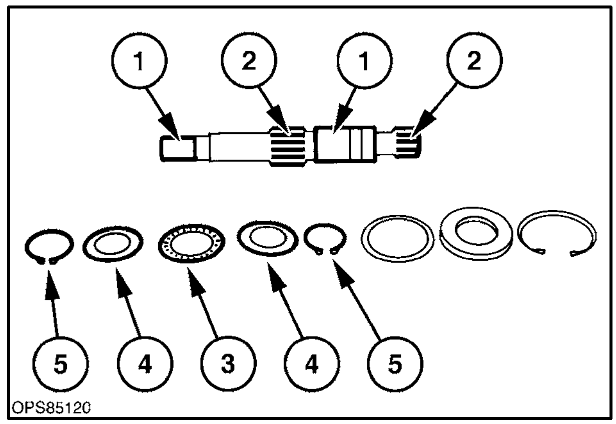
11. 1. The shaft needle bearing, 1, in the motor housing is a press fit and should not be loose. Inspect for looseness. Check that all needles are in the cage and move freely.
12. 2. If no problems are found, there is no need to replace the bearing.



140

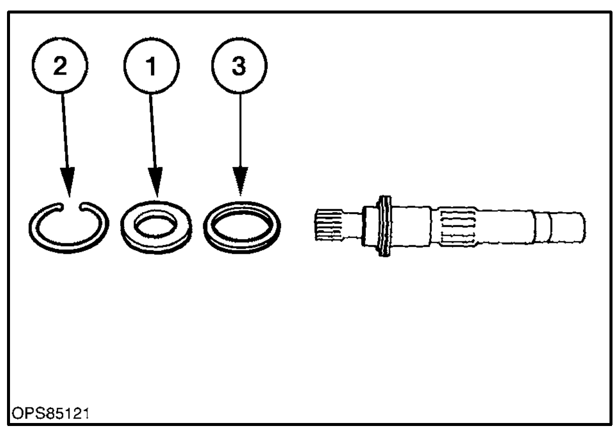
Motor Shaft

13. 1. Inspect the ares that contact the shaft needle bearings, 1, for wear or a rough bearing surface.
14. 2. Check for a bent or worn shaft.
15. 3. Check the splined areas, 2, for wear or twist.
16. 4. Inspect the thrust bearing, 3, bearing races, 4, and retaining rings and grooves, 5. If bearing or races show wear or roughness, they must be replaced.



141

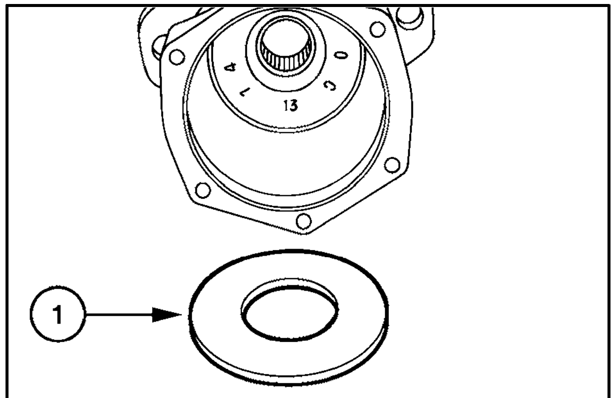
17. 5. Input seal, 1, and retaining ring, 2, will be replaced upon reassembly. Inspect washer, 3, for wear and flatness.



142

Camplate

18. 1. Shoes of the motor pistons rotate at high speeds against the camplate surface at, 1. The surface must be smooth with no metal flaked away and no scoring. Circular scratches centered on the machined surface are due to contamination. If scratches can be felt with your thumbnail, replace the camplate.
19. 2. Check the camplate surface for smearing. The surface must be smooth and bright with no discoloration or brass color on the flat surface.



OPS85122

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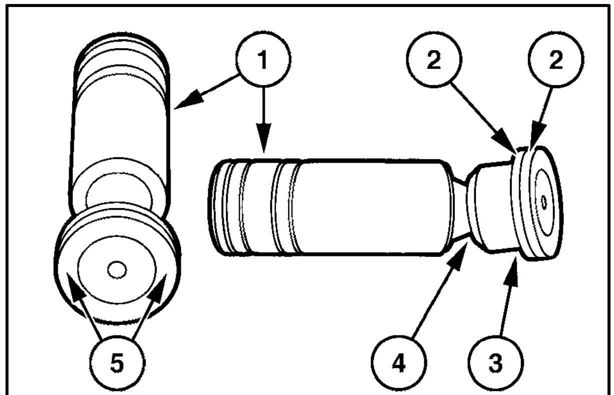
Shoe and Piston Assemblies

Replace the rotating group if:

20. 1. The piston skirt area, 1, shows signs of scratches or wear.
21. 2. The edges of the shoes, 2, are worn (shoe roll) from contact with the camplate.
22. 3. There is wear on the underside of the slipper, between the slipper and shoe plate at 3.
23. 4. The shoes have a loose, sloppy fit on the ball end of the piston at 4.
24. 5. The flat surfaces of the shoes, 5, show metal flaking or deeply scratched. Light or shallow scratches in the shoes will not cause any harm. Do not lap the shoes.



OPS85123

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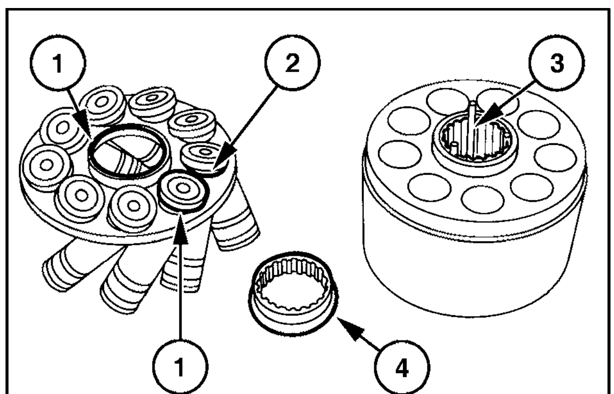
Piston Plate (Spider)

25. 1. Check for cracks at the holes for the spherical washer and shoes at 1. The shoe plate is only available as part of the rotating group.
26. 2. Check for wear in the area of the slippers, 2. This area should be flat smooth and have no grooves.
27. 3. Check the internal splines of the piston block, 3, for wear.

Spherical Washer (Pivot), 4

28. 1. Check for wear on the top surface where the piston plate fits. The spherical washer is only available as part of the rotating group.
29. 2. Check the sides or rolled area for cracks.



OPS85124

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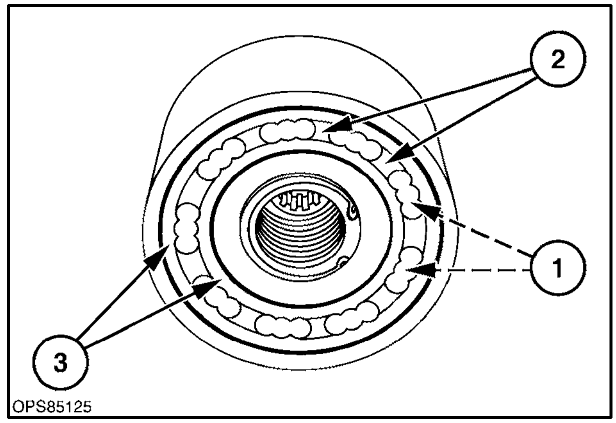
Rotating Piston Block

Replace the rotating group if:

30. 1. Cylinders, 1, are worn or scored so the pistons do not move freely.
31. 2. Surface, 2, is worn or grooved or shows metal buildup. Nicks must not extend from the cylinders to the edge of the raised area, 3.
32. 3. The pistons have side play in the piston block.



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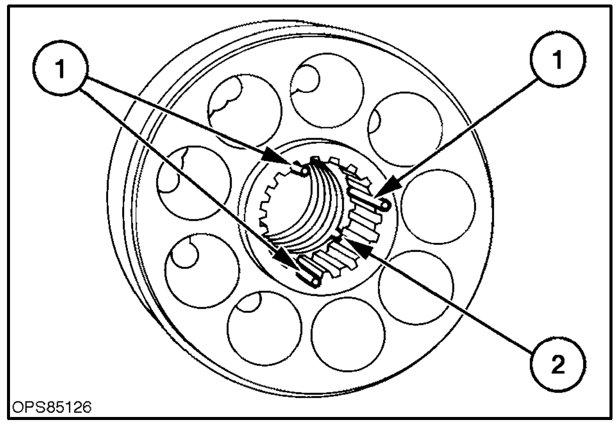
Loading Pins

The three block loading pins, 1, are spring loaded and are held in place by the pin keeper (split bushing), 2.

33. 1. The pins should be the same height.
34. 2. The pins should be seated in the special grooves.
35. 3. The head of the pins should be seated between the washer and the block.



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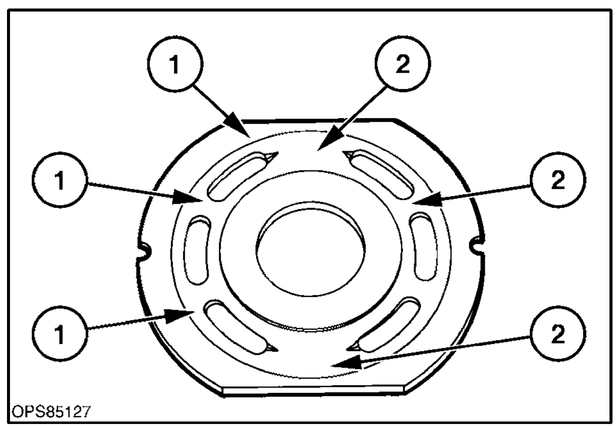
Replaceable Bearing (Valve) Plate

36. 1. Check for flatness.
37. 2. Check for scratches on the brass side of the plate, extending outward across the area where the raised area of the piston block contacts the plate at 1. If scratches can be felt with your thumbnail, replace the bearing plate.
38. 3. Check for scratches between the kidney ports at 2.



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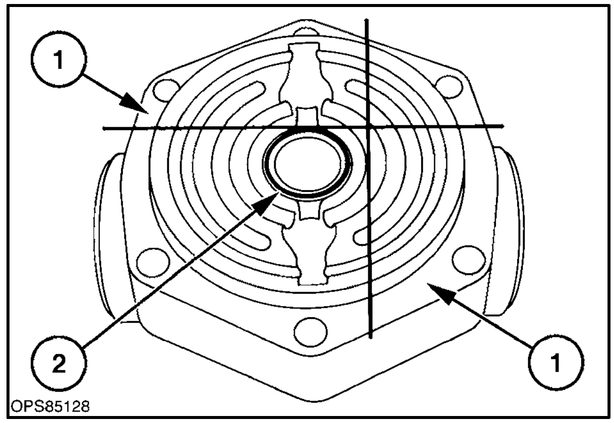
Backplate

39. 1. Check the backplate for flatness, 1.
40. 2. The backplate needle bearing assembly, 2, is a press fit and should not be loose. Inspect for looseness and wear. Check that all needles are in the cage and move freely.
41. 3. If no problems are found, there is no need to replace the bearing.
42. 4. Check the alignment pins to make sure they are in place.



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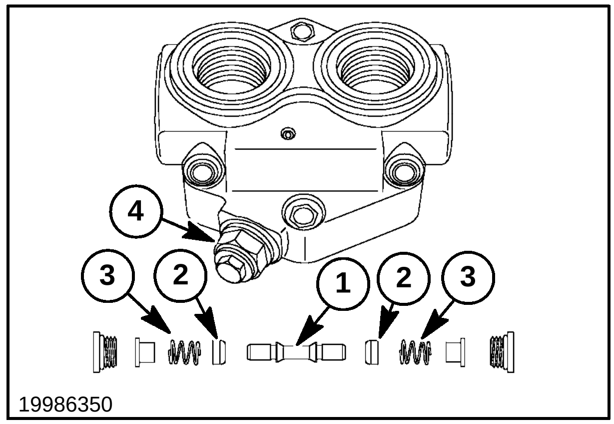
Shuttle Flow Valves

43. 1. Remove the shuttle valves. Inspect the spool, 1, seats, 2, and springs, 3, for damage.

IMPORTANT: *Do not adjust the recirculate valve screw assembly, 4.*



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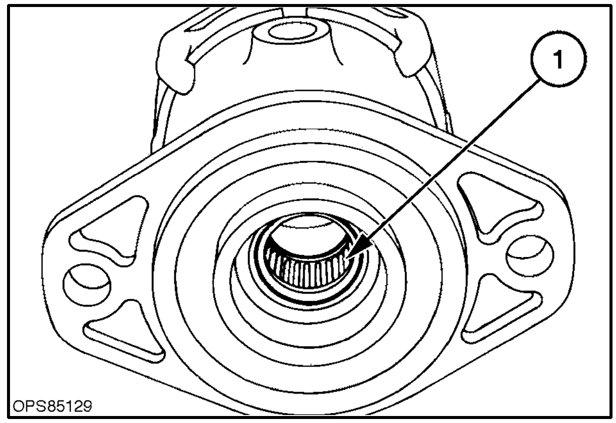
REASSEMBLY

1. Use a suitable solvent to thoroughly clean all parts. Lay the parts on a clean cardboard and air dry.

IMPORTANT: *Due to tight tolerances and finish of motor internal surfaces, it is very important to maintain absolute cleanliness during reassembly.*

2. Use a clean SAE 10W-30 oil to lubricate all moving parts as they are being reassembled.
3. Install the new O ring, seal and retaining rings included with the repair kit.
4. Motor Housing
   a. If required, install a new needle bearing, 1, in the motor housing with the numbered end toward the outside (flange end) of the housing.



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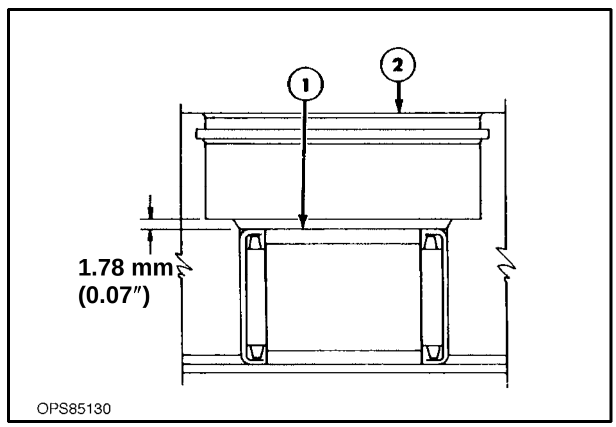
   b. Install the bearing with the numbered end, 1, facing out towards the mounting flange end of the motor housing, 2. Press into place and to the dimension shown, 1.78 mm (0.07″).

NOTE: *When installing bearings in the housing or backplate, be careful not to damage the outer bearing race. If the outer race is damaged, early bearing and shaft failures could occur.*



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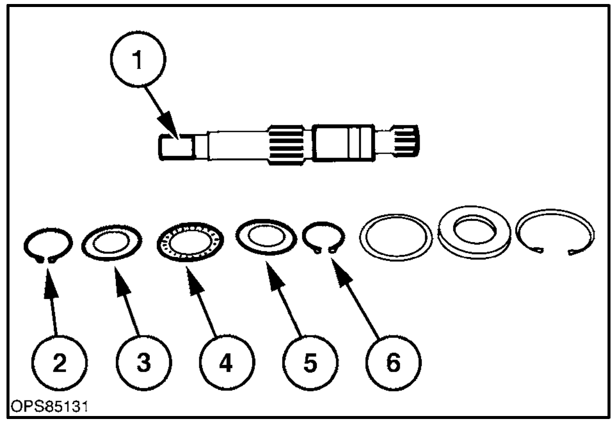
5. Reassemble the motor drive shaft, 1, by installing a new retaining ring, 2; thrust washer, 3; thrust bearing, 4; and second thrust washer, 5. Secure with a second new retaining ring, 6.



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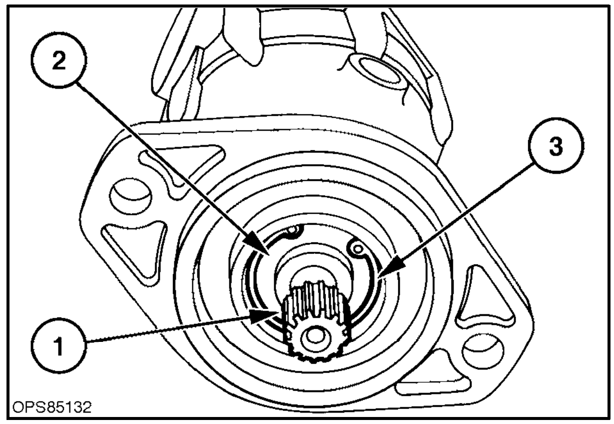
6. Install the shaft and bearing assembly, 1, into the motor housing. Install the washer and new shaft seal, 2, into the housing and set in place with a seal driver. Secure the shaft in place with a new retaining ring, 3.



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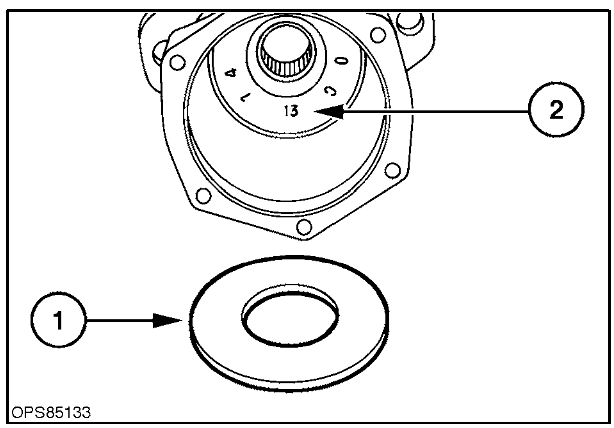
7. Install the camplate, 1, into the motor housing, 2, in the direction indicated on the camplate.



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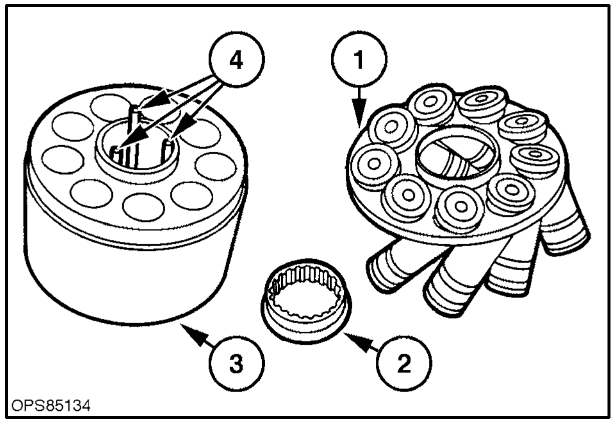
8. Reinstall the pistons and piston plate, 1, and spherical washer (pivot), 2, into the piston block, 3. Make sure the pivot is resting squarely on the loading pins, 4.



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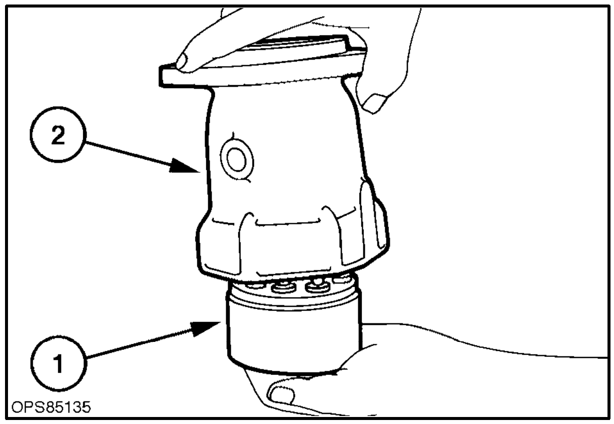
9. Invert the motor housing, 2, and insert the rotating group assembly, 1, into the housing.

***NOTE:** Piston shoes must contact the camplate. Be sure all parts are in their proper position before proceeding.*

***NOTE:** If the rotating group assembly will not easily slide over the splined shaft, DO NOT FORCE. One or more of the three loading pins may be out of their groove or the pin head is not seated properly between the washer and block. Forcing the rotating group may cause pin failure and early transmission failure.*



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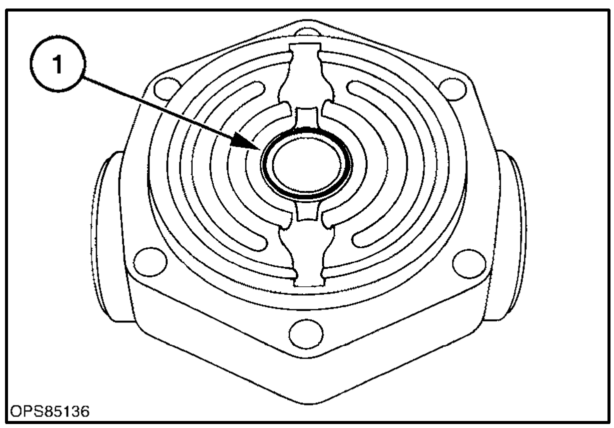
***IMPORTANT:** Make sure all mating surfaces are well lubricated with SAE 10W-30 motor oil to insure proper lubrication for start-up.*

10. Backplate
    a. If required, install a new needle bearing, 1, in the backplate. The bearing should be installed with the numbered end facing the center of the motor assembly.



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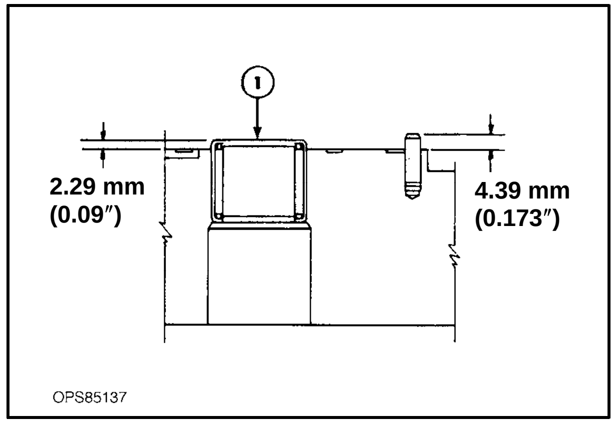
b. Press the bearing into the housing with the numbered end, 1, facing the center of the motor assembly and to the dimension shown, 2.29 mm (.09″) above the face of the backplate. The bearing is a pilot for the valve plate during assembly.

NOTE: *When installing bearings in the housing or backplate, be careful not to damage the outer bearing race. If the outer race is damaged, early bearing and shaft failures could occur.*



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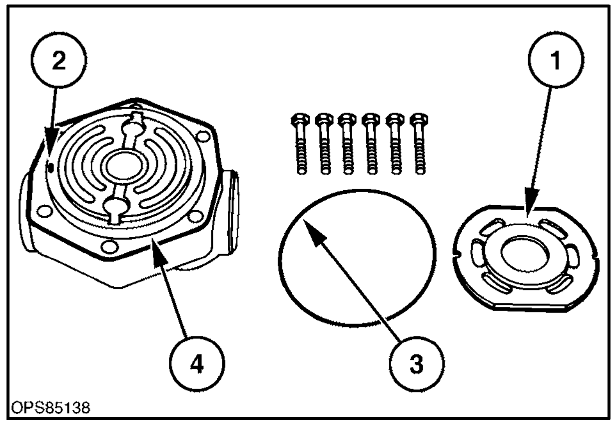
11. Lubricate the valve plate, 1, and place the steel side toward the backplate. Align one of the notches on the outer edge of the valve plate with alignment pin, 2. The brass side of the valve plate should be next to the piston block when assembled.

    To assist in reassembly, place a small amount of vaseline between the valve plate and the back plate to hold the two pieces together.

12. Install a new O ring, 3, over the backplate flange at 4.



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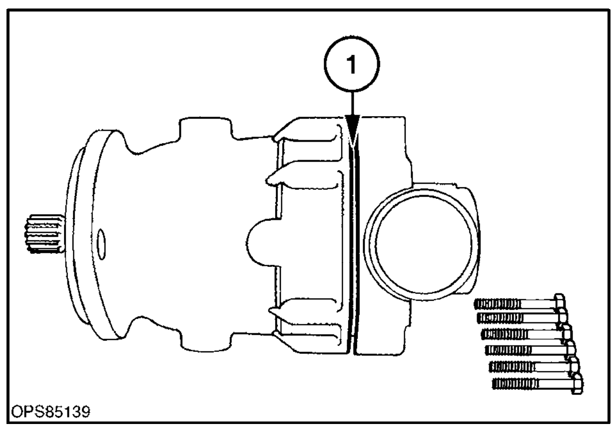
13. Clamp the motor housing and rotating group in a protected jaw vise and carefully install the backplate assembly onto the shaft. Match your alignment marks and dowel pin. Secure with six cap screws and torque to 20 - 24 N·m (15 - 18 ft. lbs.).

NOTE: *When the backplate assembly is in place and prior to inserting bolts, a small gap (approx. 1/8″) will be noticed between the motor housing and the backplate at 1. This is normal. Tightening the bolts brings the housing against the rotating group spring, resulting in an internal spring load to the valve plate and slippers. After torquing the retaining bolts, the shaft should turn easily with a pair of 8″ pliers. The shaft should have some rolling resistance but should not be tight (locked down) or rotate easily. If it is locked down or rotates freely, the motor is assembled incorrectly and requires teardown and reassembly.*



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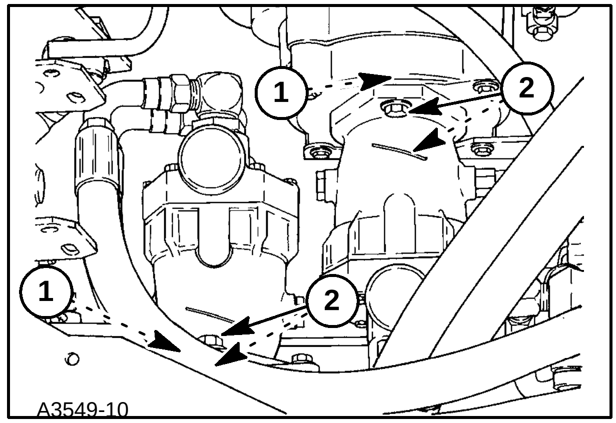
REINSTALLATION

1. Clean the previously sealed surfaces between the motor flange and gearbox at 1.

   When resealing, use a noncorrosive silicone sealer to prevent rust and corrosion to parts after assembled.

2. Place a bead of New Holland Ultra-Blue silicone sealer around the face of the motor housing.
3. Align the motor assembly splines with the coupler splines in the gearbox, and slide the motor shaft into the gearbox. Install two 1/2″ x 1-1/4″ cap screws and washers, 2, and torque to 101 N·m (75 ft. lbs.).
4. Reinstall motor fittings if removed.



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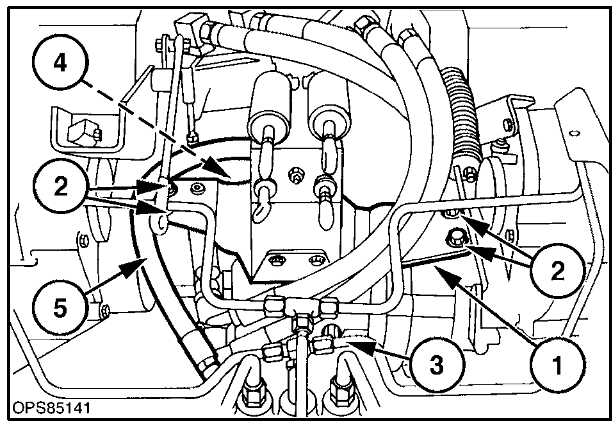
5. Install the neutralizer support bracket, 1, and secure with four attaching bolts, 2, two at each gearbox.
6. Reinstall the case drain tube that runs beneath the motor assemblies. The tube connects at the front of the left motor at 3, and at the rear of the right motor at 4. A hose assembly connects the tee fitting at the rear of the right motor, 4, and the inlet fitting of the gear pump.
7. Reconnect the high-pressure hydraulic hose, 5, between the gear pump and the main control valve.



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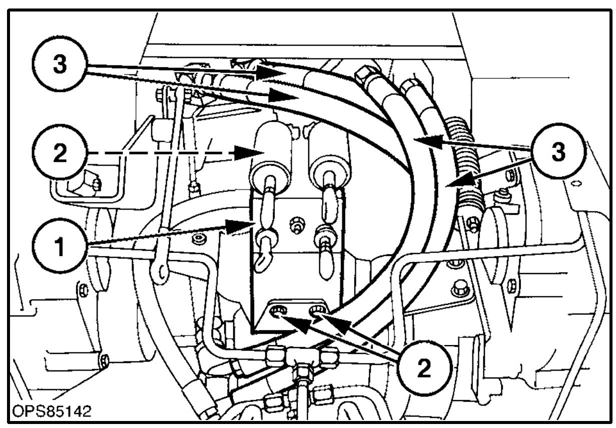
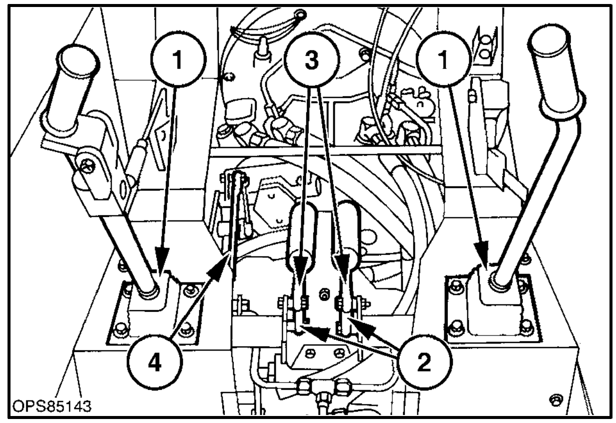
8. Install the neutralizer assembly, 1, and secure with four cap screws, 2; two at the front and two at the rear.
9. Install the high-pressure hydrostatic hoses, 3, from the pumps to the motors and tighten securely. When tightening fittings, first align hoses and tubes for clearance and tighten to seat fittings, then loosen and retorque.



164

10. Reinstall the hydrostatic control handle assemblies, 1, if removed.
11. Reconnect the neutralizer assemblies, 2, the dampener shocks, 3, and control rods, 4.



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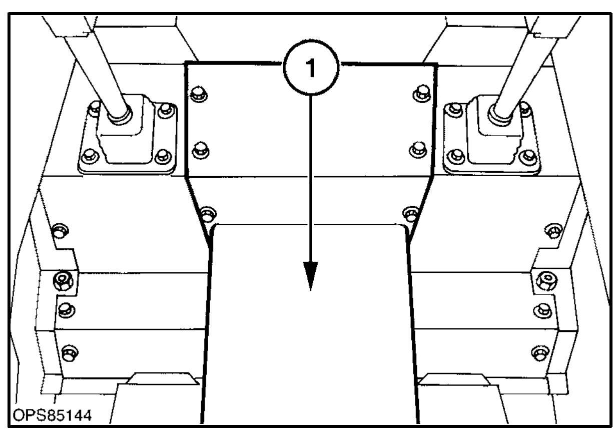
12. For neutral adjustment, refer to the “Control Linkage” section of this manual for the proper procedure and adjustments.
13. After a rebuild of any hydraulic or hydrostatic component, refer to the “Start-Up Procedure” section of this manual for the correct start-up procedure.
14. Put the Service/Run switch in the “SERVICE” position.
15. Operate the unit and check for oil leaks and repair if needed.

CAUTION

Securely support the skid steer with all four wheels off the ground, or movement of the skid steer may cause serious injury or damage to the equipment.

16. Tilt the cab and boom back into position, if tilted forward.
17. Reinstall the step shield, 1, fenders, etc., removed for the repair.
18. Fill the hydraulic system (reservoir) with SAE 10W-30 oil.



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HYDROSTATIC MOTOR - TWO-SPEED

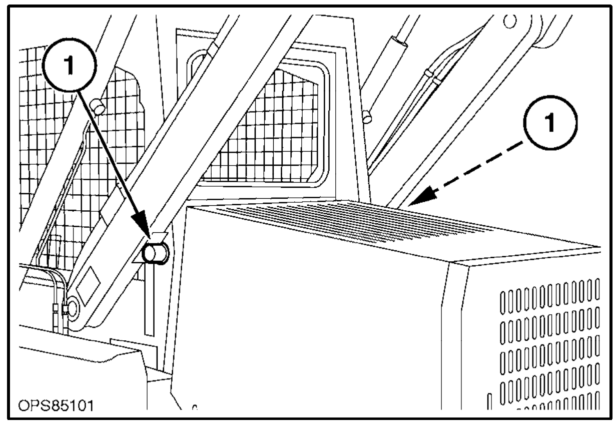
Op. 29 100 60

REMOVAL

The hydrostatic motor assembly can be removed from the top and front, or the cab and boom can be tilted forward for more access. Refer to Section 00 for the cab tilting procedure.

To remove the hydrostatic motor assembly without tilting the cab forward:

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1.



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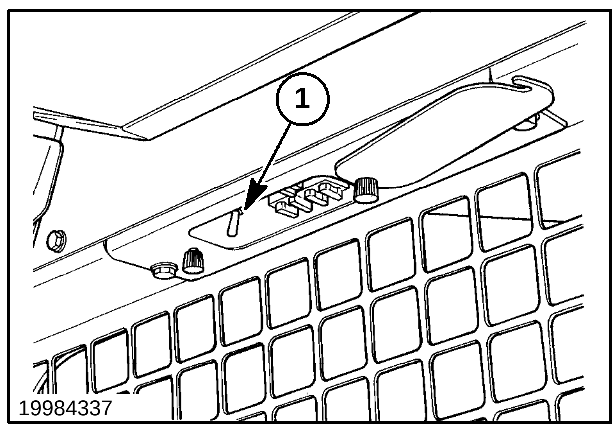
CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.

2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the “SERVICE” position.
4. Engage the parking brake.

***NOTE:** Engaging the parking brake during removal of the hydrostatic motors will hold the brake assembly components (discs, pads, coupler) in place for easier reassembly.*



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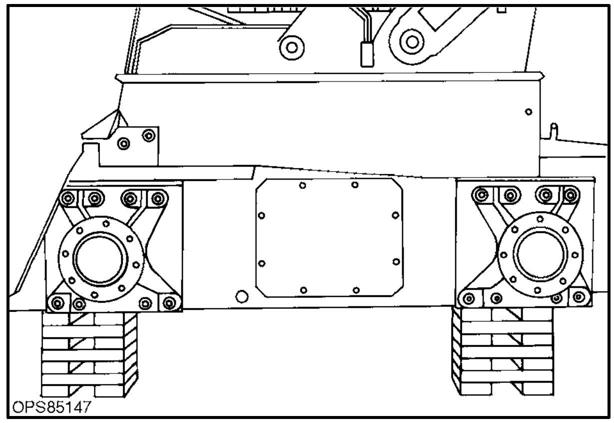
5. Securely block the skid steer with all four wheels off the ground. Refer to Section 00 for more information on properly supporting the skid steer.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer causing serious injury or damage to the equipment.



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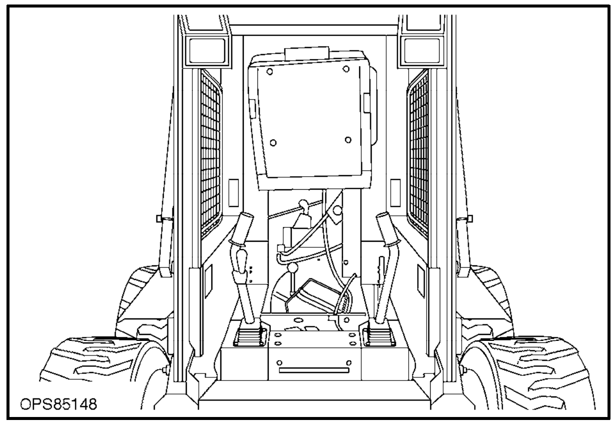
6. Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.



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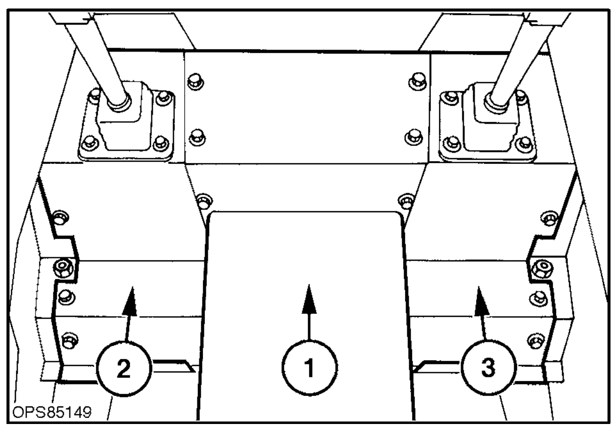
7. Remove the step shield, 1, to access the hydrostatic pump and motor area. For more access, remove the right or left hydrostatic control handle assembly, 2 or 3.
8. Relieve all pressure in the hydraulic and hydrostatic systems.

CAUTION

Never loosen any hydraulic lines without first relieving all pressure in the system to avoid serious injury.



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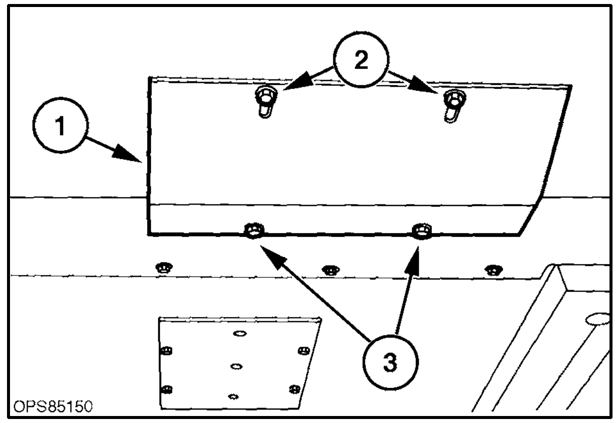
Unless the hydraulic system requires cleaning, draining of the hydraulic oil reservoir is not required. Make sure the suction and return lines are capped to prevent loss of oil.

9. To drain the system, remove the small access door, 1, at the front right corner of the engine belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



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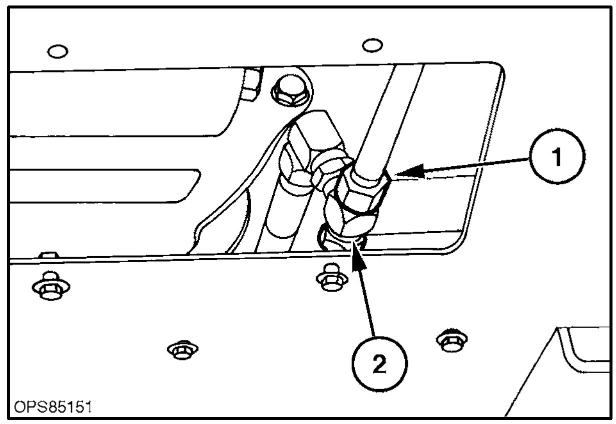
10. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.



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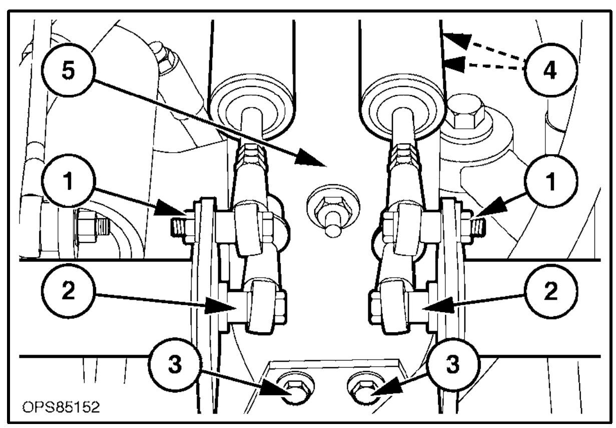
11. Disconnect the dampener shocks at, 1, and the neutralizer assemblies at, 2.
12. Remove the four neutralizer assembly attaching bolts, two at front, 3, and two at rear, 4. Lift the entire neutralizer assembly, 5, out in one piece.



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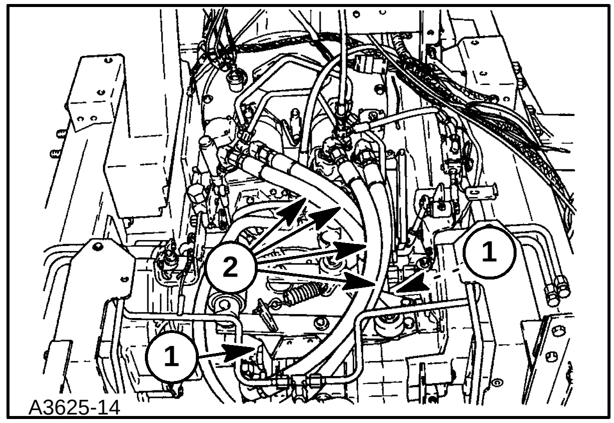
13. Clean the motors, 1, high-pressure hoses, 2, and case drain tube, located under the motors, and mark their positions to aid in reassembly.
14. Remove the high-pressure hoses, 2, from the motor and cap to prevent loss of oil. Plug the motor ports to prevent dirt from entering the motor housing.



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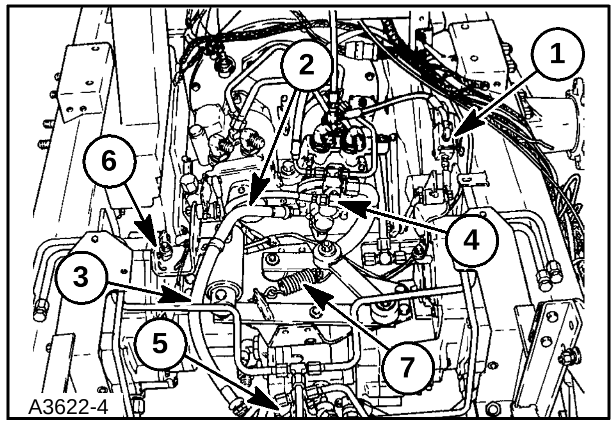
15. Disconnect the hydraulic line from the two-speed control valve, 1, to the rear of the slave cylinder, 2, and cap.
16. Disconnect the high pressure hydraulic hose, 3, from the gear pump, 4, to the main control valve, 5, and cap.
17. Remove the slave cylinder, 2, and control link, 6. Loosen and disconnect the control arm spring, 7, at the rear control arm.



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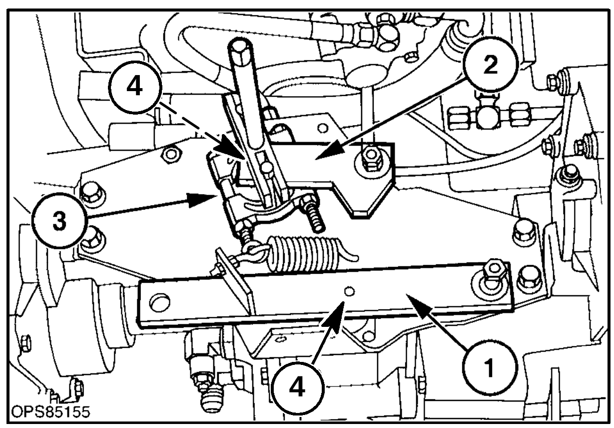
18. Remove the front and rear control arms, 1 and 2. These arms are attached to a tapered camplate shaft and should be removed using a puller arrangement as shown at 3.

NOTE: *The holes, 4, in both motor cam plate arms may be tapped and a cap screw used to remove arms.*



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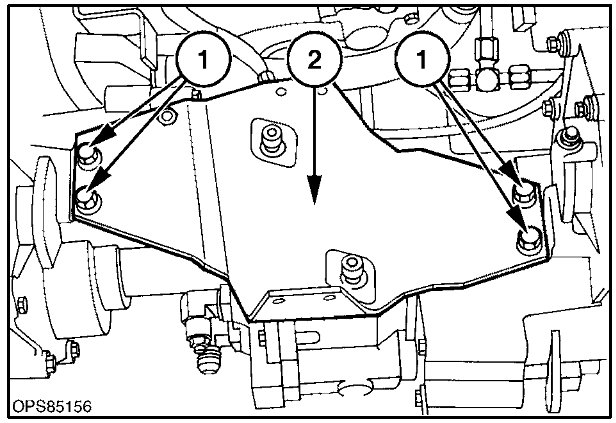
19. Remove the four neutralizer support bracket attaching bolts, 1, and remove the neutralizer support bracket, 2.



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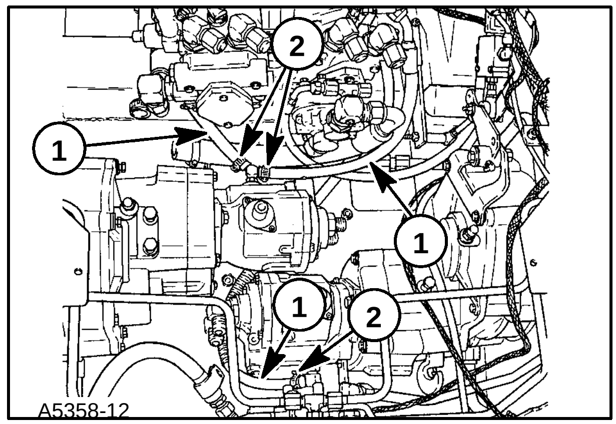
20. Remove the case drain hoses, 1, by loosening the hose clamps, 2.
21. Unbolt and remove the motors from the gearbox assembly. Make sure the parking brake is engaged. This will hold the brake components in place for easier reassembly.



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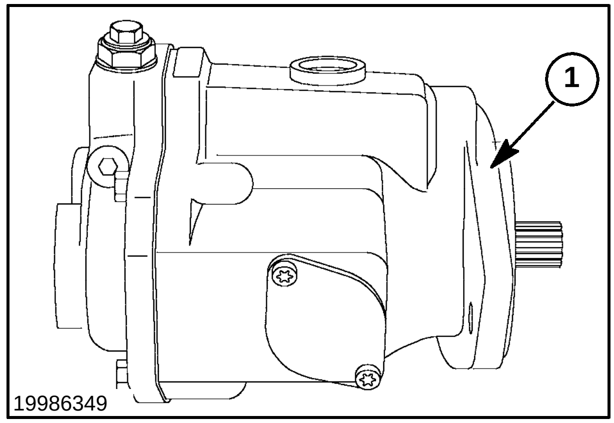
Op. 29 100 66

DISASSEMBLY

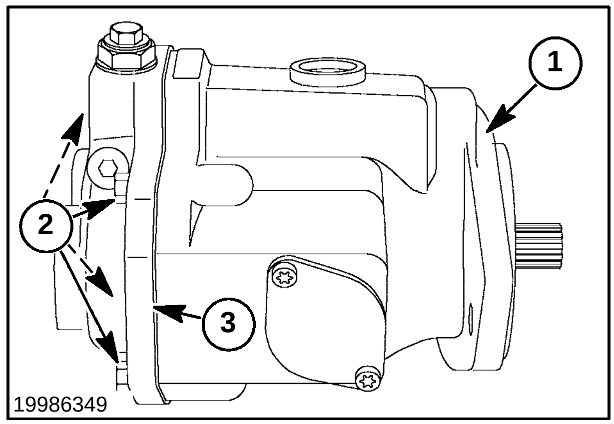
NOTE: *Dealer warranty adjustment requests for oil leak repairs, other repairs, or overhaul of the motor must include the model number of the motor and date code. These are stamped into the mounting flange of the motor housing at 1.*



180

1. Thoroughly clean the outside of the motor housing before disassembly. Plug the ports to prevent dirt and solvent from entering the motor housing.
2. To ensure proper reassembly, mark the relationship between the motor housing and backplate with a marker or scribe.
3. As the motor is being overhauled, lay the parts on a clean wooden bench or heavy cardboard to prevent damage to the machined surfaces.
4. Clamp the motor in a protected jaw vise at the mounting flange, 1. Remove the four cap screws, 2, from the backplate assembly, 3, and lift the backplate straight up from the housing to prevent damage to the shaft and bearing.

NOTE: *The backplate assembly should pop up with the removal of the six cap screws. If the plate does not pop up, use a plastic mallet and tap on the backplate to remove.*

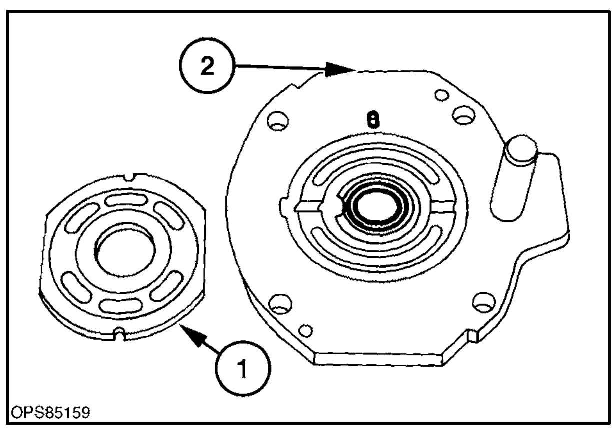


181

IMPORTANT: *The motor housing is aluminum and can be easily damaged. Do not use sharp objects to pry the backplate from the housing or damage to the machined surfaces may occur.*

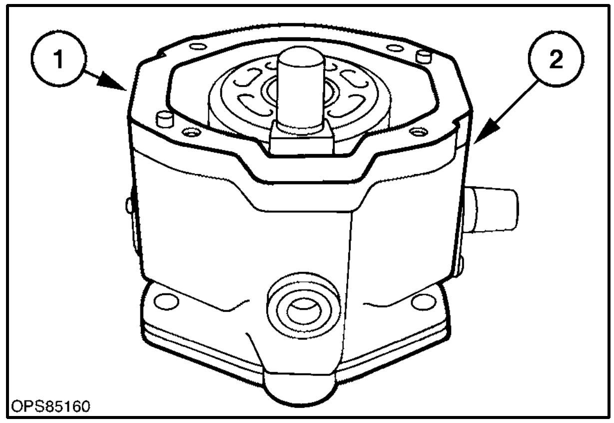
5. Remove the valve plate, 1, from backplate, 2. Note the position of the valve plate for reassembly.

   The valve plate may stick to the rotating group when the backplate is removed.



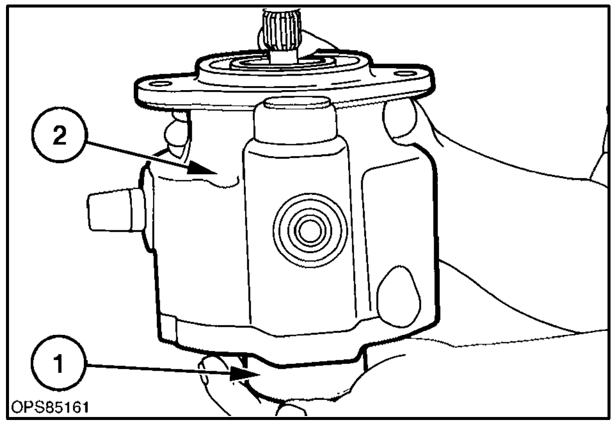
182

6. Remove the gasket, 1, from the motor housing, 2. The gasket should be replaced during reassembly.



183

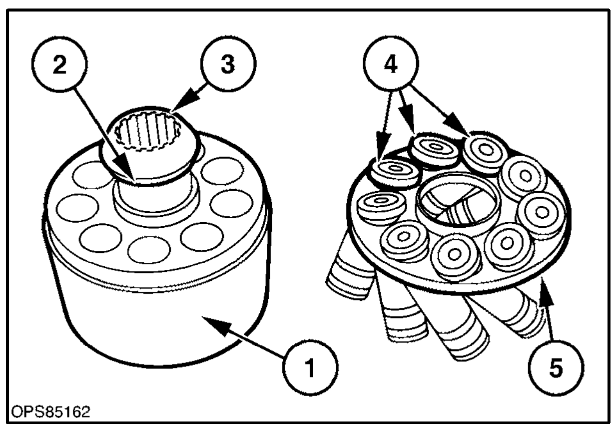
7. Hold the rotating piston block, 1, in one hand and tilt the open end of the motor housing, 2, down. Rotate the piston block and pull it out as a complete unit without scratching or burring the parts.



184

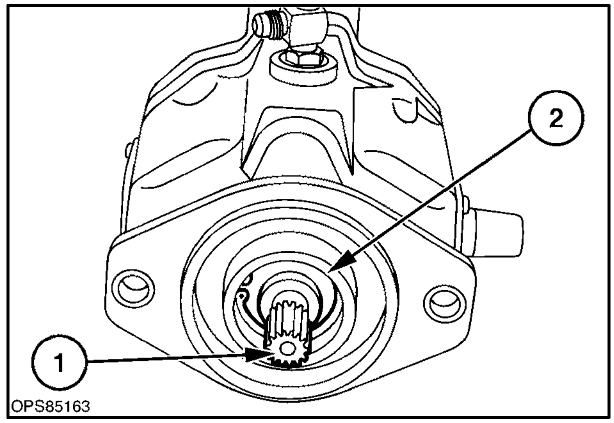
8. The rotating group consists of the following parts:
   a. Piston block, 1.
   b. Wave washer, 2.
   c. Spherical washer, 3 (spider pivot).
   d. Piston assemblies, 4.
   e. Piston plate, 5 (spider).

   Lift the rotating group parts out of the piston block and carefully lay them on clean cardboard to avoid damage. Mark the holes the pistons came from with a soft marker (do not scratch the surface) so they can be inspected and reassembled in the same manner.



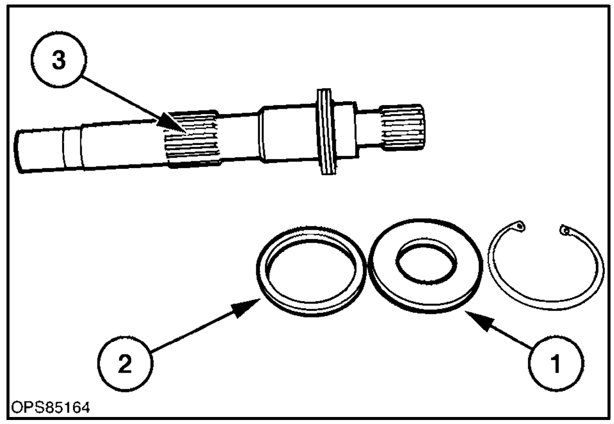
185

9. Remove the motor drive shaft, 1, from the motor housing by removing retaining ring, 2, and tapping the opposite end of the shaft with a soft mallet. The seal may be damaged during removal.



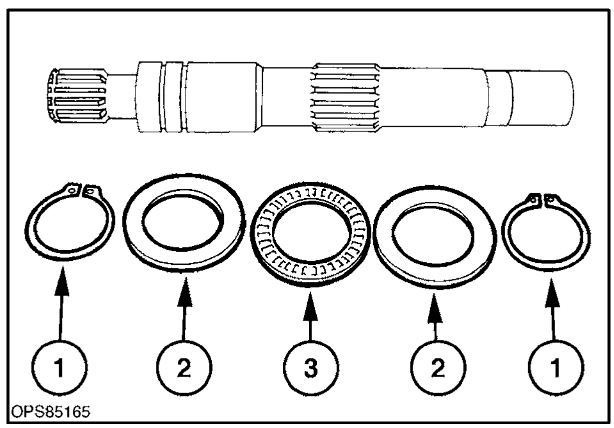
186

10. Remove the outer shaft seal, 1, and washer, 2, from the motor drive shaft, 3.



187

11. The motor shaft, thrust bearing assembly, consists of two retaining rings, 1, two thrust washers, 2, and a thrust bearing, 3. Disassemble these parts for inspection.



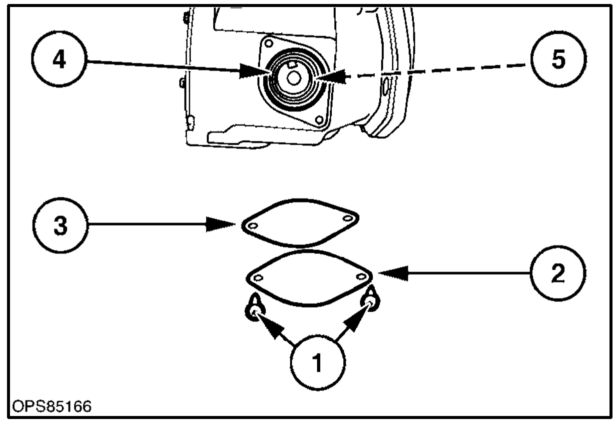
188

12. Camplate

To remove the camplate from the motor housing:

a. Remove the two torx head screws, 1, seal cover plate, 2, and gasket, 3, on the pintle shaft side of the camplate.

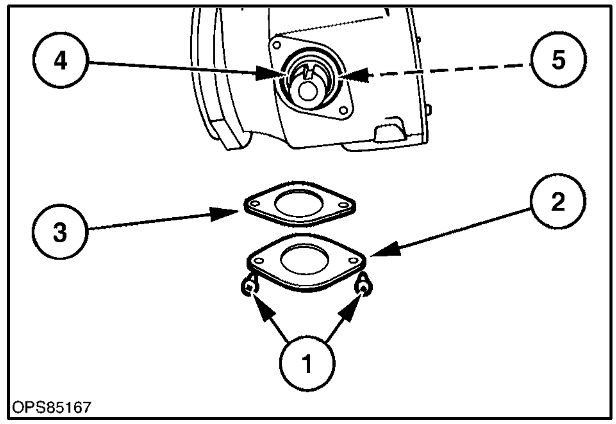
b. Remove pintle shaft seal, 4, and washer, 5, located behind the seal.



189

c. Remove the two torx head screws, 1, trunnion cover plate, 2, and gasket, 3, on the stub shaft end of the camplate.

d. Remove the O ring cover, 4, and O ring, 5, located behind the O ring cover.

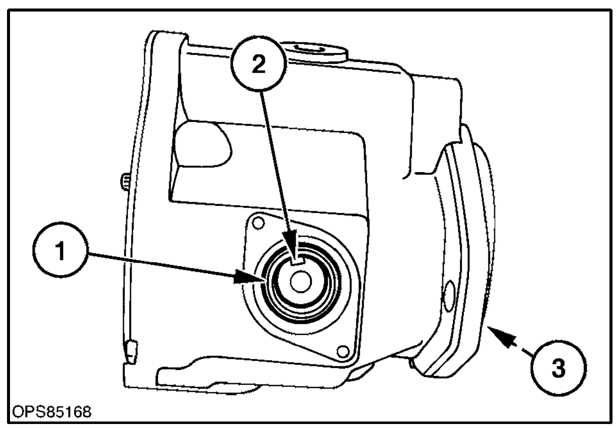


190

e. Remove needle bearing, 1, and inner race, 2, on the stub shaft end of the camplate, and needle bearing, 3, on the pintle shaft end, by sliding the camplate back and forth until the bearings can be grasped. The bearings are not a press fit and should be fairly easy to remove.

f. Remove the camplate, stub shaft end first.

NOTE: *A bearing race is not used on the pintle shaft end of the camplate.*



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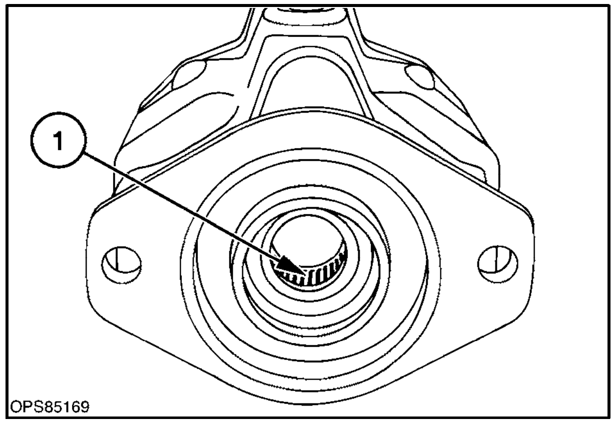
PARTS INSPECTION

Clean all parts in a suitable solvent and air dry prior to inspection.

IMPORTANT: *Due to close tolerances and finish of motor internal surfaces, it is important to maintain absolute cleanliness during inspection and reassembly or damage to the components may occur.*

Motor Housing

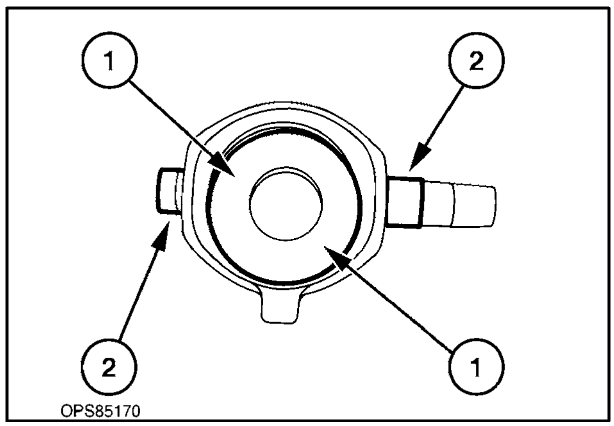
13. 1. The shaft needle bearing, 1, in the motor housing is a press fit and should not be loose. Inspect for looseness. Check that all needles are in the cage and move freely.
14. 2. If no problems are found, there is no need to replace the bearing.



192

Camplate

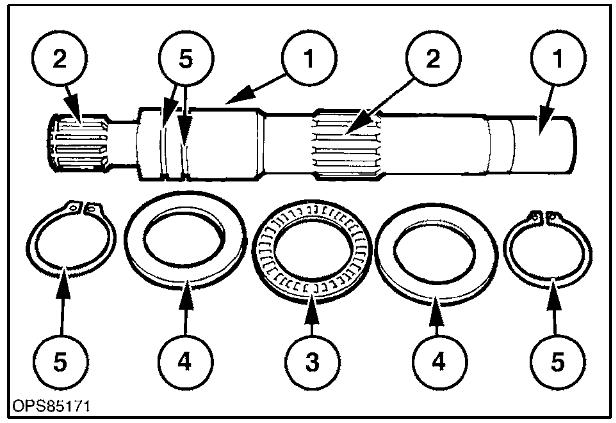
15. 1. Shoes of the motor pistons rotate at high speeds against the camplate surface at 1. The surface must be smooth with no metal flaked away and no scoring. Circular scratches centered on the machined surface are due to contamination. If scratches can be felt with your thumbnail, replace the camplate.
16. 2. Check the camplate surface for smearing. The surface must be smooth and bright with no discoloration or brass color on the flat surfaces.
17. 3. Inspect the areas that contact the camplate needle bearings, 2, for wear or a rough bearing surface.
18. 4. Inspect the camplate bearings for loose or missing needles in the bearing housing. Replace if necessary.



193

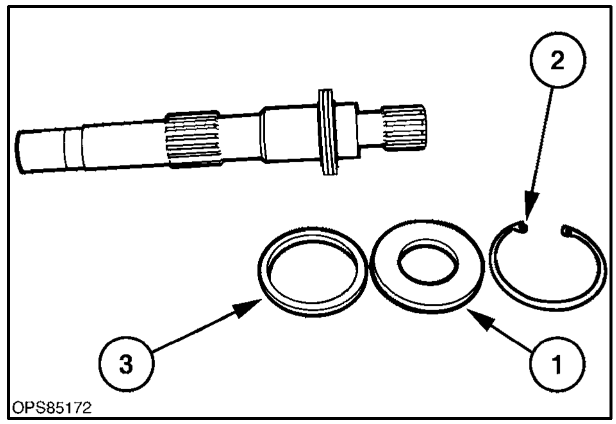
Motor Shaft

23.



194

19. 1. Inspect the areas that contact the shaft needle bearings, 1, for wear or a rough bearing surface.
20. 2. Check for a bent or worn shaft.
21. 3. Check the splined areas, 2, for wear or twist.
22. 4. Inspect the thrust bearing, 3, bearing races, 4, and retaining rings and grooves, 5. If the bearings or races show wear or roughness, they must be replaced.

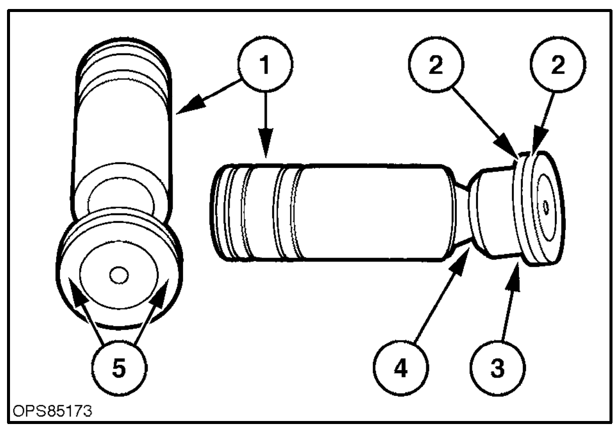


195

24. 5. The seal, 1, and retaining ring, 2, will be replaced upon reassembly. Inspect washer, 3, for wear and flatness.

Shoe and Piston Assemblies

Replace the rotating group if:



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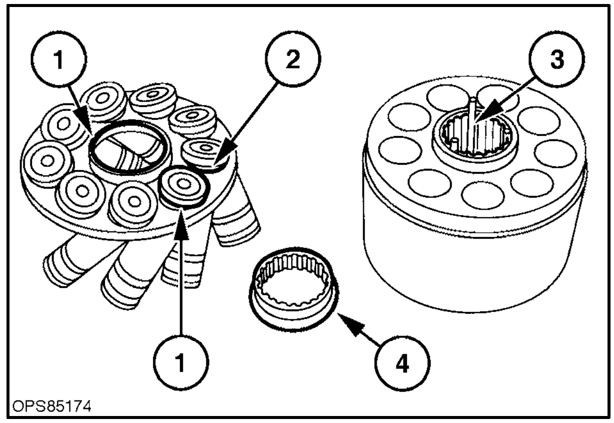
25. 1. The piston skirt area, 1, shows signs of scratches or wear.
26. 2. The edges of the shoes, 2, are worn (shoe roll) from contact with the camplate.
27. 3. There is wear on the underside of the slipper, between the slipper and shoe plate at 3.
28. 4. The shoes have a loose, sloppy fit on the ball end of the piston at 4.
29. 5. The flat surfaces of the shoes, 5, show metal flaking or deeply scratched. Light or shallow scratches in the shoes will not cause any harm. Do not lap the shoes.

Piston Plate (Spider)

30. 1. Check for cracks at the holes for the spherical washers and shoes at 1. The piston plate is only available as part of the rotating group.
31. 2. Check for wear in the area of the slippers, 2. This area should be flat smooth and have no grooves.
32. 3. Check the internal splines of the piston block, 3, for wear.



197

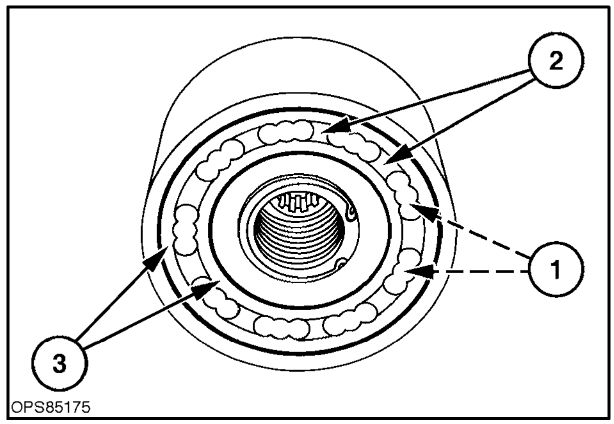
Spherical Washer (Pivot), 4

33. 1. Check for wear on the top surface where the piston plate fits. The spherical washer is only available as part of the rotating group.
34. 2. Check the sides or rolled area for cracks.

Rotating Piston Block

Replace the rotating group if:

35. 1. Cylinders, 1, are worn or scored so the pistons do not move freely.
36. 2. Surface, 2, is worn or grooved or shows metal build-up. Nicks must not extend from the cylinders to the edge of the raised area, 3.
37. 3. The pistons have side play in the piston block.



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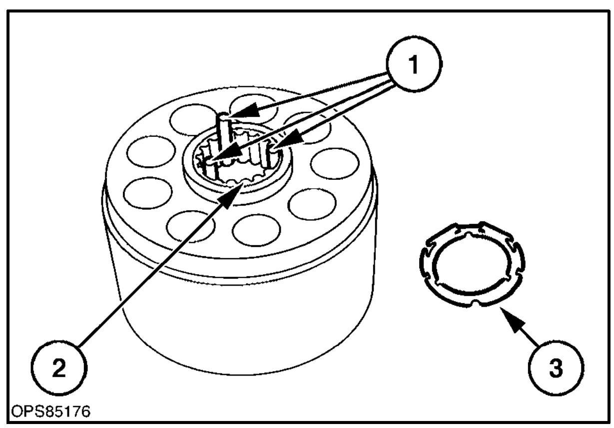
Loading Pins

The three block loading pins, 1, are spring loaded and are held in place by the pin keeper (split bushing), 2.

38. 1. The pins should be the same height.
39. 2. The pins should be seated in the special grooves.
40. 3. The head of the pins should be seated between the washer and the block.

Wave Washer

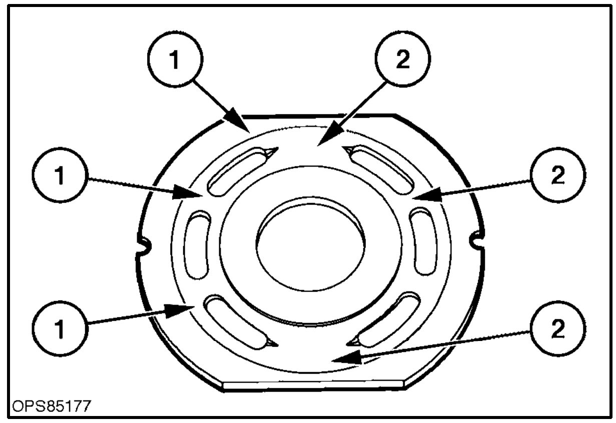
Inspect the wave washer, 3, for bent or broken tabs.



199

Replaceable Bearing (Valve) Plate

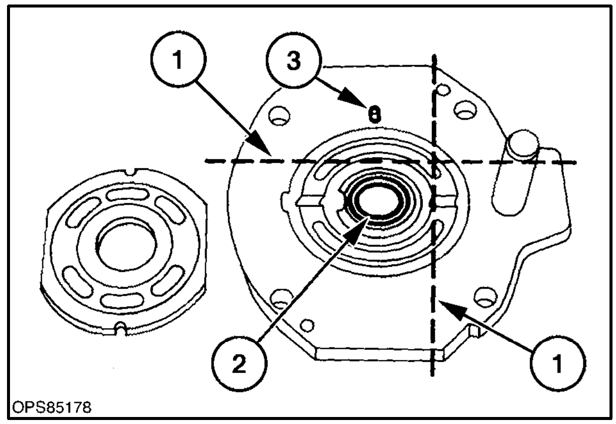
41. 1. Check for flatness.
42. 2. Check for scratches on the brass side of the plate, extending across the area where the piston block contacts the plate at 1. If scratches can be felt with your thumbnail, replace the bearing plate.
43. 3. Check for scratches across the kidney ports at 2.



200

Backplate

44. 1. Check the backplate for flatness, 1.
45. 2. The backplate needle bearing assembly, 2, is a press fit and should not be loose. Inspect for looseness and wear. Check that all needles are in the cage and move freely.
46. 3. If no problems are found, there is no need to replace the bearing.
47. 4. Check the alignment pin, 3, to make sure it is in place.



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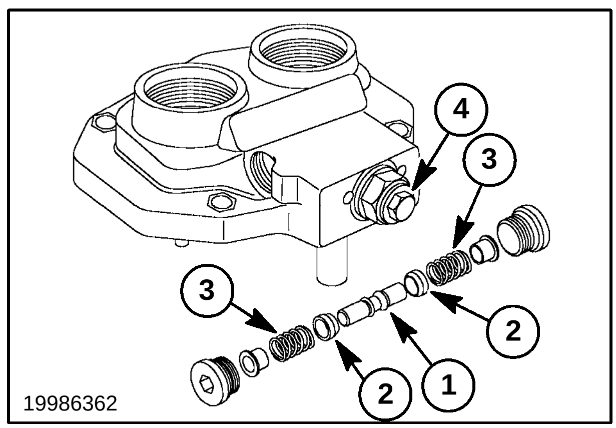
Shuttle Flow Valves

48. 1. Remove the shuttle valves. Inspect the spool, 1, seats, 2, and springs, 3, for damage.

IMPORTANT: *Do not adjust the recirculate valve screw assembly, 4.*



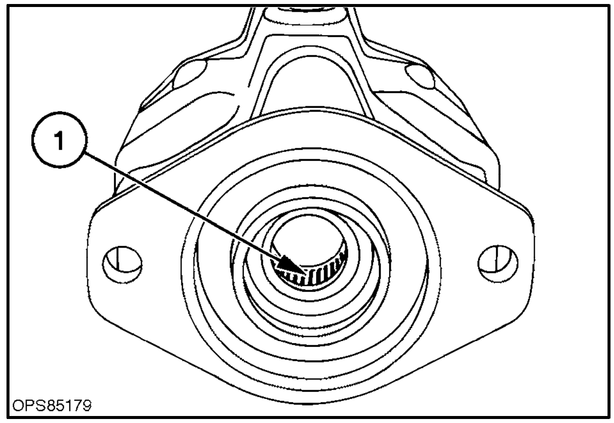
202

REASSEMBLY

1. Use a suitable solvent to thoroughly clean all parts. Lay the parts on a clean cardboard and air dry.

IMPORTANT: *Due to tight tolerances and finish of motor internal surfaces, it is very important to maintain absolute cleanliness during reassembly.*

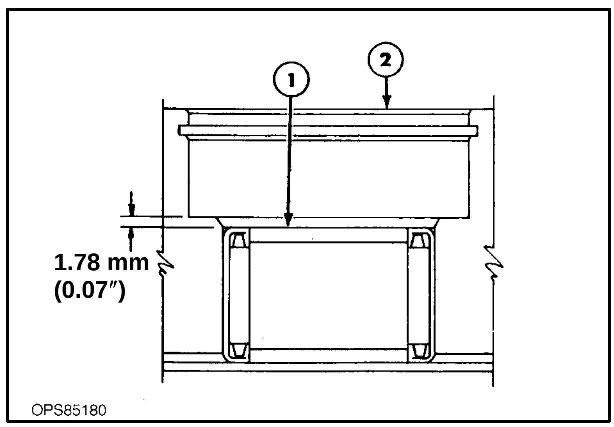
2. Use a clean SAE 10W-30 oil to lubricate all moving parts as they are being reassembled.
3. Install the new O ring, seals, gasket and retaining rings included with the repair kit.
4. Motor Housing
   a. If required, install a new needle bearing, 1, in the motor housing with the numbered end toward the outside (flange end) of the housing.



203

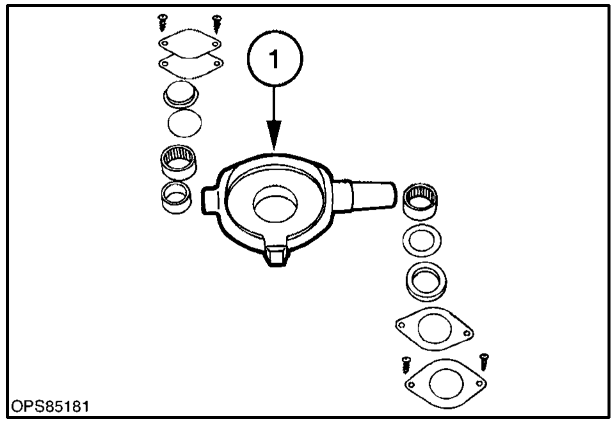
   b. Install the bearing with the numbered end, 1, facing out towards the mounting flange end of the motor housing, 2. Press into place and to the dimension shown, 1.78 mm (0.07″).

NOTE: *When installing bearings in the housing or backplate, be careful not to damage the outer bearing race. If the outer race is damaged, early bearing and shaft failures could occur.*



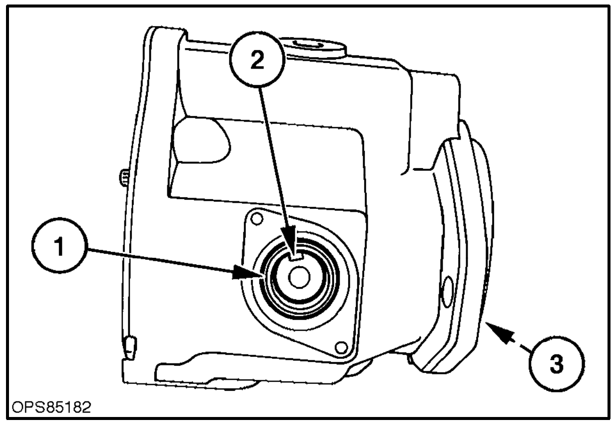
204

5. Camplate
   a. Reinstall camplate, 1, into the motor housing. Make certain that the camplate pintle shaft is on the correct side.
   b. The figure shows the camplate and all the parts used, in the order they should be reassembled.



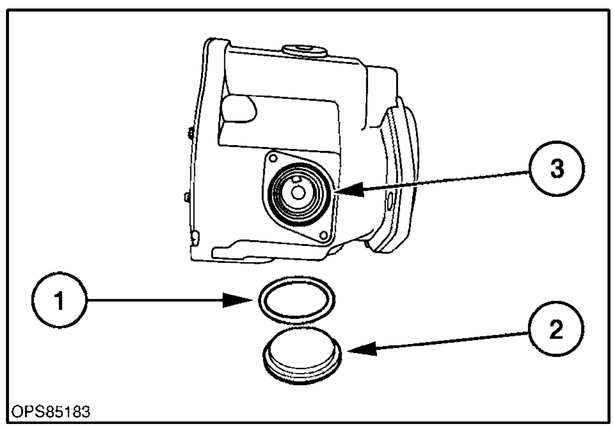
205

   c. Install the inner bearing race, 2, and shaft needle bearing, 1, on the stub shaft end of the camplate.
   d. Install the shaft needle bearing, 3, on the pintle shaft end of the camplate.



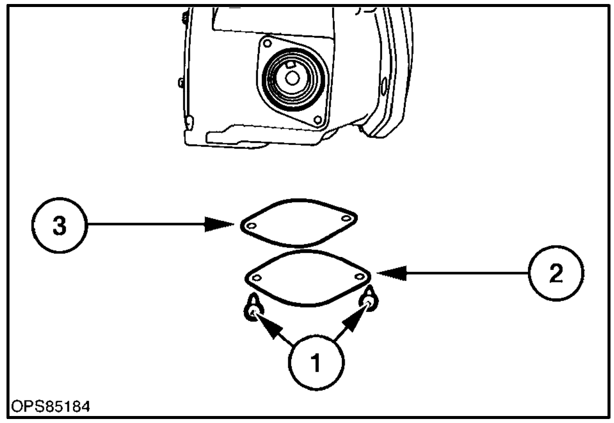
206

   e. Install a new camplate shaft O ring, 1, and O ring cover, 2, on the stub shaft end of the camplate at 3.



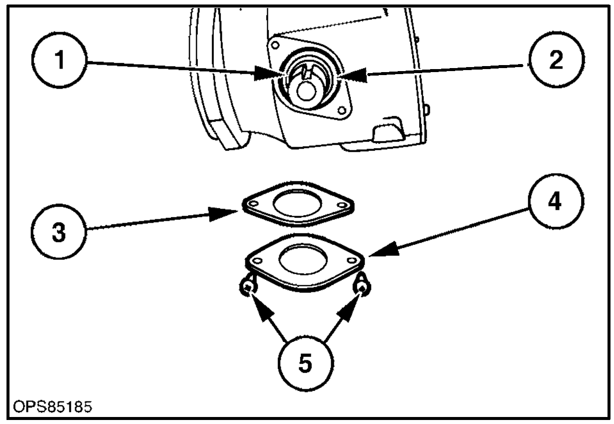
207

f. Install gasket, 1, and trunnion cover plate, 2. Secure with two torx head screws, 3, on the stub shaft end of the camplate. Torque the screws to 4 - 5 N·m (36 - 48 in lbs.).



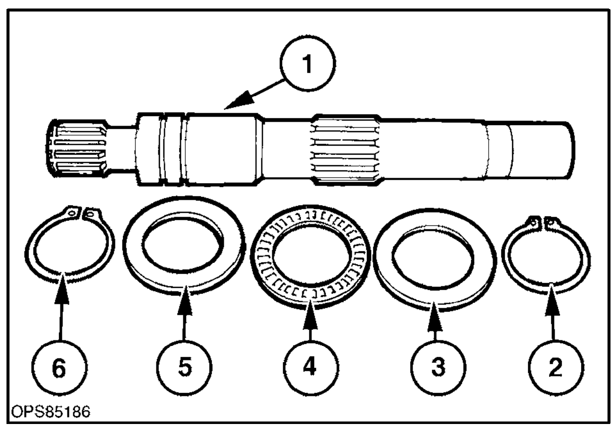
208

g. Install flat washer, 1, new pintle shaft seal, 2, gasket, 3, and seal cover plate, 4. Secure with two torx head screws, 5, on the pintle shaft end of the camplate. Torque the screws to 4 - 5 N·m (36 - 48 in. lbs).



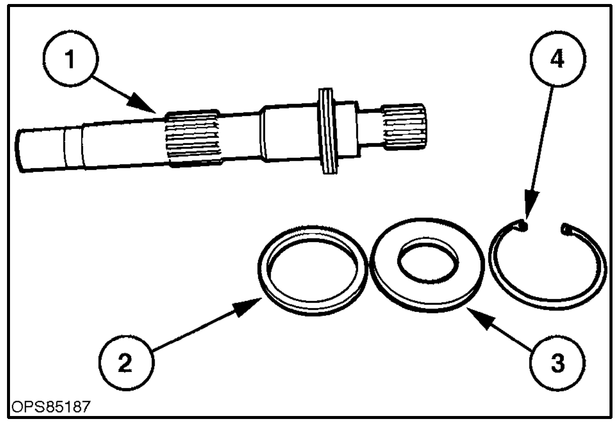
209

6. Reassemble the motor drive shaft, 1, by installing a new retaining ring, 2; thrust washer, 3; thrust bearing, 4; and second thrust washer, 5. Secure with a second new retaining ring, 6.



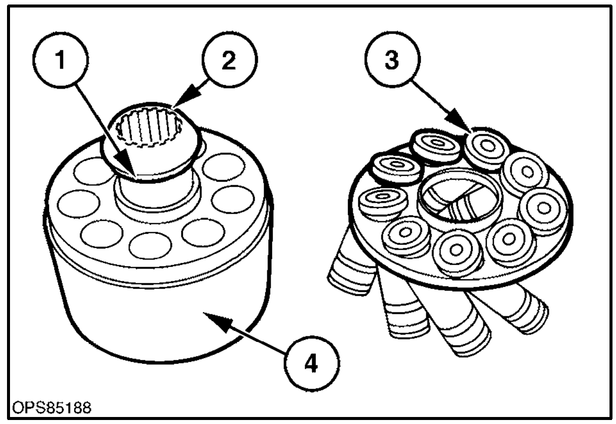
210

7. Install the shaft and bearing assembly, 1, into the motor housing. Install washer, 2, and a new motor shaft seal, 3 into the housing and set in place with a seal driver. Secure the shaft in place with a new retaining ring, 4.



211

8. Reassemble the rotating group by installing the wave washer, 1, over the loading pins. Install the spherical pivot washer, 2, and insert the piston assembly, 3, into the piston block, 4. The pistons should be reinstalled into the same piston block cylinders as they were removed.

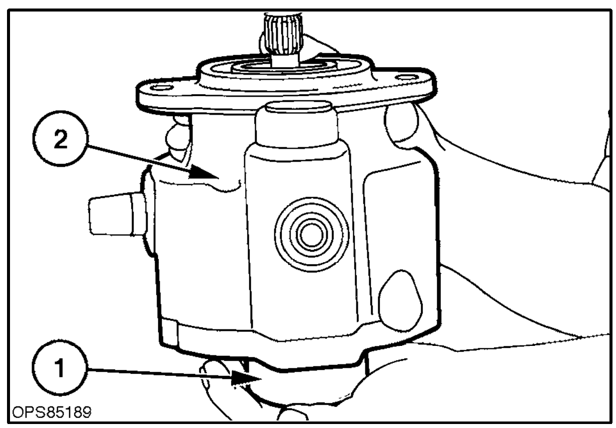


212

9. Invert the motor housing, 2, and insert the rotating group assembly, 1, into the housing.

NOTE: *Piston shoes must contact the camplate. Be sure all parts are in their proper position before proceeding.*

NOTE: *If the rotating group assembly will not easily slide over the splined shaft, DO NOT FORCE. One or more of the three loading pins may be out of their groove or the pin head is not seated properly between the washer and block. Forcing the rotating group may cause pin failure and early transmission failure.*

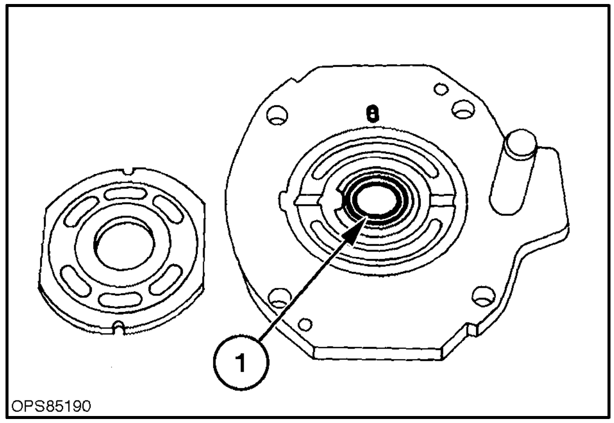


213

IMPORTANT: *Make sure all mating surfaces are well lubricated with SAE 10W-30 motor oil to insure proper lubrication for start-up.*

10. Backplate

   a. If required, install a new needle bearing, 1, in the backplate. The bearing should be installed with the numbered end facing the center of the motor assembly.



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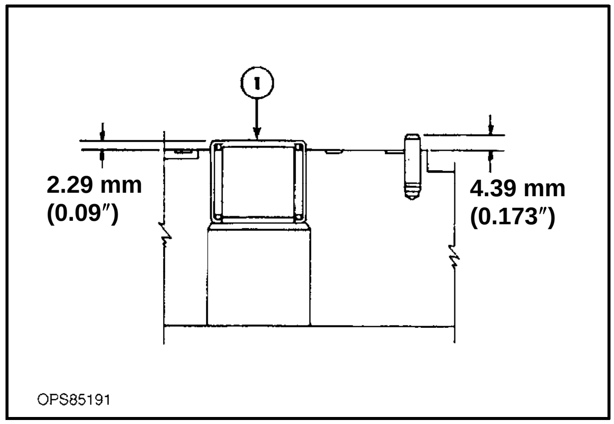
   b. Press the bearing into the housing with the numbered end, 1, facing the center of the motor assembly and to the dimension shown, 2.29 mm (0.09″) above the face of the backplate. The bearing is a pilot for the valve plate during reassembly.

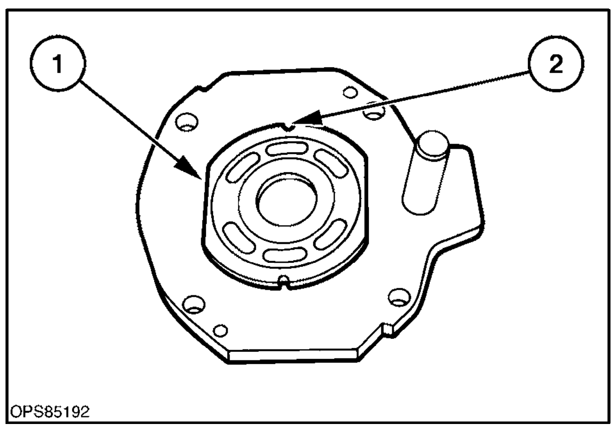
NOTE: *When installing bearings in the housing or backplate, be careful not to damage the outer bearing race. If the outer race is damaged, early bearing and shaft failures could occur.*



215

11. Lubricate the valve plate, 1, and place the steel side toward the backplate. Align one of the notches on the outer edge of the valve plate with alignment pin, 2. The brass side of the valve plate should be next to the piston block when assembled.

    To assist in reassembly, place a small amount of vaseline between the valve plate and the backplate to hold the pieces together.



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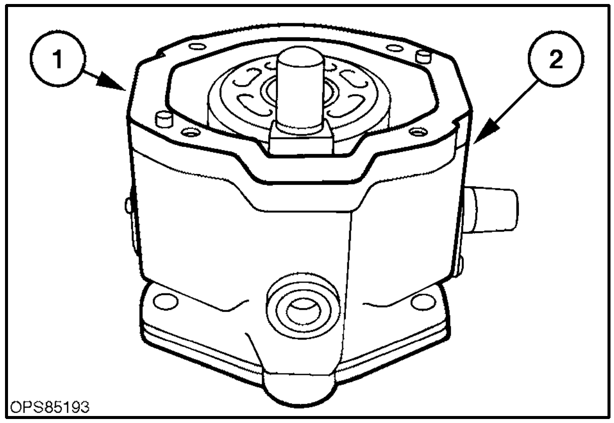
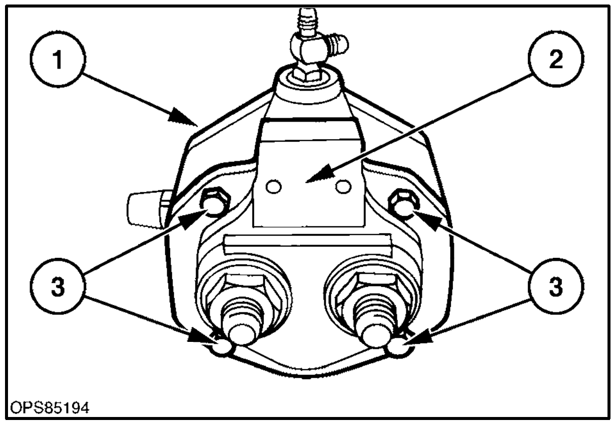
12. Install a new gasket, 1, onto the motor housing, 2.



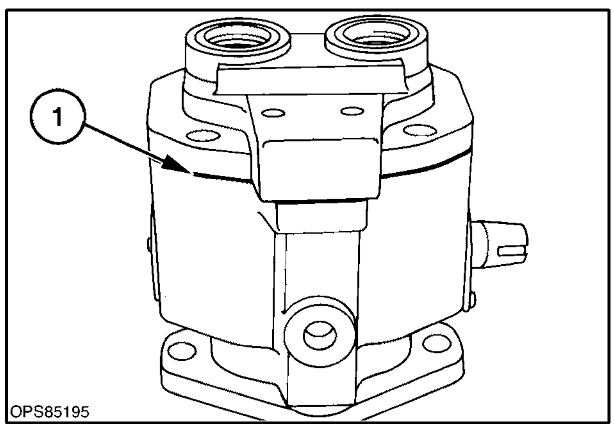
217

13. Clamp the motor housing and rotating group, 1, in a protected jaw vise and carefully install the backplate assembly, 2, onto the shaft. Match your alignment marks and dowel pins. Secure with four cap screws, 3, and torque to 37 - 42 N·m (27 - 31 ft. lbs.).



218

NOTE: *When the backplate assembly is in place and prior to inserting bolts, a small gap (approx. 1/8″) will be noticed between the motor housing and the backplate at 1. This is normal. Tightening the bolts brings the housing against the rotating group spring, resulting in an internal spring load to the valve plate and slippers. After torquing the retaining bolts, the shaft should turn easily with a pair of 8″ pliers. The shaft should have some rolling resistance but should not be tight (locked down) or rotate easily. If it is locked down or rotates freely, the motor is assembled incorrectly and requires teardown and reassembly.*



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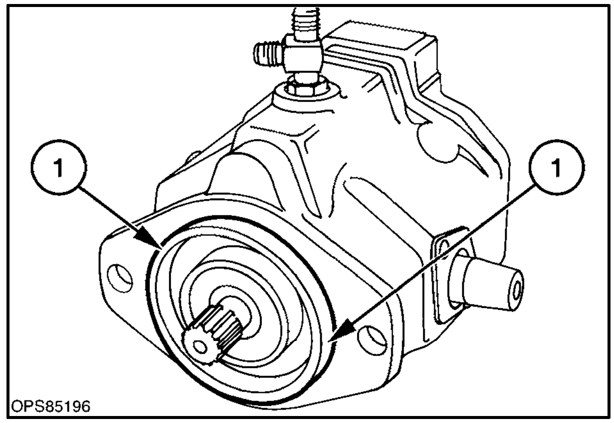
REINSTALLATION

1. Clean the previously sealed surfaces between the motor flange and gearbox.

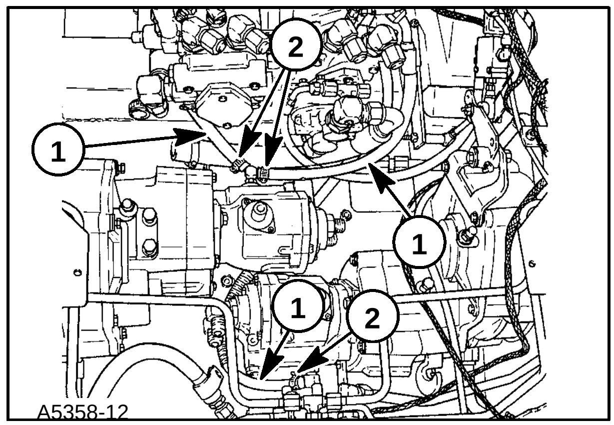
   When resealing, use a noncorrosive silicone sealer to prevent rust and corrosion to parts after assembled.

2. Place a bead of New Holland Ultra-Blue silicone sealer around the face of the motor housing at 1.
3. Align the motor assembly splines with the coupler splines in the gearbox, and slide the motor shaft into the gearbox. Install two 1/2″ x 1-1/4″ cap screws and washers, torque to 101 N·m (75 ft. lbs.).
4. Reinstall motor fittings if removed.



220

5. Install the case drain hoses, 1, and tighten the hose clamps, 2, securely.



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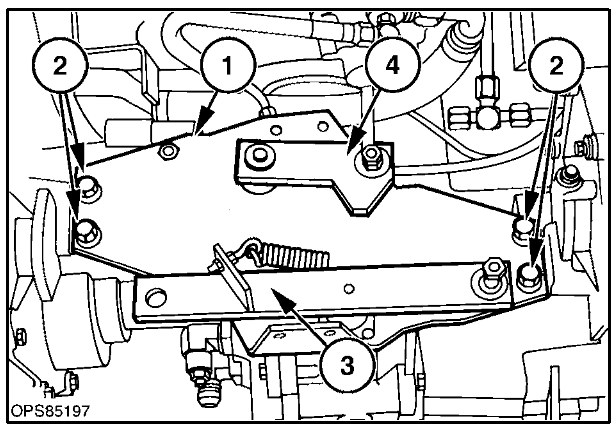
6. Install the neutralizer support bracket, 1, and secure with four attaching bolts, 2, two at each gearbox.
7. Install the front and rear control arms, 3 and 4, onto the tapered camplate pintle shafts. The short arm on the right motor, long arm on the left motor.



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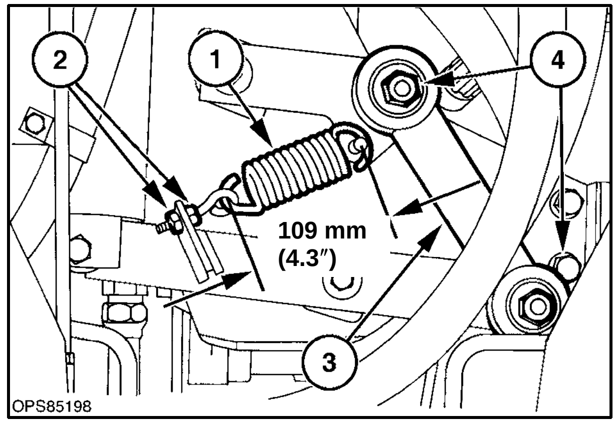
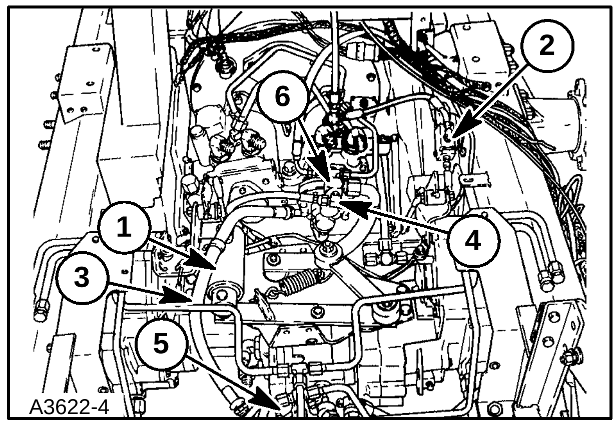
8. Install spring, 1, as shown, and adjust the drawbolt to obtain a spring length of 109 mm (4.3″). Secure with jam nuts at 2.
9. Install control link, 3, but do not tighten the hardware.
10. Make sure both the front and rear control arms are rotated clockwise and held firmly against the internal motor stops by spring, 1.
11. With the arms in this position, tighten the control link hardware at 4.



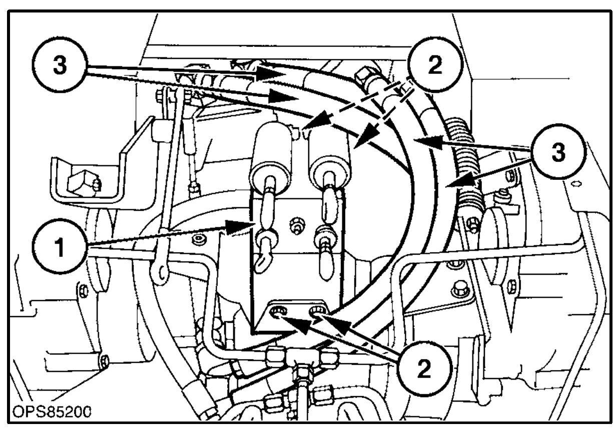
223

12. Reinstall the slave cylinder, 1. Connect the supply hose, 2, from the two-speed control valve to the rear of the cylinder.
13. Reconnect the high-pressure hydraulic hose, 3, between the gear pump, 4, and the main control valve, 5.
14. Reinstall the case drain tube that runs beneath the motor assemblies. The tube connects at the front of the left motor and at the rear of the right motor. A hose assembly runs from the tee fitting at the rear of the right motor to the inlet fitting of the hydraulic gear pump at 6.



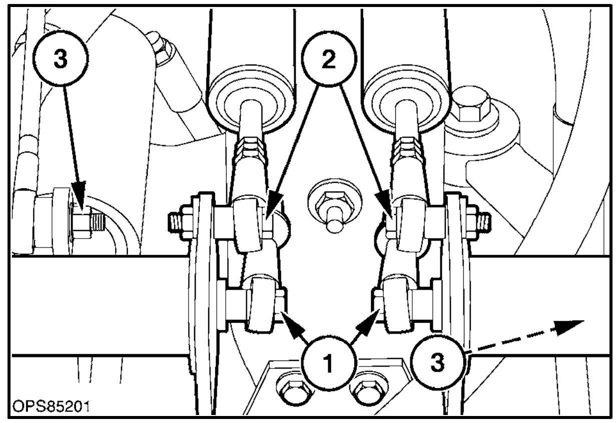
224

15. Install the neutralizer assembly, 1, and secure with four cap screws, 2; two at the front and two at the rear.
16. Install the high-pressure hydrostatic hoses, 3, from the pumps to the motors and tighten securely. When tightening fittings, first align hoses and tubes for clearance and tighten to seat fittings, then loosen and retorque.



225

17. Reinstall the hydrostatic control handle assemblies, if removed.
18. Reconnect the neutralizer assemblies, 1, the dampener shocks, 2, and control rods, 3.
19. For neutral adjustment, refer to the “Control Linkage” section of this manual for the proper procedure and adjustments.
20. After a rebuild of any hydraulic or hydrostatic component, refer to the “Start-Up Procedure” section of this manual for the correct start-up procedure.
21. Put the Service/Run switch in the “SERVICE” position.
22. Operate the unit and check for oil leaks and repair if needed.

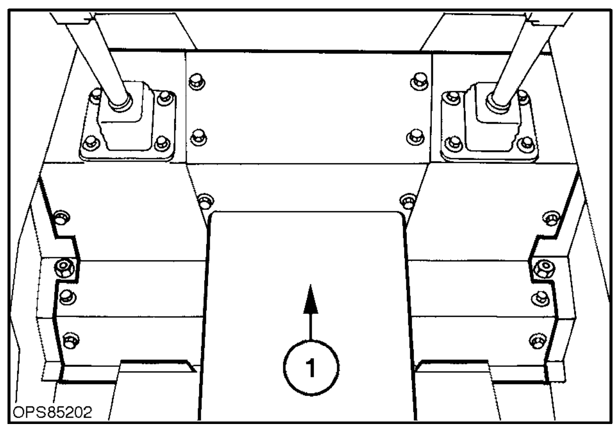


226

CAUTION

Securely support the skid steer with all four wheels off the ground, or movement of the skid steer may cause serious injury or damage to the equipment.

23. Tilt the cab and boom back into position, if tilted forward.
24. Reinstall the step shield, 1, fenders, etc., removed for the repair.
25. Fill the hydraulic system (reservoir) with SAE 10W-30 oil.



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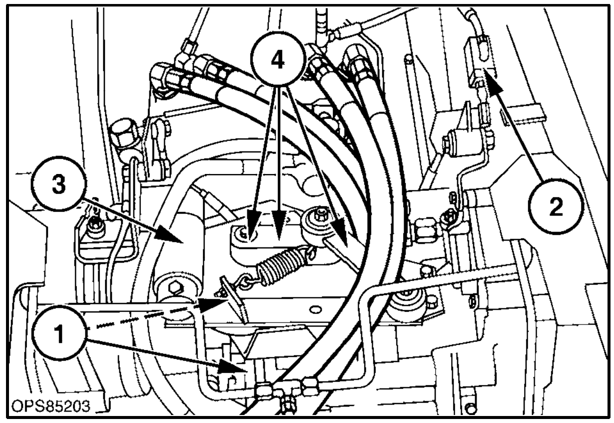
Op. 29 134

TWO-SPEED HIGH/LOW RANGE COMPONENTS

The Two-Speed, high/low range system consists of five main components:

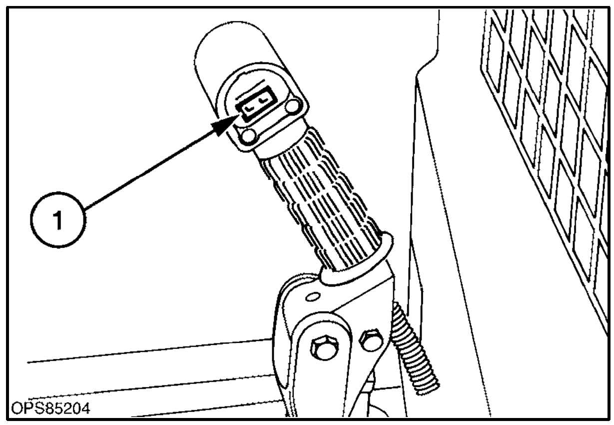
1. Two-Speed Drive Motors - Refer to “Hydrostatic Motor” Section.
2. Two-Speed Control Valve.
3. Two-Speed Slave Cylinder.
4. Two-Speed Motor Control Linkage.
5. Two-Speed Control Switch (on handle).

This feature gives the operator a wider range of travel speeds, low range for normal operations, and high range for travel between job sites.



228

The Two-Speed control switch is located in the handle of the right-hand hydrostatic control. The switch, 1, is thumb operated and protected by the handle assembly.



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Two-Speed Transmission Motor Shifting and Adjustment

- Transmission motors may not immediately shift to low range from high range when the electric switch is activated. Eye bolt, 4, may be broken.
- The machine may not run straight with handles in full forward or full reverse.

The two-speed transmission motors shift from low range to high range, using a single-acting hydraulic cylinder. When the switch is actuated to return to low range, spring, 1, pulls both transmission arms, right drive, 2, and left drive, 3, to low. Eye bolt, 4, may be broken and results in spring, 1, becoming disconnected. Eye bolt, 4, was 5/16″ (part #9615127).

A 3/8″ eye bolt (part #86526562) is now in production. The arm, 2, eye bolt mounting hole will have to be enlarged to accept the larger 3/8″ bolt.

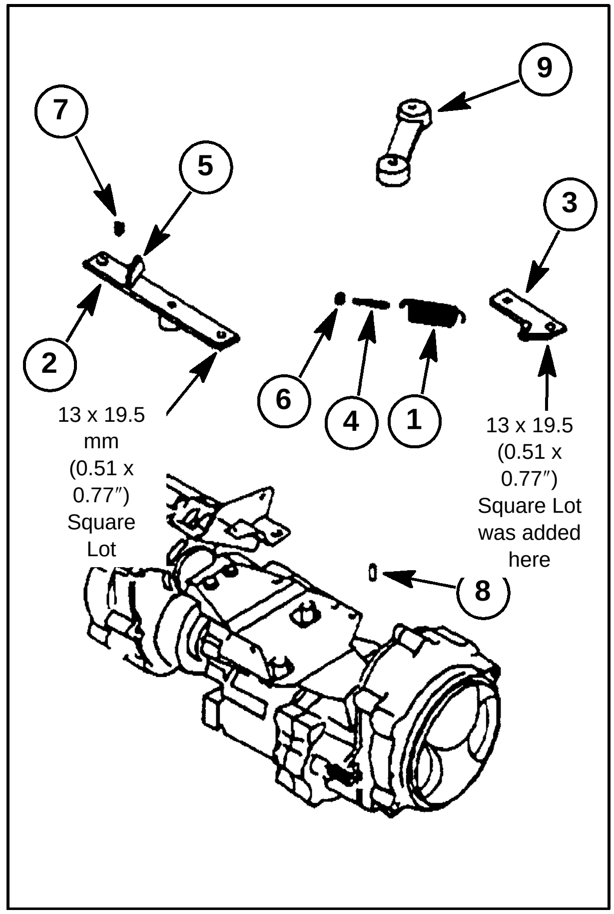
Additionally, a standard 3/8″ nut, 6, is used on the spring side of the eye bolt, and two 3/8″ nuts, 7, are used as jam nuts.

If the machine will not travel straight in forward or reverse, with levers adjusted at the steering lever stops beside the seat, the two-speed linkage should be inspected. Check that the arms, 2 and 3, are secured tightly to the motor shaft, and a key, 8 , in place on each tapered shaft.

The following adjustment procedure should be used to adjust the two-speed linkage between the two final drive motors:

1. Install arms, 2 and 3, to the pintle shafts of the hydraulic motors, using square keys and Grade 8, fine-thread bolts.
2. Install spring, 1, between the welded rivet on arm, 3, and the eye bolt, 2. Adjust the eye bolt to obtain the spring length of 109 mm (4.3″) as shown. Secure the eye bolt with jam nuts.
3. Loosely install connecting arm, 8, between arms, 2 and 3, mounted on the motors.
4. Make sure both arms are rotated clockwise and are held firmly against the internal motor stops by the spring.
5. With the arms in this location, tighten hardware on both ends of link, 9.

The square slot dimensioned 13.0 mm x 19.5 mm (0.51″ x 0.77″) in the end of arm, 2, has been in all production parts. A change was made to arm, 3. The square hole was changed to a 13.0 mm x 19.5 mm (0.51″ x 0.77″) slot and the orientation of the hub was changed by one degree. There were no part number changes made.



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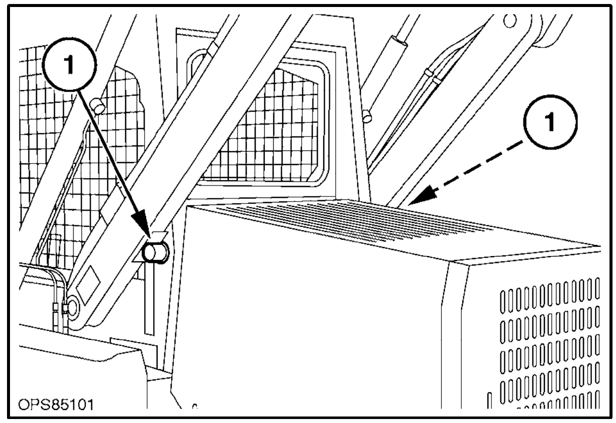
TWO-SPEED HIGH/LOW CONTROL VALVE

Before adjustments or repairs can be made to the skid steer, two-speed high/low system components, do the following:

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1.



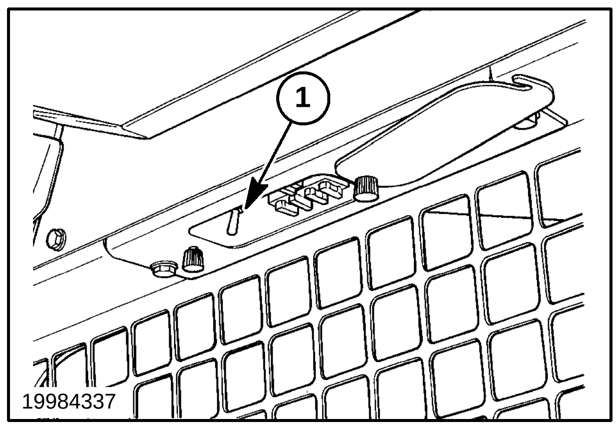
231

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

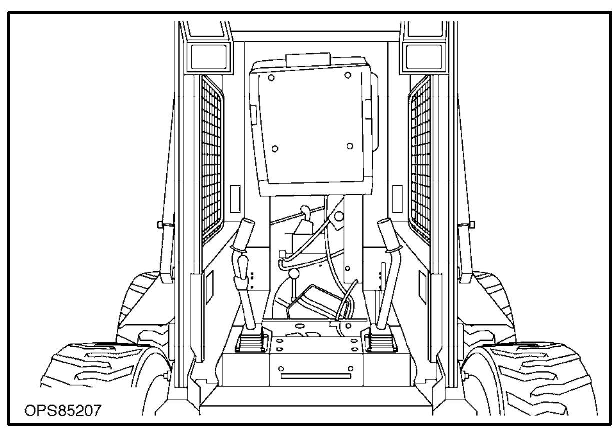
Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.

2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the "SERVICE" position.
4. Engage the parking brake.



232

5. Raise the operator's seat and latch in the raised position.

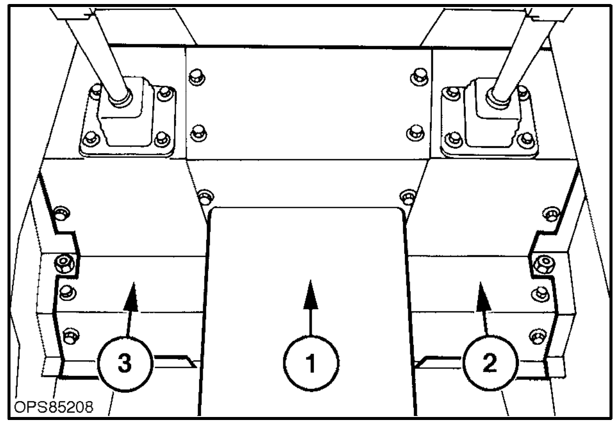


233

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

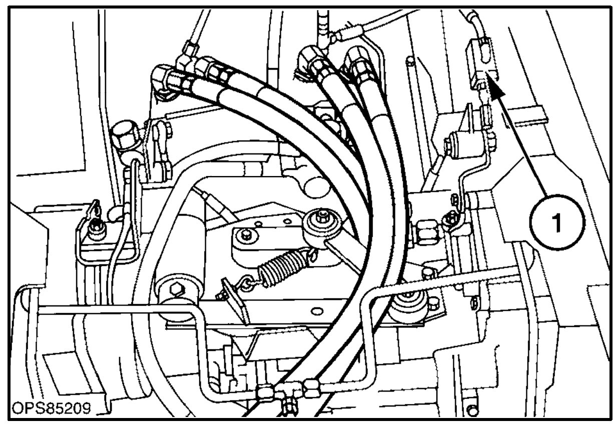
6. Remove the step shield, 1, to access the hydrostatic pump and motor area. For more access, remove the right or left hydrostatic control handle assembly, 2 or 3.



234

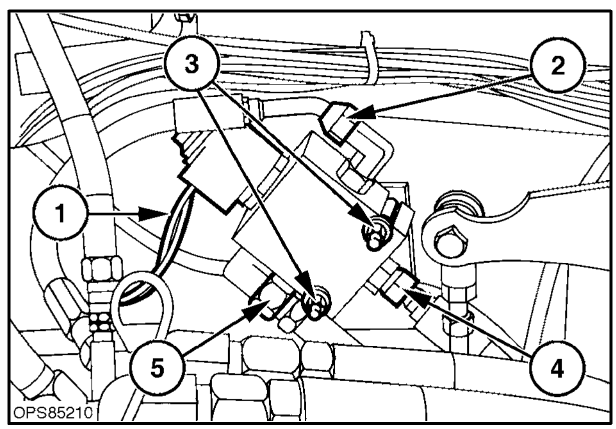
REMOVAL

1. The control valve, 1, is mounted to the left chain case along the inside edge next to the hydrostatic pumps.



235

2. To remove the control valve, disconnect the electrical connection, 1. Wires from the harness are light blue and black (Lt Blu/Blk).
3. Disconnect the hydraulic supply line to the valve at 2, the hydraulic supply line to the slave cylinder at 4, and the return line to the hydraulic gear pump at 5. Cap all hoses and fittings to prevent dirt from entering the system.
4. Remove the two attaching bolts, 3, and remove the valve.



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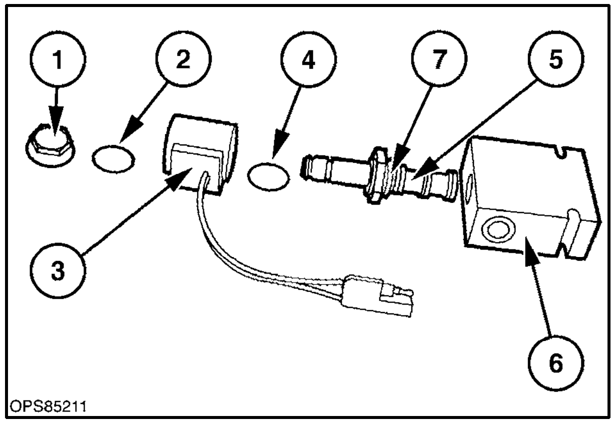
DISASSEMBLY

1. Thoroughly clean the outside of the control valve assembly prior to disassembly. Plug all ports to prevent solvent from entering the valve.
2. Remove retainer, 1; top O ring, 2; coil assembly, 3; bottom O ring, 4; and cartridge assembly, 5, from control valve body, 6.
3. Remove O ring, 7, from cartridge assembly, 5.
4. If there are no noticeable leaks around the hydraulic fittings, do not remove.

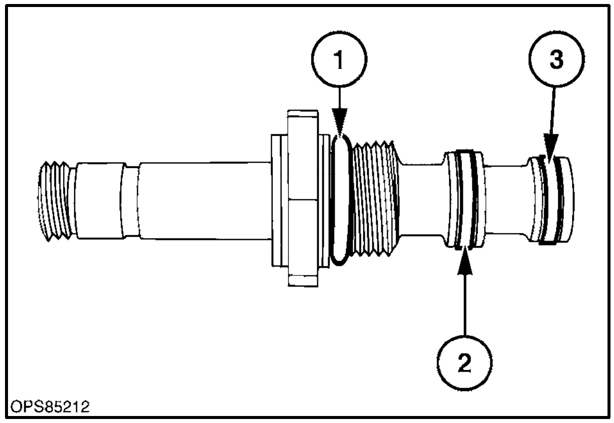


237

INSPECTION

Clean all parts in a suitable solvent and air dry prior to inspection.

1. Inspect the cartridge assembly O rings and seals at 1, 2, and 3. O ring, 1, is part of the seal kit, and will be replaced during reassembly.
2. Inspect O rings 2 and 3, they should not be broken or nicked. These must seal properly for the valve to operate correctly. Replace if necessary.



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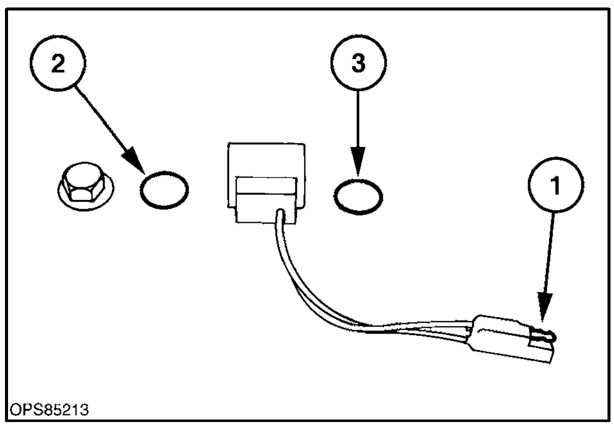
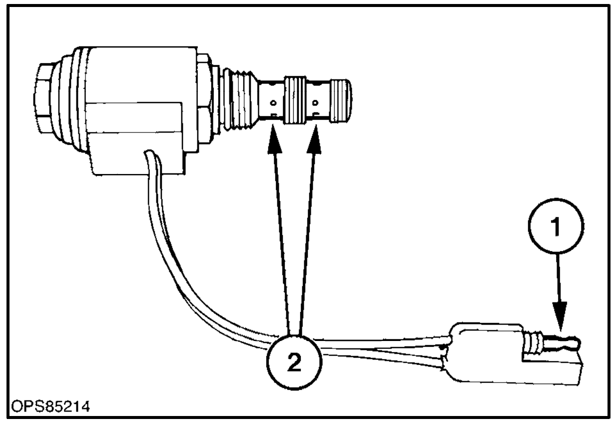
3. Using a VOM, check continuity across the coil leads at 1. There must be continuity. Also check the resistance. A reading of 7.2 ohms, plus or minus .2 ohms, indicates a good coil.
4. Apply 12 volts to the coil leads, 1. Maximum amperage draw should be 1.5 - 2.0 Amps.
5. Replace if necessary.
6. The upper and lower waterproofing O rings, 2 and 3, should be replaced during reassembly.



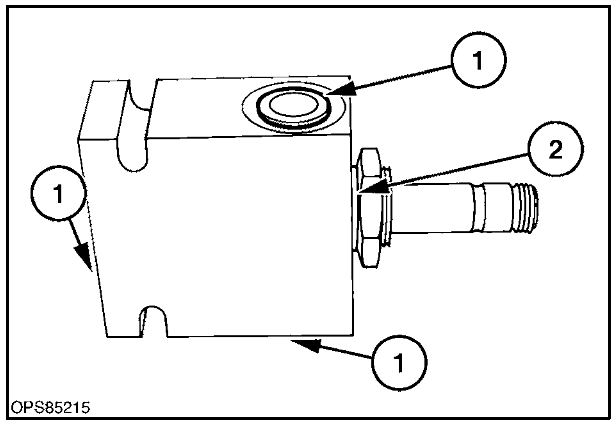
239

7. Assemble the coil onto the cartridge assembly and apply 12 volts to the coil leads, 1. A clicking sound should be heard and movement of the plunger in the cartridge noticed at 2.
8. If no sounds are heard or no movement noticed, replace the cartridge assembly.



240

9. Inspect all ports, 1, in the valve body for dirt or debris.
10. Inspect the cartridge port, 2, for scratches or damage.
11. Replace parts as needed.

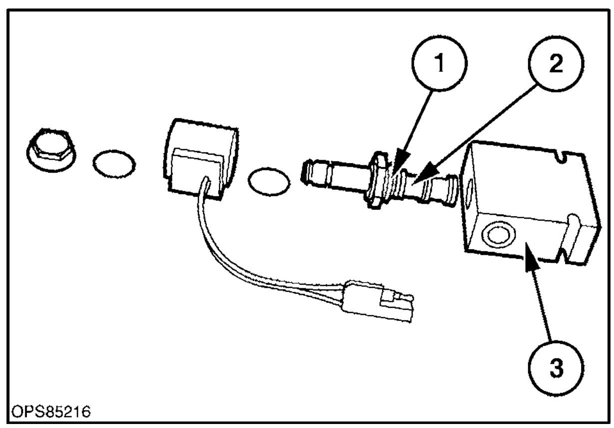


241

REASSEMBLY

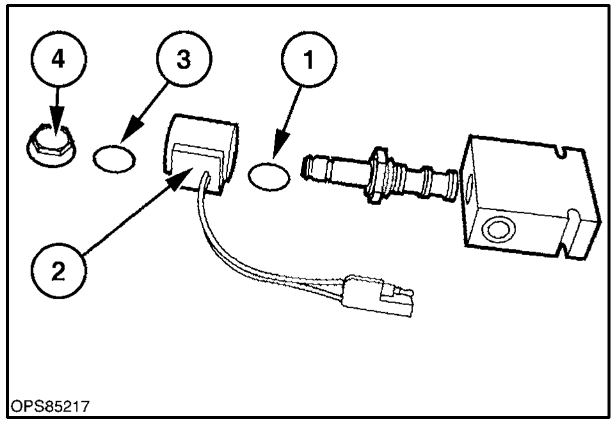
Be sure all parts are clean and air-dried before reassembly.

1. Install a new O ring, 1, on the valve cartridge, 2. Coat the lower portion of the cartridge with 10W-30 oil and screw into the valve body, 3. Torque to 22 - 27 N·m (16 - 20 ft. lbs.).



242

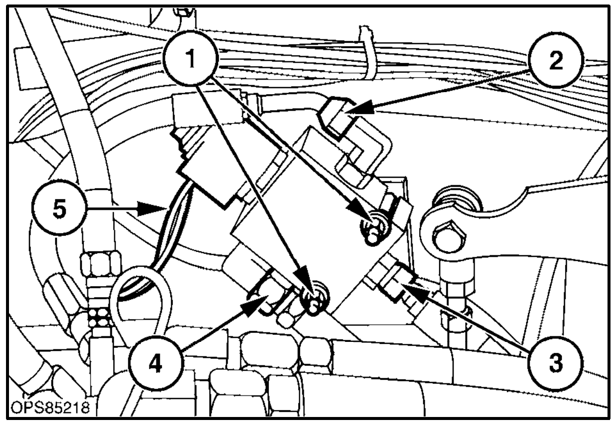
2. Install a new lower O ring, 1, coil assembly, 2, new upper O ring, 3, and retainer nut, 4. Torque nut to 5 - 7 N·m (4 - 5 ft. lbs.).



243

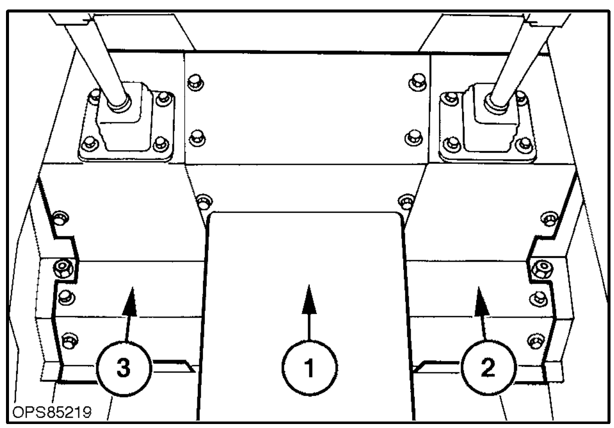
CONTROL VALVE REINSTALLATION

1. Position valve on mounting bracket as shown along the inside of the left chain case. Secure with two attaching bolts, 1.
2. Reconnect the hydraulic supply line, 2, the supply line to the slave cylinder, 3, and the return line to the hydraulic gear pump, 4.
3. Reconnect the coil wires, 5, to the main wiring harness.



244

4. Reinstall the hydrostatic control handle assemblies, 2 and 3, if removed, and the step shield, 1.
5. Return the operator's seat to its correct position.



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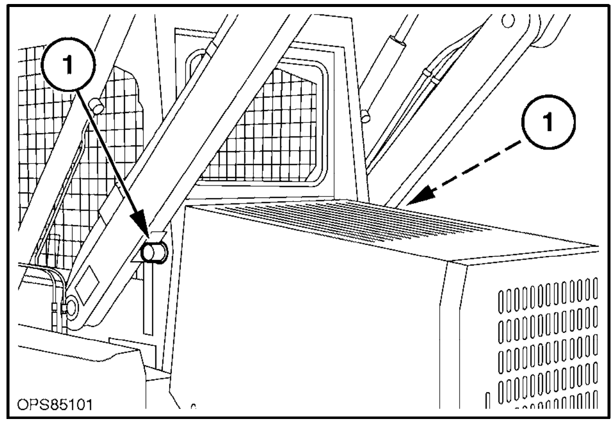
TWO-SPEED HIGH/LOW SLAVE CYLINDER

Before adjustments or repairs can be made to the skid steer, two-speed high/low system components, do the following:

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1.



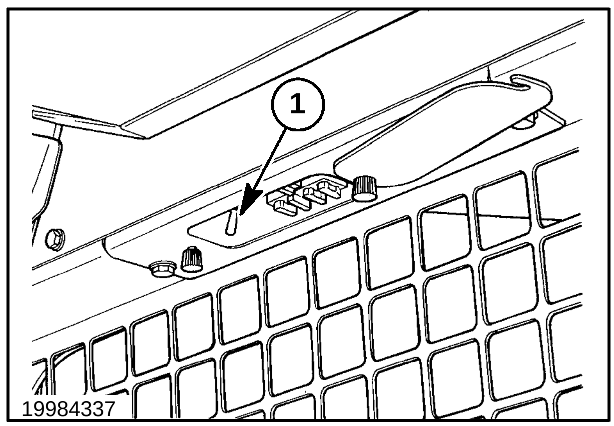
246

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

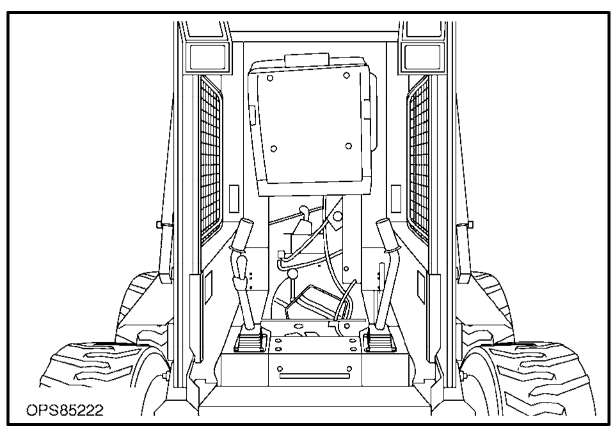
Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.

2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the “SERVICE” position.
4. Engage the parking brake.



247

5. Raise the operator’s seat and latch in the raised position.

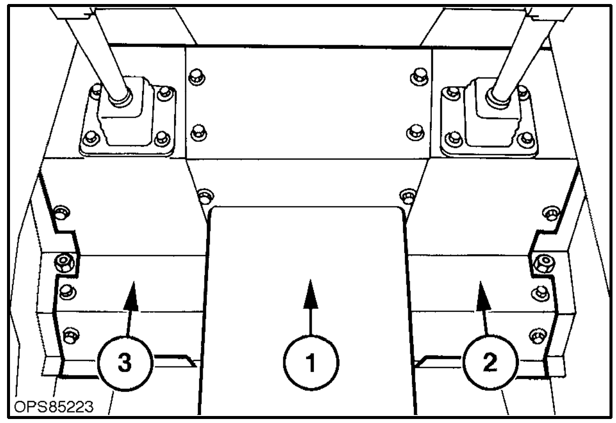


248

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

6. Remove the step shield, 1, to access the hydrostatic pump and motor area. For more access, remove the right or left hydrostatic control handle assembly, 2 or 3.

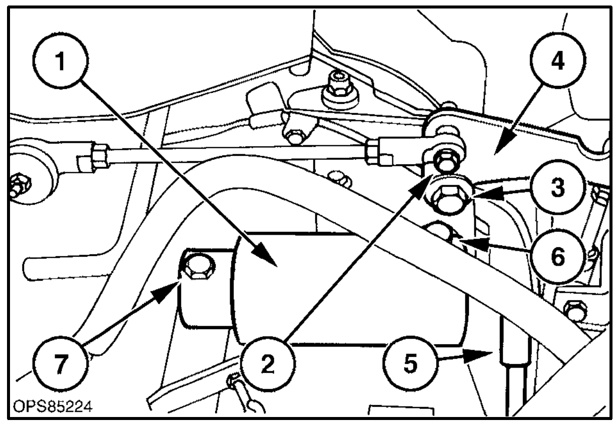


249

REMOVAL

1. The two-speed slave cylinder, 1, is located directly above the right hydrostatic motor.
2. Remove control rod attaching bolt, 2, and control link pivot bolt, 3. Rotate the control link, 4, back out of the way.
3. Disconnect the supply line to the slave cylinder, 5, and cap the ends.
4. Remove cap screws, 6, at rear of cylinder, and, 7, on the cylinder rod end. Note the position of the washers and spacers as they are removed. Remove cylinder.

IMPORTANT: *Do not remove cylinder retaining hardware until all pressure is released from the cylinder.*



250

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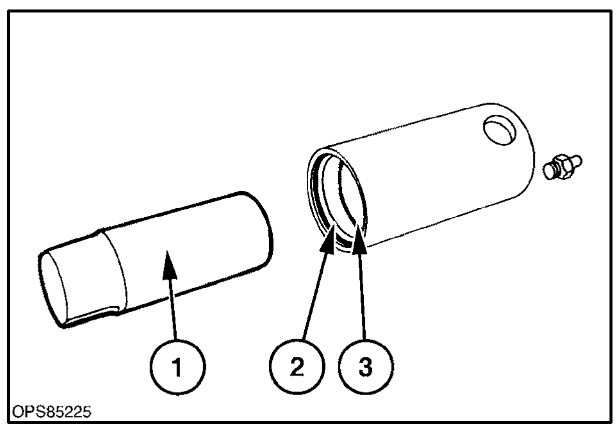
DISASSEMBLY

1. Remove piston rod, 1.
2. Remove rod seals, 2 and 3.

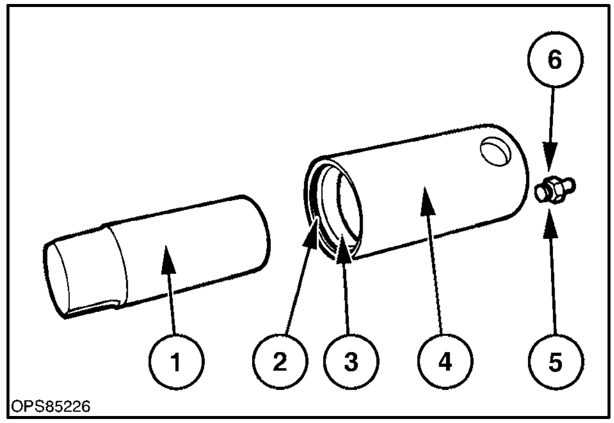


251

INSPECTION

Clean all parts in a suitable solvent and air dry prior to inspection.

1. Inspect piston rod, 1, for wear, scratches and nicks that could damage or cut the seals during reassembly.
2. Inspect the cylinder bore, 4, for damage or wear.
3. Inspect the seals, 2 and 3, for wear or damage. Replace seals if necessary.
4. If leakage is noticed at the inlet fitting, 5, remove and inspect O ring, 6, for damage. Replace if necessary.

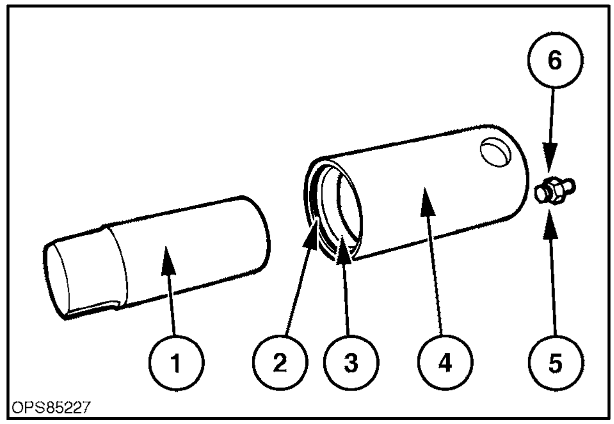


252

REASSEMBLY

Be sure all parts are clean and air-dried before reassembly.

1. Install new seals, 2 and 3, if needed.
2. Apply clean 10W-30 oil to all contact surfaces of the piston rod, cylinder, and seals.
3. Insert the piston rod, 1, into the cylinder, 4, making sure not to damage the seals.
4. Install a new O ring, 5, on hydraulic fitting, 6. Install fitting.



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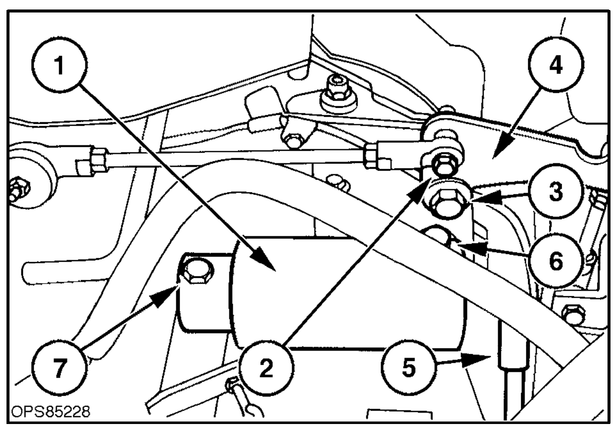
SLAVE CYLINDER REINSTALLATION

1. Align the cylinder, 1, in the mounting bracket and install the washers, spacers, and attaching bolts, 6 and 7, in the order they were removed.
2. Reconnect the hydraulic supply line, 5, to the cylinder.
3. Realign the control link, 4, and install the control link pivot bolt, 3, and control rod attaching bolt, 2.
4. Reinstall the hydrostatic control handle assemblies, if removed. Replace the step shield.
5. Return the operator’s seat to its correct position.



254

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TWO-SPEED HIGH/LOW MOTOR CONTROL LINKAGE

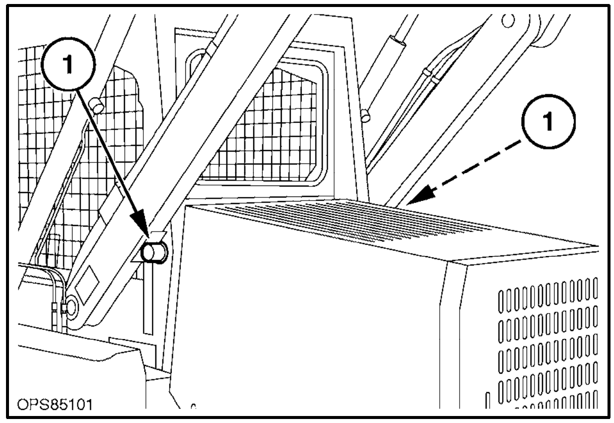
Before adjustments or repairs can be made to the skid steer, two-speed high/low system components, do the following:

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1.

CAUTION

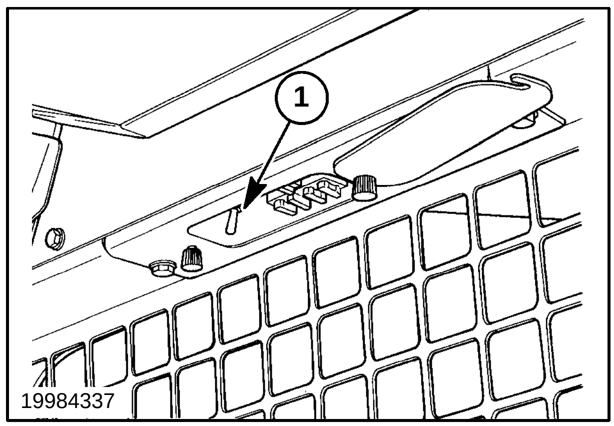
Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.



255

2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the “SERVICE” position.
4. Engage the parking brake.

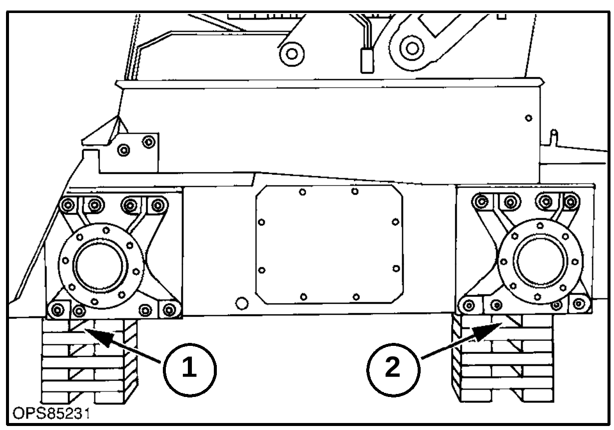


256

5. Securely block the skid steer with all four wheels off the ground. Support at the front, 1, and rear, 2, of the final drive cases.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer causing serious injury or damage to the equipment.

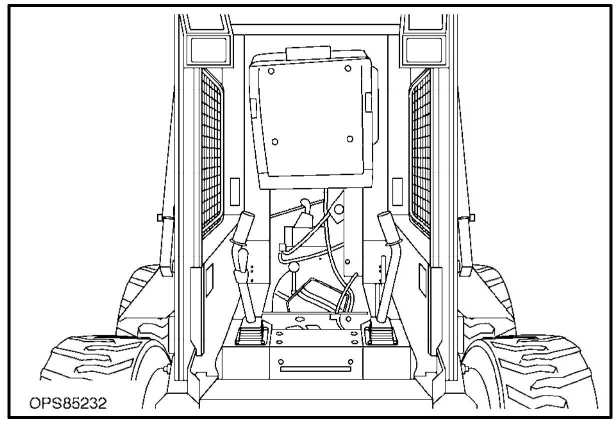


257

6. Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.



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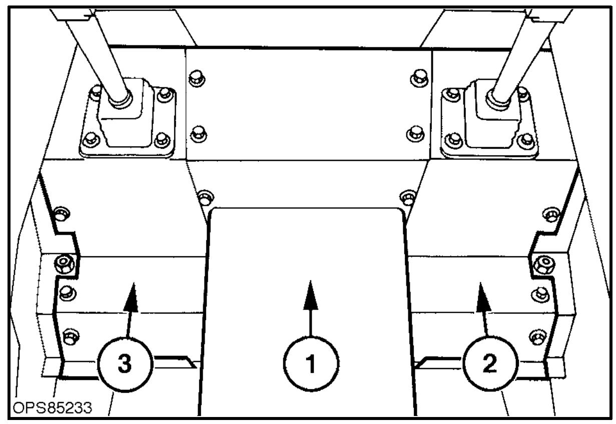
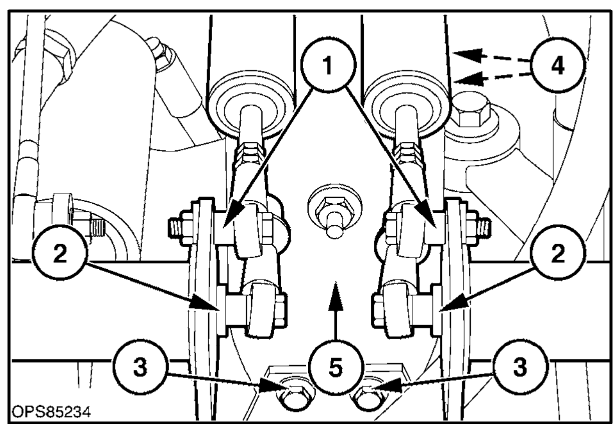
7. Remove the step shield, 1, to access the hydrostatic pump and motor area. For more access, remove the right or left hydrostatic control handle assembly, 2 or 3.



259

REMOVAL

1. Disconnect the dampener shocks at 1, and the neutralizer assemblies at 2.
2. Remove the four neutralizer assembly attaching bolts, two at front, 3, and two at rear, 4. Lift the entire neutralizer assembly, 5, out in one piece.



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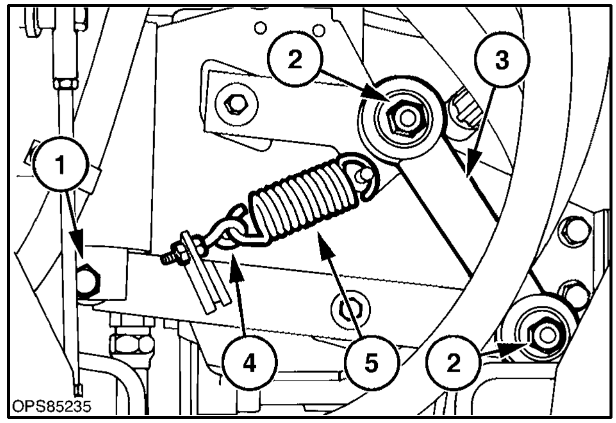
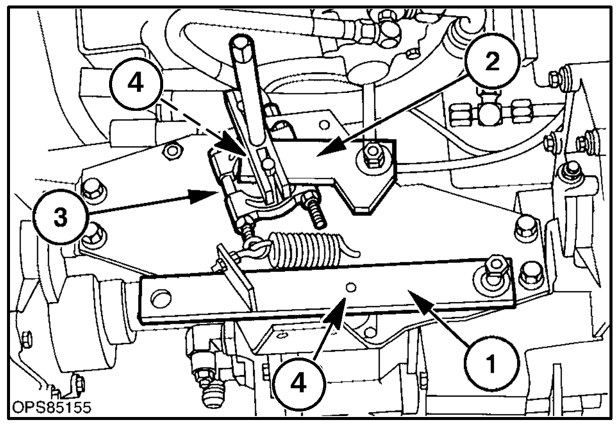
3. Remove the cylinder rod bolt at 1.
4. Undo the bolts at 2, and remove the control link, 3.
5. Loosen the drawbolt, 4, and remove the spring, 5.



261

6. Remove the front and rear control arms, 1 and 2. These arms are attached to a tapered camplate shaft and should be removed using a puller arrangement as shown at 3.

NOTE: *The holes, 4, in both motor cam plate arms may be tapped and a cap screw used to remove arms.*



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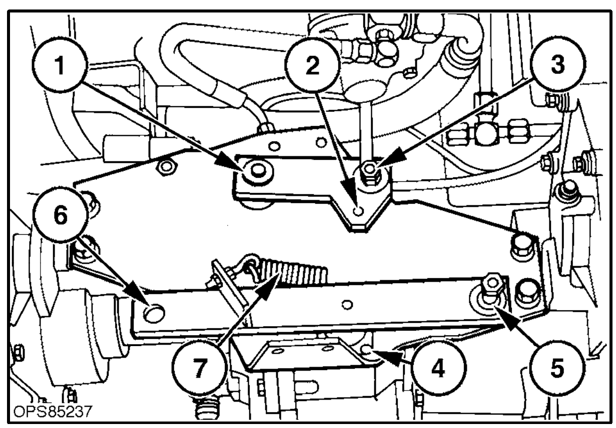
INSPECTION

1. Inspect the rear control arm shaft hub, 1, for wear on the taper and keyway. Check the spring attaching pin, 2, for wear, and inspect the bolt hole at 3, to make sure it's not worn or enlarged.
2. Inspect the front control arm shaft hub, 4, for wear on the taper and keyway. Check for worn or enlarged bolt holes at the control link attaching point, 5, and the cylinder attaching point, 6.
3. Inspect the spring, 7, for stretch and for wear at the end hooks.



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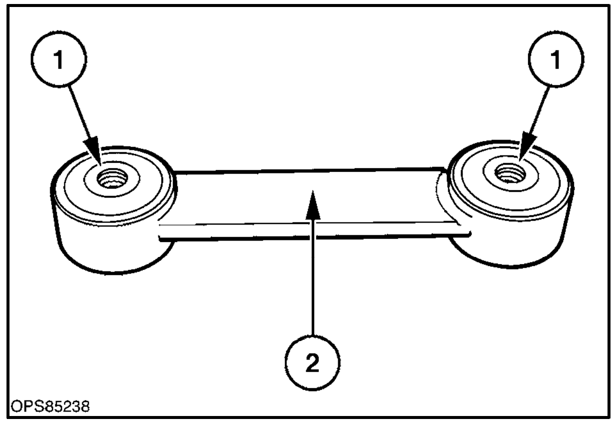
4. Inspect the bushings, 1, in the control link, 2. If the bushings are worn, loose, or damaged, replace the control link.
5. 5. Check for worn or damaged hardware.



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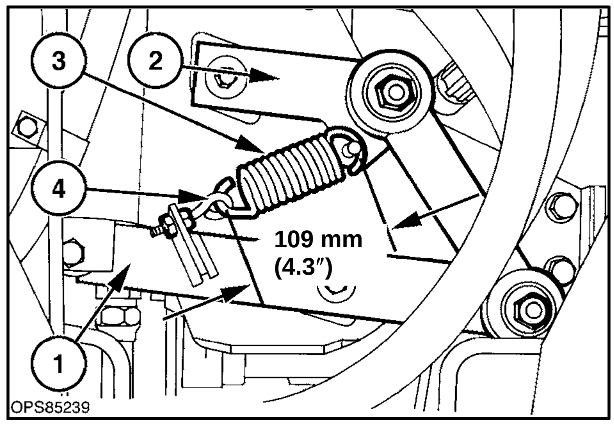
CONTROL LINKAGE REINSTALLATION

1. Install the front and rear control arms, 1 and 2, to the tapered camplate pintle shafts. The short arm on the right motor, long arm on the left motor.
2. Install spring, 3, as shown, and adjust the drawbolt to obtain a spring length of 109 mm (4.3″). Secure with jam nuts at 4.



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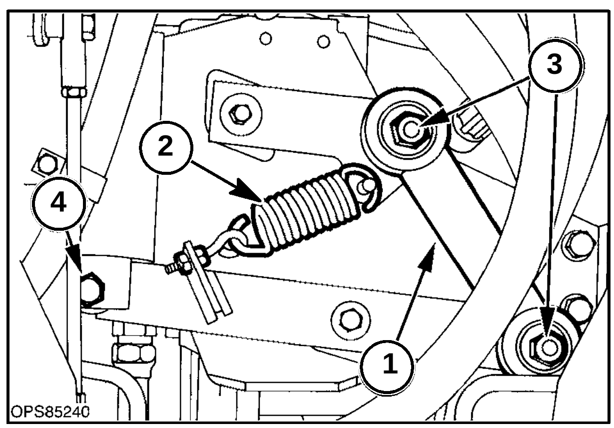
3. Install control link, 1, but do not tighten the hardware.
4. Make sure both the front and rear control arms are rotated clockwise and held firmly against the internal motor stops by spring, 2.
5. With the arms in this position, tighten the control link hardware, 3.
6. Install cylinder rod bolt, 4.



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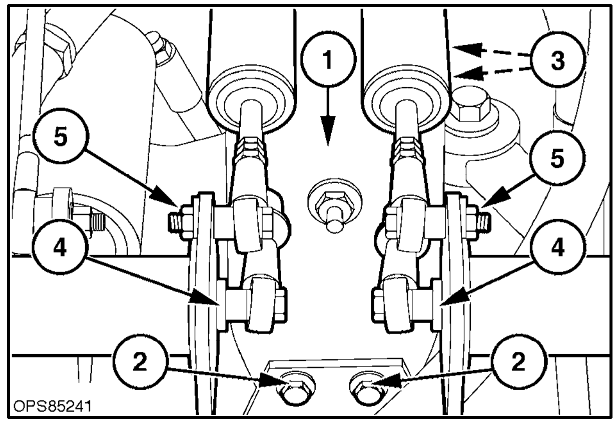
7. Reinstall the neutralizer assembly, 1, by installing the four neutralizer assembly attaching bolts, two at front, 2, and two at rear, 3.
8. If removed, reinstall the hydrostatic control handle assemblies.
9. Connect the neutralizer assembly to the control handles at 4, and the dampener shocks at 5.



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TWO-SPEED CONTROL SWITCH

The two-speed control switch, 1, located in the right hydrostatic control handle, supplies power to the two-speed control valve when the switch is shifted to the high speed position.

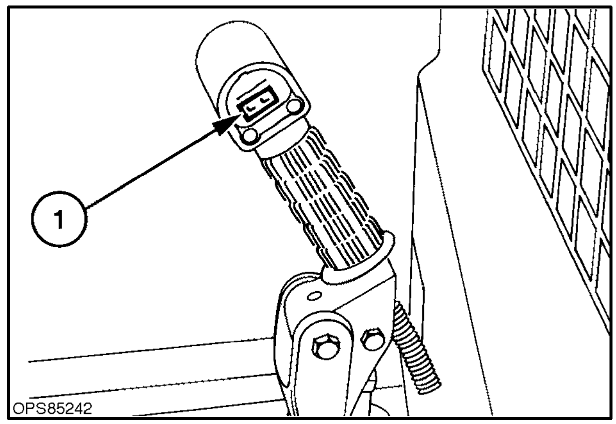
Wiring from the harness is dark green/red and light blue (DK GN/R, LT BL). A white and black (W, B) wire run from the switch to the harness connector.

To check the switch, use a VOM to check continuity at the white and black wires. There should only be continuity with the switch in the high speed position.

Replace the switch if necessary.

With the skid steer still securely blocked with all four wheels off the ground, start the engine and operate the control switch. Check for correct operation of the valve, cylinder and control linkage.

Install the step shield and return the operator’s seat to its correct position.



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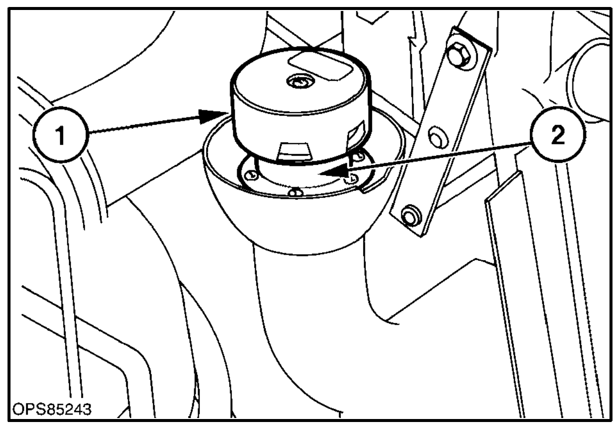
HYDRAULIC SYSTEM CLEANING PROCEDURE

After A Hydraulic System Or Transmission Overhaul

The hydraulic/hydrostatic system must be cleaned if contamination caused a problem and the transmissions show wear on the pistons and shoes, rotating piston blocks, valve plate or cam plate.

IMPORTANT: *Do not use the gear pump and gerotor charge pump to flush the system with solvent. The solvent will not provide enough lubrication to protect moving parts inside the transmissions or gear pump.*

1. Drain all remaining oil from the hydraulic system.
2. Remove the fill breather cap, 1, and screen, 2, by removing the six retaining screws from the reservoir fill neck. Thoroughly clean the screen, the area around the screen, and the fill breather cap in solvent.



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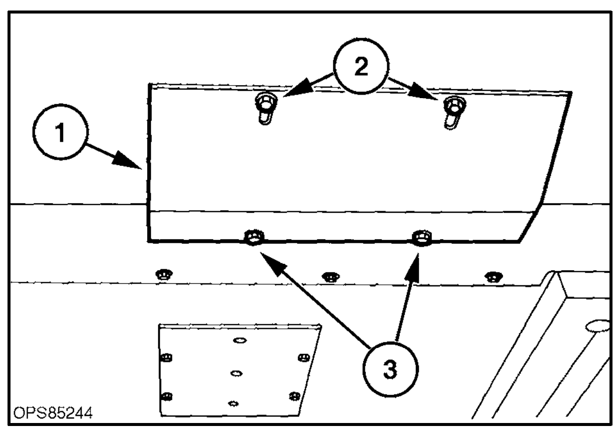
3. Drain and flush the hydraulic oil reservoir.
   a. Remove the small access door, 1, at the front right corner of the belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



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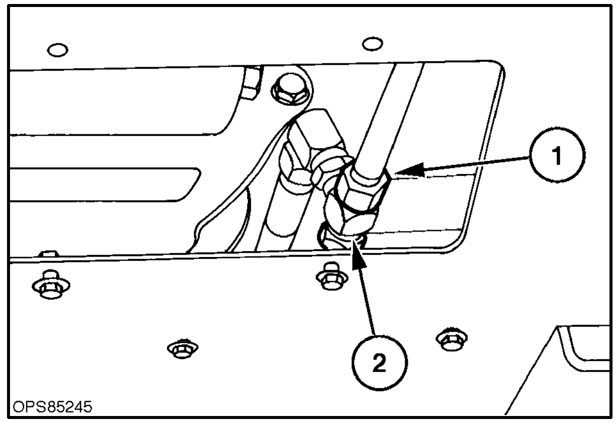
b. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.

c. Thoroughly flush the reservoir with a suitable clean solvent or clean, SAE 10W-30 oil.



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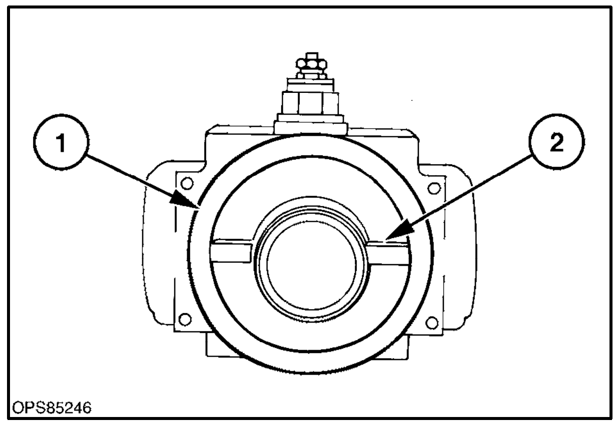
4. Thoroughly flush the oil cooler with solvent by forcing the solvent through the cooler.
5. Remove the oil filter and base, clean the base, 1, and check the bypass valve, 2, for operation.
6. Clean and flush all hydraulic lines. If the failure was hydrostatic, be sure to flush and clean the high pressure hoses from the pumps to the motors.



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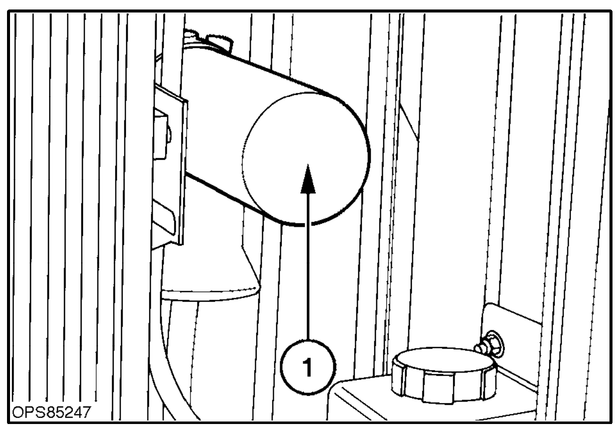
7. After the system is cleaned, thoroughly flush out the solvent used to clean the system with fresh, clean SAE 10W-30 oil.
8. Reconnect all lines removed for cleaning.
9. Install a new oil filter, 1.
10. Before start-up, fill the hydraulic system, pumps, motors, etc., as full as the case drain lines permit with SAE 10W-30 oil.



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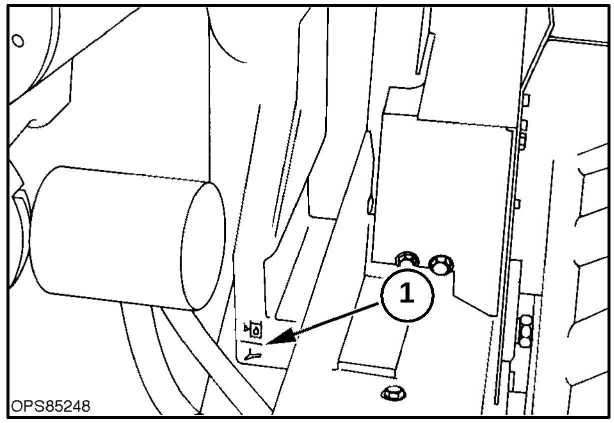
11. Fill the hydraulic oil reservoir with clean SAE 10W-30 oil. Check the oil level at 1.



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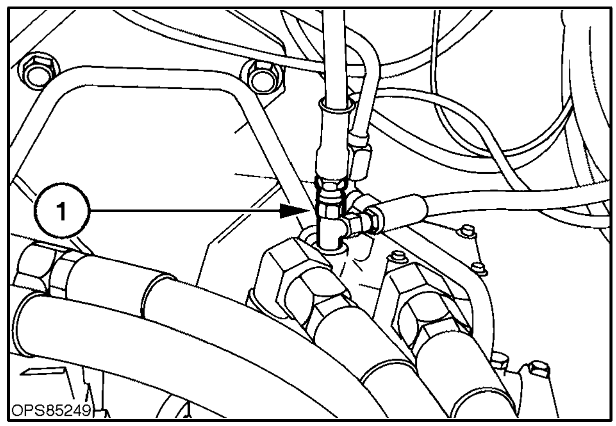
START-UP PROCEDURE AFTER REBUILD (AFTER PUMP OR MOTOR REPLACEMENT)

After replacement or repair of a hydrostatic pump or motor, and prior to start-up, the “Hydraulic System Cleaning Procedure” should be performed. This will clean the system of contaminants or water that may have entered the system during repair.

1. Check all hydraulic/hydrostatic lines to be sure they are tight.
2. Fill the hydraulic reservoir with SAE 10W-30 oil the proper level, as indicated on the back of the reservoir.
3. Install a 0 - 50 bar (600 psi) gauge in the charge pressure line at 1.



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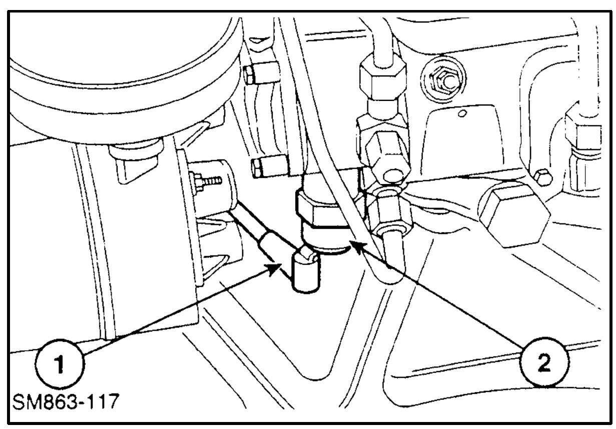
4. Remove the fuel solenoid power wire, 1, from the fuel solenoid, 2, to prevent the engine from starting.
5. Put the steering control levers in the neutral position and set the parking brake.



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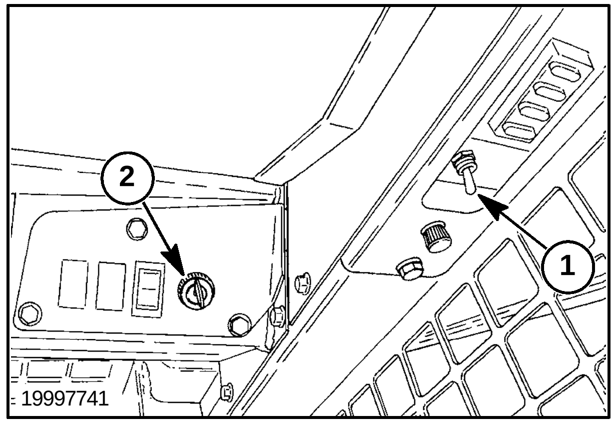
6. Put the Service/Run switch, 1, in the “SERVICE” position.
7. Turn the ignition key, 2, to the start position, and allow the engine to crank for 30 seconds at a time, until the pressure gauge starts to move. If the gauge does not move after trying three times, loosen the gear pump pressure line at the control valve to bleed the air from the hydraulic system.

   Re-crank the engine until the gauge moves. After the gauge moves, stop cranking and reconnect the fuel solenoid wire.



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CAUTION

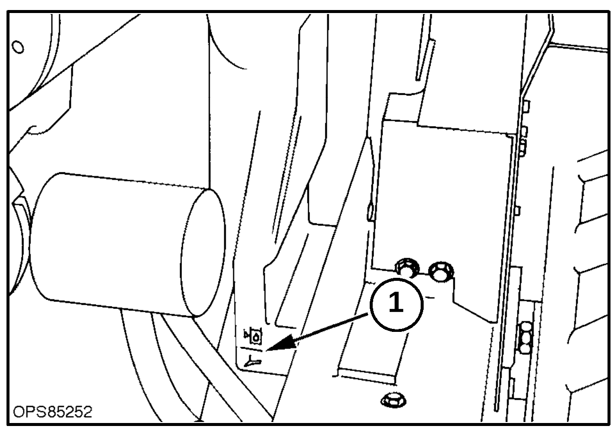
Do not crank the starter for more than 30 seconds or damage to the starter may occur. Crank the starter for 30 seconds and cool 1 minute.

8. Start the engine and monitor the charge pressure gauge to ensure charge oil to the hydrostatic system. The pressure reading should be 17.2 - 20.7 bar (250 - 300 PSI).

IMPORTANT: *If charge pressure remains below 3.4 bar (50 PSI) for more than 10 seconds, stop the engine and locate the cause. If the unit is operated with low or no charge pressure, severe damage will occur to the hydrostatic system.*

   Do not stroke the hydrostatic controls or operate the boom and bucket controls at this time.

9. Start the engine and operate at 1500 RPM for approximately 30 minutes. Stop the engine; check the oil level at 1, and fill as required.



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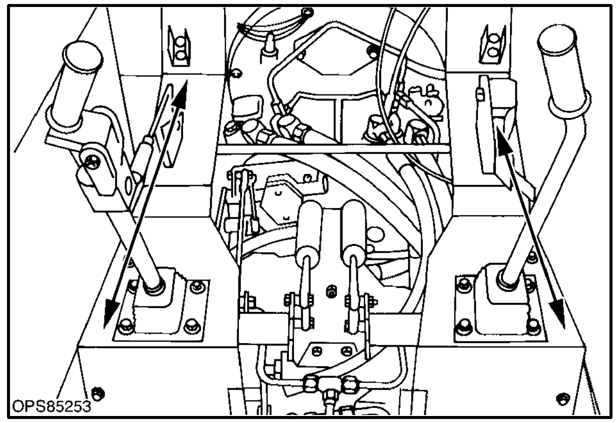
10. Restart the engine and operate at 1500 RPM. Slowly operate the hydrostatic controls to remove air trapped in the system; monitor the charge pressure. Operate the boom and bucket controls several times to remove air from the hydraulic system.
11. Stop the engine and recheck the hydraulic oil level and add as required.
12. Remove the charge pressure test gauge.



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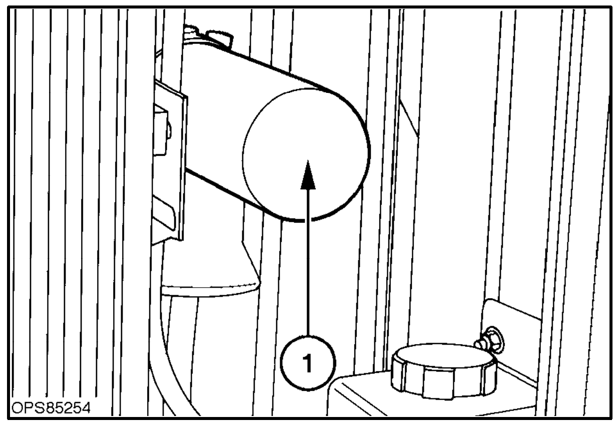
13. Adjust the neutral control linkage if required; refer to neutral adjustment procedures in this manual.
14. Run the engine at 1500 RPM for an additional 30 minutes to filter the oil. Stop the engine and change the oil filter, 1.
15. Check for oil leaks and repair as required.
16. Reinstall all shields removed for repair.
17. Lower the skid steer to the ground and operate.



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STEERING SYSTEM

HYDROSTATIC SYSTEM CONTROLS

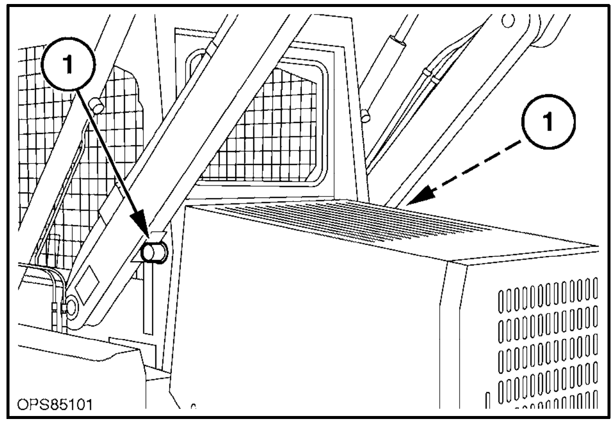
Before any control linkage adjustments or repairs are made to the skid steer, do the following:

1. Lower the boom and bucket to the lowered position, resting on the ground, or remove any attachment and raise the boom and rest on the boom lock pins, 1.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.



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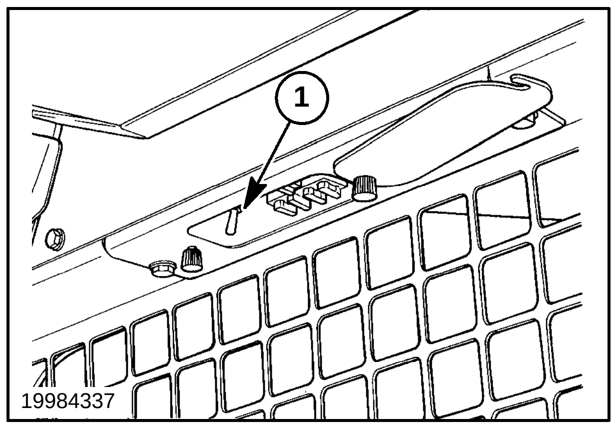
2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Put the Service/Run switch, 1, in the “SERVICE” position.
4. Engage the parking brake.



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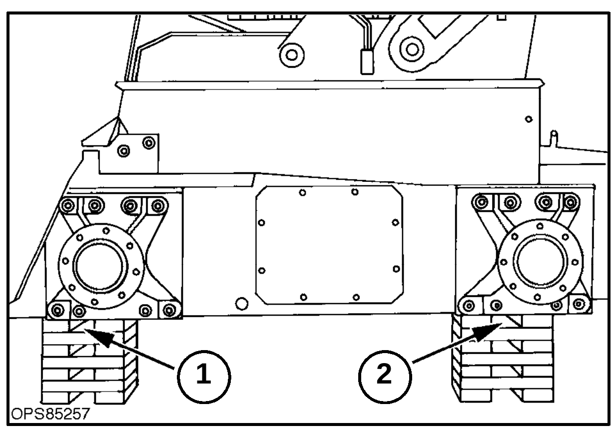
5. Securely block the skid steer with all four wheels off the ground. Support at the front, 1, and rear, 2, of the final drive cases.

CAUTION

Failure to securely support the skid steer could result in movement of the skid steer during testing causing serious injury or damage to the equipment.



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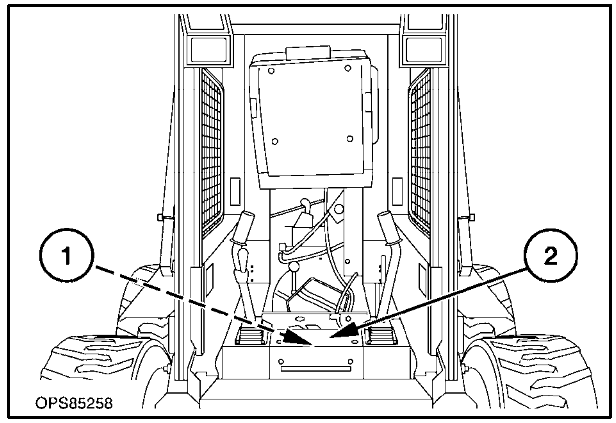
6. Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

7. Remove the step shield, 2, to access the control linkages, 1.



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NEUTRALIZER ASSEMBLY

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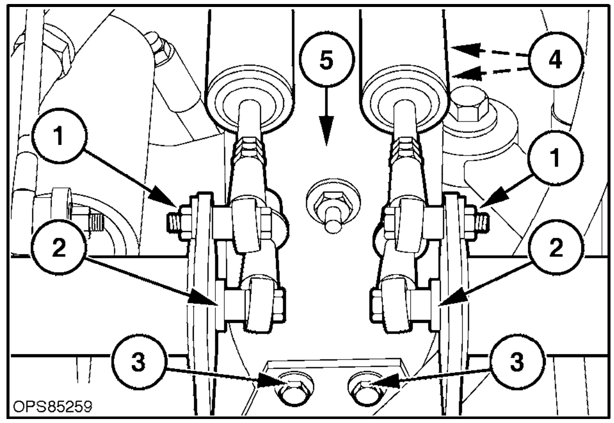
REMOVAL

1. Disconnect the dampener shocks at 1, and the neutralizer assemblies at 2.
2. Remove the four neutralizer assembly attaching bolts, two at front, 3, and two at rear, 4.
3. Lift the entire neutralizer assembly, 5, out in one piece.



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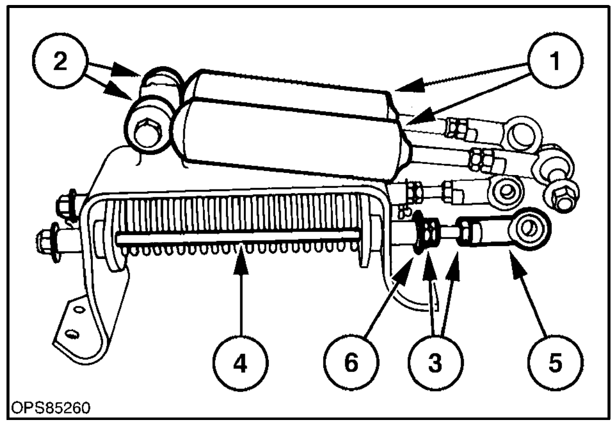
DISASSEMBLY

1. Unbolt the dampener shocks, 1, at the mounting tabs, 2, and remove.
2. Loosen the jam nuts, 3, on the neutralizer rod, 4, and unscrew ball joint end, 5.
3. Remove the three jam nuts at 3, the washer at 6, and remove the neutralizer rod, 4.
4. Repeat these steps for both rods.



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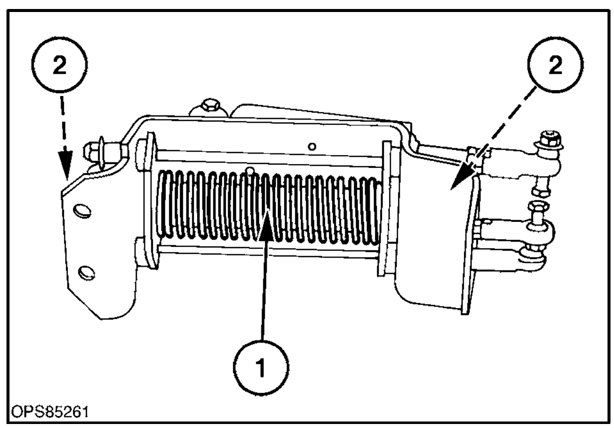
5. Remove the neutralizer spring assembly, 1, by first removing the two lube fitting cap screws, 2.

CAUTION

Spring is under tension. Use extreme care when removing.



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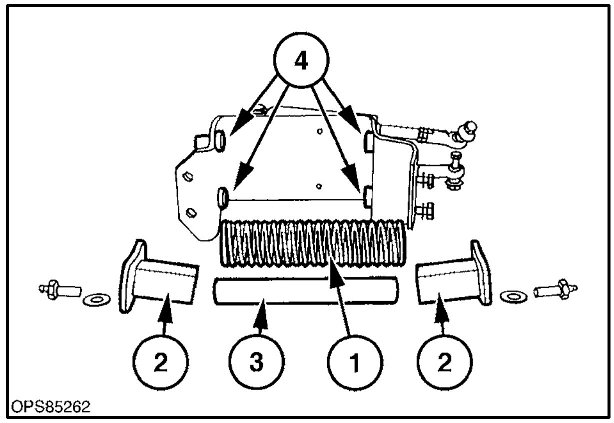
6. Carefully remove the neutralizer spring, 1, the spring guides, 2, and shaft, 3.
7. Remove the four neutralizer rod bushings, 4, and set with the rod assemblies for inspection.



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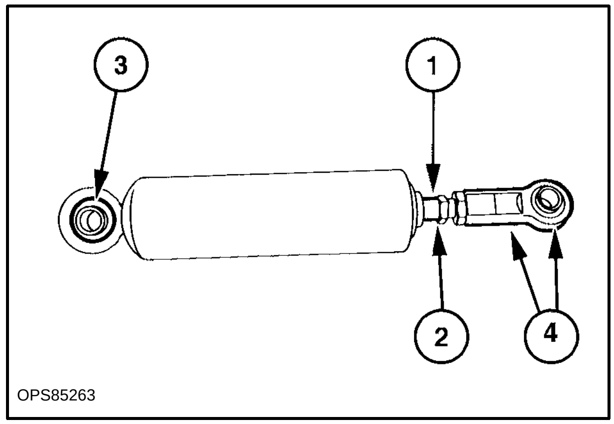
INSPECTION
Thoroughly clean all parts before inspection.



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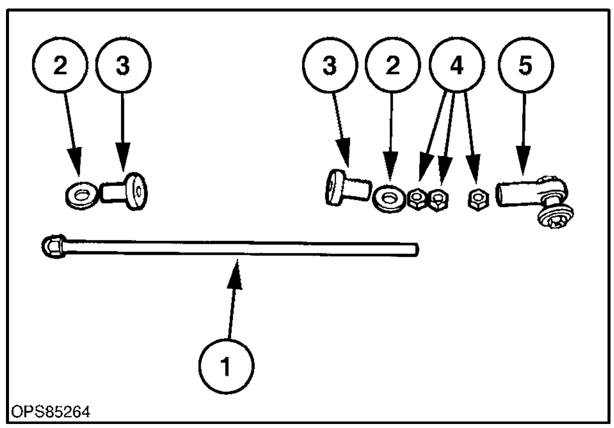
1. Inspect the dampener shocks for equal pressures for both extending and retracting. Check for leakage around the rod seals at 1.
2. Check for a bent piston rod, 2, and for any binding.
3. Check the rubber bushing, 3, for wear and damage.
4. Replace dampener shock if worn or damaged.
5. Check the ball joint end, 4, for looseness and wear. Replace if worn.

6. The neutralizer rod assembly consists of the following parts:
   a. Neutralizer rod, 1.
   b. Flat washers, 2.
   c. Nylatron bushings, 3.
   d. Jam nuts, 4.
   e. Ball joint end, 5.



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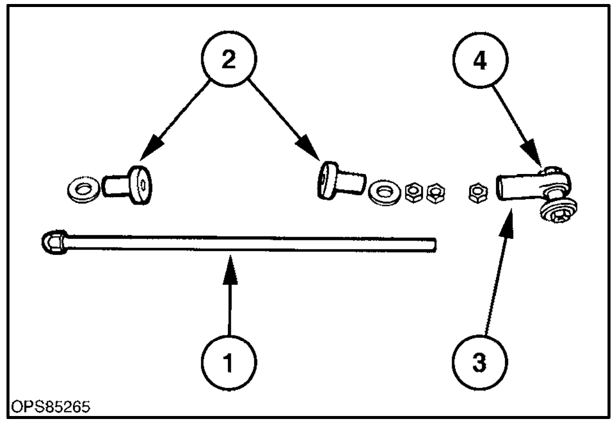
7. Inspect the rod, 1, for wear and bending that may cause binding in the neutralizer assembly.
8. Check the bushings, 2, for wear on the internal bore. Also check the fit in the mounting bracket. Inspect for cracks or breaks.
9. Inspect the ball joint end, 3, for looseness and wear in the ball area, 4.
10. Replace parts that are worn or damaged.



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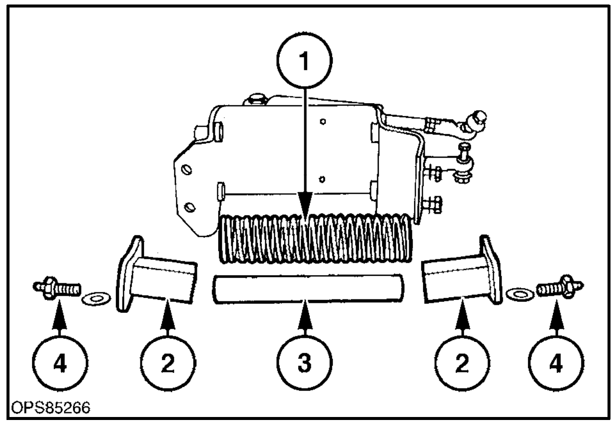
11. Inspect the neutralizer spring, 1, for wear or a permanent spring set. Free length of the spring is 200.7 mm ± 4.6 mm (7.9″ ± 0.18″).
12. Inspect the spring guides, 2, for wear on both the inner and outer surfaces of the tube and at the guide holes for the neutralizer rods.
13. Inspect the shaft, 3, for wear or bending. Look for scratches or wear that may indicate lack of lubrication.
14. Check the lube fitting cap screws, 4, for blockage that would prevent proper lubrication.
15. Replace all parts that are worn or damaged.



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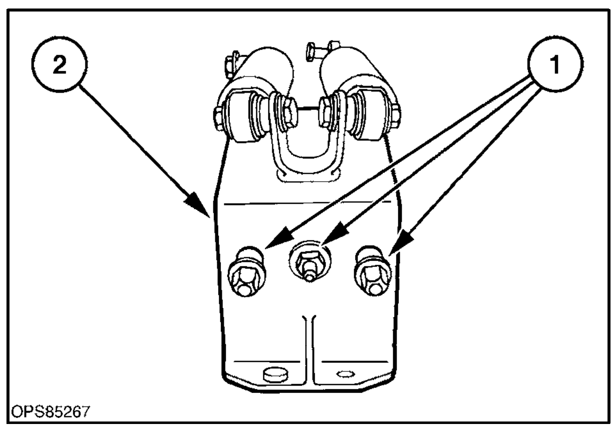
16. Inspect the bushing and guide holes, 1, on both sides of the mounting bracket, 2, for wear. Replace bracket if worn.



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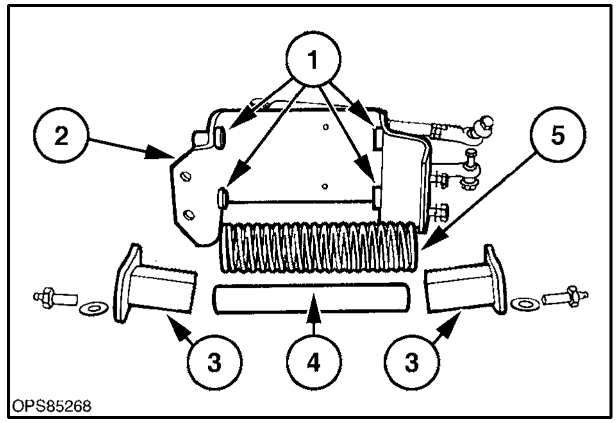
REASSEMBLY

1. Insert the four neutralizer rod bushings, 1, into the mounting bracket, 2, with the shoulder to the inside.
2. Apply grease to the inner bore of the spring guides, 3, and to the ends of the shaft, 4.
3. Insert shaft, 4, into one of the spring guides, 3, and slide spring, 5, over this assembly. Assemble the second spring guide into the open end of the spring and align with the shaft.



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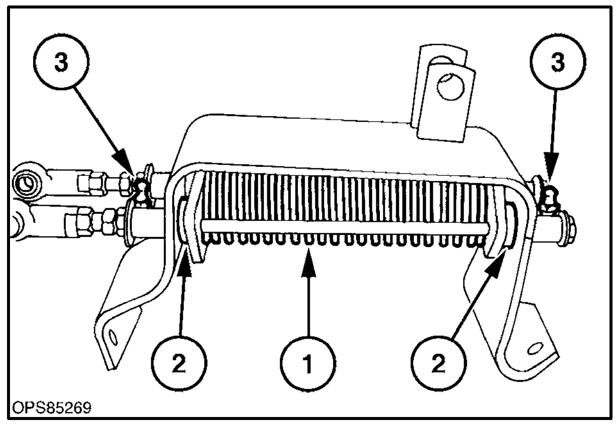
4. Insert the neutralizer spring assembly, 1, into the mounting bracket and resting against the rod bushings at 2. Be careful not to break the bushings when installing the spring assembly.

NOTE: *The spring assembly must be pried into place and will be under tension. Be cautious until the retaining bolts and rods are in place.*

5. Install a flat washer and lube fitting cap screws, 3, at both ends and tighten.



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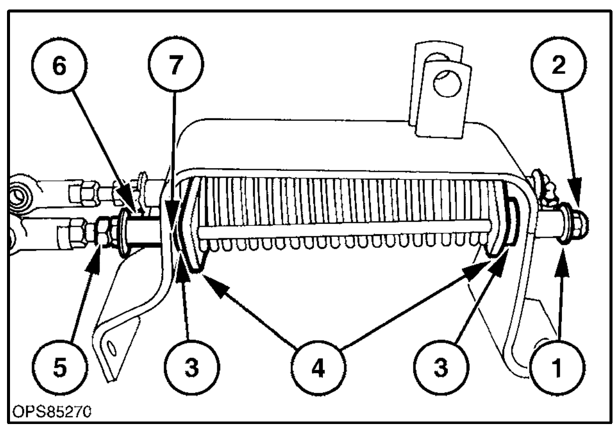
6. Install flat washer, 1, onto the neutralizer rod, 2, and insert the rod through the bushings, 3, and spring guides, 4.
7. Install a second flat washer and two jam nuts at 5. Tighten the inner jam nut finger tight. There should be no free play between the rod and bushing at 6, or between the bushing and mounting bracket at 7. Tighten the outer jam nut against the inner jam nut.

NOTE: *If the jam nuts on the rods are turned in too far or not far enough, free play will result.*

8. Repeat these steps for both neutralizer rods.



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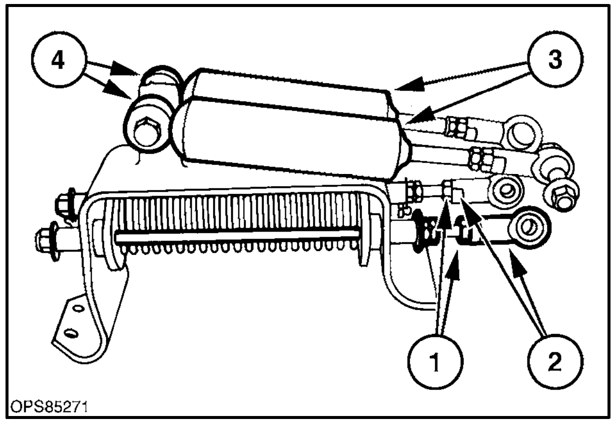
9. Install the third jam nut, 1, and ball joint end, 2, on both neutralizer rods. Do not tighten the jam nut at this time. The location of the ball joint end determines the position of the hydrostatic control handles.
10. Reinstall the dampener shocks, 3, at the mounting tabs, 4.



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Op. 29 130 30

CONTROL LINKAGE

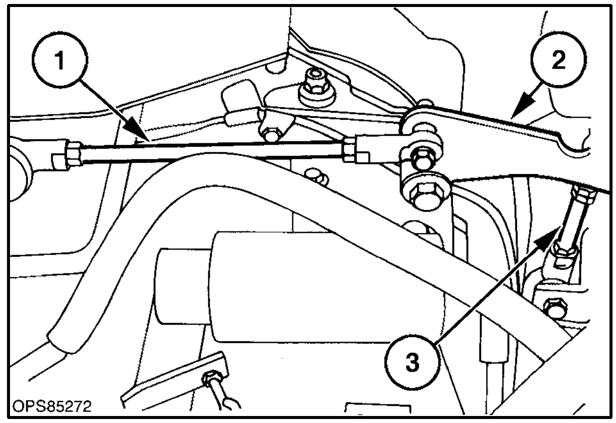
REMOVAL

The neutralizer assembly is removed for clarity.

1. The control linkage consists of three main components:
   a. Front control rod, 1.
   b. Control link (pivot), 2.
   c. Rear control rod, 3.

   The right side control linkage is shown; the left side control linkage is the same except for control rod lengths.

   Repeat each step for the left side.



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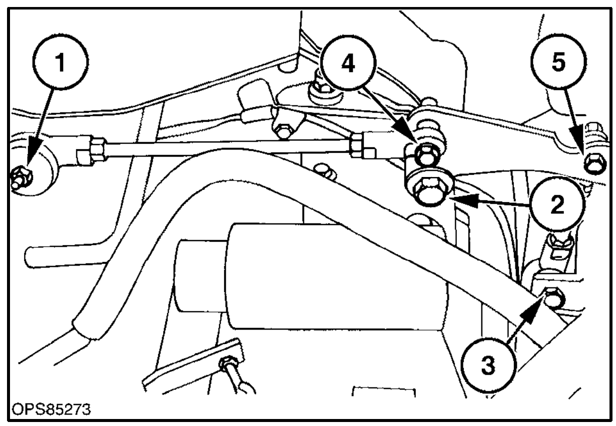
2. Disconnect the front control rod at 1, the control link at pivot bolt, 2, and the rear control rod at, 3. Remove the control linkage assembly.

DISASSEMBLY

1. Remove the front control rod from the control link at 4, and the rear control rod, 5.



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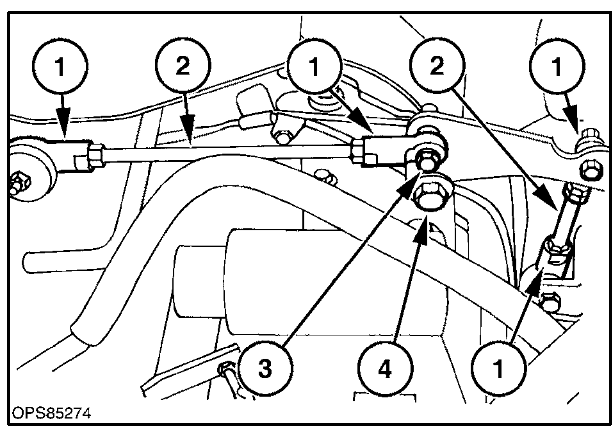
INSPECTION

1. Inspect the control rod ball joint ends, 1, for looseness and wear in the swivel.
2. Inspect the control rods, 2, for straightness.
3. Inspect the control link pivot bushing, 3, for wear and damage.
4. Check for wear and bending of the pivot bolt, 4.
5. Replace any parts that are worn, damaged, or bent.



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REASSEMBLY

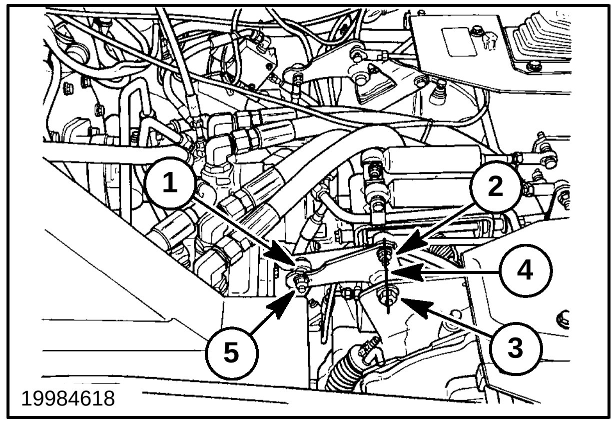
Control rod lengths are measured from center to center of the ball joint ends.

1. Adjust the length of the right rear control rod, 1, to obtain a vertical center line of the control arm pivot, 2, and link pivot, 3, shown at 4, with the control linkage in neutral and no tire rotation.

   The center of the control arm pivot, 2, and center of link pivot, 3, must align to ensure equal stroke forward and reverse.

   Remove the control link, 1, at 5, and adjust the length of the link if required.

2. Reattach the rear control rod, 1, to the control link at 5, and the front control rod to the control link at 2.



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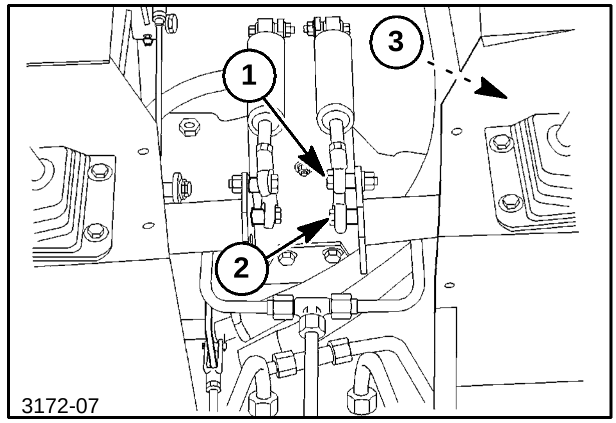
LEFT CONTROL HANDLE WITH NO BOOM CONTROL

Op. 29 100 10

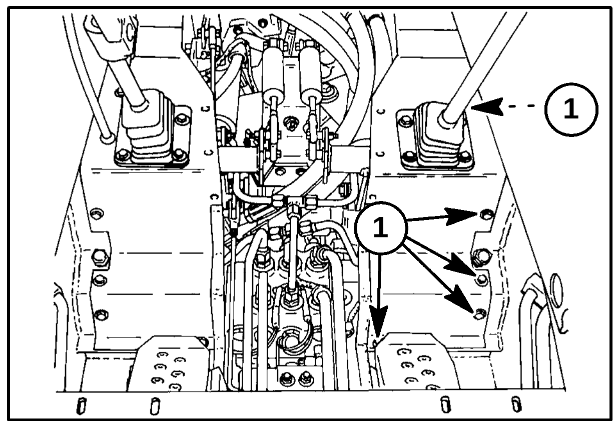
REMOVAL

1. Securely latch the seat in the raised and latched position. Remove the step shield and front step cover to access the control handle, linkage and valve area.
2. Disconnect the dampener shock, 1, the neutralizer, 2, and the hydrostatic pump control link, 3, under the left handle support plate. Take note of the number and position of all washers and spacers for reference during installation.



302

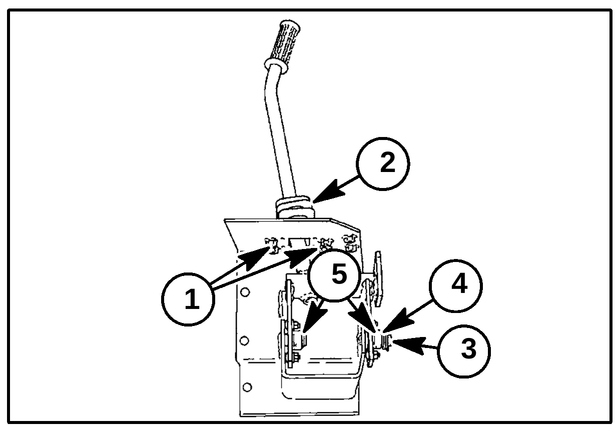
3. If the unit is high-flow, disconnect the wires from the high-flow switch. Remove the five handle mounting bolts, 1, and remove the handle assembly from the unit.



303

DISASSEMBLY

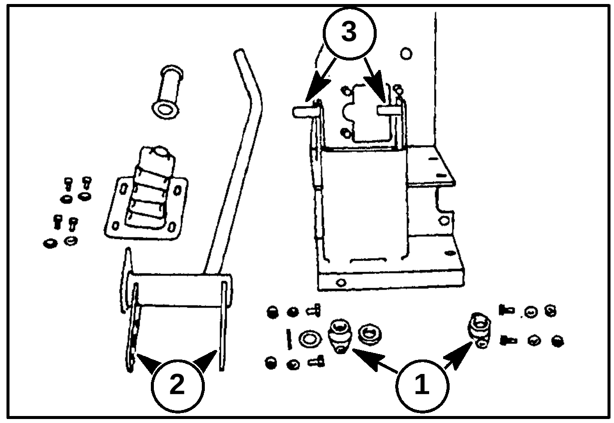
1. Loosen the boot securing bolts, 1, and slide the boot, 2, off the handle.
2. Remove the roll pin, 3, and shim washers, 4. Take note of the number and position of all shim washers for reassembly.
3. Slide the handle sideways and remove from the stub shafts.
4. Remove the bearings, 5, from the handle.



304

INSPECTION

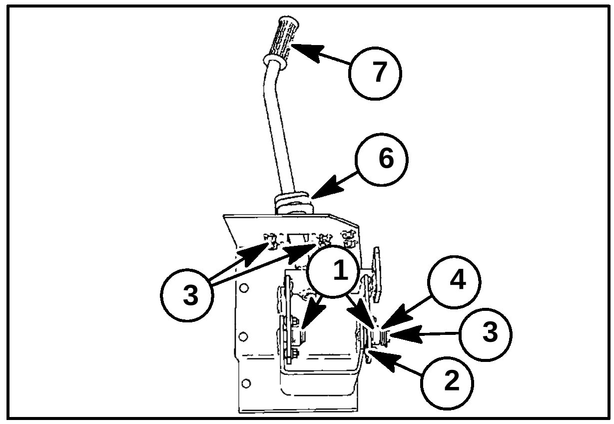
1. Inspect the handle pivot bearings, 1; replace if worn or damaged.
2. Inspect the control handle for excessive wear or bends in the bearing mounting plates, 2, and pivot stub shafts, 3.



305

REASSEMBLY

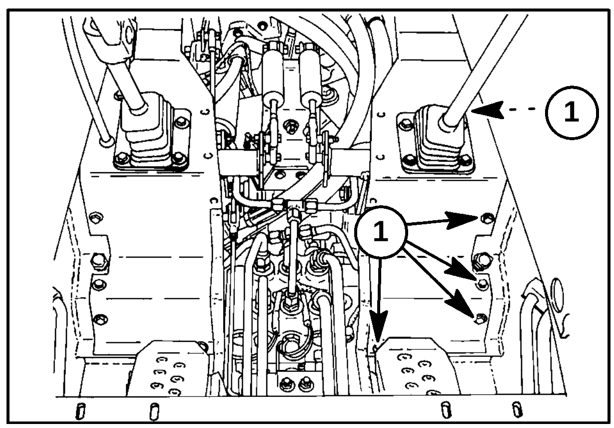
1. Slide the handle sideways over the stub shafts.
2. Install the bearings, 1, on the handle. Install shim washers, 2, to center the handle in the slot, 3.
3. Install shim washers, 4, to reduce side play on the stub shafts. Retain the shims on the stubs shaft with a roll pin, 5.
4. Slide the boot, 6, over the handle and tighten the boot securing bolts.
5. Install a new hand grip, 7, if grip is worn.



306

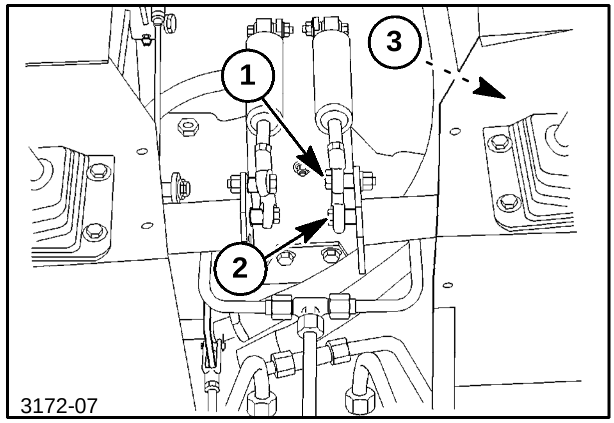
REINSTALLATION

1. Place the handle assembly in the unit and install the five handle mounting bolts, 1, and tighten securely. If the unit is high-flow, reconnect the wires from the high-flow switch.



307

2. Reconnect the dampener shock, 1, the neutralizer, 2, and the hydrostatic pump control link, 3. Use the same number and position of spacers and washers noted during removal.
3. Reinstall all shields removed for the repair.



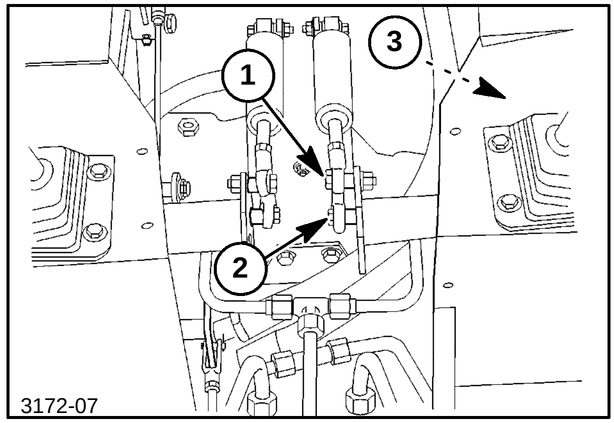
308

LEFT CONTROL HANDLE WITH BOOM CONTROL

Op. 29 100 11

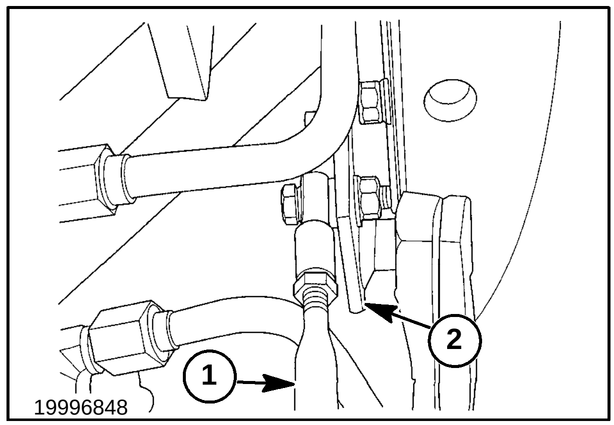
REMOVAL

1. Securely latch the seat in the raised and latched position. Remove the step shield and front step cover to access the control handle, linkage and valve area.
2. Disconnect the dampener shock, 1, the neutralizer, 2, and the hydrostatic pump control link, 3, under the left handle support plate. Take note of the number and position of all washers and spacers for reference during installation.



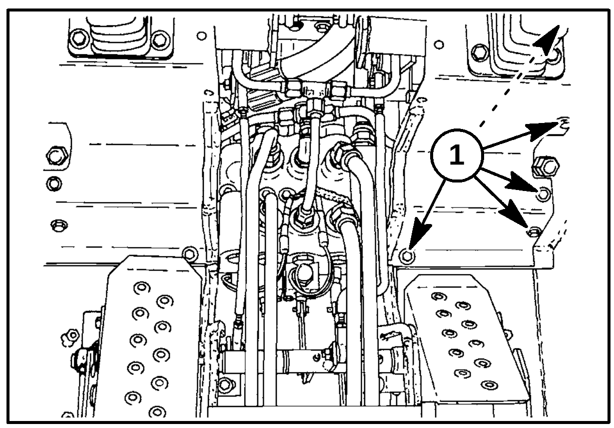
309

3. Remove the boom control rod, 1, from the left control handle arm, 2.



310

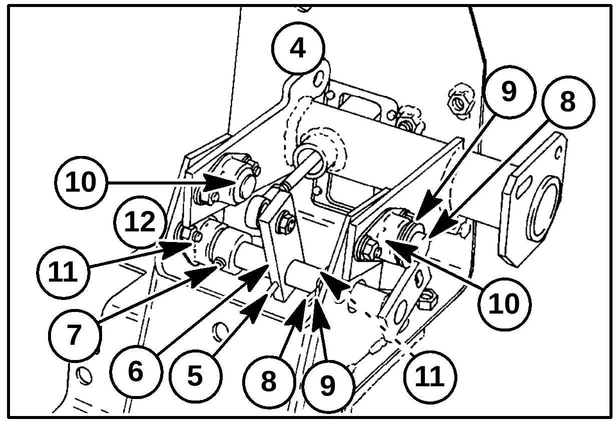
4. If the unit is high-flow, disconnect the wires from the high-flow switch. Remove the five handle mounting bolts, 1, and remove the handle assembly from the unit.



311

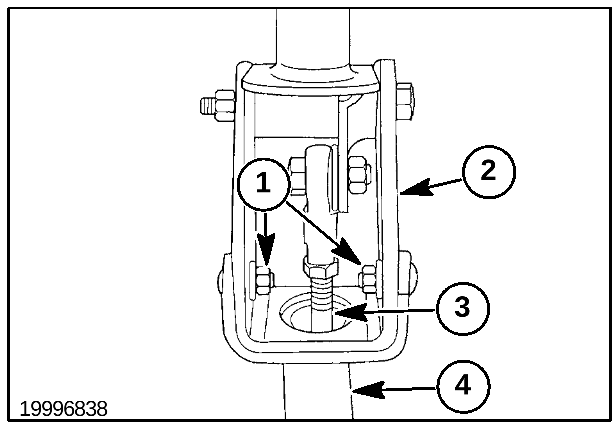
DISASSEMBLY

1. Take note of the number and position of all shim washers for reassembly.
2. Remove the bolt, 1, securing the ball end to the control arm.
3. Remove the jam nut, 2, and ball end, 3, from the rod, 4.
4. Remove the groove pin, 5, from the arm, 6.
5. Loosen the set screw, 7, on the set collar. Remove the cotter pins, 8, and shim washers, 9, taking note of the number of shim washers for reassembly.
6. Remove the bearings, 10, from the control handle and the bearings, 11, from the handle mounting plates. Slide the handle sideways and remove from the stub shafts.



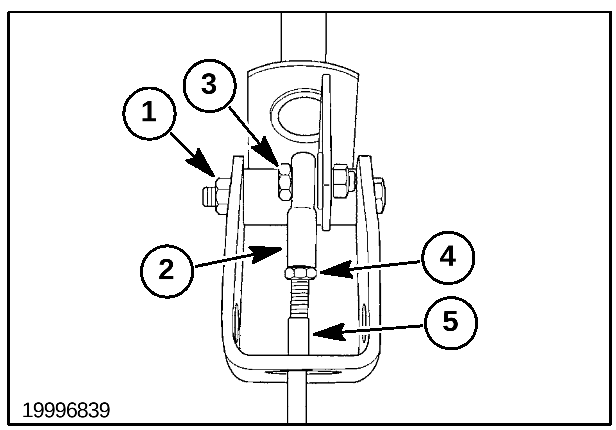
312

7. Remove the nuts, 1, lock washers, and carriage bolts securing the handle support to the handle tube. Remove the handle support, 2, and control rod, 3, from the handle tube, 4.



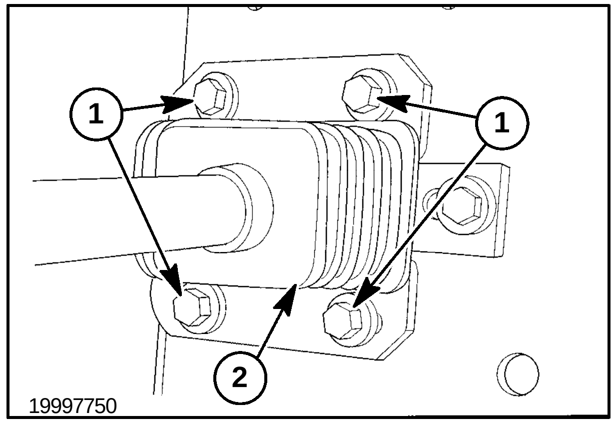
313

8. Remove the locknut, 1, and bolt to separate the handle from the handle support.
9. Remove the ball end, 2, from the handle by removing the capscrew, 3, flat washer and locknut. Remove the ball end, 2, and jam nut, 4, from the rod, 5.



314

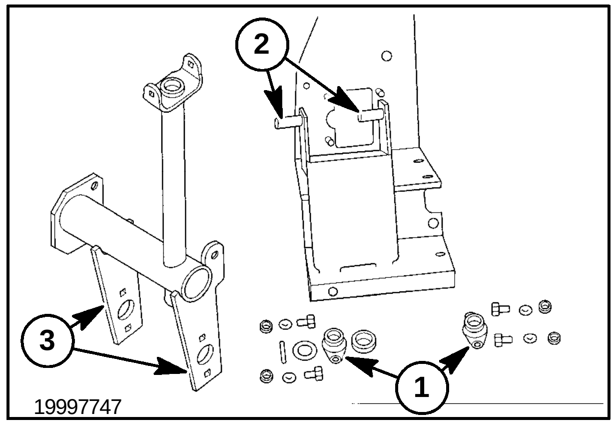
10. Loosen the boot securing bolts, 1, and slide the boot, 2, off the handle.



315

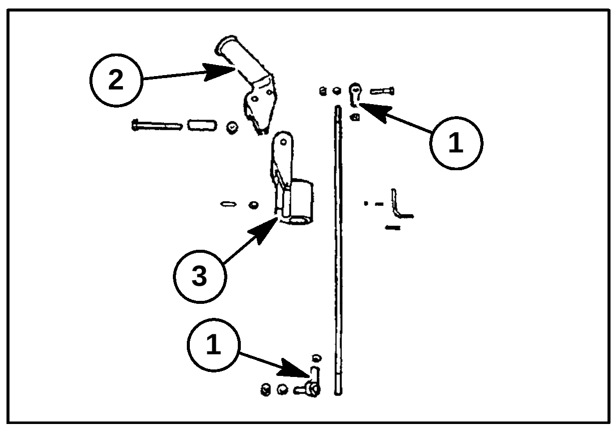
INSPECTION

1. Inspect the handle pivot bearings, 1; replace if worn or damaged.
2. Inspect the pivot stub shafts, 2, for any obvious bends or deformation.
3. Inspect the control handle for excessive wear or bends in the bearing mounting plates, 3.



316

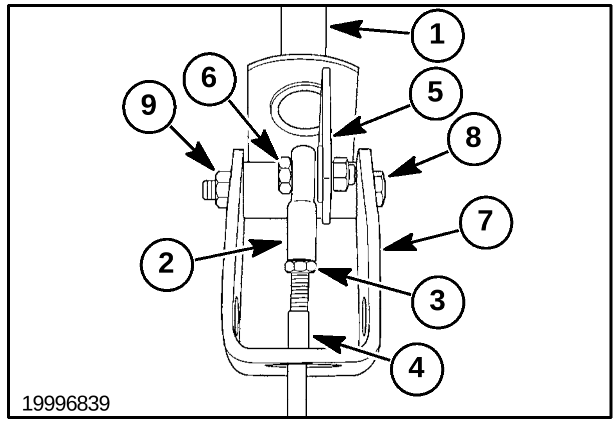
4. Inspect the pivot handle linkage for looseness in the ball joints, 1; replace if worn.
5. Inspect the pivot handle, 2, and handle support, 3, for damage or deformation. Replace as necessary.



317

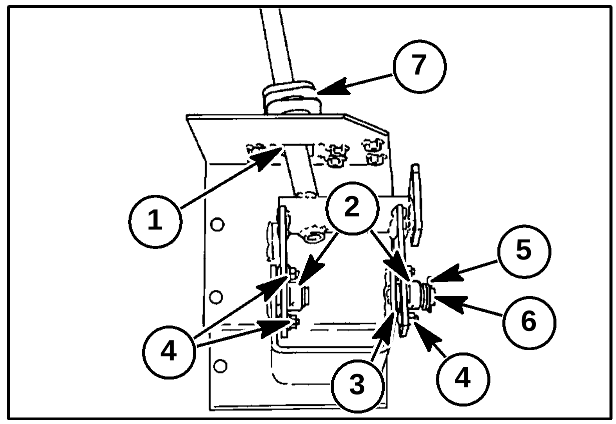
REASSEMBLY

1. Install a new hand grip on the top of the handle, 1, if grip is worn.
2. Attach the ball end, 2, and jam nut, 3, to the rod, 4. Fasten the ball end to the handle, 5, with the capscrew, 6, flat washer and locknut. Position the flat washer between the ball end and handle. Do not tighten the jam nut at this time.
3. Attach the handle assembly to the handle support, 7, with the long bolt, 8, and locknut, 9.
4. Tighten the locknut to remove any movement between the handle assembly and support, but do not overtighten. The support should be loose enough to allow the handle to pivot without binding.



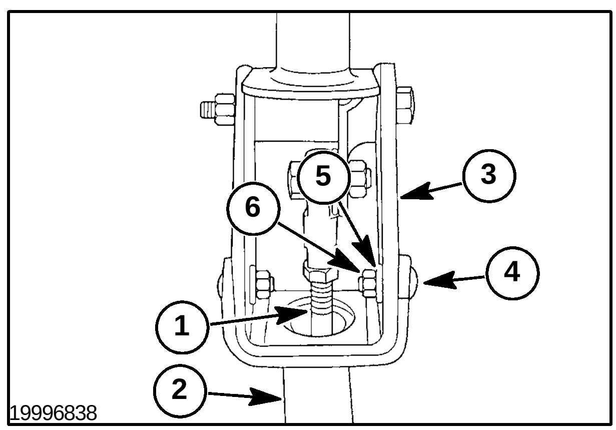
318

5. Slide the handle tube up through the slot, 1, in the handle support base.
6. Slide the handle sideways over the stub shafts.
7. Install the bearings, 2, on the handle, install shim washers, 3, to center the handle in the slot, 1. Fasten each bearing with two 5/16″ x 3/4″ carriage bolts, lock washers, and nuts at 4.
8. Install shim washers, 5, to reduce side play on the stub shafts. Retain the shims on the stubs shaft with a roll pin, 6.
9. Slide the rubber boot, 7, down over the end of the control handle, one side at a time, and secure with the the hardware removed during disassembly.



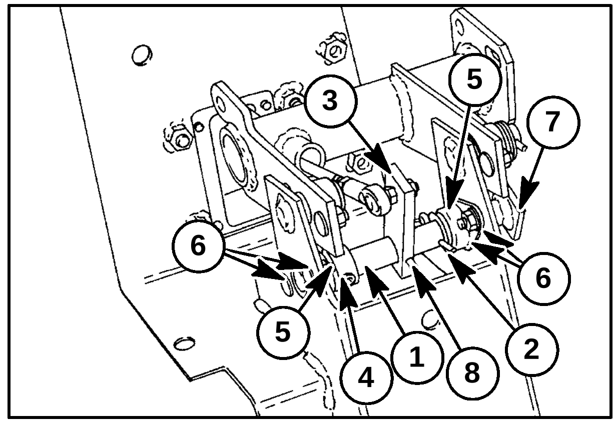
319

10. Attach the handle and rod assembly, 1, to the control handle by first sliding the rod down through the control handle tube, 2.
11. Attach the handle assembly to the handle tube arms, 3, with the short carriage bolts, 4, lock washers, 5, and nuts, 6. Tighten securely.



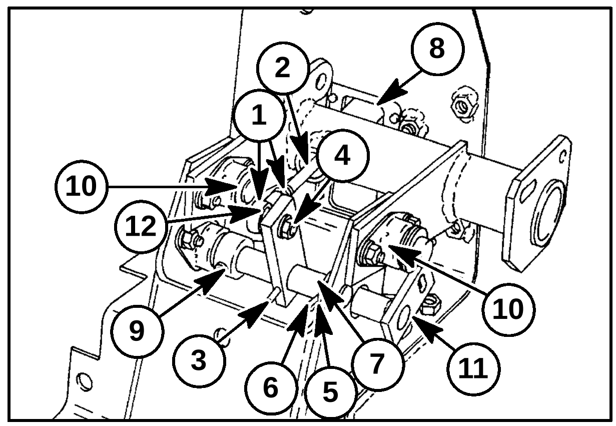
320

12. Assemble the pivot shaft, 1, shim washers, 2, arm, 3, set collar, 4, and bearings, 5, in the control arm housing.
13. Rotate the pivot shaft, 1, to position the arm upward as shown at 7.
14. Note the position of the arm, 3, on the shaft in relation to the arm at 7. Insert groove pin, 8, through arm, 3, and into shaft just far enough to position the arm. Do not hammer into place at this time.



321

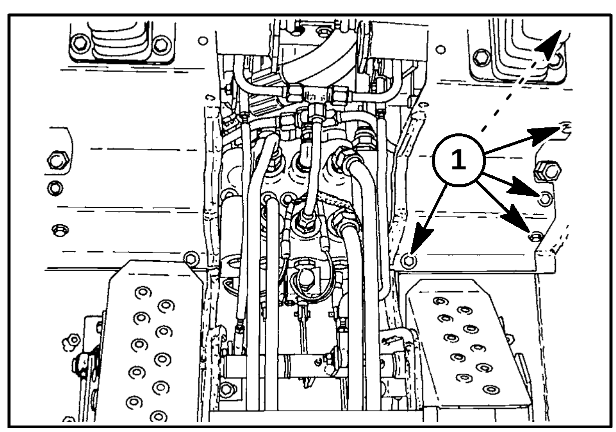
15. Attach the ball end and jam nut, 1, onto rod, 2. Install spacer, 12, (OD - 7/16″; length - 15/32″) between the ball end and arm, 3. Secure with a 5/16″ x 1-3/4″ bolt, lock washer, and nut at 4.
16. Install shim washers at 5, between the cotter pin, 6, and bearing, 7, to center rod, 2, in the control handle tube at 8. Secure the cotter pin and slide the set collar, 9, against the opposite bearing to remove any side movement of the shaft and tighten the setscrew.
17. Drive the groove pin in the arm, 3, completely into place.
18. With the handle in the neutral position angle, adjust the length of the rod, 12, so the ball stud at the arm aligns with the pivot bearings at 10. This will also set the pivot arm, 11, in a vertical position.
19. Rotate the handle to make sure the rod, 2, does not interfere at the top or bottom of the control handle tube. Move the control handle back and forth (forward and reverse) and make sure the control arm, 3, does not move. When there is no movement, tighten the jam nuts at both ends of the rod.



322

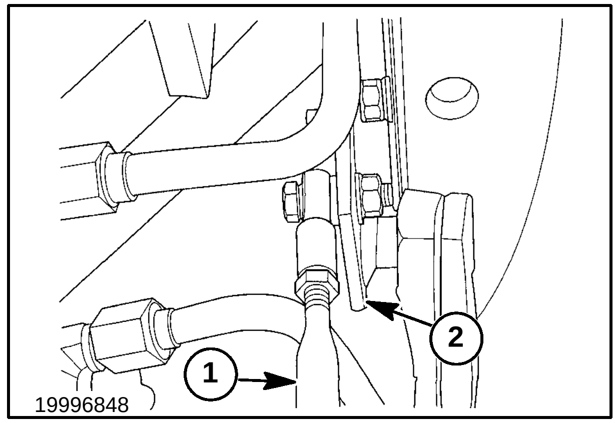
REINSTALLATION

1. Place the handle assembly in the unit and install the five handle mounting bolts, 1, and tighten securely. If the unit is high-flow, reconnect the wires from the high-flow switch.



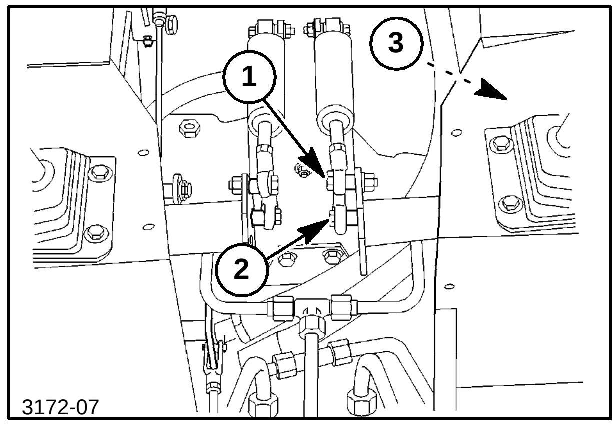
323

2. Install the left control rod, 1, on the boom control handle arm, 2.



324

3. Reconnect the dampener shock, 1, the neutralizer, 2, and the hydrostatic pump control link, 3. Use the same number and position of spacers and washers noted during removal.
4. Reinstall all shields removed for the repair.



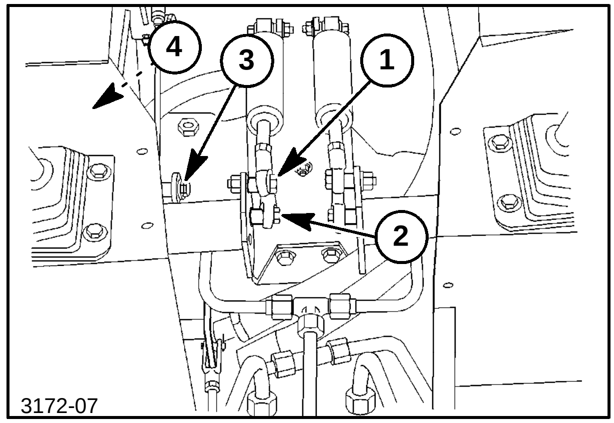
325

RIGHT CONTROL HANDLE WITH AUXILIARY OR BUCKET CONTROL

Op. 29 100 15

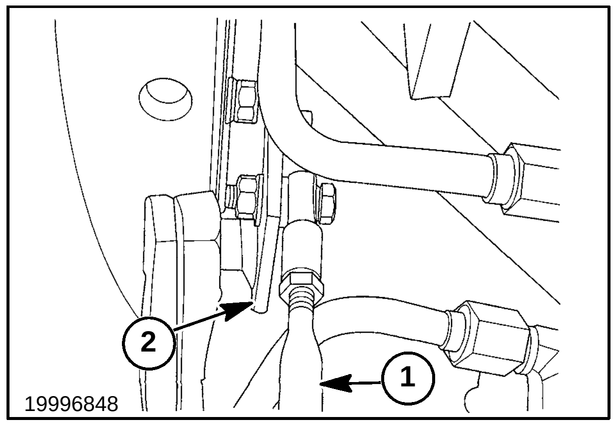
REMOVAL

1. Securely latch the seat in the raised and latched position. Remove the step shield and front step cover to access the control handle, linkage and valve area.
2. Disconnect the dampener shock, 1, the neutralizer, 2, and the hydrostatic pump control link, 3. Take note of the number and position of all washers and spacers for reference during installation.
3. Disconnect the wires, 4, to the two-speed control switch under the right control handle support, if applicable.



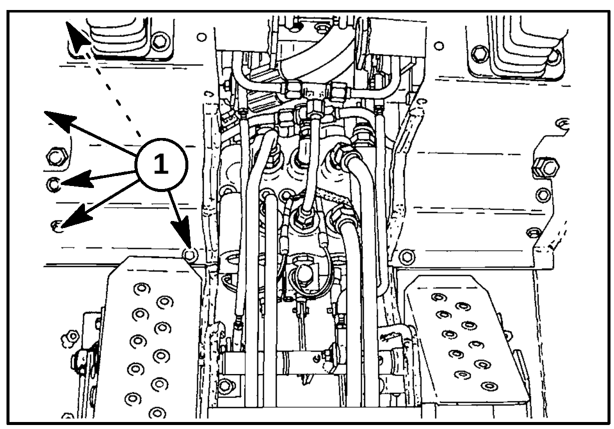
326

4. Remove the auxiliary hydraulic control or bucket control rod, 1, from the right control handle arm, 2.



327

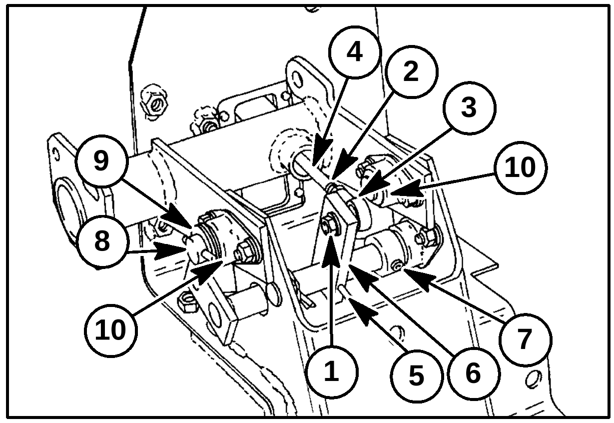
5. Remove the five handle mounting bolts, 1, and remove the handle assembly from the unit.



328

DISASSEMBLY

1. Take note of the number and position of all shim washers for reassembly.
2. Remove the bolt, 1, securing the ball end to the control arm.
3. Remove the jam nut, 2, and ball end, 3, from the rod, 4.
4. Remove the groove pin, 5, from the arm, 6.
5. Loosen the set screw, 7, on the set collar.
6. Remove the cotter pins, 8, and shim washers, 9, taking note of the number of shim washers for reassembly.
7. Remove the bearings, 10, from the control handle and the bearings, 11, from the handle mounting plates. Slide the handle sideways and remove from the stub shafts.

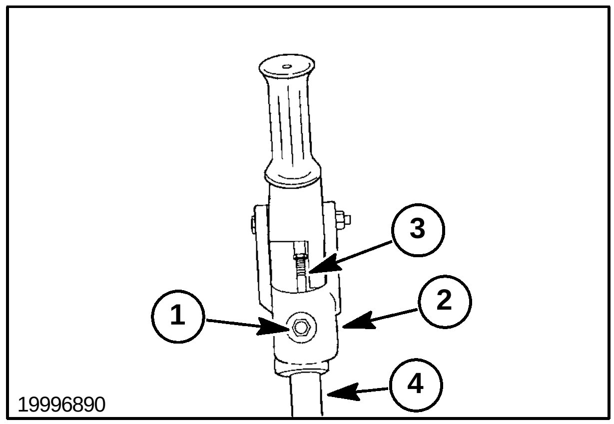


329

Op. 29 100 15

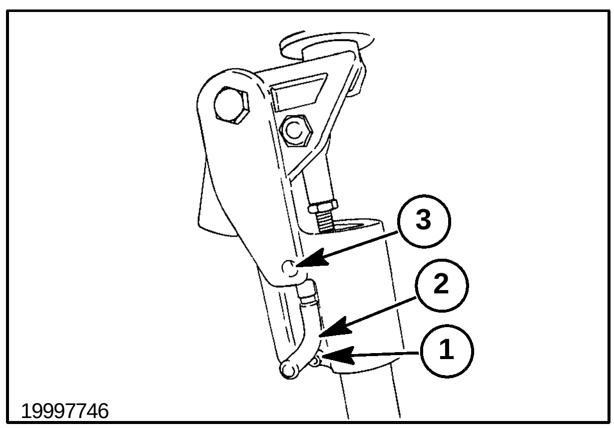
Auxiliary Boom Control Handle (only)

8. Boom hydraulics control - Remove the setscrew, 1, and remove the handle support, 2, and control rod, 3, from the handle tube, 4.



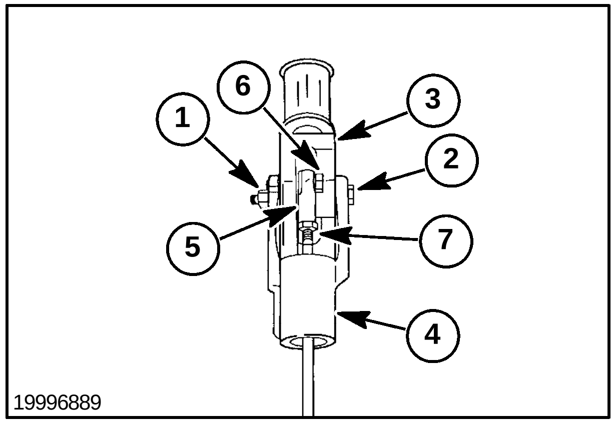
330

9. Boom hydraulics control - Remove the roll pin, 1, the L-pin, 2, and the spring and ball at 3.



331

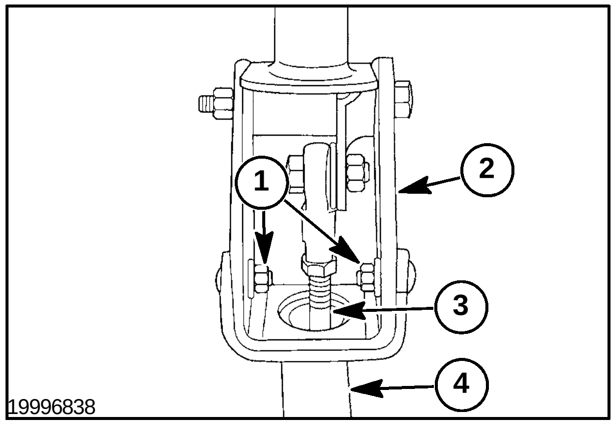
10. Boom hydraulics control - Remove the locknut, 1, and bolt, 2, to separate the handle, 3, from the handle support, 4. Retain the bushing and capscrew. Remove the ball end, 5, from the handle by removing the capscrew, 6, flat washer and locknut. Remove the ball end, 5, and jam nut, 7, from the rod.



332

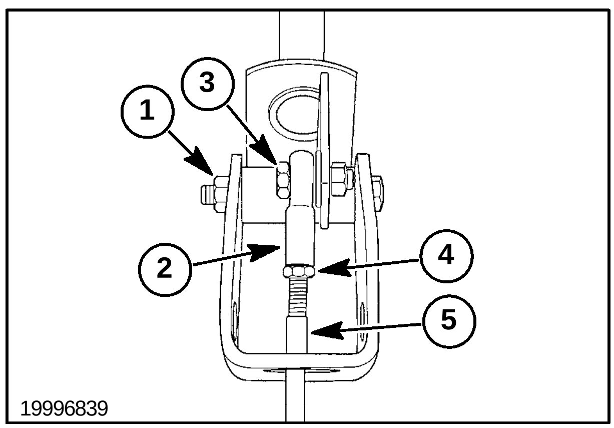
Bucket Control Handle

11. Bucket control - Remove the nuts, 1, lock washers, and carriage bolts securing the handle support to the handle tube. Remove the handle support, 2, and control rod, 3, from the handle tube, 4.



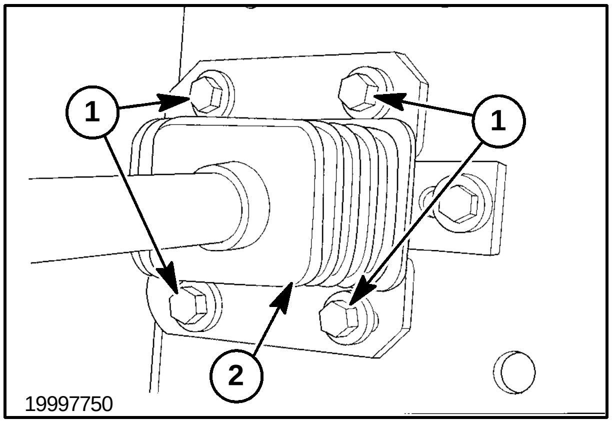
333

12. Bucket control - Remove the locknut, 1, and bolt to separate the handle from the handle support. Remove the ball end, 2, from the handle by removing the capscrew, 3, flat washer and locknut. Remove the ball end, 2, and jam nut, 4, from the rod, 5.



334

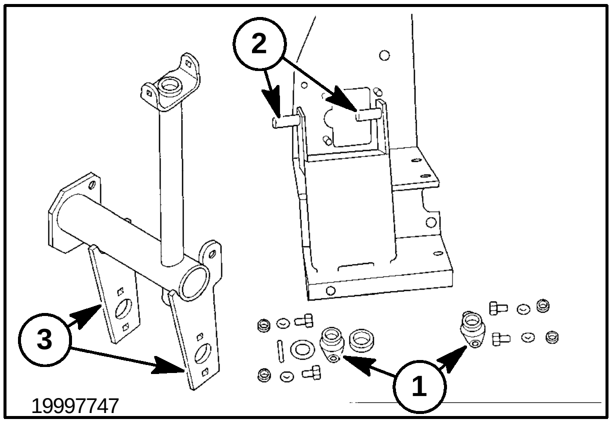
13. Loosen the boot securing bolts, 1, and slide the boot, 2, off the handle.



335

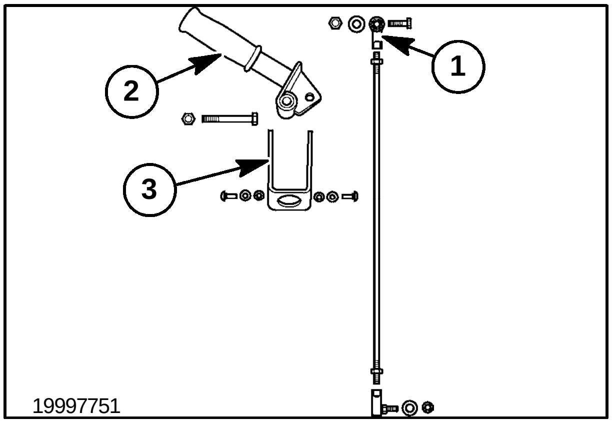
INSPECTION

1. Inspect the handle pivot bearings, 1; replace if worn or damaged.
2. Inspect the pivot stub shafts, 2, for any obvious bends or deformation.
3. Inspect the control handle for excessive wear or bends in the bearing mounting plates, 3.



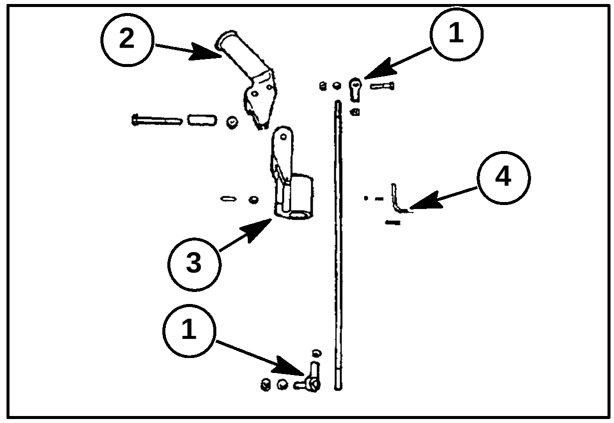
336

4. Bucket control - Inspect the pivot handle linkage for looseness in the ball joints, 1; replace if worn.
5. Bucket control - Inspect the pivot handle, 2, and handle support, 3, for damage or deformation. Replace as necessary.



337

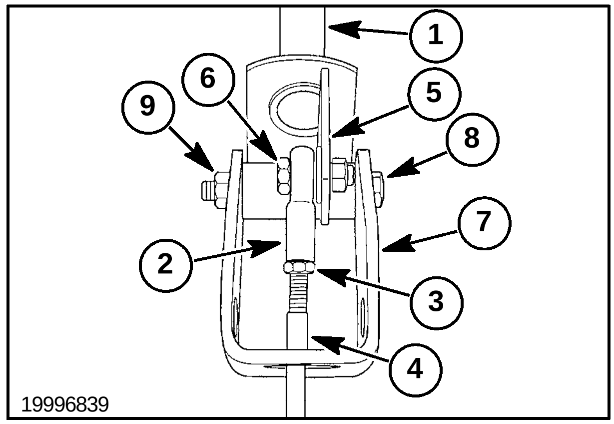
6. Boom Hydraulics Control - Inspect the pivot handle linkage for looseness in the ball joints, 1; replace if worn.
7. Boom Hydraulics Control - Inspect the pivot handle, 2, and handle support, 3, for damage or deformation. Replace as necessary.
8. Boom Hydraulics Control - Inspect the handle lock components, 4. Replace the spring if bent or broken.



338

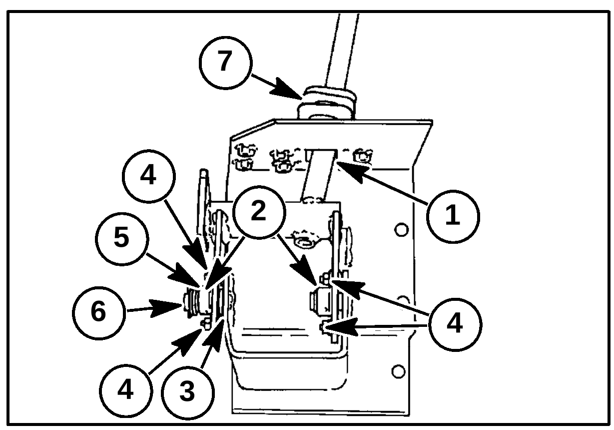
REASSEMBLY

1. Bucket control - Install a new hand grip on the top of the handle, 1, if grip is worn.
2. Bucket control - Attach the ball end, 2, and jam nut, 3, to the rod, 4, and fasten to the handle, 5, with the capscrew, 6, flat washer and locknut. Position the flat washer between the ball end and handle. Do not tighten the jam nut at this time.
3. Bucket control - Attach the handle assembly to the handle support, 7, with the long bolt, 8, and locknut, 9.
4. Bucket control - Tighten the locknut to remove any movement between the handle assembly and support, but should be loose enough to all the handle to pivot without binding.



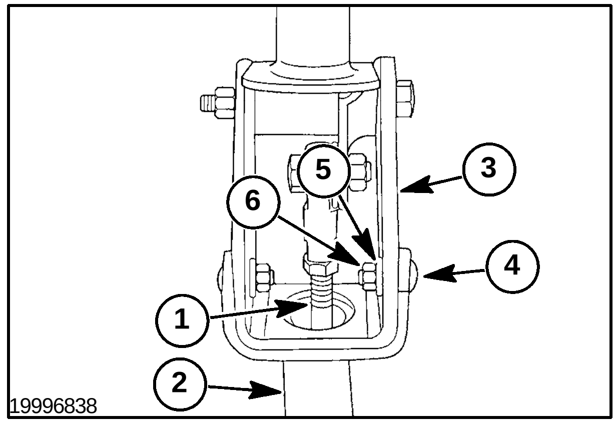
339

5. Bucket control - Slide the handle tube up through the slot, 1, in the handle support base.
6. Bucket control - Slide the handle sideways over the stub shafts.
7. Bucket control - Install the bearings, 2, on the handle, install shim washers, 3, to center the handle in the slot, 1. Fasten each bearing with two 5/16″ x 3/4″ carriage bolts, lock washers, and nuts at 4.
8. Bucket control - Install shim washers, 5, to reduce side play on the stub shafts. Retain the shims on the stubs shaft with a roll pin, 6.
9. Bucket control - Slide the rubber boot, 1, down over the end of the control handle, one side at a time, and secure with the the hardware, 2, removed during disassembly.



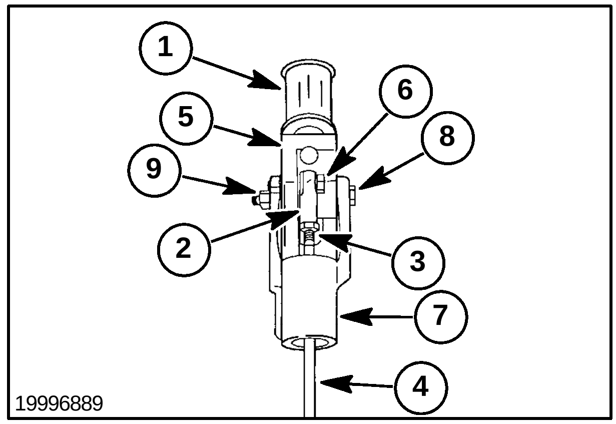
340

10. Bucket control - Attach the handle and rod assembly, 1, to the control handle by first sliding the rod down through the control handle tube, 2.
11. Bucket control - Attach the handle assembly to the handle tube arms, 3, with the short carriage bolts, 4, lock washers, 5, and nuts, 6. Tighten securely.



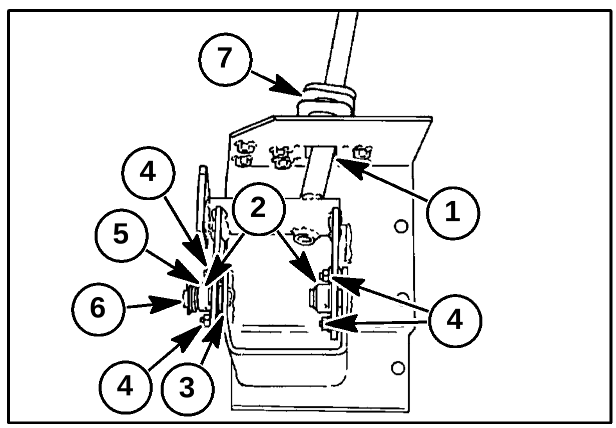
341

12. Boom hydraulics control - Install a new hand grip on the top of the handle, 1, if grip is worn.
13. Boom hydraulics control - Attach the ball end, 2, and jam nut, 3, to the rod, 4, and fasten to the handle, 5, with a 5/16″ x 1-1/4″ capscrew, 6, flat washer and locknut. Position the flat washer between the ball end and handle. Do not tighten the jam nut at this time.
14. Boom hydraulics control - Attach the handle assembly to the handle support, 8, with the long bushing, 3/8″ x 3-1/4″ capscrew and locknut at 9.
15. Boom hydraulics control - Tighten the locknut to remove any movement between the handle assembly and support, but should be loose enough to all the handle to pivot without binding.



342

16. Boom hydraulics control - Slide the handle tube up through the slot, 1, in the handle support base.
17. Boom hydraulics control - Slide the handle sideways over the stub shafts.
18. Boom hydraulics control - Install the bearings, 2, on the handle, install shim washers, 3, to center the handle in the slot, 1. Fasten each bearing with two 5/16″ x 3/4″ carriage bolts, lock washers, and nuts, 4.
19. Boom hydraulics control - Install shim washers, 5, to reduce side play on the stub shafts. Retain the shims on the stubs shaft with a roll pin, 6.
20. Boom hydraulics control - Slide the rubber boot, 7, down over the end of the control handle and secure with the the hardware removed during disassembly.



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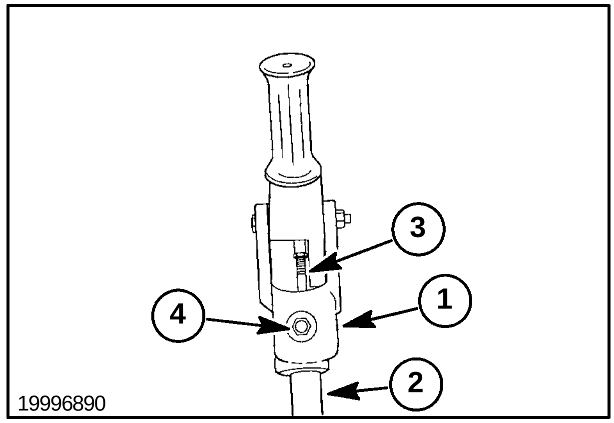
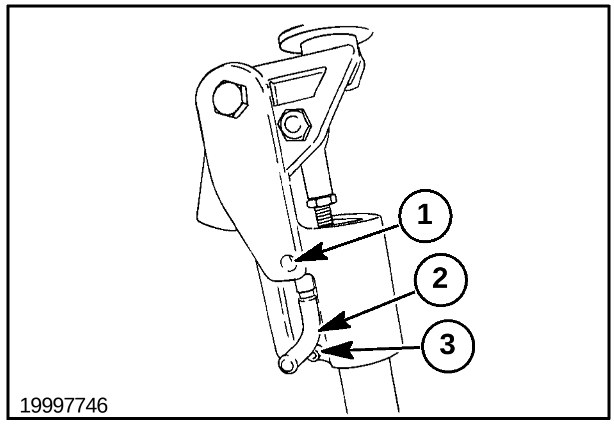
21. Boom hydraulics control - Attach the handle and rod assembly, 1, to the control handle, 2, by first sliding the rod, 3, down through the control handle tube.
22. Boom hydraulics control - Position the handle support on the tube by aligning the setscrew, 4, with the drilled hole in the tube. Tighten the setscrew and locknut.



344

23. Boom hydraulics control - Insert the spring and ball at 1. Insert the L-pin, 2, and drive the roll pin, 3, in flush to retain the L-pin.



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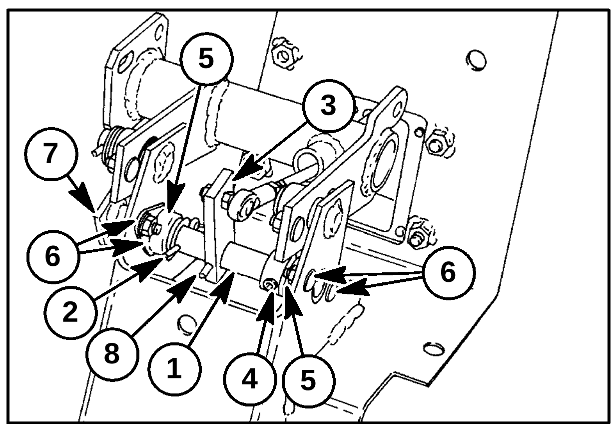
24. Assemble the pivot shaft, 1, shim washers, 2, arm, 3, set collar, 4, and bearings, 5, into the control arm housing. Fasten each bearing with two 5/16″ x 3/4″ carriage bolts, lock washers, and nuts at 6.
25. Rotate the pivot shaft, 1, to position the arm upward as shown at 7.
26. Note the position of the arm, 3, on the shaft, 1, in relation to the arm at 7. Insert groove pin, 8, through arm, 3, and into shaft, 1, just far enough to position the arm. Do not hammer into place at this time.



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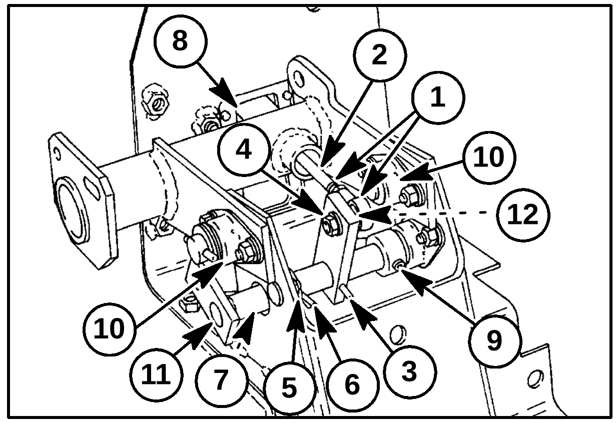
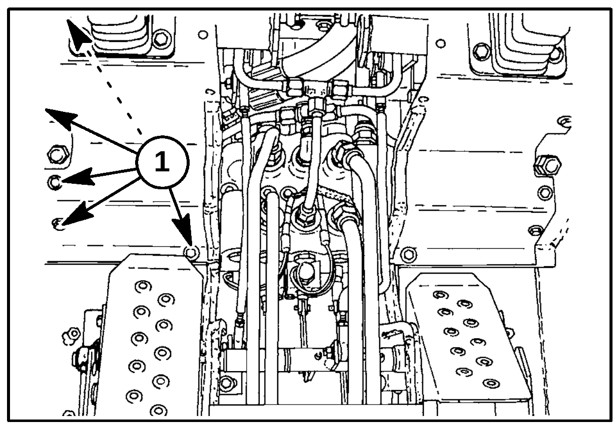
27. Attach the ball end and jam nut, 1, onto rod, 2. Install spacer, 12, (OD - 7/16″; length - 15/32″) between the ball end and arm, 3. Secure with a 5/16″ x 1-3/4″ bolt, lock washer, and nut at 4.
28. Install shim washers at 5, between the cotter pin, 6, and bearing, 7, to center rod, 2, in the control handle tube at 8. Secure the cotter pin and slide the set collar, 9, against the opposite bearing to remove any side movement of the shaft and tighten the setscrew.
29. Drive the groove pin in the arm, 3, completely into place.
30. With the handle in the neutral position angle, adjust the length of the rod, 2, so the ball stud at the arm, 3, aligns with the pivot bearings at 10. This will also set the pivot arm, 11, in a vertical position.
31. Rotate the handle to make sure the rod, 2, does not interfere at the top or bottom of the control handle tube. Move the control handle back and forth (forward and reverse) and make sure the control arm, 3, does not move. When there is no movement, tighten the jam nuts at both ends of the rod.



347

REINSTALLATION

1. Place the handle assembly in the unit, install the five handle mounting bolts, 1, and tighten securely.



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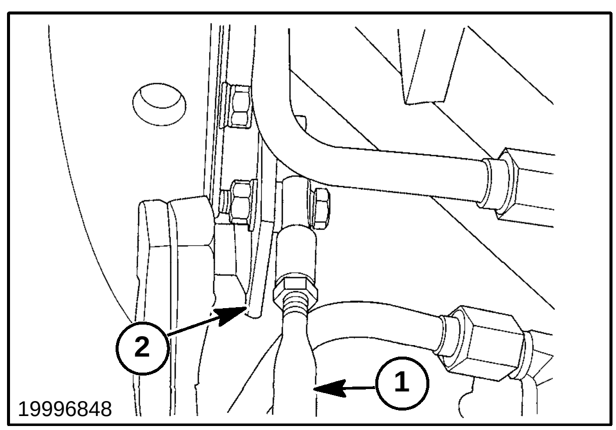
2. Install the auxiliary hydraulic control or bucket control rod, 1, on the right control handle arm, 2.



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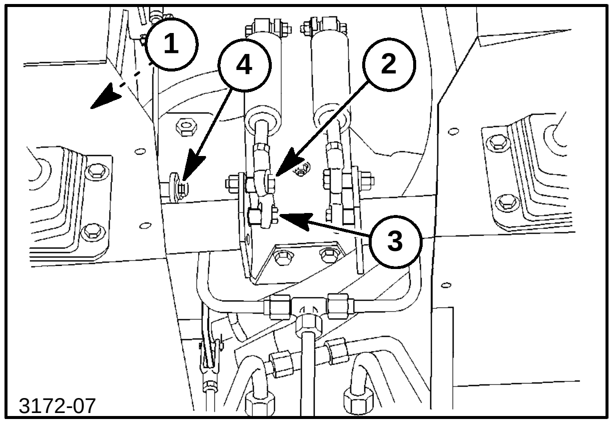
3. Reconnect the wires, 1, to the two-speed control switch under the right control handle support.
4. Connect the dampener shocks, 2, the neutralizer, 3, and the hydrostatic pump control link, 4. Use the same number and position of spacers and washers noted during removal.
5. Reinstall all shields removed for the repair.



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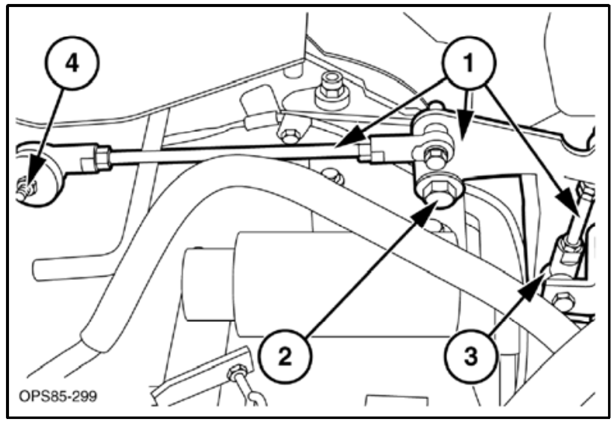
CONTROL LINKAGE AND NEUTRALIZER

REINSTALLATION

1. Install the control handle assemblies into their correct positions, and secure with hardware previously removed.
2. Install the control linkage assembly, 1, by reconnecting the control link (pivot) at 2, the rear control rod at 3, and the front control rod at 4.



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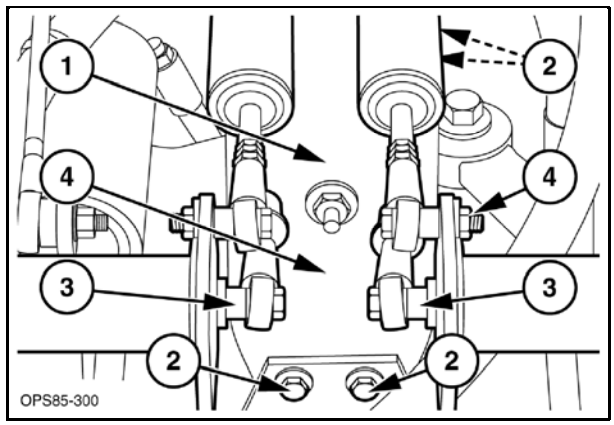
3. Install the neutralizer assembly, 1, and secure with four attaching bolts, 2. Two at the front and two at the rear.
4. Connect the neutralizer assemblies to the control handles at 3, and reconnect the dampener shocks at 4.



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Op. 29 130 06

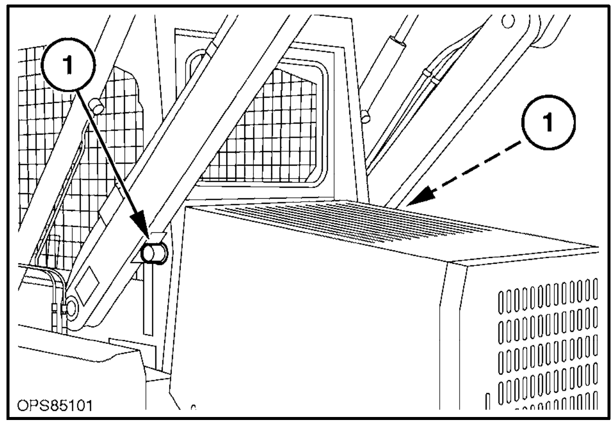
DRIVE CONTROL ADJUSTMENT PROCEDURE

If the machine creeps (tires rotate slowly with steering control in neutral) and the transmissions make a noise indicating they are being slightly stroked, a neutralizing adjustment is required.

CAUTION

To make a neutralizer adjustment, block the machine off the ground so that the wheels turn freely. Raise the boom and place it on the boom lockpins. When the engine is running, stay clear of the rotating wheels.

To make any transmission control linkage adjustments, first block the skid steer off the ground with the boom in the raised position resting on the boom lockpins, 1. Put the Service/Run switch in the "SERVICE" position to prevent movement of the boom and bucket.



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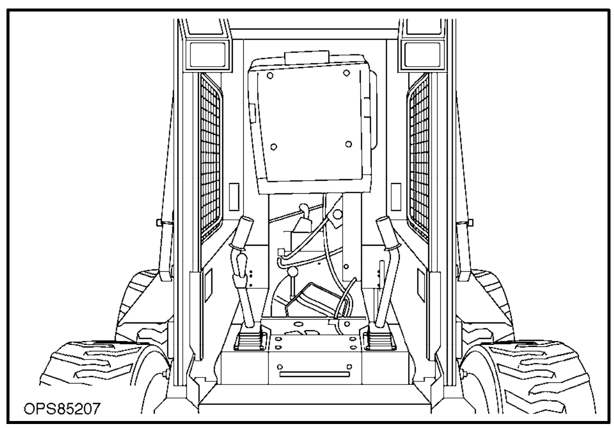
Raise the operator's seat and latch in the raised position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.



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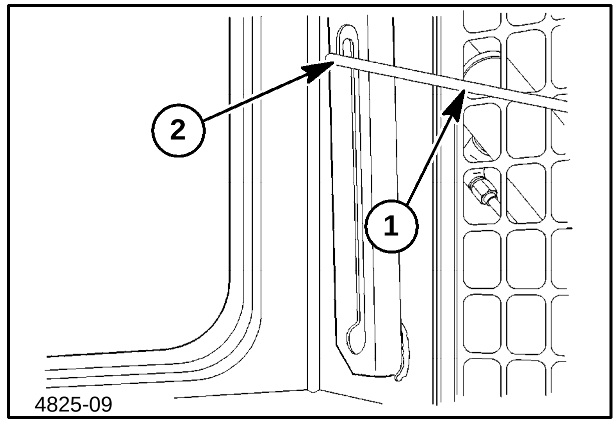
The seat and seat support rod, 1, shown properly latched in the raised supported position.



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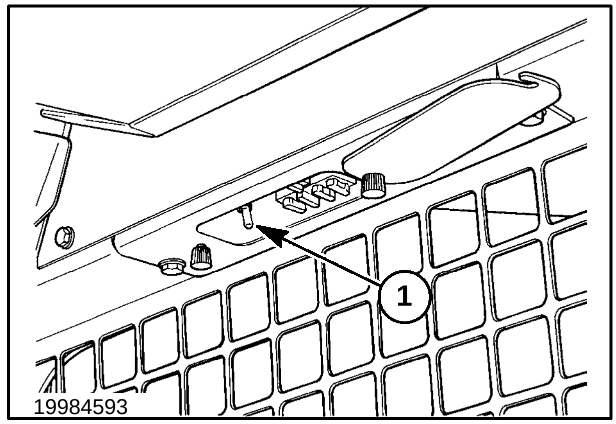
CAUTION

Make sure the seat is properly latched before working under the seat assembly.

Before making any adjustments make sure there is no binding in the control linkage, shocks or neutralizers.

The skid steer must be raised and supported with the tires off the ground. Use adequate blocking or jack stands to securely support the skid steer.

The engine must be started and running to make final linkage or neutral adjustments. Place the “SERVICE/ RUN” Switch, 1, in the “SERVICE” position to allow the engine to be started.



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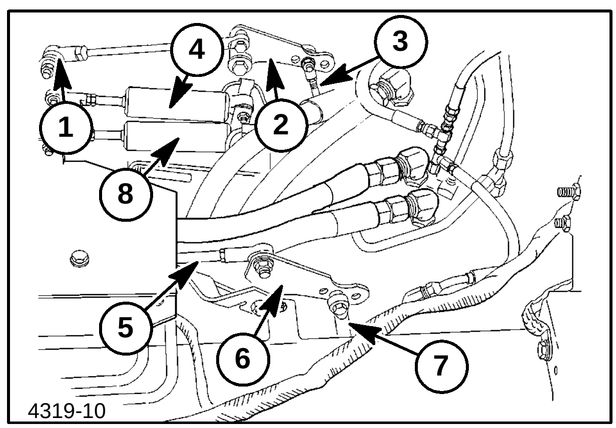
LS180 LINKS AND ARMS

Control lever and link, 1, arm, 2, link, 3, and dampener assembly, 4, controls the right side. Control lever and link, 5, arm, 6, link, 7, and dampener assembly, 8, controls the left side. The two dampener shocks, 4 and 8, are connected to the steering linkage to dampen the hydraulic vibration from the control levers and the operator’s hands. The neutralizer assemblies are spring loaded to return the steering linkage to the neutral position.



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When the operator strokes both control levers in the same direction the unit will travel in that direction until the levers are stroked differently to change direction. When both levers are released the steering linkage will return to neutral.

The control arm, 1, and linkage, 2, must be set in the appropriate hole for linkage travel and wheel speeds.

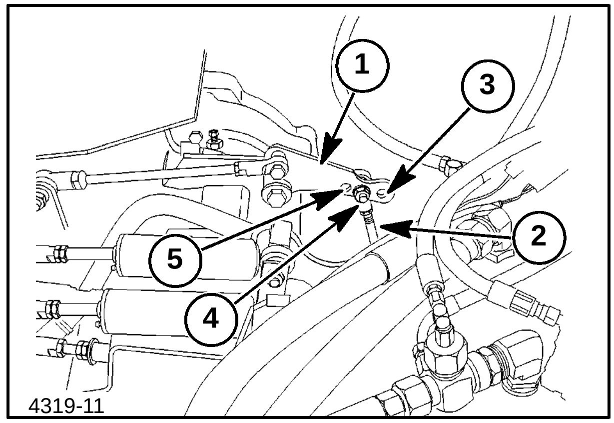
Hole 3 – Gives maximum linkage travel and wheel speed.

Hole 4 – Reduces linkage travel and wheel speed when steering levers are fully stroked to provide more wheel torque.

Hole 5 – Maximum reduction in linkage travel and corresponding wheel speed.

Factory assembly of linkage is in hole, 4, as shown. If an operator is in a less power-demanding operation and needs maximum ground speed, the linkage can be moved to hole, 3.

For maximum wheel torque, use hole, 5.



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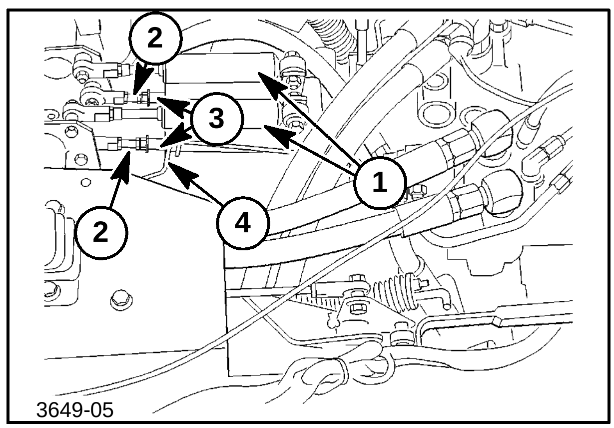
NOTE: *Left and right control linkage must be in the same holes for machines to operate in a straight line of travel and with the same power.*

For maximum use of engine horse power and wheel torque the skid steer must be operated at reduced wheel speed (ground speed) by positioning the steering levers closer to the neutral position.

Op. 29 130 06

LS180 NEUTRALIZER ADJUSTMENT

1. Check the dampeners, 1, for equal pressure required to move shaft in/out of housing and for no binding. Repair or replace dampener if required.
2. Check the rods, 2, and front and rear bushing, 3, to ensure there is no binding between the rods and bushings and bushings and support, 4.



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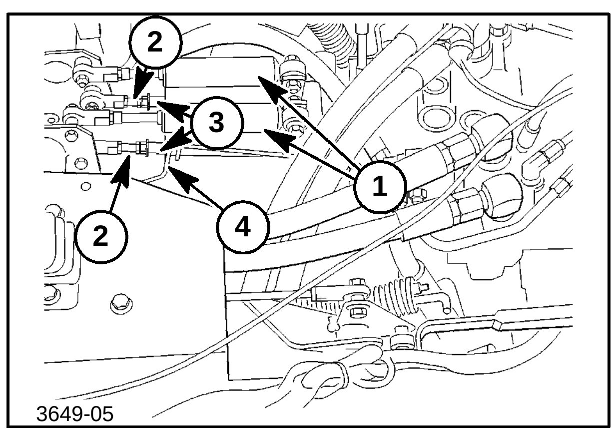
3. Check and remove any free play in the neutralizer spring assemblies, 1, right side and, 2, left side. There should be no free play between the rod and bushing at, 3, or between the bushings and the support at, 4. To remove the free play loosen nuts and adjust on rods at, 5.

NOTE: *If the rods are turned in too far or not far enough, free play will result.*



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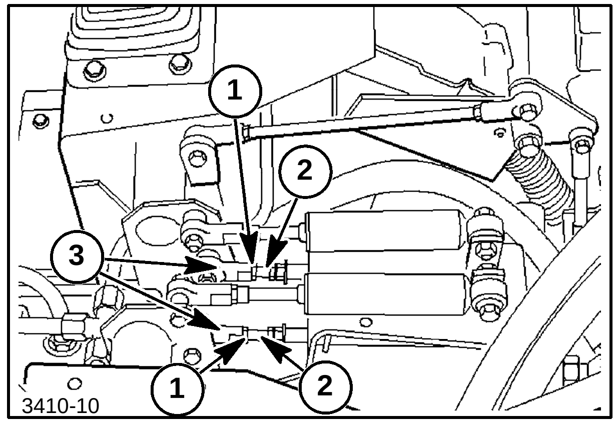
CONTROL LEVER PARALLEL ADJUSTMENT

1. Set the hydrostatic control levers to 9.5 degrees forward and parallel with each other. To obtain the proper settings loosen jam nuts at, 1, and thread rods, 2, in/or out of yokes, 3. Each side must be set.

***IMPORTANT**: If the hydrostatic control levers are not set properly, the straight travel and forward/reverse stop adjustment and equal wheel speeds will be difficult to obtain.*

***NOTE:** If the skid steer is equipped with a back-up alarm, the alarm switches will require adjustment if rods, 2, are rotated.*



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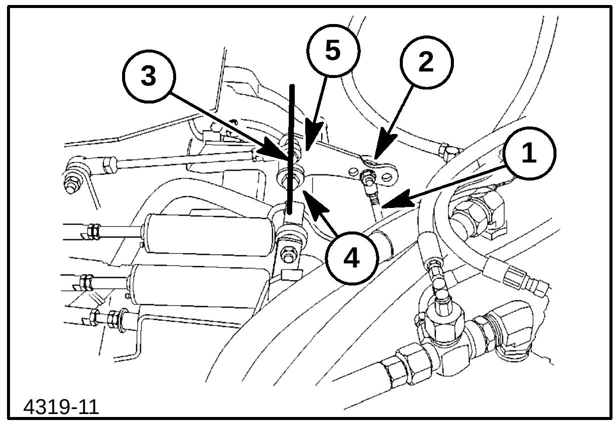
LS180 LINKAGE AND CONTROL LEVER EQUAL MOVEMENT

Right Control Linkage Adjustment

1. Check the length of link, 1, and adjust if required to obtain a vertical center line at 3, with the control linkage in neutral and no tire rotation.

   The center of the control arm pivot, 4, and center of link pivot, 5, must align to insure equal stroke forward and reverse.

   Remove the control link, 1, at 2, and adjust the length of the link if required.



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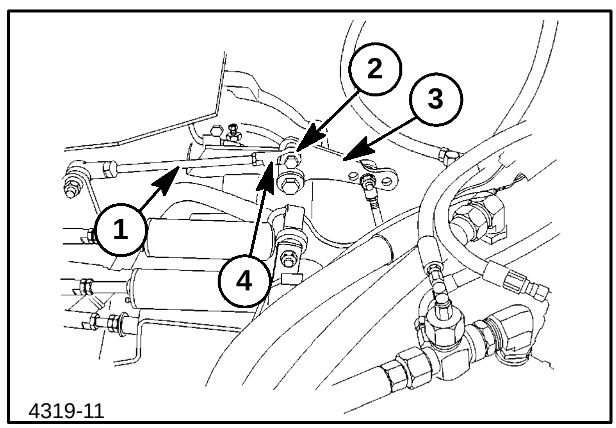
2. Unhook link, 1, at 2 and start the skid steer engine, at this time. Pivot the control arm, 3, until the hydrostat control neutralizes the hydrostatic pump with no tire rotation.
3. With the control levers previously set to the 9.5 degrees, forward position, rotate the arm, 3, until the tires start to rotate forward and then rotate the arm, 3, back until tires just stop rotating. Now adjust the length of link, 1, with yoke, 4, to allow the yoke to be reconnected at, 2. Adjust both the right and left sides in this sequence.

   Start the unit and check for neutral, no tire rotation. If the tires rotate repeat step three, if there is no tire rotation go to straight travel adjustment.



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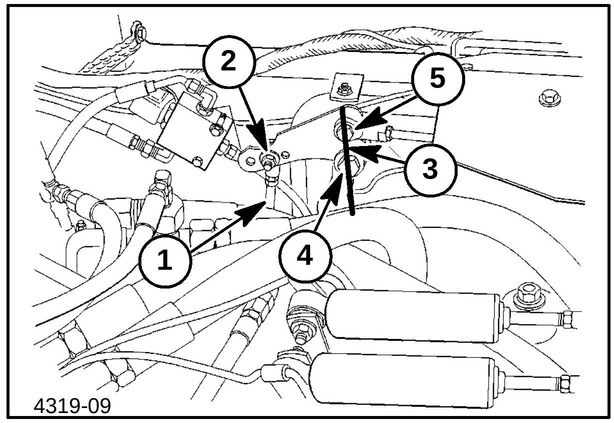
***NOTE:** If adjusted correctly it will take the same movement of the left and right hydrostatic control levers to produce tire rotation in the forward direction.*

LEFT CONTROL LINKAGE ADJUSTMENT

1. Check the length of link, 1, and adjust if required to obtain a vertical center line at 3, with the control linkage in neutral and no tire rotation.

   The center of the control arm pivot, 4, and center of link pivot, 5, must align to insure equal stroke forward and reverse.

   Remove the control link, 1, at 2, and adjust the length of the link if required.



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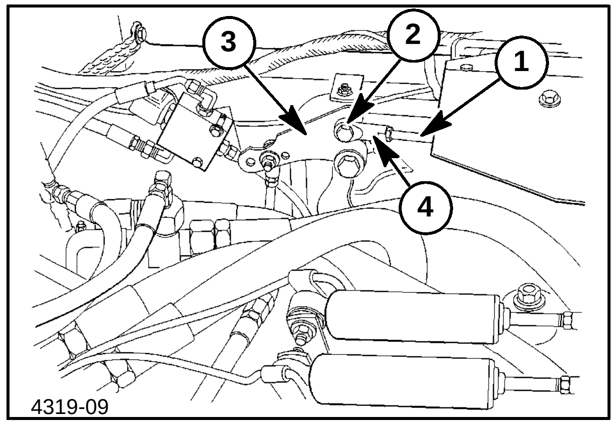
2. Unhook link, 1, at 2 and start the skid steer engine, at this time. Pivot the control arm, 3, until the hydrostat control neutralizes the hydrostatic pump with no tire rotation.
3. With the control levers previously set to the 9.5 degrees, forward position, rotate the arm, 3, until the tires start to rotate forward and then rotate the arm, 3, back until tires just stop rotating. Now adjust the length of link, 1, with yoke, 4, to allow the yoke to be reconnected at, 2. Adjust both the right and left sides in this sequence.

   Start the unit and check for neutral, no tire rotation. If the tires rotate repeat step three, if there is no tire rotation go to straight travel adjustment.

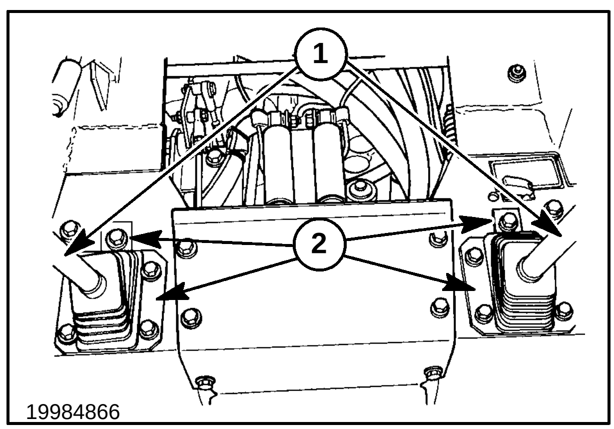


365

NOTE: *If adjusted correctly it will take the same movement of the left and right hydrostatic control levers to produce tire rotation in the forward direction.*

LS180 STRAIGHT TRAVEL AND FORWARD/REVERSE STOP ADJUSTMENT

Before straight travel can be adjusted, the control levers, 1, must be set for equal movement. When both the right and left control levers are stroked forward, the tires should start rotating at the same time. To obtain equal movement, refer to steps 2 and 3 of LINKAGE AND CONTROL LEVER EQUAL MOVEMENT ADJUSTMENT. A hand held tach is required to properly set forward and reverse wheel speeds.



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IMPORTANT: *If the external control lever stops, 2, are not adjusted properly, overspeed may occur and the control linkage and transmission may be damaged.*

Once the control levers are set for equal movement, adjust the control lever forward stops, 2, and the reverse stops, 3, for correct wheel speed and straight travel.

If no hand tach is available, adjust the stops as follows to prevent transmission overspeed:

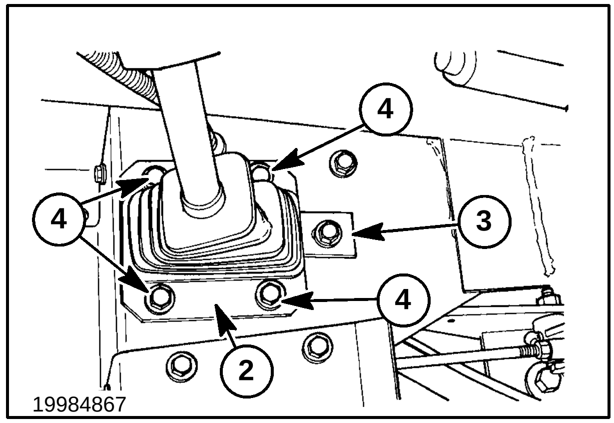
1. Set the forward stops, 2, in the middle of the slots, 4.
2. Set the reverse stops, 3, with the stop fully forward.

NOTE: *This procedure will not set the wheel speeds to maximum, but should insure against transmission overspeed and linkage and transmission damage.*

Use a hand tach to adjust the forward and reverse stops to set wheel speeds to maximum equal speeds:

1. Loosen the forward stop retaining hardware, 1, and slide stops, 2, forward.
2. Loosen the reverse stop hardware, 3, and slide stops, 4, rearward.
3. Using a hand tach, set wheel hub speed forward and reverse equal by RPM in low range, or in high range if the loader is equipped with the two–speed variable motors.

IMPORTANT*: DO NOT EXCEED a maximum of 120 RPM in high range to prevent transmission overspeed.*



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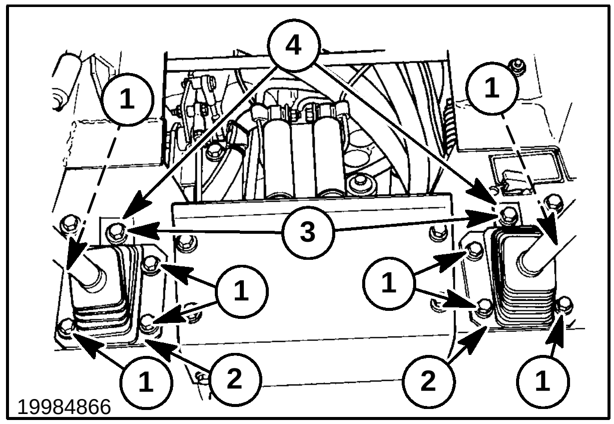

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4. Operate unit and stroke control levers forward to obtain maximum speed, and slide the forward stops rearward to contact the control lever and tighten stop retaining hardware.
5. Stroke the control levers in reverse to obtain maximum speed and slide the reverse stops against the control levers and tighten retaining hardware.

IMPORTANT: *The hydrostatic pump control valve and linkage has a dead band area in neutral, forward, and reverse. Within the dead band areas, there will be a control lever movement without wheel movement or increase in speeds.*

6. Operate the skid steer and check for straight travel and make final adjustment by slowing down the fast side.

NOTE: *If stop plates are not adjusted properly equal travel speeds forward and reverse will not be obtained. If too much forward stroke is allowed, the reverse speed may be diminished.*

CAUTION

the skid steer must be raised and supported with the tires off the ground. Use adequate blocking or jack stands to securely support the skid steer.

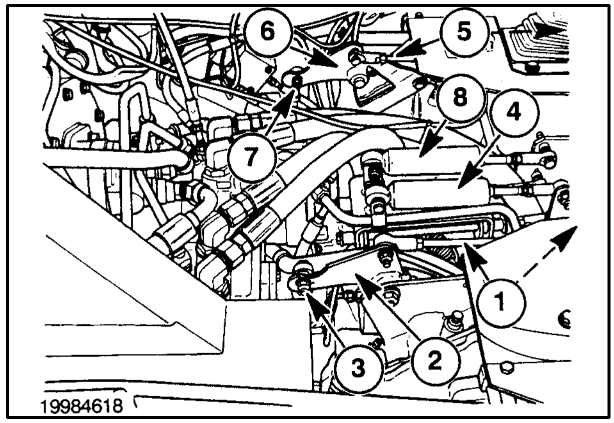
IMPORTANT: *If the external control lever stops are not adjusted properly the control linkage and transmission may be damaged.*

7. Return the “SERVICE/RUN” Switch to the “RUN” position.

LS190 LINKS AND ARMS

Control lever and link, 1, arm, 2, link, 3, and dampener assembly, 4, controls the right side. Control lever and link, 5, arm, 6, link, 7, and dampener assembly, 8, controls the left side. The two dampener shocks, 4 and 8, are connected to the steering linkage to dampen the hydraulic vibration from the control levers and the operator's hands. The neutralizer assemblies are spring loaded to return the steering linkage to the neutral position.

When the operator strokes both control levers in the same direction the unit will travel in that direction until the levers are stroked differently to change direction. When both levers are released the steering linkage will return to neutral.



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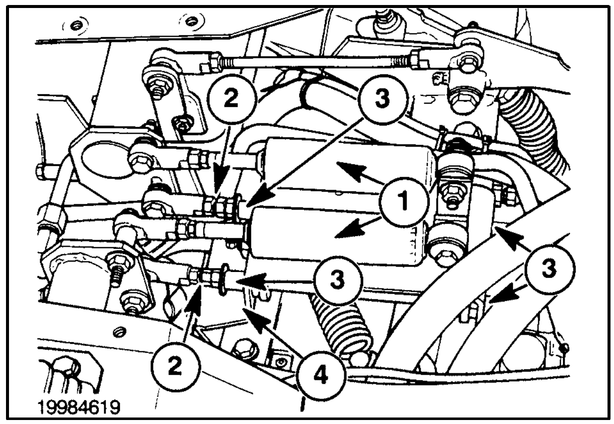
Op. 29 130 06

LS190 NEUTRALIZER ADJUSTMENT

1. Check the dampeners, 1, for equal pressure required to move shaft in/out of housing and for no binding. Repair or replace dampener if required.
2. Check the rods, 2, and front and rear bushing, 3, to ensure there is no binding between the rods and bushings and bushings and support, 4.



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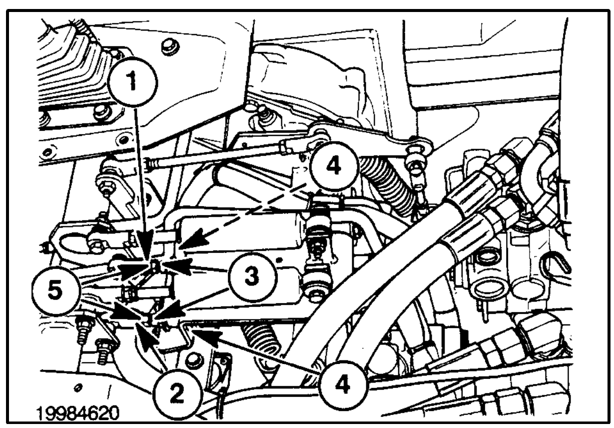
3. Check and remove any free play in the neutralizer spring assemblies, right side, 1, and left side, 2. There should be no free play between the rod and bushing at, 3, or between the bushings and the support at, 4. To remove the free play loosen nuts and adjust on rods at, 5.

***NOTE:** If the rods are turned in too far or not far enough, free play will result.*



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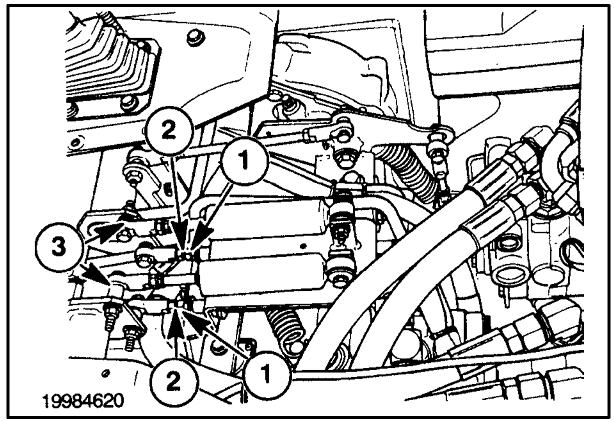
LS190 HYDROSTATIC CONTROL LEVER

1. Set the hydrostatic control levers to 9.5 degrees forward of vertical and parallel with each other. To obtain the proper settings loosen jam nuts at, 1, and thread rods, 2, in/or out of yokes, 3. Each side must be set.

***IMPORTANT**: If the hydrostatic control levers are not set properly, the straight travel and forward/reverse stop adjustment and equal wheel speeds will be difficult to obtain.*



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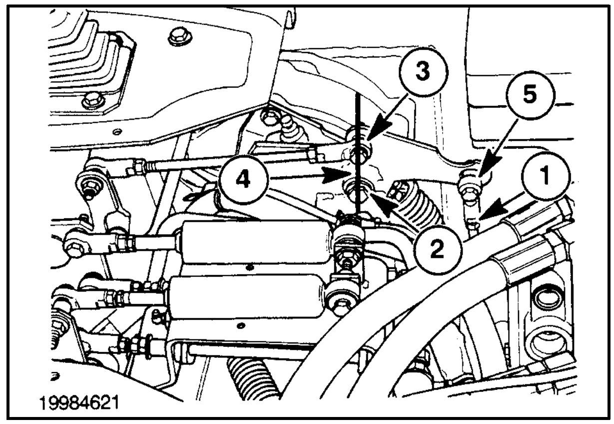
LS190 LINKAGE AND CONTROL LEVER EQUAL MOVEMENT

Right Control Linkage Adjustment

1. Check the length of link, 1, and adjust if required to obtain a vertical center line of the control arm pivot, 2, and link pivot, 3, shown at 4, with the control linkage in neutral and no tire rotation.

   The center of the control arm pivot, 2, and center of link pivot, 3, must align to insure equal stroke forward and reverse.

   Remove the control link, 1, at 5, and adjust the length of the link if required.



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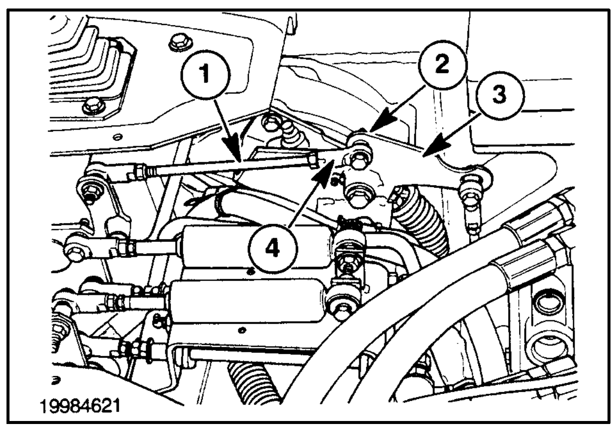
2. Unhook link, 1, at 2 and start the skid steer engine, at this time. Pivot the control arm, 3, until the hydrostat control neutralizes the hydrostatic pump with no tire rotation.
3. With the control levers previously set to the 9.5 degrees, forward position, rotate the arm, 3, until the tires start to rotate forward and then rotate the arm, 3, back until tires just stop rotating. Now adjust the length of link, 1, with yoke, 4, to allow the yoke to be reconnected at, 2. Adjust both the right and left sides in this sequence.

   Start the unit and check for neutral, no tire rotation. If the tires rotate repeat step three, if there is no tire rotation go to straight travel adjustment.



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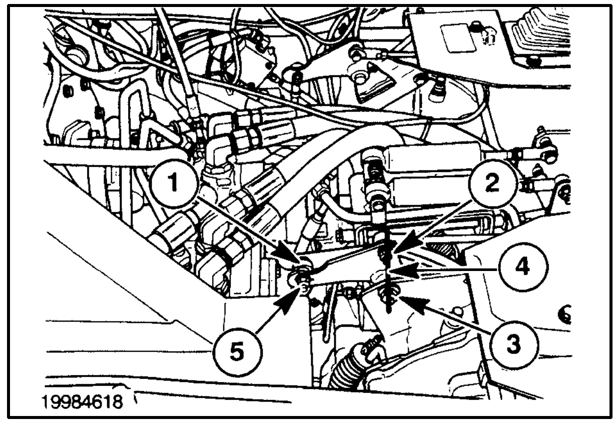
***NOTE:** If adjusted correctly it will take the same movement of the left and right hydrostatic control levers to produce tire rotation in the forward direction.*

LEFT CONTROL LINKAGE ADJUSTMENT

1. Check the length of link, 1, and adjust if required to obtain a vertical center line at 3, with the control linkage in neutral and no tire rotation.

   The center of the control arm pivot, 4, and center of link pivot, 5, must align to insure equal stroke forward and reverse.

   Remove the control link, 1, at 2, and adjust the length of the link if required.



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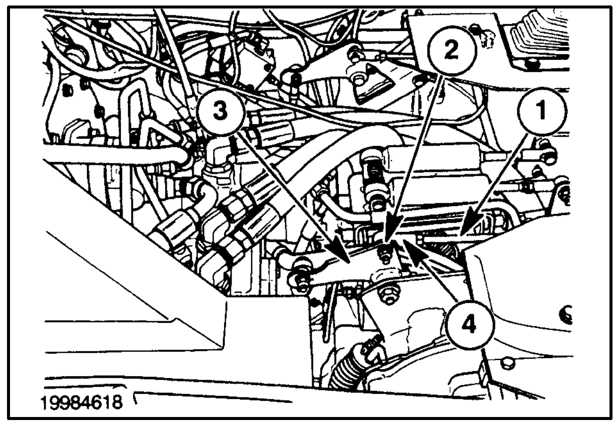
2. Unhook link, 1, at 2 and start the skid steer engine, at this time. Pivot the control arm, 3, until the hydrostat control neutralizes the hydrostatic pump with no tire rotation.
3. With the control levers previously set to the 9.5 degrees, forward position, rotate the arm, 3, until the tires start to rotate forward and then rotate the arm, 3, back until tires just stop rotating. Now adjust the length of link, 1, with yoke, 4, to allow the yoke to be reconnected at, 2. Adjust both the right and left sides in this sequence.

   Start the unit and check for neutral, no tire rotation. If the tires rotate repeat step three, if there is no tire rotation go to straight travel adjustment.



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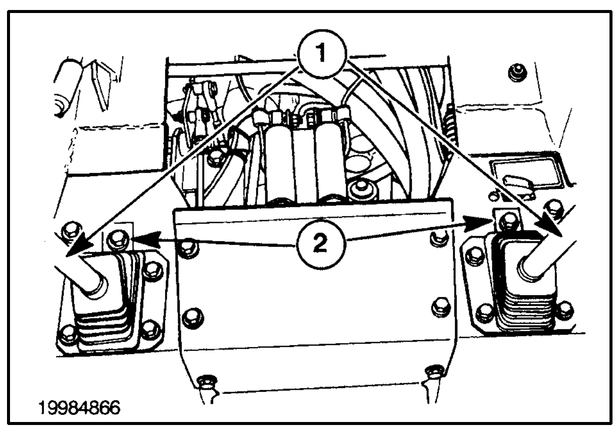
NOTE: *If adjusted correctly it will take the same movement of the left and right hydrostatic control levers to produce tire rotation in the forward direction.*

LS190 STRAIGHT TRAVEL AND FORWARD/REVERSE STOP ADJUSTMENT

Before straight travel can be adjusted, the control levers, 1, must be set for equal movement. When both the right and left control levers are stroked forward, the tires should start rotating at the same time. To obtain equal movement, refer to steps 2 and 3 of LINKAGE AND CONTROL LEVER EQUAL MOVEMENT ADJUSTMENT. A hand held tach is required to properly set forward and reverse wheel speeds.



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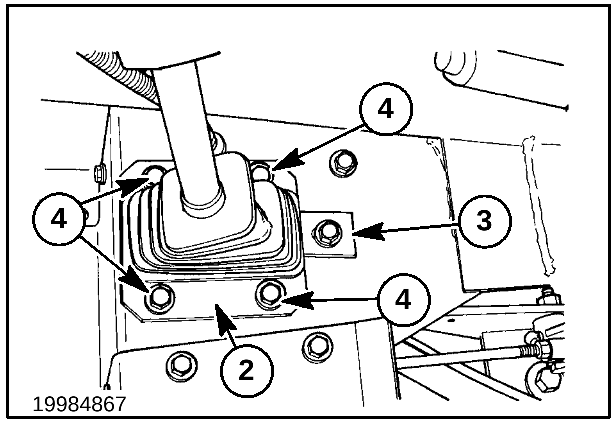
IMPORTANT: *If the external control lever stops, 2, are not adjusted properly, overspeed may occur and the control linkage and transmission may be damaged.*

Once the control levers are set for equal movement, adjust the control lever forward stops, 2, and the reverse stops, 3, for correct wheel speed and straight travel.

If no hand tach is available, adjust the stops as follows to prevent transmission overspeed:

1. Set the forward stops, 2, in the middle of the slots, 4.
2. Set the reverse stops, 3, with the stop fully forward.

NOTE: *This procedure will not set the wheel speeds to maximum, but should insure against transmission overspeed and linkage and transmission damage.*



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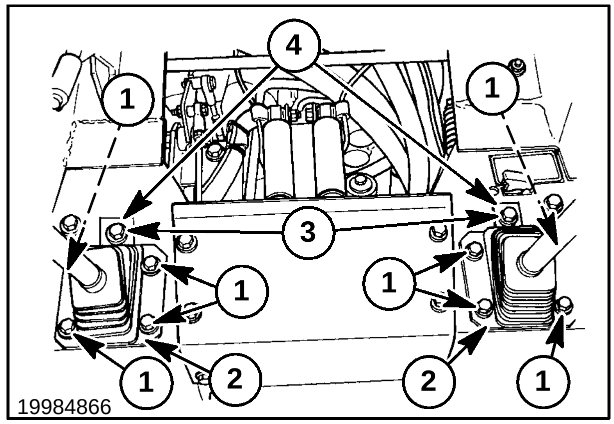
Use a hand tach to adjust the forward and reverse stops to set wheel speeds to maximum equal speeds:

1. Loosen the forward stop retaining hardware, 1, and slide stops, 2, forward.
2. Loosen the reverse stop hardware, 3, and slide stops, 4, rearward.
3. Using a hand tach, set wheel hub speed forward and reverse equal by RPM in low range, or in high range if the loader is equipped with the two–speed variable motors.

IMPORTANT*: DO NOT EXCEED a maximum of 120 RPM in high range to prevent transmission overspeed.*



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4. Operate unit and stroke control levers forward to obtain maximum speed, and slide the forward stops rearward to contact the control lever and tighten stop retaining hardware.
5. Stroke the control levers in reverse to obtain maximum speed and slide the reverse stops against the control levers and tighten retaining hardware.

IMPORTANT: *The hydrostatic pump control valve and linkage has a dead band area in neutral, forward, and reverse. Within the dead band areas, there will be a control lever movement without wheel movement or increase in speeds.*

6. Operate the skid steer and check for straight travel and make final adjustment by slowing down the fast side.

NOTE: *If stop plates are not adjusted properly equal travel speeds forward and reverse will not be obtained. If too much forward stroke is allowed, the reverse speed may be diminished.*

CAUTION

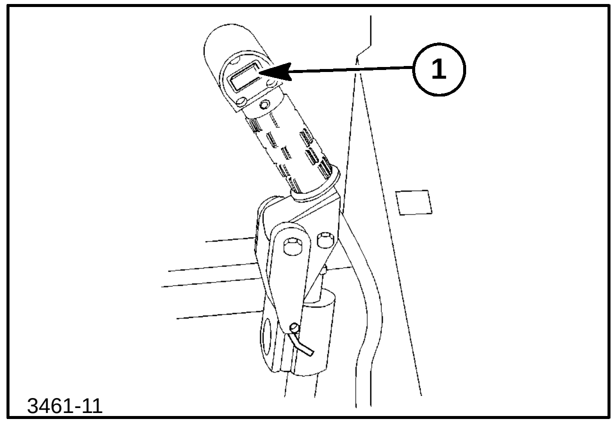
the skid steer must be raised and supported with the tires off the ground. Use adequate blocking or jack stands to securely support the skid steer.

IMPORTANT: *If the external control lever stops are not adjusted properly the control linkage and transmission may be damaged.*

7. Return the “SERVICE/RUN” Switch to the “RUN” position.

LS180 and LS190 HIGH/LOW RANGE ADJUSTMENT (OPTIONAL ON LS180)

The HIGH/LOW (two–speed) feature gives the operator more range in travel speeds. The control is at, 1, on the right hydrostatic control lever.



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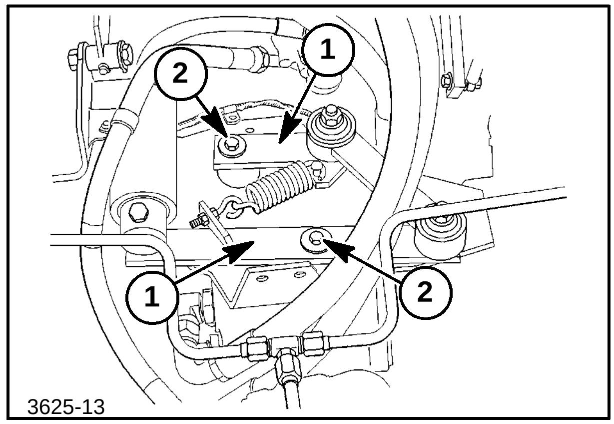
Before checking or adjusting the HIGH/LOW linkage, make sure the control arms, 1, are tight on the motor cam plate shafts, 2. The neutralizer and dampeners are shown removed for clarity.



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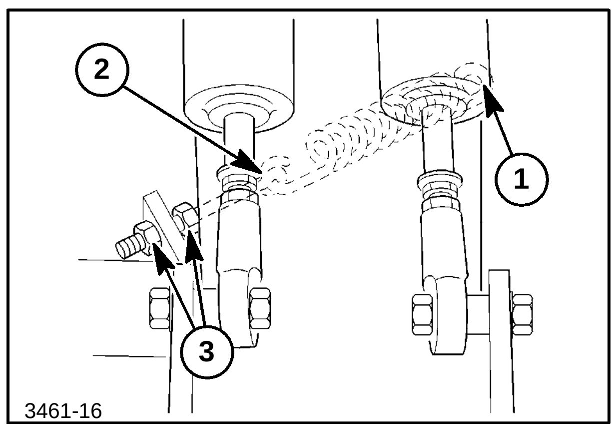
Spring Adjustment
Adjust the high/low return spring to a spring length of 4-5/16″ (109 mm) from eye at, 1, to eye, 2, by tightening or loosening the draw bolt, 3.

NOTE: *Once the skid steer neutral adjustments and straight travel speeds are correct in low range, and the variable motors are set to the high range position, the skid steer may not run in a straight line.*



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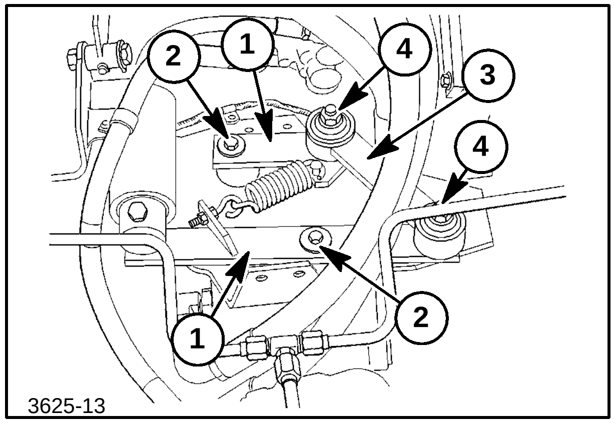
High/Low Linkage Adjustment

1. Control arms, 1, clamped tight onto the motor cam plate shafts, 2.
2. Spring adjusted to the proper length.
3. Loosen the control link, 3, on the control arms at 4.
4. Rotate both control arms, 1, clockwise and hold firmly against the internal motor stops by the spring.
5. With both arms, 1, firmly against the internal motor stops, tighten link, 3, and retaining hardware, 4.



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LABOR GUIDE

HYDROSTATIC SYSTEM AND STEERING SYSTEM

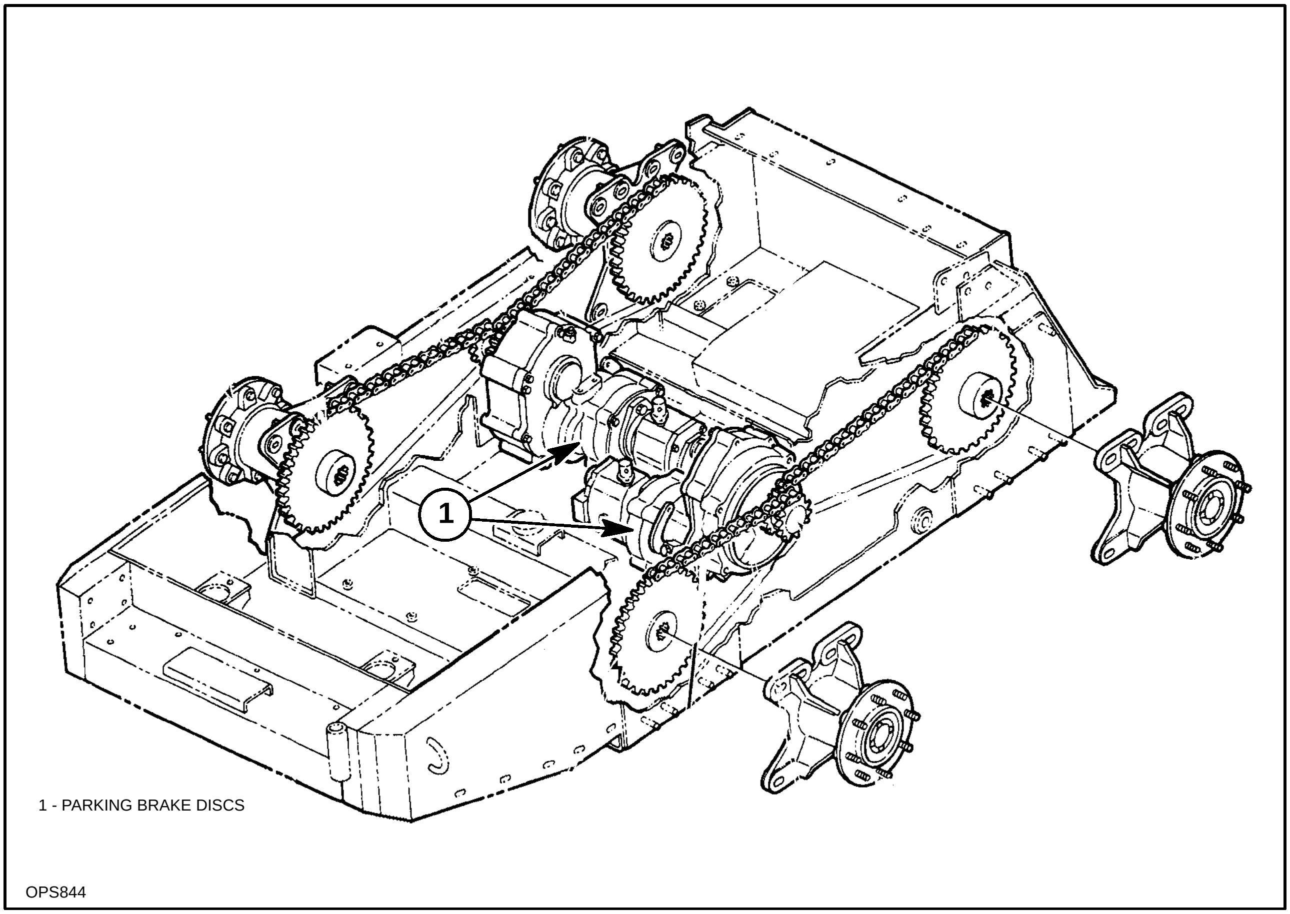
The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job	Hours
Hydrostatic pump - RH or LH assembly - remove/replace	4.0
Hydrostatic pump - repair	1.0
Hydrostatic motor RH - remove/replace	3.0
Hydrostatic motor LH - remove/replace	3.0
Hydrostatic motor - repair	1.0
Gerotor charge pump - remove/replace	2.0
Gerotor charge pump - repair	1.0
Neutralizer assembly - remove/replace	0.5
Two-Speed control valve - remove/replace	0.5
Two-Speed control valve - repair	0.5
Two-Speed shift cylinder - remove/replace	1.0
Two-Speed shift cylinder - repair	0.5
Hydrostatic control handle assembly - remove/replace one assembly	0.25
Neutral adjustment	0.5
Time required to tilt cab and boom	1.0

SECTION 33 – BRAKES AND CONTROLS

Chapter 1 – Parking Brake

CONTENTS



1

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GENERAL INFORMATION

The parking brake system is a mechanically activated double disc brake system. Brake discs are attached to each of the two hydrostatic motor shafts, located inside the gearboxes, 1. Both left and right side parking brakes are activated by a single control lever. The park brake prevents movement of the loader when power is applied or the machine is parked on an incline.

CAUTION

Always engage the parking brake before exiting the loader. Never operate the loader until the parking brake is released.

SPECIFICATIONS

Chain Case and Gearbox

Side Cover Bolt Torque . . . . 15 N·m (11 ft. lbs.)

Drive Chain . . . . #100

Front Chain Length (64 links) . . . . 80″ (2032 mm)

Rear Chain Length – LS180 (58 links) . . . . 72.5″ (1841.5 mm)

Rear Chain Length – LS190 (64 links) . . . . 80″ (2032 mm)

Chain Tension . . . . 0 to 6 mm (0″ to 1/4″) movement at tire tread

Gearbox Mounting Bolt Torque . . . . 233 ft. lbs. (316 N·m)

Drive Motor Mounting Bolt Torque . . . . 63 ft. lbs. (85 N·m)

Front Cover Plate Bolt Torque . . . . 15 ft. lbs. (20 N·m)

Lubrication . . . . 9.5 liters (2.5 gal.) each side - 80W-90 API Service GL-5 Gear Oil

Other Materials

Description	Use
Ultra/Blue Silicone Sealer	Gearbox mounting bolts Axle housing bolts Chain case cover bolts Gearbox to chain case Gearbox cover and bolts
Sealing Material	NH Ultra Blue silicone sealer NH #L81724 - 3.35-oz. tube (cord) NH #L82519DS - 8-oz. tube NH #L58775 - 10.2-oz. cartridge
Gear Oil	80W-90 API Service GL-5 Gear Oil NH #9613295 - 1 qt. NH #9613294 - 5 gal. NH #9613375 - 4 L
Grease	High viscosity lithium base NH #9613310 - tube

NOTE: *Always use a noncorrosive silicone sealer to seal where required to prevent corrosion during the silicone curing process.*

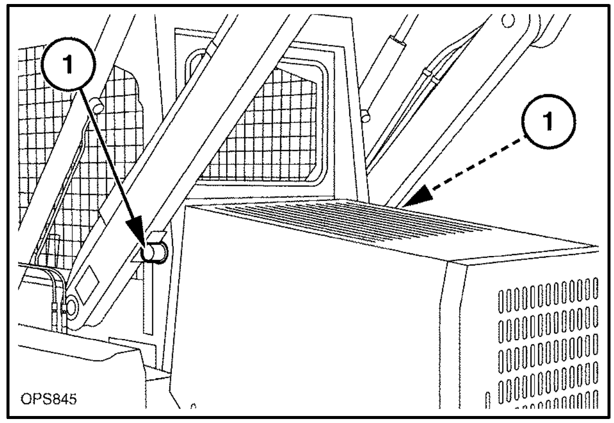
TROUBLESHOOTING

FINAL DRIVE/PARKING BRAKE SYSTEM

Before servicing or adjusting the final drive/parking brake system, the skid steer should be jacked up with the wheels off the ground.

Remove any attachment from the skid steer; boom, bucket, etc. Lower the boom to the lowered position or, if servicing requires the boom to be in the raised position, support the boom on the boom lock pins.

Raise the boom and lower onto the boom lock pins, 1.



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1. Raise the boom above the boom lock pins.
2. Engage the boom lock pins.
3. Stop the engine; ignition key in the “OFF” position.
4. Turn the ignition key to the “ON” position.
5. Lower the boom onto the boom lock pins.
6. Turn the ignition key to the “OFF” position.

CAUTION

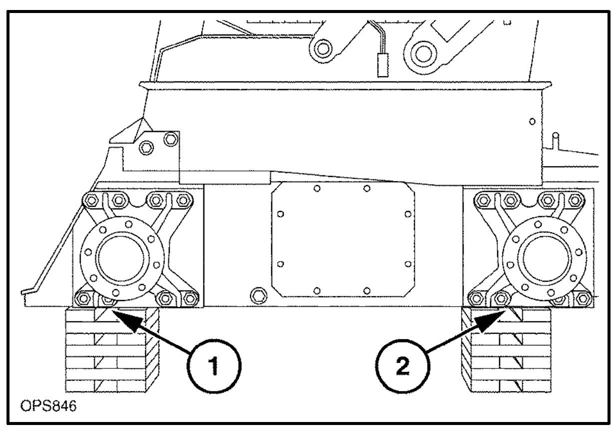
Never exit the loader with the boom in the raised position unless the boom is supported on the boom lock pins.

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment mounted. Always remove the attachment from the loader.

Jack up the loader and support the loader with the wheels off the ground. Use adequate jack stands or blocks to securely support the loader.

Support the loader at the front of the final drive cases at 1, and at the rear at 2.



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CAUTION

Never service a raised loader unless it is securely supported with adequate jack stands or blocks.

TROUBLESHOOTING

PARKING BRAKE SYSTEM

PROBLEM	POSSIBLE CAUSES	CORRECTION
Parking brake will not hold loader.	Park brake not engaged.	Engage parking brake.
	Brake not adjusted properly.	Adjust parking brake.
	Handle not operating or latching.	Check handle components; repair or replace.
	Loose brake linkage.	Inspect and repair linkage.
	Worn brake pad.	Inspect and repair brake pad.
Parking brake will not release.	Brake not adjusted properly.	Adjust parking brake.
	Handle not operating properly.	Check handle components; repair or replace.
	Brake caliper not releasing.	Check brake caliper and repair.
Parking brake handle will not move or release.	Handle not operating properly.	Check handle components; repair or replace.
	Control linkage not moving.	Check and repair linkage.
	Brake caliper not releasing.	Check brake caliper and repair.
Grinding noise when operating.	Handle not releasing properly.	Check handle components; repair or replace.
	Brake not adjusted properly.	Adjust parking brake.
	Brake caliper not releasing.	Check brake caliper and repair.

TESTING

PARKING BRAKE

Pretest instructions:

* Operator in seat with seat belt buckled.

* Engine running at 1500 RPM.

* Park brake in disengaged position.

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Push both drive controls forward equally and loader should move without restriction.	YES NO	Brake system OK. Parking brake not releasing; check control handle. If OK, go to next step.
2			Parking brake linkage not free; check for loose or binding linkage. If OK, go to next step.
3			Parking brake not releasing; check caliper and brake pad and repair.

Pretest instructions:

* Operator in seat with seat belt buckled.

* Engine running at 1500 RPM.

* Park brake in engaged position.

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Push both drive controls forward equally and loader should not move.	NO YES	Parking brake OK. Parking brake not adjusted properly. If OK, go to next step.
2			Parking brake linkage loose or broken. If OK, go to next step.
3			Parking brake caliper not operating properly. Check and repair.

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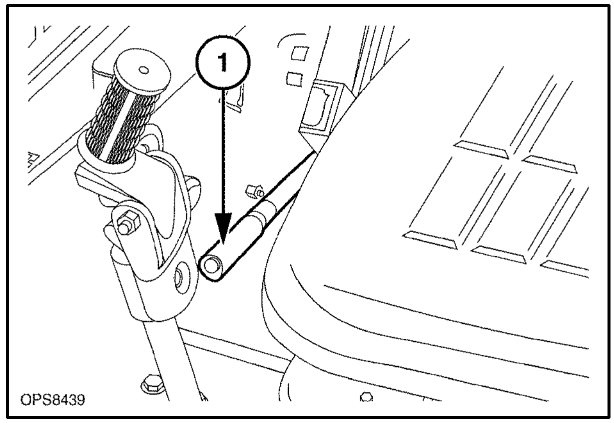
PARKING BRAKE

OPERATION

The parking brake system is a mechanically activated, double disc brake system. Brake discs are attached to each of the two hydrostatic motor shafts located in the gearboxes. Both left and right side parking brakes are activated by a single control lever. The park brake prevents movement of the loader when power is applied or the machine is parked on a slope.



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The parking brake control lever, 1, is located to the right of the operator's seat. When the lever is in the lowered, unlatched position, the brake is disengaged. When the lever is in the raised, latched position, the brake is engaged.

When the parking brake is engaged and the hydrostatic control levers are stroked, the skid steer should not move if the brake is adjusted properly.

The hydrostatic system is the primary brake for the skid steer when the unit is in operation. The parking brake is intended to hold a stopped machine in place, preventing rolling or creeping when parked.

The parking brake should always be engaged before exiting the skid steer.

CAUTION

Always activate the parking brake before leaving the operator station. Never operate the skid steer unless the brake is released.

REMOVAL AND INSPECTION

The hydrostatic motor two-speed control linkage, hydraulic cylinder (if applicable), and hydrostatic motor will need to be removed to access the parking brake assembly.

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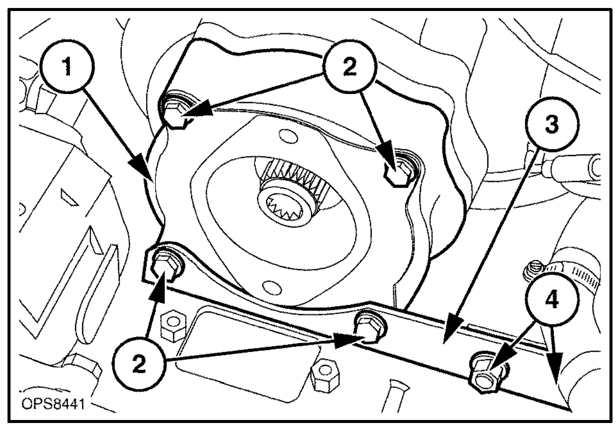
Removal

1. Tilt the cab and boom forward. Refer to Section 00 for the cab and boom tilting procedure.
2. Remove the hydrostatic motor two-speed hydraulic cylinder and control linkage (if applicable). Refer to Section 29 for the removal procedure.
3. Remove the hydrostatic motor. Refer to Section 29 for the removal procedure.

NOTE: *If only the hydrostatic motor is to be removed, apply the parking brake before removal to retain the brake discs and splined coupler in place.*

4. Remove two cap screws, 4.
5. Remove four cap screws, 2. Remove the park brake housing cover, 1, and bracket, 3.



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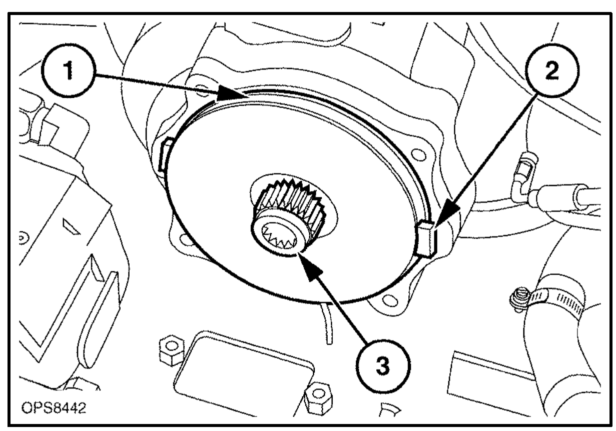
6. Remove two discs, 1; divider plate, 2; and splined coupler 3, by sliding them off the gearbox input shaft.



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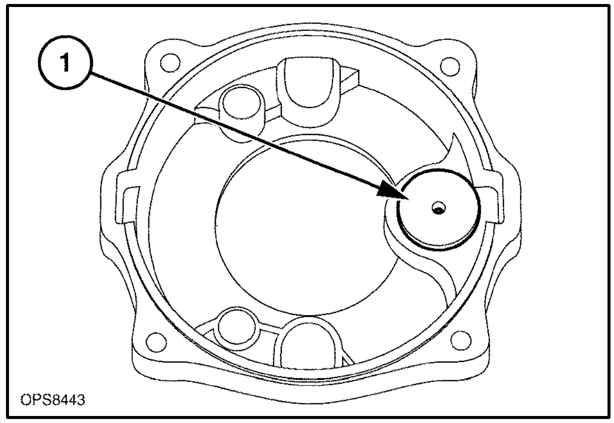
7. Remove the steel friction pad, 1, from the park brake housing cover.



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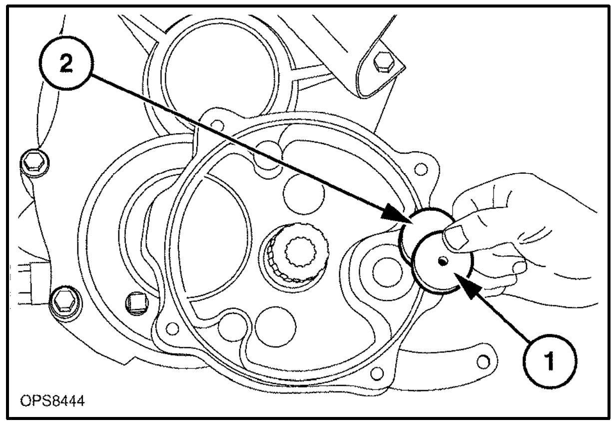
8. Remove the steel friction pad, 1, and spacer, 2, from the gearbox housing.



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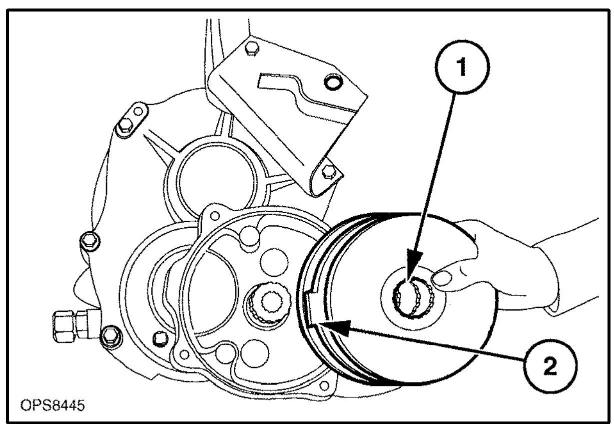
Inspection

1. Inspect the discs and divider plates for warping, scoring, galling or wear. Inspect the spline area, 1, of the discs and the lugs, 2, on the separator plates. Replace if necessary.



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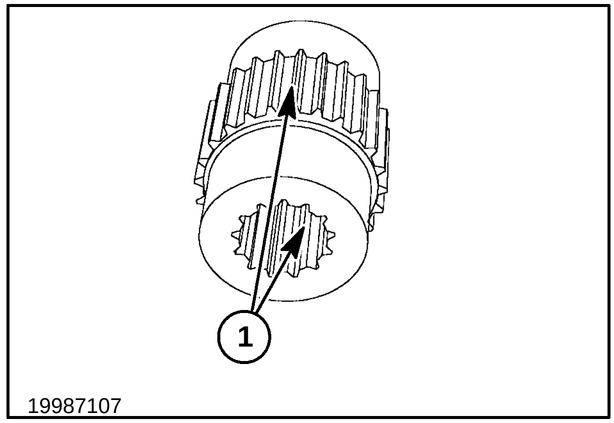
2. Inspect the coupler splines, 1, for excessive wear or chipped teeth.



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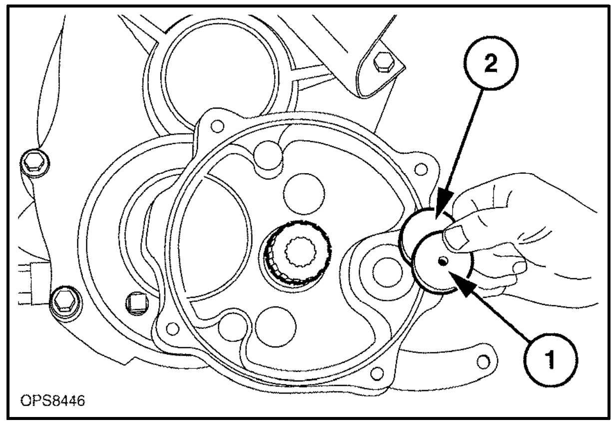
3. Inspect the brake friction pads, 1. If worn to 7 mm (1/4″) or less, replace.
4. The spacer plate, 2, will show a small amount of wear in the center. This is normal.



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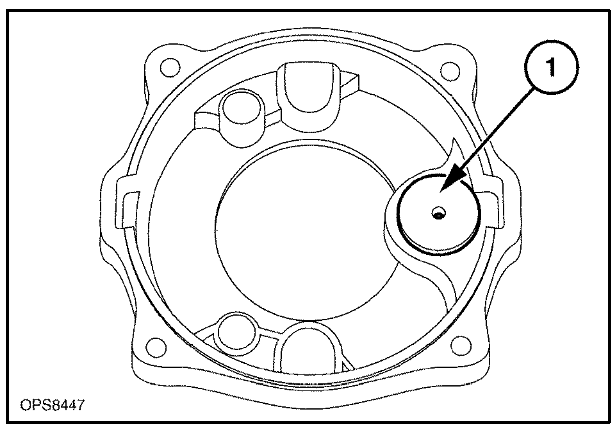
Repair and Assembly

After cleaning and careful inspection, reassemble the parking brake, using new parts where necessary.

1. Install the friction pad, 1, into the brake end cap.



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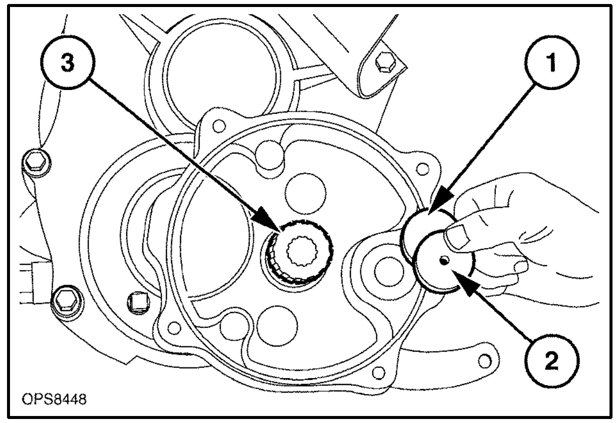
2. Install the thinner spacer plate, 1, into the gearbox housing, then the thicker friction pad, 2. Install the splined coupler, 3, onto the gearbox input shaft.



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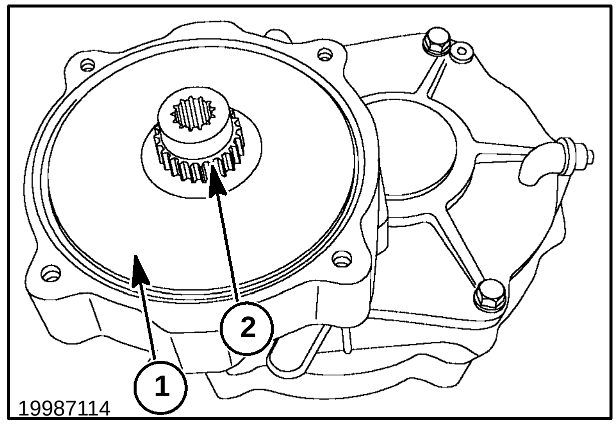
3. Install the first brake disc, 1, over the splines of the drive coupler, 2.



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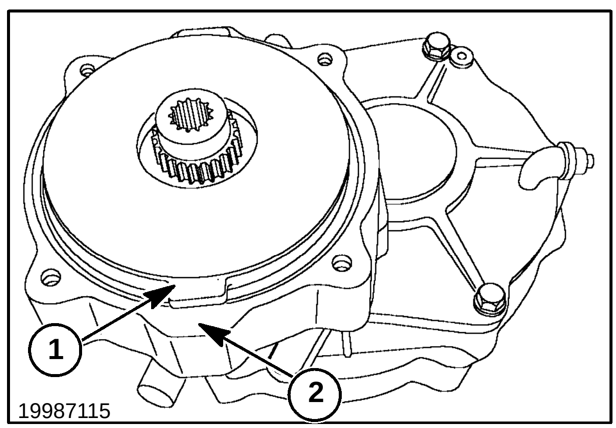
4. Install the separator plate on the drive coupler, with the lugs, 1, over the extended tabs, 2, on the gearbox case.



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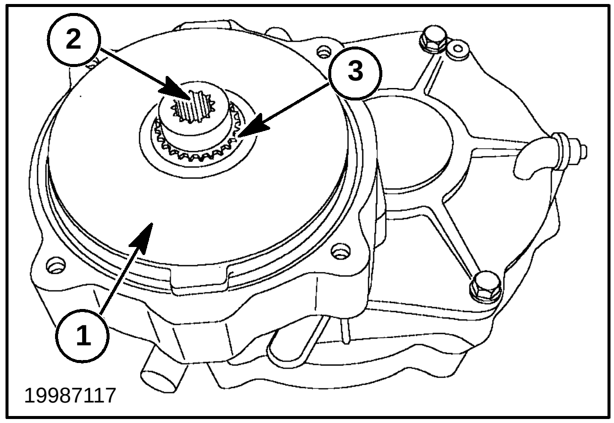
5. Install the second brake disc, 1, on the drive coupler, 2. The splines, 3, of the drive coupler should be visible above the brake disc.



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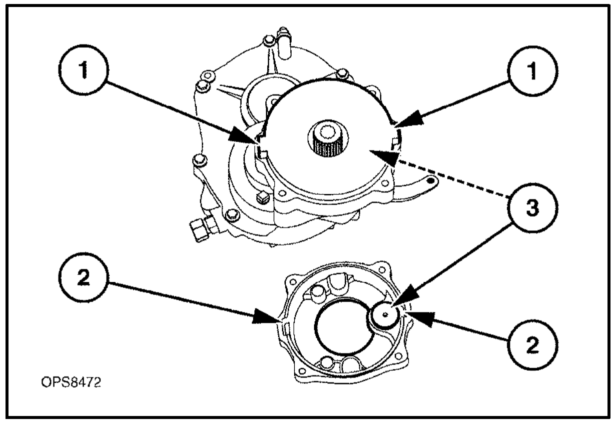
6. Apply silicone sealer to the mating surfaces of the housing and end cap.
7. Install the end cap onto the brake housing making sure the lugs, 1, on the separator plate fit in the notches, 2, on the end cap and the brake friction pads, 3, line up opposite each other across the brake and separator plates.



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PARKING BRAKE ADJUSTMENT

The parking brake control lever is located to the right of the operator's seat. With the lever in the down position, the brake is released; up is engaged. The parking brake should prevent movement of the loader when power is applied or parked on an incline.

To adjust the parking brake, do the following:

1. Put the control lever in the released (down) position.
2. Put the seat in the raised position, making sure the seat assembly is locked up securely.

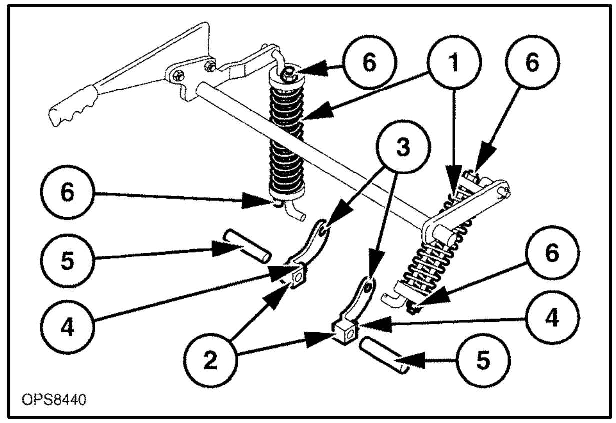
NOTE: *The fenders can be removed to access brake linkage.*

3. Remove cotter pin from spring link, 1, and lever, 2, at 3.
4. Unhook the spring link.
5. Adjust the spring assembly bolts, 6, equally to obtain a spring length of 152 mm (6″) with the parking brake control lever in the released position.
6. Loosen the setscrew, 4, in lever, 2, to allow the lever to be removed from the actuator shaft, 5.
7. Rotate the lever down to turn the actuator shaft into the caliper support to remove any play in brake caliper.
8. Slide the lever off the actuator shaft and rotate the lever up on the splined shaft until the spring link can be rehooked.
9. Slide the lever onto the shaft and reposition the lever to prevent contact with the hydraulic oil reservoir, hoses, etc. and tighten the setscrews.
10. Reinstall the cotter pin to retain the spring link to the lever.

CAUTION

Before adjusting the brake linkage, be sure that the brake is disengaged and the loader is on level ground to prevent the loader from rolling.

Always engage the parking brake before leaving the operator's seat. Never operate the unit unless the brake is released.



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LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
General	
Jack up machine and secure on blocking	0.5 hr.
Parking Brake	
Handle - Remove, rebuild, replace	1.0 hr.
Linkage - Remove, rebuild, replace	0.5 hr.
Discs - Remove and replace, with gearbox removed from machine. Includes R & R friction discs	1.0 hr.
Friction disc - Remove and replace, with gearbox removed from machine	1.0 hr.

SECTION 35 – HYDRAULIC SYSTEM

Chapter 1 – Valves, Gear Pump, Cylinders, and Pedal Controls

CONTENTS

Op. 35 000

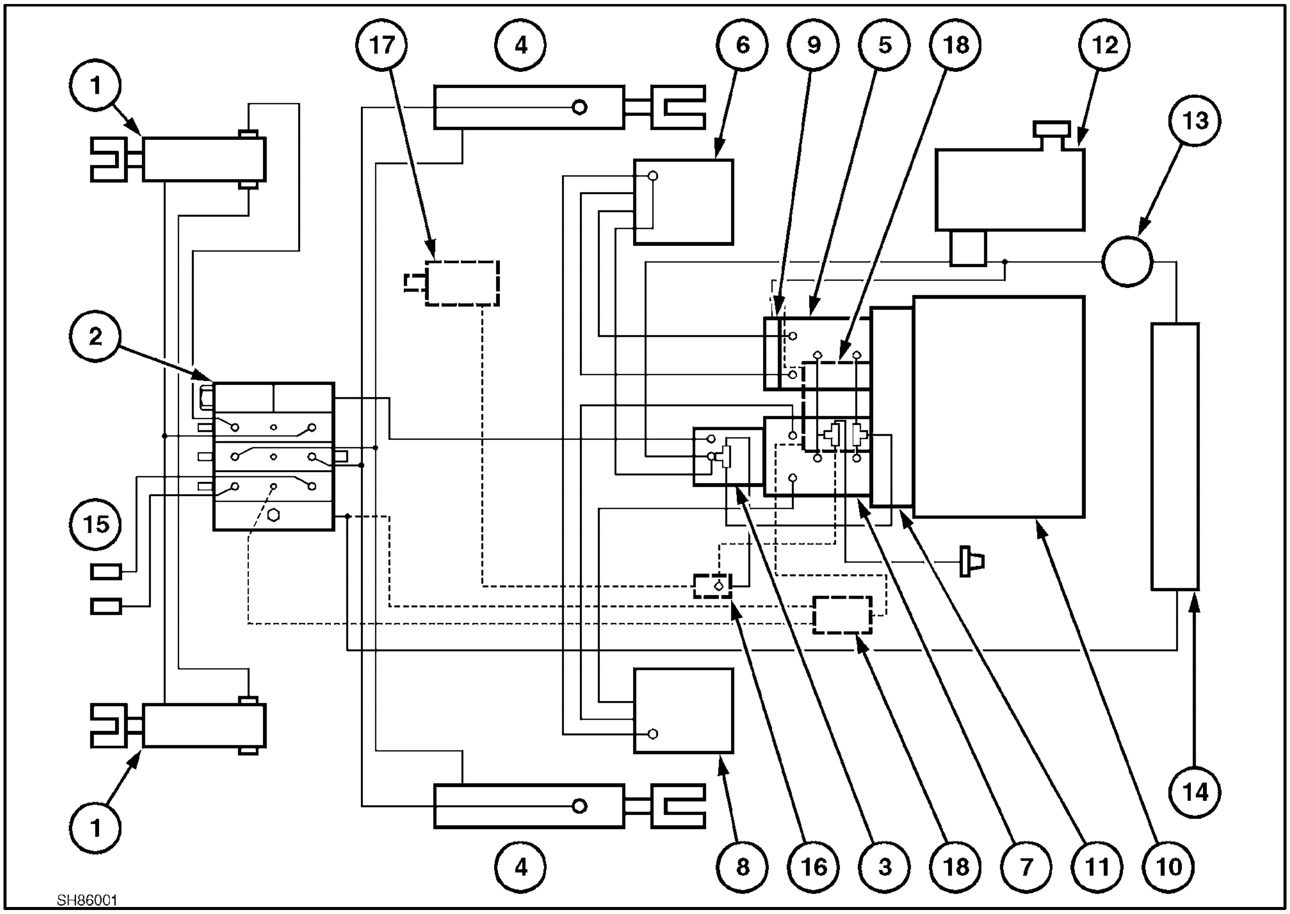
GENERAL INFORMATION

The hydraulic system provides hydraulic oil to the boom and bucket circuits. On skid steers equipped with the boom auxiliary hydraulic kit, system oil will also be supplied to quick couplers at the front of the boom to operate optional hydraulic attachments.

The hydraulic system on the LS180 and LS190 is an open center type hydraulic system. An open center system means that the first control valve function has priority over the next function in line.

The hydraulic gear pump, which is attached to the left-hand hydrostatic pump, provides continuous oil flow through the system to power the boom and bucket circuits and, if equipped, the auxiliary boom circuit.

Figure 1 shows the hydraulic circuit layout and system components for the LS180 and LS190 skid steers.



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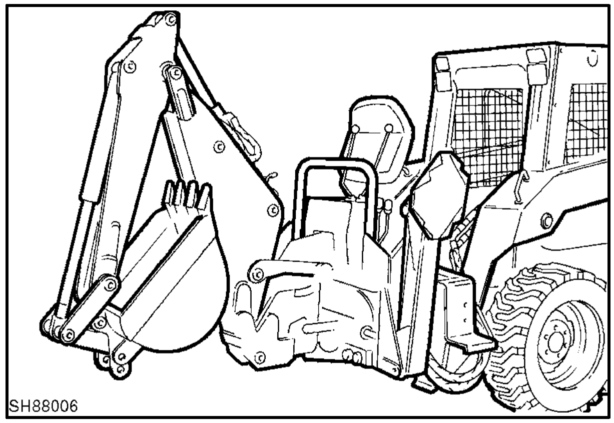
1. Bucket cylinders
2. Control valve (3 spool)
3. Hydraulic gear pump
4. Boom cylinders
5. Hydrostatic pump (RH)
6. Hydrostatic motor (RH)
7. Hydrostatic pump (LH)
8. Hydrostatic motor (LH)
9. Charge pump
10. Engine (power supply)
11. Engine gearbox
12. Hydraulic reservoir
13. Hydraulic filter
14. Hydraulic oil cooler
15. Auxiliary boom hydraulics
16. High/low control valve (if two-speed equipped)
17. High/low shift cylinder (if two-speed equipped)
18. Hydraulic high flow kit (optional)

HYDRAULIC SYSTEM COMPATIBILITY

There are important questions that must be answered before adapting attachments that require hydraulic oil power.



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1. **What is the hydraulic pressure requirement, minimum and maximum? Are they higher than the maximum pressure of the model?**

Model	Maximum Pressure
LS180	170-176 bar (2500 to 2600 PSI)
LS190	170-176 bar (2500 to 2600 PSI)

2. **What is the hydraulic oil flow requirement? Is it more than the highest total flow rate of the skid steer model?**

Model	Standard Hydraulics*	High Flow Hydraulics*
LS180	18.5 GPM (70.0 l/min.) @2350 RPM 68 bar (@1000 PSI)	32.0 GPM (122 l/min.) @2350 RPM 68 bar (@1000 PSI)
LS190	20.0 GPM (75.7 l/min.) @2350 RPM 68 bar (@1000 PSI)	33.8 GPM (128 l/min.) @2350 RPM 68 bar (@1000 PSI)

* Hydraulic flow rates are rated at 150 RPM below high idle at 90% pump efficiency.

NOTE: *When using the High-Flow system, 3/4″ quick couplers must be used or high system backpressure may result.*

3. **Will the attachment accept oil flow in both directions?**

   If “YES”, nothing is required.

   If “NO”, install a check valve or cross into the attachment return line to prevent reverse oil flow to the attachment.

   Examples: Backhoes and trees spades with a separate control valve do not accept oil flow in both directions.

4. **Must the attachment “Free Wheel” to a STOP?**

   If “YES”, a crossover relief connection must be installed on the attachment side to allow the attachment to free wheel to a stop after the skid steer hydraulics is turned off.

   If “NO”, nothing is required.

   Example: Snow blowers must free wheel to a stop.

5. **Will the attachment accept hydraulic system backpressure?**

   If “YES”, nothing is required.

   If “NO”, the attachment will not function properly on a New Holland skid steer. Normal backpressure for New Holland skid steers is between 13.8 to 17.3 bar (200 to 250 PSI).

   Examples: Post drivers, some breakers, and some hand held hydraulic tools do not accept system backpressure.

   If all the skid steer oil flow is not required to operate an attachment (e.g., shaver post driver), a flow divider can be installed into the hydraulic oil circuit on the attachment. The flow divider sends the required oil flow to the attachment and the remainder back to the normal skid steer hydraulic circuits.

6. Does the attachment have a separate case drain oil line?

If “NO”, nothing is required.

If “YES”, install a separate case drain line to return the attachment case drain oil directly to the hydraulic oil reservoir.

Example: Cold planners have a separate case drain oil line.

NOTE: *Most attachment case drains will not accept backpressure and must drain directly into the reservoir.*

NOTE: *Skid steers equipped with High Flow Hydraulics have a separate case drain coupler and return line attached to the right boom arm.*

7. Does the attachment require circuit relief in the bucket circuit?

If “NO”, nothing is required.

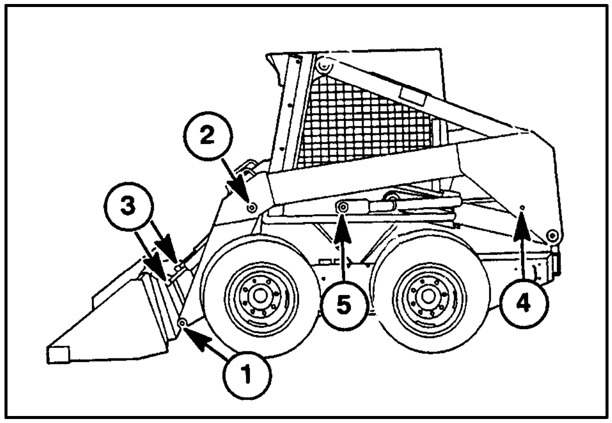
If “YES”, install a bucket circuit relief valve on front of the control valve.

Example: Some mini-backhoes attach like a bucket, and require a bucket circuit relief.

BOOM CYLINDER PIVOT PINS

When the main boom, upper and lower boom links and cylinders are removed, the following figures and charts may be used for proper pin placement.

The figure and chart show the boom and cylinder tapered and straight pivot pins, location/description, quantity used, part number, and model skid steer the pin is used on.



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BOOM AND CYLINDER PIVOT PIN LOCATION AND MACHINE USAGE

Ref.#	Description	Qty.	Part Number
1	Mounting Plate Pivot	2	86501434
2	Upper Bucket Cylinder Pivot	2	86501432
3	Lower Bucket Cylinder Pivot	2	9614349
4	Upper Boom Cylinder Pivot	2	86521982
5	Lower Boom Cylinder Pivot	2	86501428

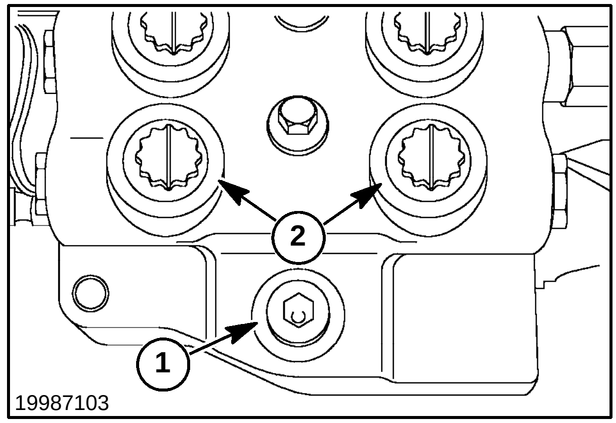
SEAL KITS/DUST CAPS

Seal kits are available for coupler seal repair. A special tool must be used to disassemble the couplers. It is recommended each dealer have this tool for coupler repair. Also, dust caps are available for the 1/2″ couplers only.

Part Number	Description
86539430	1/2″ male coupler seal kit
86539431	1/2″ female coupler seal kit
86539432	Coupler repair tool
86539389	1/2″ male coupler dust cap
86539390	1/2″ female coupler dust cap

CONTROL VALVE POWER BEYOND

The control valve, used on all skid steers, has a plugged power-beyond port, 1. This port is not normally used with New Holland-supplied attachments, as these can be operated through the auxiliary boom hydraulics (the third control valve spool), 2.



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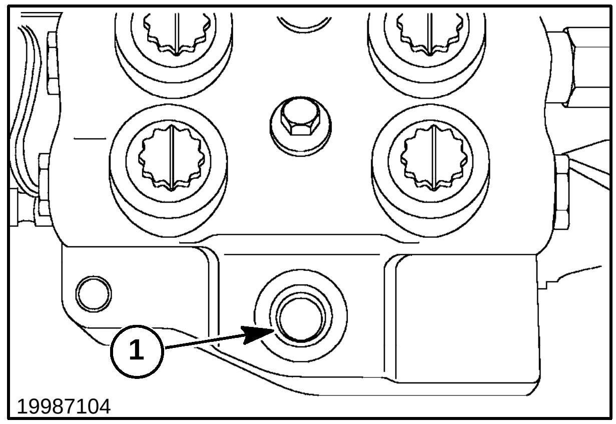
To use the power-beyond port for a second oil supply to additional attachments, remove the factory power-beyond plug to access inner hole, 1. This hole must be plugged to divert oil to the power-beyond instead of normal oil flow to the out port.



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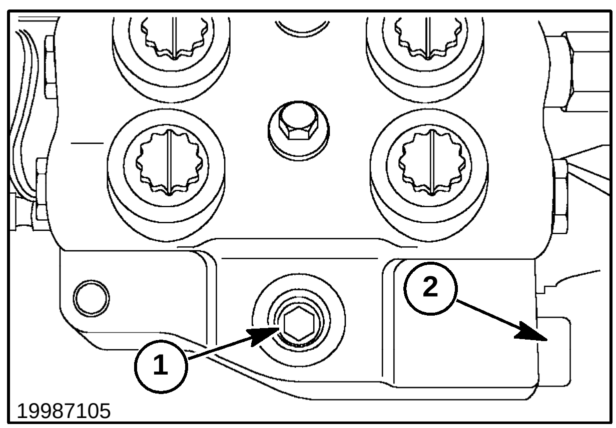
Install part #236622 allen head type pipe plug in the inner port, 1. Tighten the plug securely. A regular O ring type fitting can now be inserted in the power-beyond port.

IMPORTANT: *Once the power-beyond fitting and plug is installed, oil must be constantly returned from the attachment valve into the return line, 2. If oil is blocked at the power-beyond port, hydraulic system overheating and component damage could occur. Also, engine horsepower requirements will increase. A tee fitting can be inserted in the return line at 2, for attachment oil return.*



6

SPECIFICATIONS

MAIN CONTROL VALVE

Type . . . . 3-spool open center

Relief Valve . . . . 170-176.8 bar (2500 PSI-2600 PSI)
Nonadjustable

Circuit Relief (boom) . . . . 238 bar (3500 PSI)
Nonadjustable

Electrical solenoid boom and bucket spool locks (controlled by the EIC) will lock the control valve spools when the operator is out of the seat or the ignition key is in the “OFF” position with the spools in the neutral position.

HYDRAULIC PUMP

Type . . . . Gear pump

Output @ 2225 RPM - @ 1000PSI . . . . 17.6 GPM (66.6 LPM)

BOOM CYLINDERS - LS180

Type . . . . Double Acting

Bore Diameter . . . . 63.5 mm (2.50″)

Stroke . . . . 611.12 mm (24.06″)

Cycle Times (Seconds)
Raise 3.6
Lower 1.5

BOOM CYLINDERS - LS190

Type . . . . Double Acting

Bore Diameter . . . . 70.0 mm (2.75″)

Stroke . . . . 611.12 mm (24.06″)

Cycle Times (Seconds)
Raise 4.0
Lower 2.7

BUCKET CYLINDERS - LS180

Type . . . . Double Acting

Bore Diameter . . . . 63.5 mm (2.50″)

Stroke . . . . 447.04 mm (17.60″)

Cycle Times (Seconds)
Curl back 1.8
Curl down (dump) 2.4

BUCKET CYLINDERS - LS190

Type . . . . Double Acting

Bore Diameter . . . . 63.5 mm (2.50″)

Stroke . . . . 447.04 mm (17.60″)

Cycle Times (Seconds)
Curl back 2.1
Curl down (dump) 2.4

RESERVOIR

Capacity . . . . 24.6 L (6.5 gal.)

Fluid Type . . . . SAE 10W-30 motor oil

Filter Spin-on Canister . . . . 10 micron (FNH #9842392)

TORQUE SPECIFICATIONS

Control Valve

Control Valve Retaining Hardware . . . . . 24 N·m (18 ft. lbs.)

Control Valve Plugs (large) . . . . . 38 N·m (28 ft. lbs.)

Control Valve Plugs (small) . . . . . 31 N·m (23 ft. lbs.)

Circuit Relief Valve (boom) . . . . . 38 N·m (28 ft. lbs.)

Spool Lock Solenoids . . . . . 15 N·m (11 ft. lbs.)

Solenoid Mounting Block Hardware . . . . . 16 N·m (12 ft. lbs.)

Main System Relief Valve . . . . . 51 N·m (38 ft. lbs.)

Spool Cap Assembly Hardware . . . . . 16 N·m (12 ft. lbs.)

Plugs, BYD Port . . . . . 38 N·m (28 ft. lbs.)

Boom Cylinders

Piston Locknut Torque . . . . . 230 N·m (170 ft. lbs.)

Cylinder Gland Torque . . . . . 306 N·m (225 ft. lbs.)

Lower Pivot Pin Hardware . . . . . 169 N·m (125 ft. lbs.)

Upper Pivot Pin Hardware . . . . . 38 N·m (28 ft. lbs.)

Bucket Cylinders

Piston Cap Screw Torque . . . . . 305 N·m (225 ft. lbs.)

Cylinder Head Torque . . . . . 305 N·m (225 ft. lbs.)

Lower Pivot Pin Hardware . . . . . 169 N·m (125 ft. lbs.)

Upper Pivot Pin Hardware . . . . . 38 N·m (28 ft. lbs.)

Gear Pump

Pump Mounting Hardware . . . . . 39 N·m (29 ft. lbs.)

Pump Body Hardware . . . . . 35 N·m (26 ft. lbs.)

OTHER MATERIALS

Sealing Material . . . . . NH Ultra Blue silicone sealer
NH #L81724 - 3.35 oz. tube (card)
NH #L82519DS - 8 oz. tube
NH #L58775 - 10.2 oz. cartridge

Hydraulic Oil . . . . . SAE10W-30 motor oil-API Service SH/CG4
NH #9613313 - 1 qt.
NH #9613314 - 5 gal.
NH #9613358 - 1 L
NH #9613360 - 20 L

NOTE: *Always use a noncorrosive silicone sealer to prevent damage to the components being sealed during the silicone curing process.*

TROUBLESHOOTING

When performing a test on the hydraulic system, use the proper test procedures and test equipment.

Before testing, lower the attachment to the ground or remove the attachment from the skid steer.

If testing is to be performed with a raised boom, make sure the boom is raised above and resting on the boom lock pins.

Before opening the hydraulic system, clean the area thoroughly to prevent contaminating the system.

Before opening the hydraulic system, relieve all pressure from the system.

Before testing the hydraulic system, check the hydraulic oil level.

Before testing the hydraulic system, the oil must be at normal operating temperature.

If testing requires the skid steer to be raised, use adequate blocking and/or jack stands to securely support the skid steer.

CAUTION

When connecting test equipment to the hydraulic system, relieve the pressure in the system. Stop the engine, turn the ignition switch to the "on" position and operate all hydraulic control valve circuits to relieve pressure. Turn the ignition switch to the "off" position.

WARNING

Gauges, gauge fittings, and hoses must have operating pressure ratings of at least 25% higher than the highest pressures of the system.

Never adjust or replace the relief valves to get higher pressures than those specified by the equipment manufacturer.

Fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. always protect the skin and eyes from escaping fluid under pressure.

Before disconnecting lines or fittings, be sure to turn off the skid steer engine and relieve all pressure. Before applying pressure to the system, be sure all connections are tight and that lines, pipes, and hoses are not damaged.

If injured by escaping fluid, obtain medical assistance at once. Serious infection or reaction can develop if medical treatment is not administered immediately.

Rmove any attachment from the mounting plate before loosening or disconnecting any hydraulic lines.

CAUTION

Use adequate blocking and/or jack stands to make sure that the skid steer is safely supported with all four wheels off the ground.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noisy system pump	Oil level too low	Add proper oil and amount
	Oil of incorrect viscosity	Replace oil and filter
	Suction line plugged	Clean or replace line
	Reservoir air vent plugged	Clean reservoir cap
	Air leaks at pump inlet line fittings	Tighten or replace line and fittings
		Check for air leak in hydrostatic pump case drain line from hydrostatic pumps to suction side of gear pump
Hydraulic reservoir oil foaming/milky	Air or water in system	Check for air leak on suction side of pump and check reservoir fill neck for leaks allowing water to enter system
		Check for air leak in hydrostatic pump case drain line from hydrostatic pumps to suction side of gear pump
Low system pump oil flow, under pressure	Plugged inlet line	Clean or replace line
	Low oil level in reservoir	Add proper oil and amount
	Air leaks at pump inlet line and fittings	Tighten or replace line and fittings
		Check for air leak in hydrostatic pump case drain line from hydrostatic pumps to suction side of gear pump
	Worn pump body	Replace body if ID of body exceeds acceptable limits. Refer to Hydraulic Pump Inspection.
No system pressure	Inoperative relief valve	Replace valve
	Plugged inlet line	Clean or replace inlet line
	Worn hydraulic pump	Rebuild or replace pump
	Pump shaft broken	Replace relief valve and replace or repair pump
	Internal leak in control valve or cylinders	Rebuild components

PROBLEM	POSSIBLE CAUSE	CORRECTION
Boom and bucket will not function	Service/Run switch in the service position	Put Service/Run switch in the run position
	Boom and bucket solenoids malfunctioning	Check solenoid operation
	Pump shaft broken	Replace relief valve and replace or repair pump
Boom arms will not raise, or raise slowly	Low oil flow from pump	Plugged inlet line or worn pump
	Low relief valve pressure	Check pressure, replace valve if pressure is not correct
	Control linkage binding	Free linkage
	Boom solenoid malfunctioning	Check solenoid operation
	Boom and bucket overloaded	Reduce load
	Cylinder rods are bent	Rebuild or replace cylinders
	Boom arms are binding at pivots	Remove binding and lubricate linkage
	Boom circuit relief valve malfunctioning	Check circuit relief valve pressure setting
	Bucket tilt valve spool is not returning to center position, binding	Correct binding, spool centering spring damaged.
	Auxiliary hydraulic handle locked in detent position	Return handle to neutral position
Boom or bucket leaks down, or low bucket circuit pressure	Control valve O rings leaking on plugs or circuit relief valve	Repair control valve with seal kit and replace O rings and back-up rings
Boom and/or bucket will not move smoothly, jerky.	Air leaks at pump line and fittings	Tighten or replace line and fittings
Bucket will not tilt back, tilts back slowly, or tilts forward slowly	Low oil flow from pump	Plugged inlet line, clean or replace line
	Worn or damaged pump	Check pump flow, rebuild or replace pump as necessary
	Valve spool is not in correct position, spool binding	Free control linkage, centering spring damaged
	Bucket solenoid malfunctioning	Check solenoid operation
	Cylinder rods are bent	Rebuild or replace cylinders
	Cylinder seals are leaking	Rebuild cylinders
	Bucket is overloaded	Reduce load
	Auxiliary hydraulic handle locked in detent position	Return handle to neutral
Bucket cylinder pin will not take grease	Pin drilled incorrectly	Replace with new pin

PROBLEM	POSSIBLE CAUSE	CORRECTION
Hydraulic system hot	Low oil flow from pump	Plugged inlet line, clean or replace line
	Main control valve linkage or spool is binding or damaged	Check and correct linkage
	Auxiliary boom hydraulic control not in neutral	Lock handle in neutral when not in use
	Hydraulic oil cooler restricted	Clean oil cooler
	Leaking cylinder packing	Repair cylinders
	Main system relief valve low pressure	Check main system pressure
	Hydraulic attachment being overused	Back off and let system cool down, DO NOT operate at or close to relief pressure
Oil filter indicator light stays on	Oil filter clogged	Change filter
	Incomplete circuit	Check the DkGn/O wire and connections
	Undersize tubes, hoses, or fittings	Replace any undersize tubes, hoses, or fittings
	Filter base	Replace if pressure differential across filter is over 40 PSI

AUXILIARY BOOM HYDRAULICS TROUBLESHOOTING

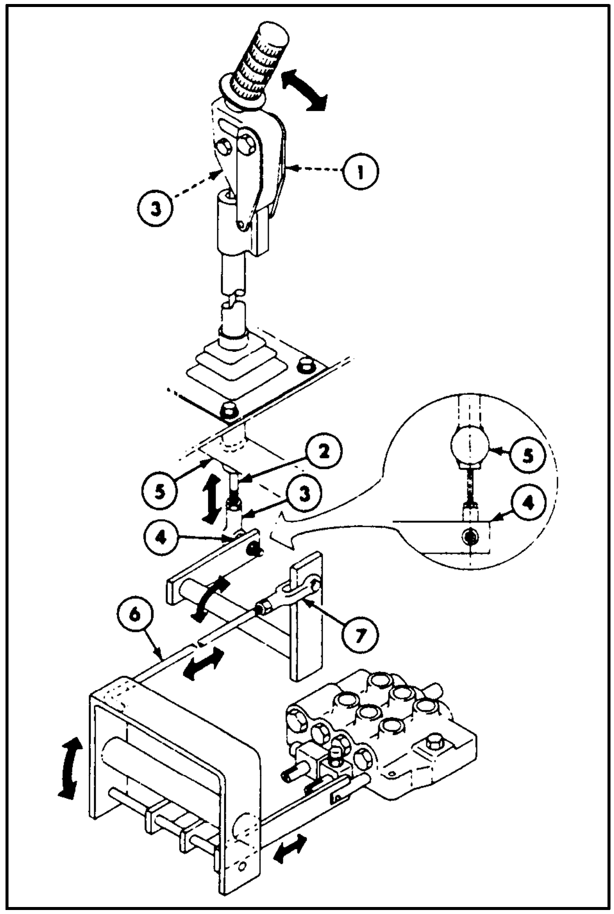
PROBLEM	POSSIBLE CAUSE	CORRECTION
No oil flow to quick couplers	Broken control linkage	Check and repair linkage
	Inoperative quick coupler	Repair or replace
	Plugged supply line	Clean or replace
	Control valve plugs leaking oil to return	Check O ring and back-up washer on plugs
	Inoperative gear pump	Check and repair
Control will not hold in detent position	Loose linkage	Repair
	Misadjusted linkage	Repair
	Inoperative control valve spool (binding)	Check and repair
	Inoperative control valve detent cap	Check and repair
Hydraulic system overheats when auxiliary hydraulics is in use	Restriction in return line	Check and repair
	Inoperative quick coupler	Repair or replace
	Restriction in attachment	Check and repair
	Operating at, or close to, relief pressure	Operate at lesser loads
	Relief pressure too low	Check operating pressure
	Plugged oil cooler not allowing cooking air to pass through	Clean oil cooler
Hydraulic system overheats when auxiliary hydraulics is not in use	Control handle shifted slightly	Return control to neutral and lock
	Control linkage not adjusted properly	Adjust linkage
	Control valve spool binding	Check and repair

Adjustments Control Handle Locked, 1, In Neutral

Lock the control handle in Neutral with the L-pin,1. Adjust the length of rod, 2, by threading the ball joints, 3, on or off, at both ends of the rod to set the link, 4, vertical. Check adjustment by shifting the hydrostatic control lever forward and reverse. If the rod length is set correctly, there should be no movement in the link, 4, as the rod, 5, moves.

With the control handle locked in neutral and the control valve spool centered in the neutral position, adjust the length of rod, 6, with yoke, 7, to allow the installation of the yoke pin.

When the skid steer is operated, there should be no noise in the hydraulic system when in neutral.



7

HYDRAULIC SYSTEM TESTING

Foot or hand controls and control valve spool locks:

Pretest instructions:
* Hydraulic oil reservoir oil at proper oil level
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “OFF” position

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Foot and/or hand controls, (boom and bucket) Controls should not move.	NO YES	System OK Check linkage to control valve spools, if OK go to next step.
2			Check control valve spools for centering, if OK go to next step.
3			Check for bent control valve spools, if OK go to next step.
4			Check spool lockout solenoid operation, if not OK refer to solenoid testing

Foot or hand controls and control valve spool locks:

Pretest instructions:
* Hydraulic oil reservoir oil at proper oil level
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Foot and/or hand controls, (boom and bucket) Controls should move.	YES NO	System OK Check linkage to control valve spools, if OK go to next step.
2			Check control valve spools for centering, if OK go to next step.
3			Check for bent control valve spools, if OK go to next step.
4			Check spool lockout solenoid operation, if not OK refer to solenoid testing

Foot or hand control and control valve spool lock solenoids:

Pretest instructions:
* Hydraulic oil reservoir oil at proper oil level
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Solenoid Solenoid plunger should move from valve spool.	YES NO	System OK Check for battery voltage at solenoid wire connection, if OK replace solenoid. If not OK go to next step.
			Sit in seat and buckle seat belt in sequence, if not OK check operation of seat belt buckle. If OK go to next step.
			Check wires from solenoid to EIC board, if OK go to next step.
			Check EIC board operation

Electronic instrument cluster (EIC) hydraulic oil temperature light:

Pretest instructions:
* Hydraulic oil reservoir oil at proper oil level
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Electronic instrument cluster (EIC) Hydraulic oil temperature light should be off.	YES NO	System OK Check hydraulic oil temperature, if OK go to step 3. If not OK go to next step.
2			Check oil cooler and radiator for restricted air flow.
3			Check oil temperature sender for proper operation.

Electronic instrument cluster (EIC) hydraulic oil filter light:

Pretest instructions:
* Hydraulic oil reservoir oil at proper oil level
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Electronic instrument cluster (EIC) Hydraulic oil filter light should be off.	YES NO	System OK Replace oil filter, if problem still exists go to next step.
2			Check filter sender and wires.

Boom operation:

Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Boom movement Boom should move freely through full range when the foot or hand controls are moved.	YES NO	System OK Check for binding in boom linkage, if OK go to next step.
2			Check for bent cylinders, if OK go to next step.
3			Check hydraulic system oil flow and pressure, if OK go to next step.
4			Check cylinders for internal damage.
5	Boom movement Boom should raise smoothly without jerking.	YES NO	System OK Check for air in the hydraulic system. Check, tighten, or replace suction line and fittings. Check for air leak in hydrostatic pump case drain line from the hydrostatic pumps to the suction side of gear pump.

Boom lift check test:

Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Boom stopped midrange and restarted, the boom should start raising without dropping first.	YES NO	System OK Check for a leaking lift check valve, broken spring, or scored plunger and/or seat. If OK go to next step.
2			Check cylinders for leaky packing.
3			Check O ring and backup washer on circuit relief valve and O ring on front plug in control valve.

Boom drift down test:

Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Boom stopped midrange should hold in position with no visual movement.	YES NO	System OK Check control valve spool for centering, if OK go to next step.
2			Check for leaky packing in cylinders, if OK go to next step.
3			Check boom circuit relief valve, if OK go to next step.
4			Check control valve for leakage.
5			Check O ring and backup washer on circuit relief valve and O ring on front plug in control valve.

Bucket operation:

Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Bucket movement Bucket should move freely through full range when the foot or hand controls are moved.	YES NO	System OK Check for binding in the bucket pivots, if OK go to next step.
2			Check for bent cylinders, if OK go to next step.
3			Check hydraulic system oil flow and pressure, if OK go to next step.
4			Check cylinders for internal damage.
5	Boom movement Boom should raise smoothly without jerking	YES NO	System OK Check for air in the hydraulic system. Check, tighten, or replace suction line and fittings. Check for air leak in hydrostatic pump case drain line from the hydrostatic pumps to the suction side of gear pump.

Bucket lift check test:

Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Bucket stopped midrange and restarted, the bucket should not drop first	YES NO	System OK Check for a leaking lift check valve, broken spring, or scored plunger and/or seat. If OK go to next step.
2			Check cylinders for leaky packing.
3			Check O ring and backup washer on front and rear plug in control valve.

Bucket drift down test:

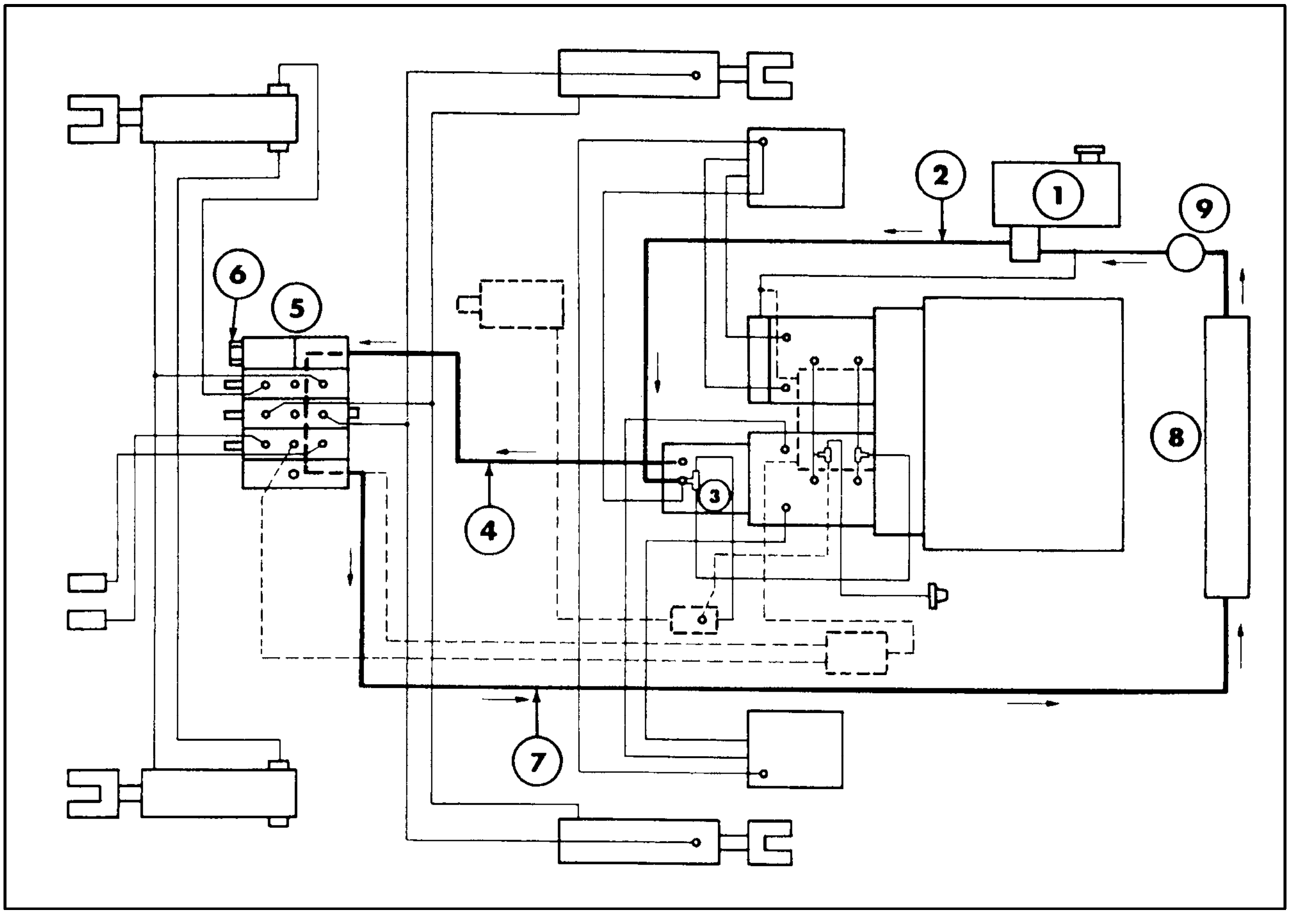
Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position
* Engine running half throttle, 1500 RPM

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Bucket stopped midrange should hold in position with no visual movement	YES NO	System OK Check control valve spool for centering, if OK go to next step.
2			Check for leaky packing in cylinders, if OK go to next step.
3			Check boom circuit relief valve, if OK go to next step.
4			Check control valve for leakage.
5			Check O ring and backup washer on front and rear plug in control valve.

Spool lock solenoid test:

Pretest instructions:
* Operator in seat
* Service/Run switch in “RUN” position
* Seat belt fastened
* Ignition switch in the “ON” position

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Battery voltage at solenoid	YES NO	System OK, go to step 5. Check seat belt operation, if OK go to next step.
2			Check wires to the solenoid valves for open circuit, if OK go to next step.
3			Check EIC board operation, if OK go to next step.
4			Check EIC board operation, if not OK refer to ELECTRICAL SECTION of the SERVICE MANUAL.
5			Remove solenoid coil and check operation, if OK go to next step.
6			Check control valve spools for centering, binding, and binding between solenoid and block, if OK replace solenoid valve.

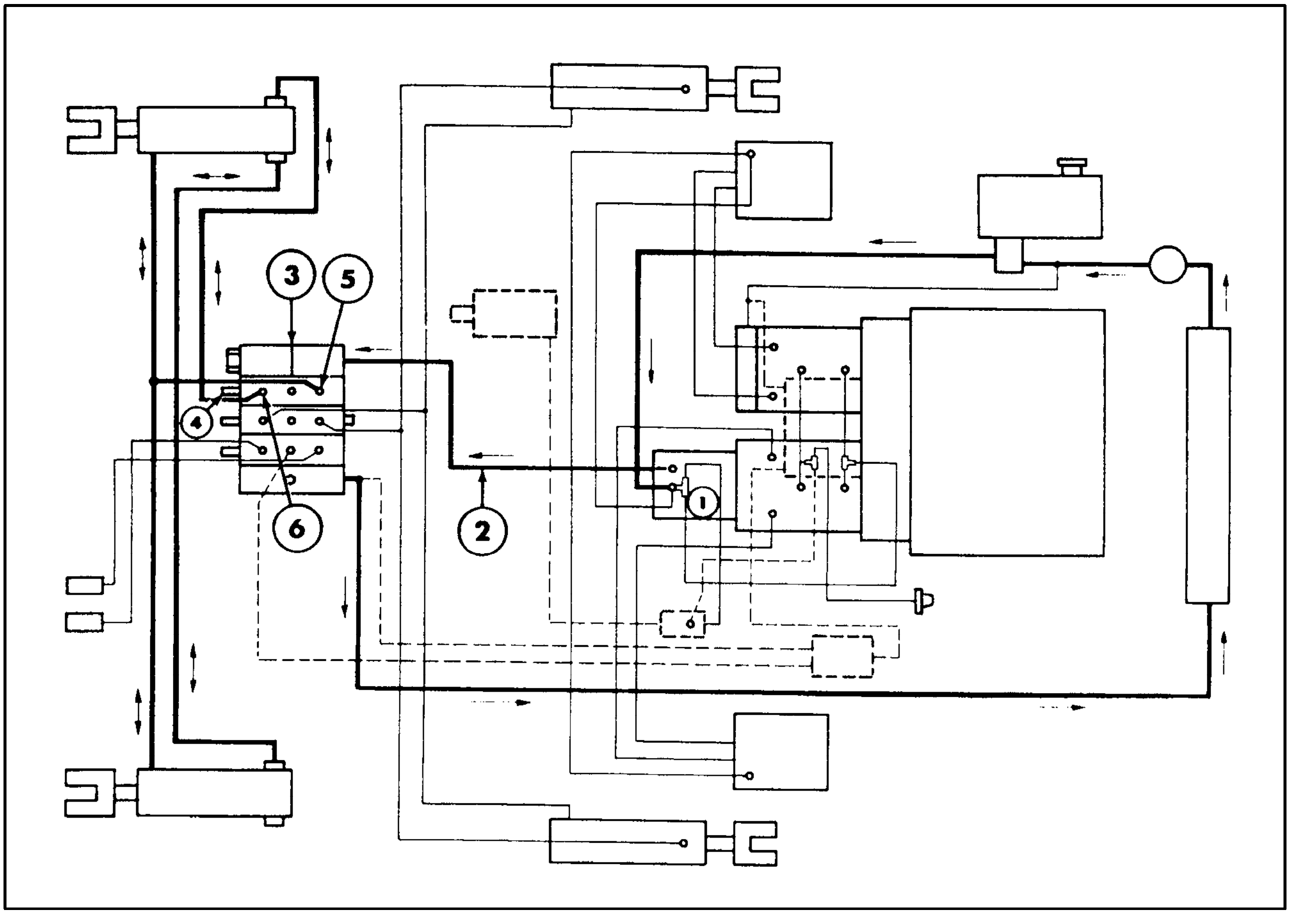


8

HYDRAULIC SYSTEM OIL FLOW

Control Valve - Spools in Neutral Position

1. Hydraulic oil reservoir, 1, storage for system oil.
2. Oil flows through suction line, 2, from reservoir, 1, to gear pump, 3.
3. Oil flows from gear pump, 3, through pressure line, 4, to control valve, 5.
4. Control valve, 5, is equipped with a system relief valve, 6.
5. With the control valve spools in neutral position, the oil flows through center of control valve, 5, to return line, 7.
6. The oil flows through return line, 7, to oil cooler, 8.
7. Oil passes through the oil cooler, 8, being cooled with the air blast from engine fan through the cooler.
8. Oil flows from the oil cooler, 8, through oil filter, 9, and back to reservoir, 1.



9

CONTROL VALVE - BUCKET SPOOL SHIFTED

Bucket Control Operation

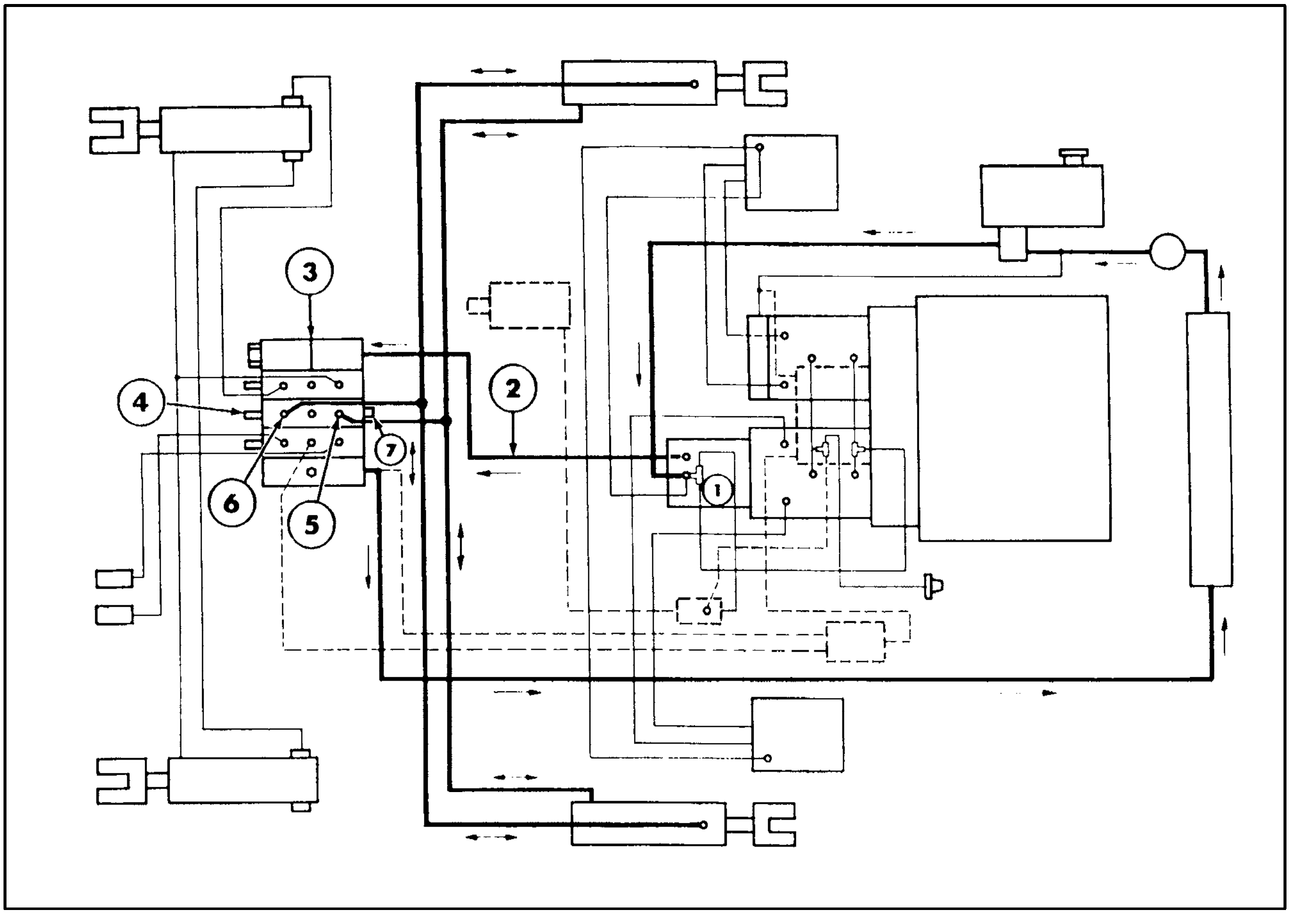
Foot Controls

When the toe of the control pedal is pushed down, it will shift the control valve spool in, dumping the bucket. When the heel of the control pedal is pushed down, it will shift the control valve spool out, curling the bucket back.

Hand Controls

When the right control handle is pivoted up, it will shift the control valve spool in, dumping the bucket. When the right control handle is pivoted down, it will shift the control valve spool out, curling the bucket back.

1. Oil flows from the gear pump, 1, through pressure line, 2, to the control valve, 3.
2. When the bucket valve spool, 4, is pulled out, the oil flows from the rear work port, 5, to the shaft side of the bucket cylinder to curl the bucket back.
3. When the bucket valve spool, 4, is pushed in, the oil flows from the front work port, 6, to the base (piston) end of bucket cylinder to dump the bucket.
4. When the bucket circuit is operated to maximum pressure or cylinders are bottomed, the main system relief valve will relieve the high pressure oil into the return oil galley in the control valve, returning the oil to the reservoir.
5. The return oil from the opposite side of the cylinder being pressurized will return through the control valve to the reservoir.



10

CONTROL VALVE - BOOM SPOOL SHIFTED

Boom Control Operation

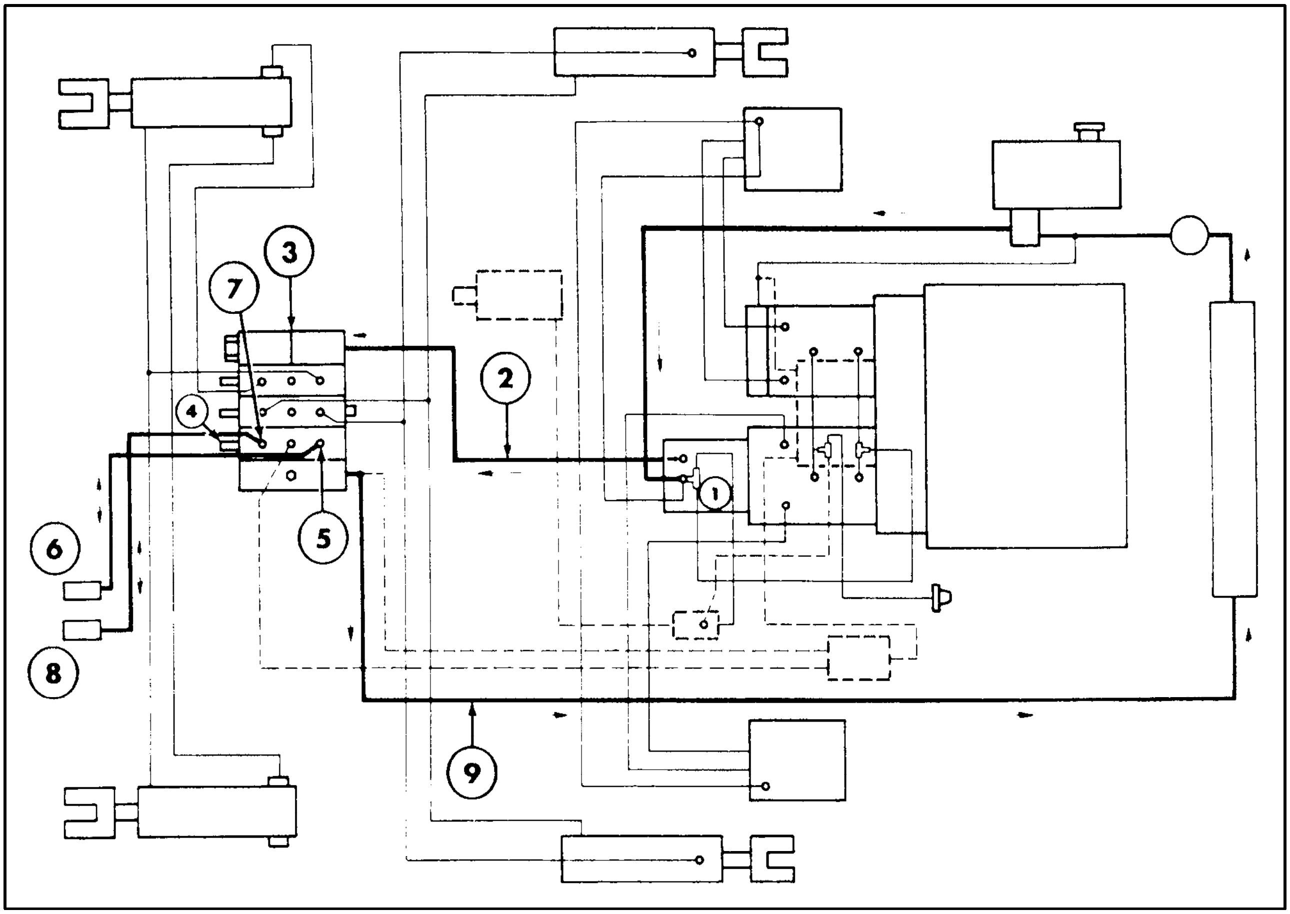
Foot Controls

When the toe of the control pedal is pushed down, it will shift the control valve spool in, lowering the boom. When the heel of the control pedal is pushed down, it will shift the control valve spool out, raising the boom.

Hand Controls

When the left control handle is pivoted down, it will shift the control valve spool in, lowering the boom. When the left control handle is pivoted up, it will shift the control valve spool out, raising the boom.

1. Oil flows from the gear pump, 1, through pressure line, 2, to control valve, 3.
2. When the boom valve spool, 4, is pulled out, the oil flows from the rear work port, 5, to the base (piston) end of the boom cylinder raising the boom.
3. When the boom valve spool, 4, is pushed in, the oil flows from the front port, 6, to the shaft end of boom cylinders to lower the boom.
4. When the boom circuit is operated to maximum pressure or cylinders are bottomed, the main system relief valve will relieve the high pressure oil into the return oil galley in the control valve, returning the oil to the reservoir.
5. The return oil from the opposite side of cylinders being pressurized will return through the control valve to the reservoir.
6. When the boom cylinders are extended, the boom control valve spool is in neutral, and a load is put on the boom cylinders causing them to retract, the circuit relief valve, 7, will relieve the pressure in the base (piston) side of the cylinders protecting the cylinder and lines. The oil relieved from the circuit relief valve enters the return oil galley in the control valve and returns to the reservoir.
7. When the boom valve spool, 4, is pushed in all the way, it will put the spool into detent position, opening both work ports 5 and 6 to the return oil galley, allowing the boom to float.



11

CONTROL VALVE - AUXILIARY SPOOL SHIFTED

Auxiliary Control Operation

Hand Controls

When the right control handle is pivoted down, it will shift the control valve spool in, supplying oil to the male quick coupler. When the right control handle is pivoted up, it will shift the control valve spool out, supplying oil to the female quick coupler.

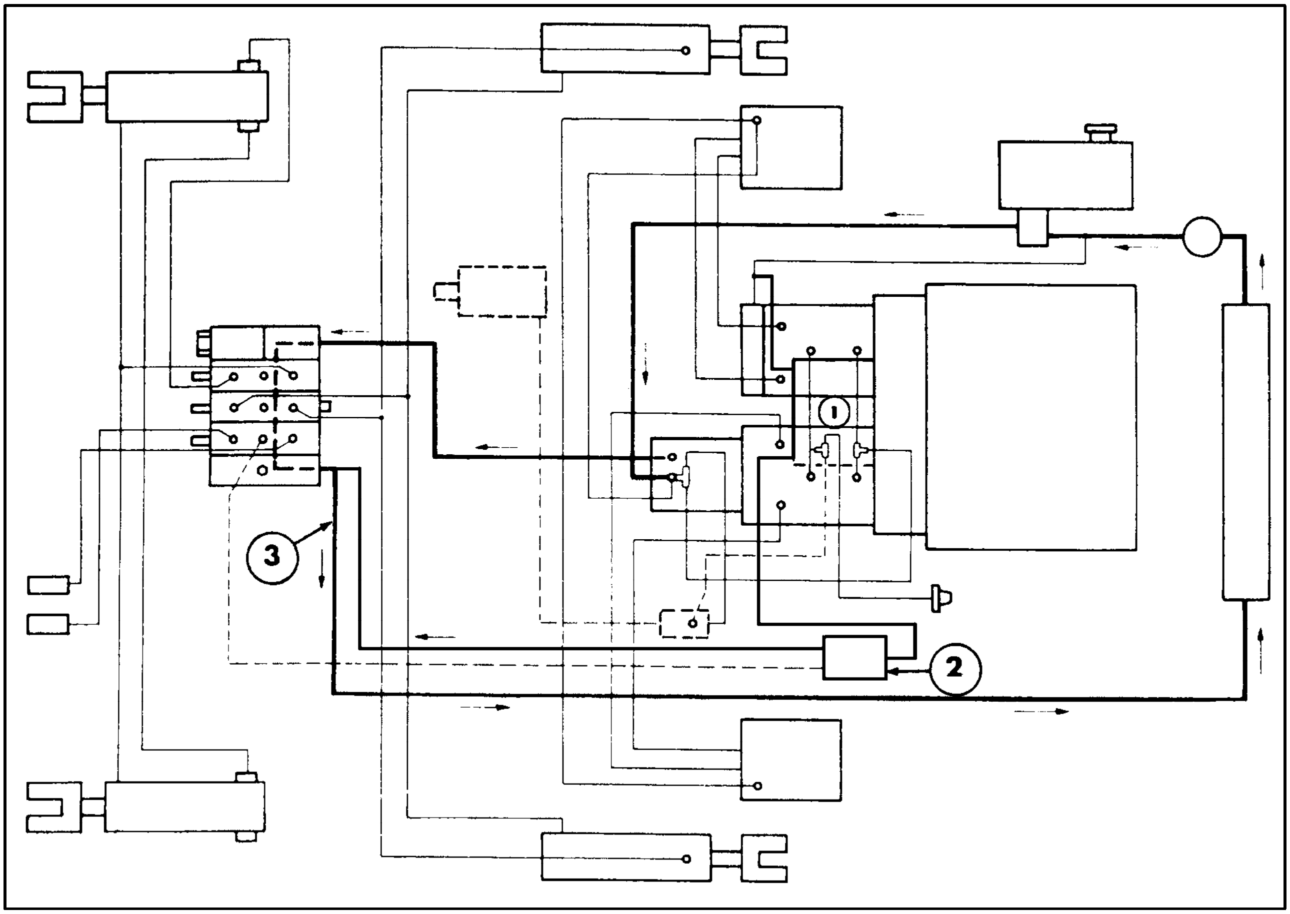
Foot Control

When the toe of the control pedal is pushed down, it will shift the control valve spool in, supplying oil to the male quick coupler. When the heel of the control pedal is pushed down, it will shift the control valve spool out, supplying oil to the female quick coupler.

1. Oil flows from the gear pump, 1, through pressure line, 2, to control valve, 3.
2. When the auxiliary valve spool, 4, is pulled out, the oil flows from the rear work port, 5, and supplies oil to the female quick coupler, 6, at the front of the boom.
3. When the auxiliary valve spool, 4, is pushed in, the oil flows from the front work port, 7, and supplies oil to the male quick coupler, 8, at the front of the boom.
4. When the auxiliary circuit is operated to maximum pressure, the main system relief valve will relieve the high pressure oil into the return oil galley in the control valve, returning the oil to the reservoir.
5. The return oil from the opposite quick coupler being pressurized will return through the control valve to the reservoir.

***NOTE:** The return oil from the quick couplers must be returned through the normal return line, 9, to replenish the hydrostatic system; hydrostatic charge oil is required for lubrication of the hydrostatic pumps and motors.*

6. When the auxiliary valve spool, 4, is pushed in all the way, it will put the spool into detent position, holding the spool for continuous oil flow to the male quick coupler.



12

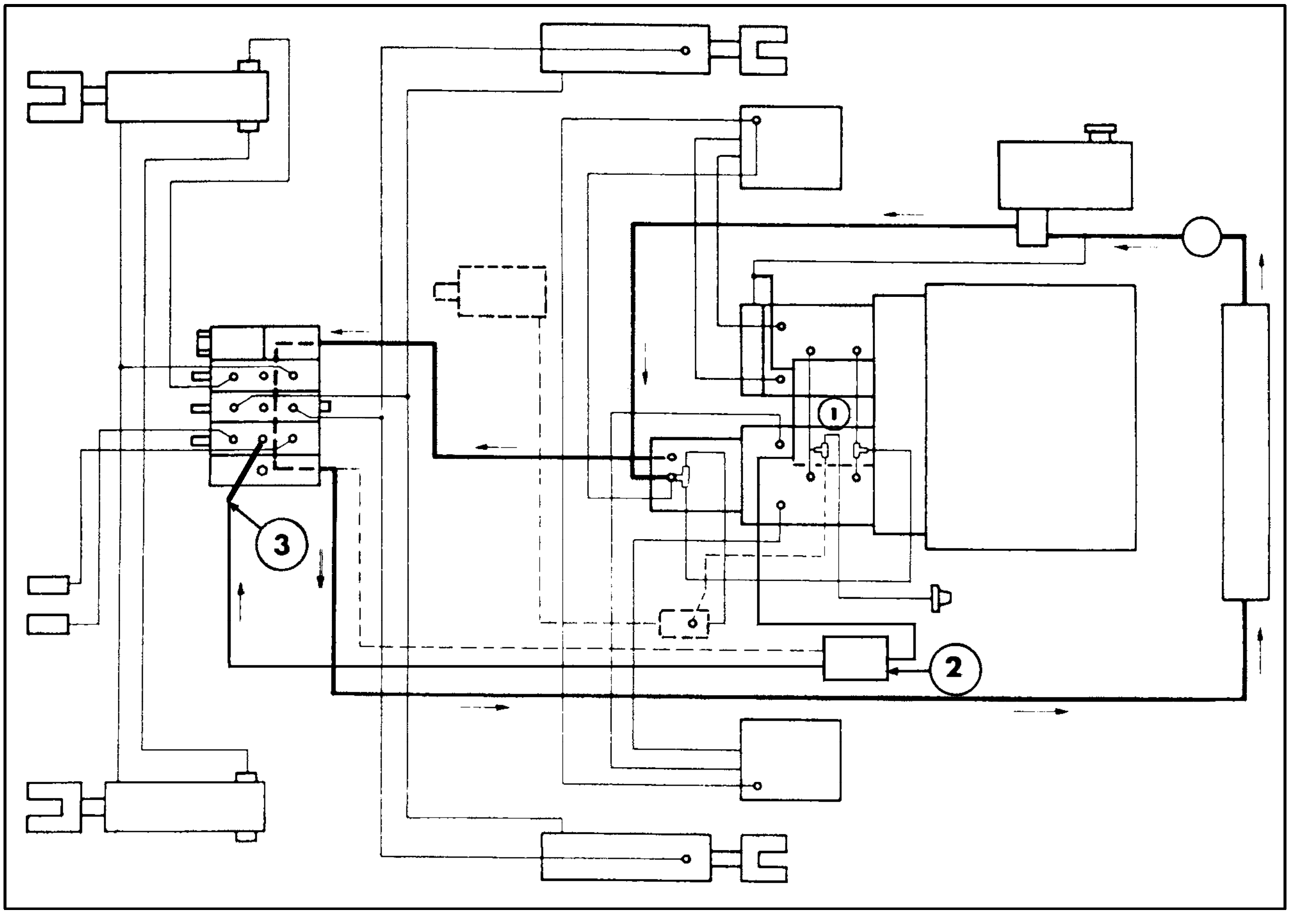
HYDRAULIC SYSTEM OIL FLOW

High Flow - Selector Off

The high flow gear pump, 1, supplies the high flow oil to the control valve block through the selector, 2.

When the selector is Off, the oil is directed to the control valve return line, 3.

When using the high flow, always use the 3/4″ couplers to prevent high back pressure and overheating of the hydraulic system.



13

HYDRAULIC SYSTEM OIL FLOW

High Flow - Selector On
The high flow gear pump, 1, supplies high flow oil to the control valve block through the selector, 2.

When the selector is On, the high flow oil is directed to the control valve, 3.

When using high flow, always use the 3/4″ couplers to prevent high back pressure and overheating of the hydraulic system.

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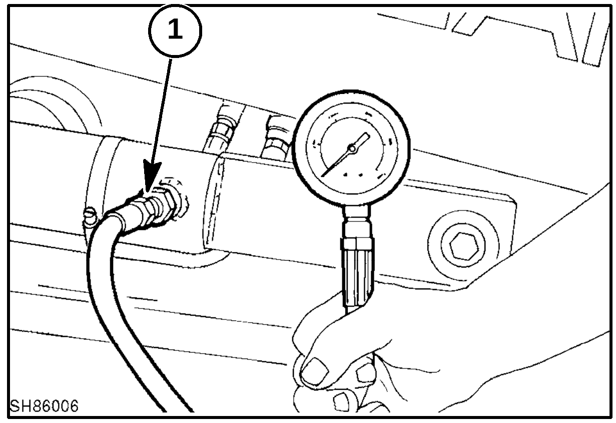
MAIN SYSTEM PRESSURE TESTS

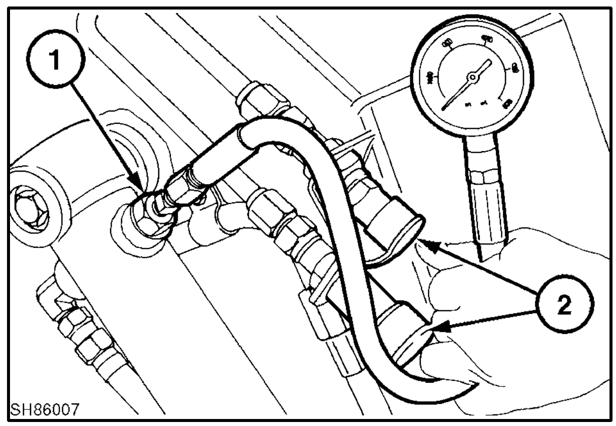
Check the main system pressure to ensure the main relief valve is within specifications and providing adequate working pressure to the hydraulic system.

The main system pressure can be checked at the base end of the boom cylinders at 1.



14

The main system pressure can also be checked at the base end of the left bucket cylinder at 1 or at the auxiliary boom hydraulic quick couplers, 2, if equipped.



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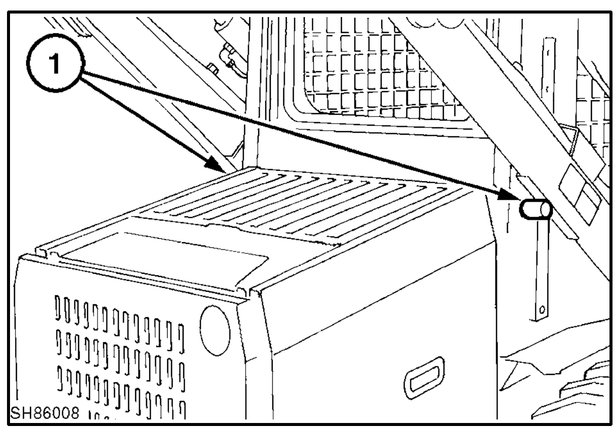
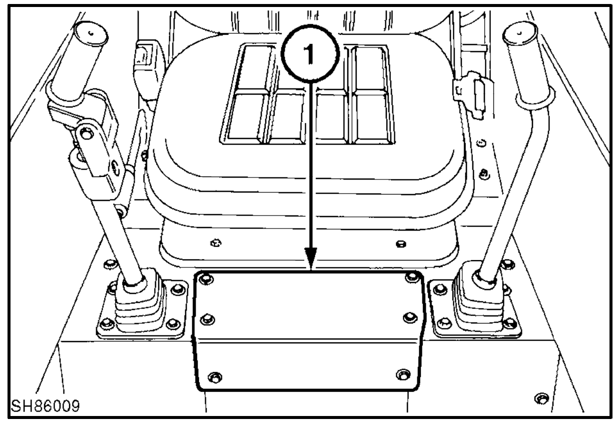
To check main system pressure at the boom cylinders, the boom must be up and resting on the boom lockpins, 1.



16

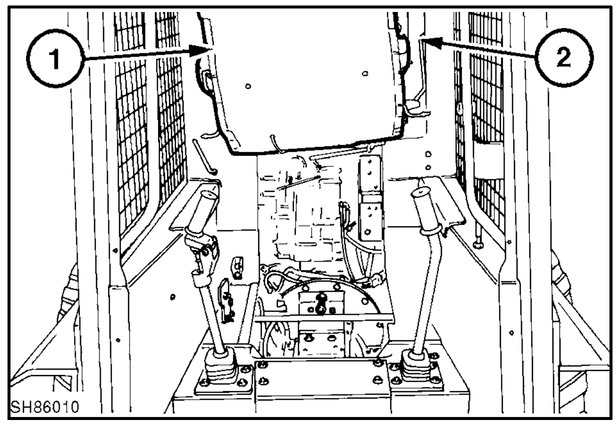
The hydraulic system pressures are factory set. Changes to the settings should not be necessary.

To access the control and relief valve area, remove the step shield, 1.



17

Raise the seat and seat pan to the raised latched position, 1. Be sure the seat support rod is latched securely at 2, before working under a raised seat.



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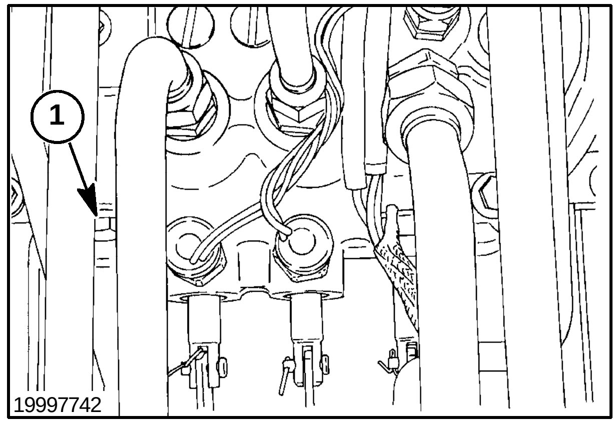
CAUTION

Do not work under raised seat unless securely latched in the raised position.

The main system relief valve, 1, is located in the control valve. If there is some reason to suspect incorrect pressure, check the pressures as follows:



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WARNING

Gauges, gauge fittings, and hoses must have operating pressure ratings of at least 25% higher than the highest pressures of the system.

Never adjust or replace the relief valves to get higher pressures than those specified by the equipment manufacturer.

Fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Always protect the skin and eyes from escaping fluid under pressure.

Before disconnecting lines or fittings, be sure to turn off the skid steer engine and relieve all pressure. Before applying pressure to the system, be sure all connections are tight and that lines, pipes, and hoses are not damaged.

If injured by escaping fluid, obtain medical assistance at once. Serious infection or reaction can develop if medical treatment is not administered immediately.

Remove any attachment from the mounting plate before loosening or disconnecting any hydraulic lines.

CHECKING MAIN SYSTEM PRESSURE AT BOOM CYLINDERS

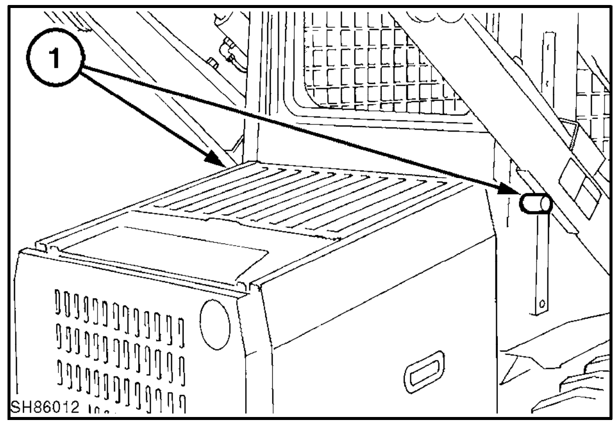
NOTE: *Before performing any hydraulic test, operate the skid steer to get the hydraulic oil to operating temperature (about 55° C [100° F] above ambient temperature).*

Fittings and gauge required:

1. 238 bar (3500 PSI) gauge (minimum)
2. 3/4″ - 16 UNF O ring fitting

Test Procedure

1. Raise the boom, extend the boom lockpins, 1, and lower the boom down on the lockpins.
2. Stop the engine, turn the ignition key to the run position, and operate the boom and bucket control pedals to relieve pressure in the cylinders. Turn off the key.



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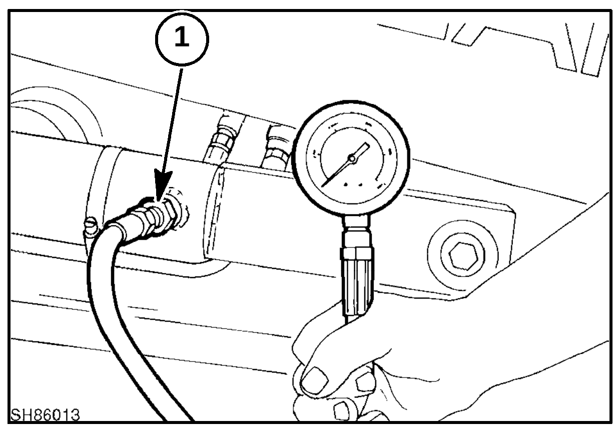
3. Install the pressure test gauge in the boom cylinder at 1.
4. Start the engine and run it at full throttle (2175 RPM - 2275 RPM).
5. Operate the boom control to raise the boom to the fully raised position until the system by-passes and take a pressure reading. Lower the boom down to the boom lockpins and relieve pressure in the system.
6. The pressure should be from 177 - 190 bar (2600 - 2800 PSI) when the hydraulic oil is at operating temperature.



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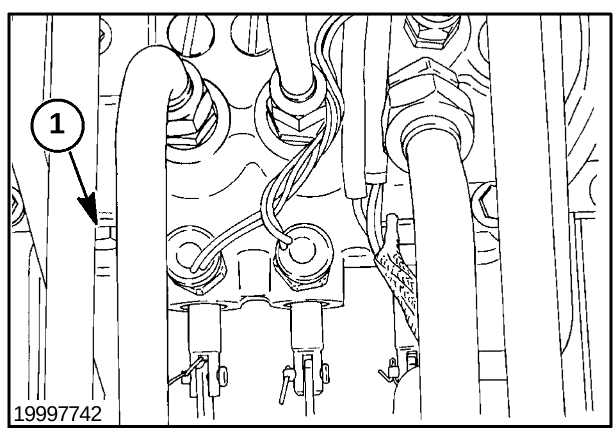
7. The relief valve is a cartridge type and is not adjustable. Replace the relief valve cartridge, 1, if the pressure is not within specifications.

CAUTION

Do not attempt to change the pressure setting or alter the pressure to a higher setting as the hydraulic components, hoses, tubes, and cylinders may be damaged and could cause injury.



22

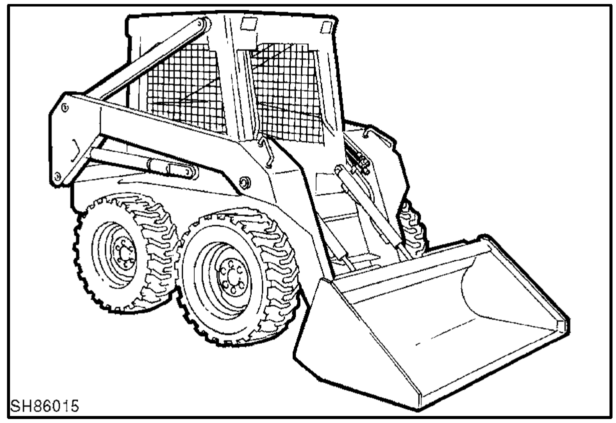
CHECKING MAIN SYSTEM PRESSURE AT BUCKET CYLINDERS

Fittings and gauge required:

1. 238 bar (3500 PSI) gauge (minimum)
2. 3/4″ - 16 UNF O ring fitting

Test Procedure

1. Lower the boom and attachment to the ground.
2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the cylinders. Turn off the key.



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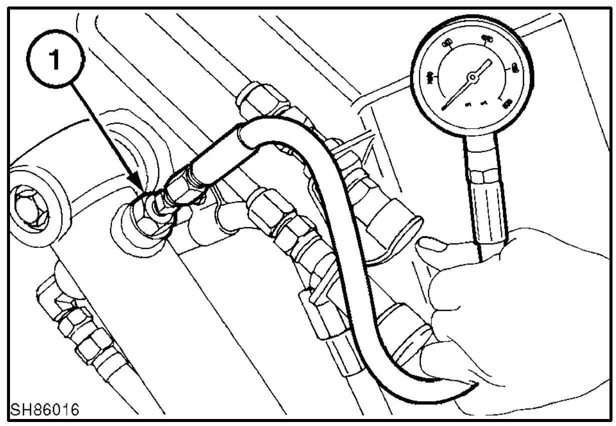
3. Install the pressure test gauge in the left bucket cylinder at 1.
4. Start the engine and run it at full throttle (2175 RPM - 2275 RPM).
5. Operate the bucket control to dump the bucket to the fully dumped position until the system by-passes and take a pressure reading. Curl the bucket back to relieve pressure in the system.
6. The pressure should be from 177 - 190 bar (2600 - 2800 PSI) when the hydraulic oil is at operating temperature.

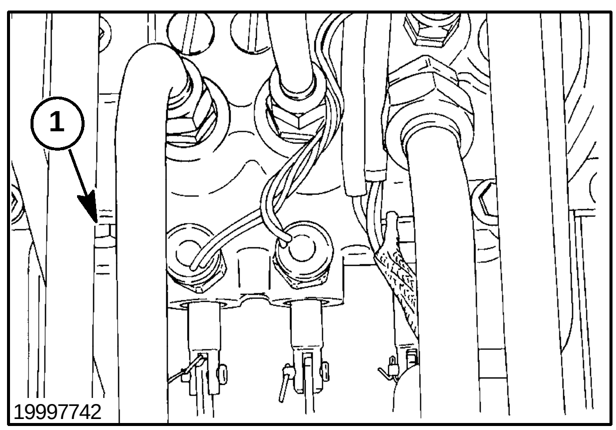


24

7. The relief valve is a cartridge type and is not adjustable. Replace the relief valve cartridge, 1, if the pressure is not within specifications.

CAUTION

Do not attempt to change the pressure setting or alter the pressure to a higher setting as the hydraulic components, hoses, tubes, and cylinders may be damaged and could cause injury.



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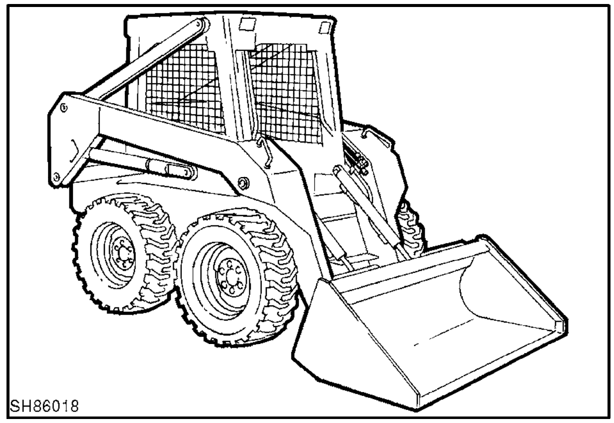
CHECKING MAIN SYSTEM PRESSURE AT AUXILIARY BOOM HYDRAULIC QUICK COUPLERS

Fittings and gauge required:

1. 238 bar (3500 PSI) gauge (minimum)
2. 1/2″ quick coupler fitting

Test Procedure

1. Lower the boom and attachment to the ground.
2. Stop the engine, turn the ignition key to the run position and operate the boom, bucket, and auxiliary controls to relieve pressure in the systems. Turn off the key.



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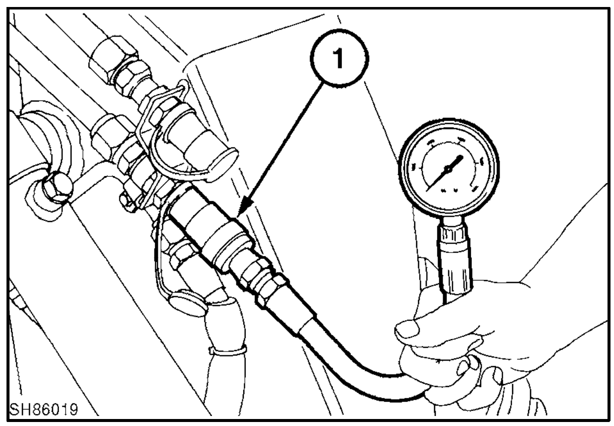
3. Install the pressure test gauge in one of the quick couplers at 1.
4. Start the engine and run it at full throttle (2175 RPM - 2275 RPM).
5. Operate the auxiliary control to pressurize the auxiliary circuit until the system bypasses and take a pressure reading. Move the control handle in the opposite direction to relieve pressure in the system.

NOTE: *Pivoting the control handle down supplies oil to the male quick coupler.*

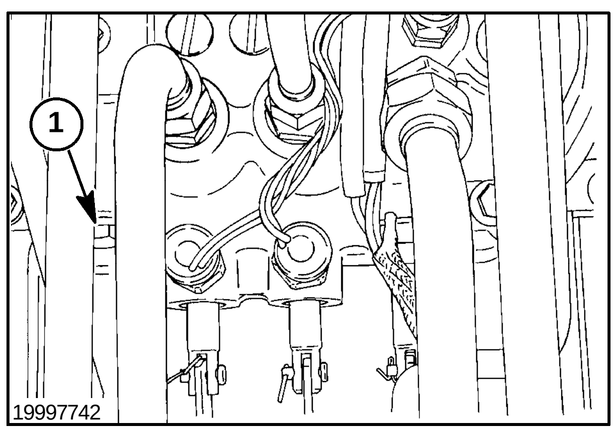


27

6. The pressure should be from 177 - 190 bar (2600 - 2800 PSI) when the hydraulic oil is at operating temperature.
7. The relief valve is a cartridge type and is not adjustable. Replace the relief valve cartridge, 1, if the pressure is not within specifications.

CAUTION

Do not attempt to change the pressure setting or alter the pressure to a higher setting as the hydraulic components, hoses, tubes, and cylinders may be damaged and could cause injury.



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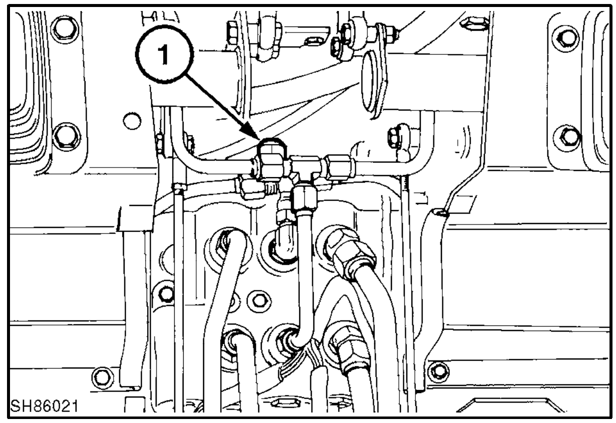
BOOM CIRCUIT RELIEF VALVE TEST

The boom circuit is equipped with a circuit relief valve, 1, located in the boom control valve. This valve will protect the cylinders and lines when the control valve spool is in the neutral (centered) position.



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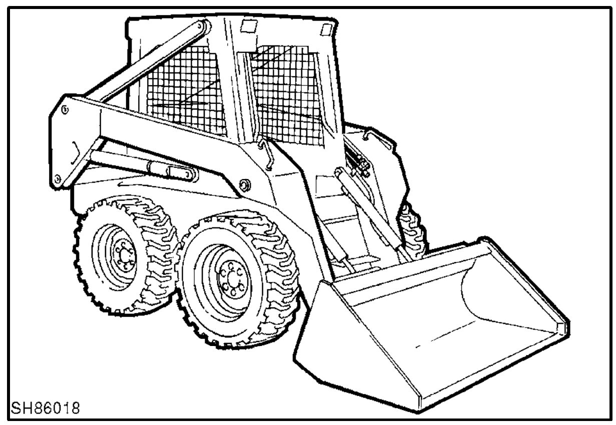
Fittings and gauge required:

1. 340 bar (5000 PSI) gauge (minimum)
2. 3/4″ - 16 UNF O ring fitting
3. Hydraulic hand pump

NOTE: *The relief valve is factory set at 241±3 bar (3500 ± 50 PSI). The boom circuit relief valve is not adjustable. All replacement valves are set at 3500 PSI.*

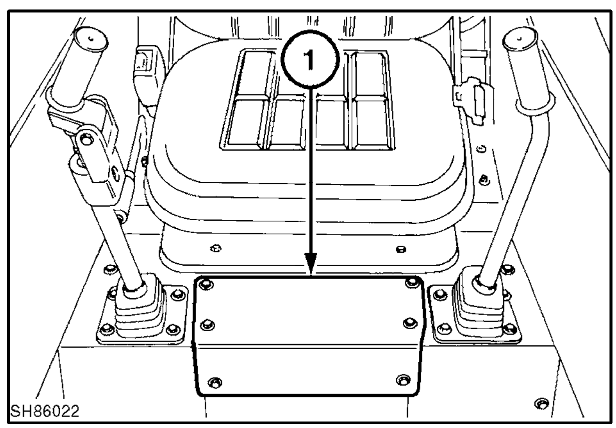
Test Procedure

1. Lower the boom and attachment to the ground.
2. Stop engine, turn ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the cylinders. Turn off the key.



30

3. Remove the step shield, 1, to access the control valve and circuit relief valve area.



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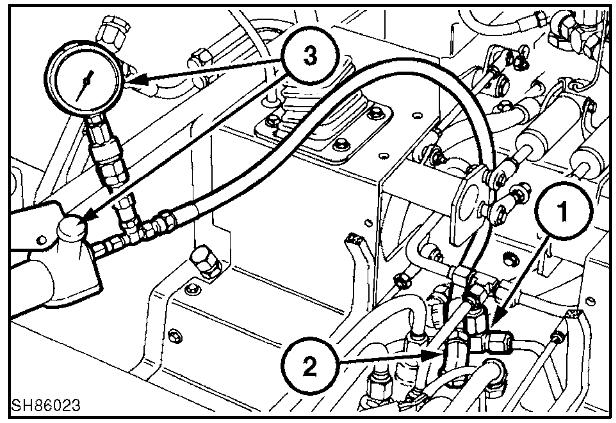
4. Place the boom control valve spool in the neutral (centered) position.
5. Disconnect the tee fitting, 1, from the control valve elbow, 2. Loosen the tee fitting at the side tubes, and rotate the tee fitting upward. Loosen the elbow, 2, and rotate counterclockwise approximately 45°.
6. Connect a hand pump and pressure gauge, 3, to the elbow, 2, and build pressure against the circuit relief valve. Monitor the pressure gauge to read the pressure at the point where the relief valve starts to open.



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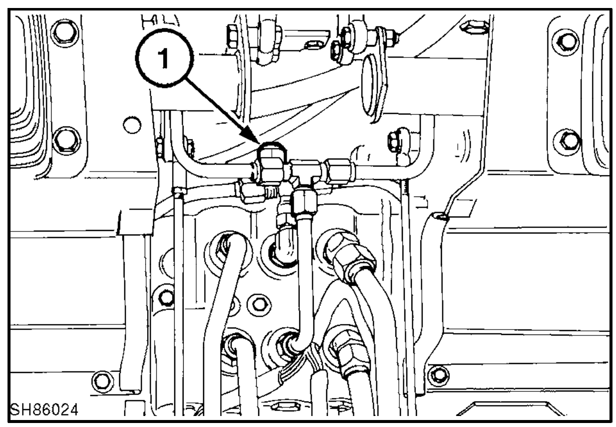
CAUTION

Do not increase pressure over 3800 PSI. If the relief valve does not open when pressure reaches 3600 PSI, discontinue the test and replace the valve.

7. If there is an operational complaint and the boom circuit relief valve releases pressure under 235 bar (3400 PSI), replace the valve, 1. If the valve does not release pressure by 248 bar (3600 PSI), also replace the valve. All replacement boom circuit relief valves are set at 241 bar (3500 PSI) and are not adjustable.



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GEAR PUMP FLOW EFFICIENCY TEST

Fittings and gauges required:

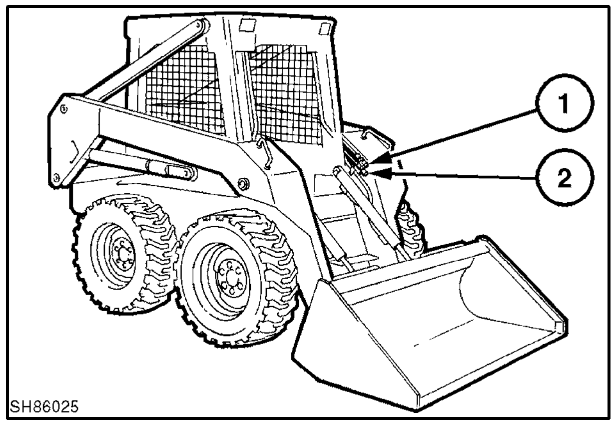
1. Hydraulic flow tester (30 GPM capacity).
2. Male and female 1/2″ quick couplers for units equipped with auxiliary boom hydraulics.
3. Two male 3/4″ UNF 37° flare to tester fittings for units without auxiliary boom hydraulics.

Test Procedure

Gear pump flow test on units equipped with auxiliary boom hydraulics.

1. Lower the boom and bucket to the lowered position, resting on the ground.
2. Stop engine, turn ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the cylinders. Turn off the key.
3. Attach the pressure (inlet) hose from the flow tester with the female quick coupler to the male half on the skid steer at 1.
4. Attach the return (outlet) hose from the flow tester with the male coupler to the female half on the skid steer at 2.

***IMPORTANT:** Make sure the flow tester is connected into the hydraulic system properly for proper oil flow through the tester to prevent damage to the hydraulic test equipment or hydraulic system.*



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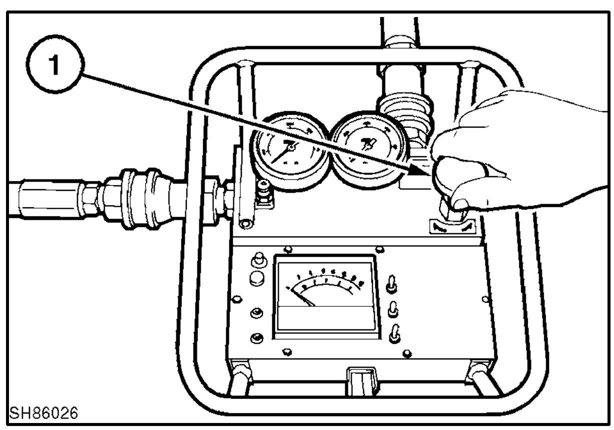
CAUTION

Never position tester between the gear pump and control valve as the system relief valve will be out of the test circuit, and pump over pressure may cause a pump failure by splitting the center section or twisting off the input shaft.

5. Turn the resistance valve on tester to “O” setting.
6. Start the engine and run it at full throttle (2175 RPM - 2275 RPM).
7. Operate the auxiliary control handle by pivoting down to pressurize the male quick coupler and inlet hose to tester.
8. Take a free flow and pressure reading and record it. The flow at this time is oil flow through the hydraulic system and the pressure reading at this point is force required to pump the oil through the system. The pressure is called back pressure.



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9. Turn the resistance valve on the tester to apply resistance in the hydraulic system to obtain the following specifications:

   2225 RPM (engine)
   68 bar (1000 PSI) - 17.6 GPM (63.2 LPM)

If the gear pump flow in step 9 is not within 80% of the pump flow in step 8, remove and repair or replace the pump.

Example:

17.0 GPM free flow Step 8.

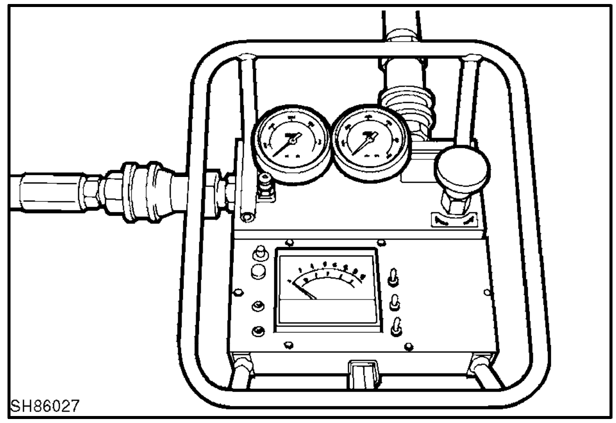
12.7 GPM flow Step 9.

80% of 17 GPM = 13.6 GPM

The pump is not within 80% of free flow. Repair or replace pump.

NOTE: *The oil must be at operating temperature before any hydraulic testing.*

If the pressure cannot be obtained, replace the main system relief valve.



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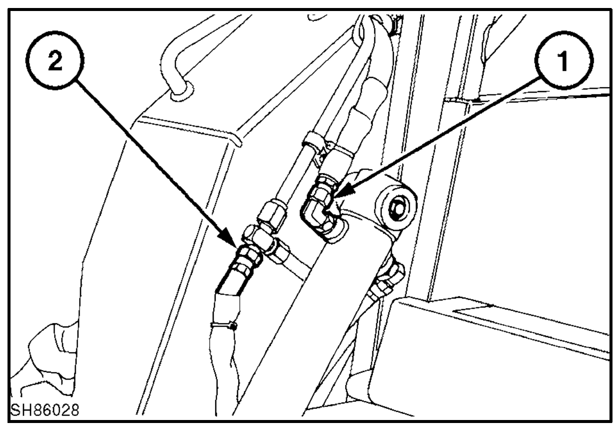
Test Procedure
Gear pump flow test with units NOT equipped with auxiliary boom hydraulics.

1. Lower the boom and bucket to the lowered position, resting on the ground.
2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the cylinders. Turn off the key.
3. Unhook line, 1, from the base end of the bucket cylinder, cap cylinder port.
4. Attach the pressure (inlet) hose from the flow tester to line, 1, with 3/4″ UNF 37° flare fitting to tester.
5. Unhook line, 2, and cap the hose fitting.
6. Attach the return (outlet) hose from the flow to line, 2, with 3/4″ UNF 37° flare fitting to tester.

IMPORTANT: *Make sure the flow tester is connected into the hydraulic system properly for proper oil flow through the tester to prevent damage to the hydraulic test equipment or hydraulic system. Refer to the test equipment manufacturer's Operator's Manual.*



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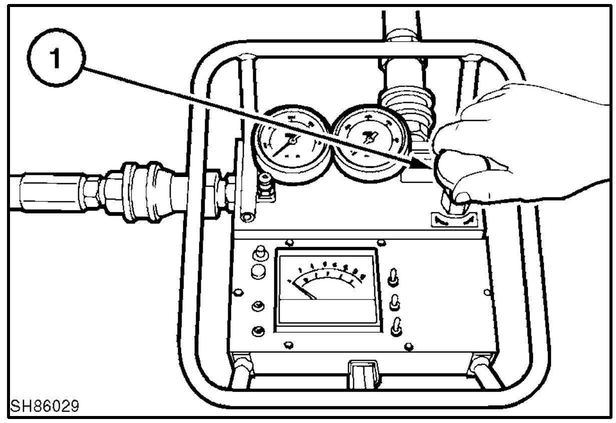
7. Turn the resistance valve, 1, on the tester to “O” setting.
8. Start the engine and run it at full throttle (2175 RPM - 2275 RPM).
9. Operate the bucket control to dump the bucket for proper oil flow to the inlet hose and tester.
10. Take a free flow and pressure reading and record it. The flow at this time is oil flow through the hydraulic system and the pressure reading at this point is force required to pump the oil through the system. The pressure is called back pressure.
11. Turn the resistance valve on the tester to apply resistance in the hydraulic system to obtain the following specifications:

    2225 RPM (engine)
    68 bar (1000 PSI) - 17.6 GPM (63.2 LPM)



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If the gear pump flow in step 9 is not within 80% of the pump flow in step 10, remove and repair or replace the pump.

Example:

17.0 GPM free flow Step 8.

12.7 GPM flow Step 9.

80% of 17.0 GPM = 13.6 GPM

The pump is not within 80% of free flow. Repair or replace pump.

NOTE: *The oil must be at operating temperature before any hydraulic testing.*

If the pressure cannot be obtained, replace the main system relief valve.

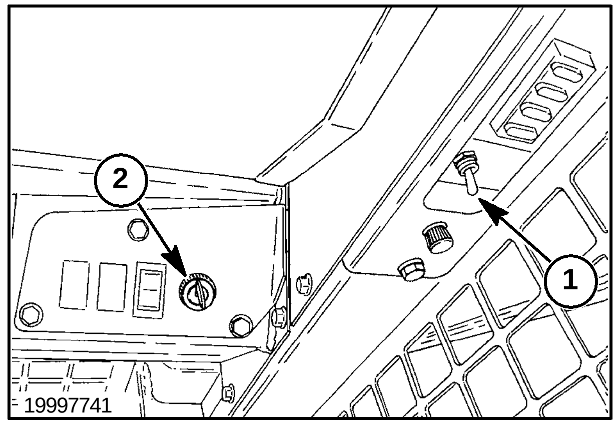
BOOM AND BUCKET SPOOL LOCK SOLENOID TEST

The boom and bucket control valve solenoid spool locks are controlled by the EIC (Electronic Instrument Cluster). The operator must be in the operator's seat with the seat belt buckled for the EIC to unlock the control valve spool lock solenoids.

Operational check procedure:

1. Service/Run switch, 1, in "RUN" position.
2. Sit in seat.
3. Turn ignition key switch, 2, to the "ON" position.
4. Attempt to move boom and bucket foot or hand controls. The controls should not move the control valve spools from the neutral position.
5. Fasten the seat belt.
6. Attempt to move boom and bucket foot or hand controls. The controls should move the control valve spools from the neutral position.

NOTE: *If the EIC shows an FOA fault in the readout display, this is an indication of a shorted/open circuit to the solenoid locks.*



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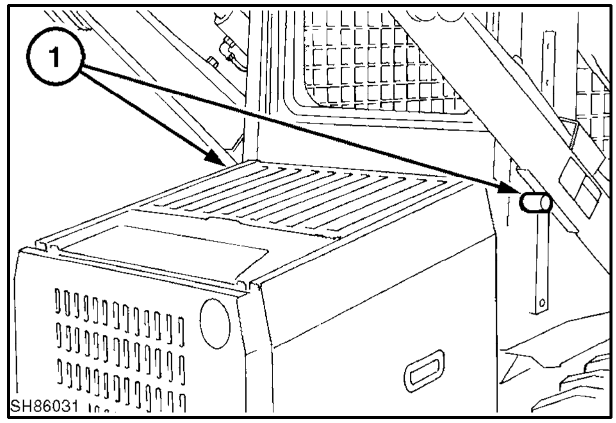
Electrical test procedure:

1. Lower the boom and attachment to the ground or rest the boom on the boom lock pins, 1; remove attachment if on boom locks.



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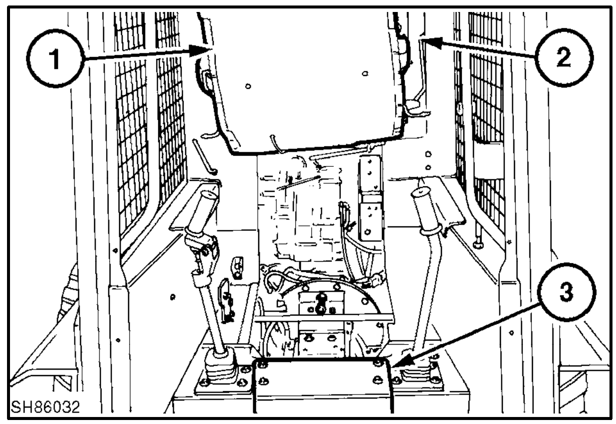
2. Raise the seat, 1, and latch securely in the raised latch position, 2. Remove the step shield, 3, from over the control valve to access the solenoid locks.



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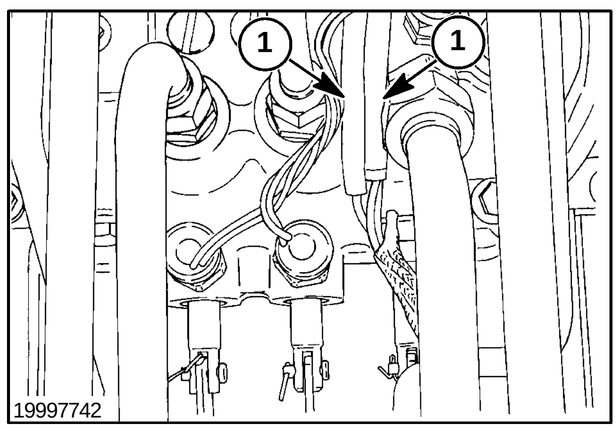
3. Unplug one solenoid, 1, at a time and check for battery voltage at the main wire harness plugs, pink/light-blue and black wires. The operator must be in the seat with the seat belt buckled and the ignition key in the “ON” position.

NOTE: *If both solenoids are unplugged, the EIC will show an FOA fault and there will be no voltage from the EIC to the solenoids.*



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4. If there is battery voltage at the solenoids, remove the coils and check their operation. If the plunger moves in when power is applied, check for binding when the coil is threaded into the body. Check for spool centering to allow the coil plunger to seat into the groove in the spool.

DANGER

If the lockout solenoids are loosened or removed from the control valve body, the pedal(s) are no longer locked. Pedal or hand control movement will result in spool movement and boom/bucket movement.

HYDRAULIC, HYDROSTATIC SYSTEM AIR INGRESS TEST

Hydraulic system air ingress, causing oil aeration, can affect performance of the hydraulic oil. This may be evident on a machine by jerky or uneven movement of the skid steer boom or bucket.

To assist in testing and finding leaks, a tool has been developed (part #FNH22ESS95). This tool comprises of a cap which replaces the reservoir filler breather for testing purposes, a pressure gauge and a relief valve. The cap has fittings for air pressure to be applied to the hydraulic reservoir.

CAUTION

Do not start the engine with the test tool installed, as the hydraulic system must be able to breathe.

Test Procedure:

1. Remove the filler/breather cap.
2. Remove the self-tapping screws around the cap base and screen assembly.
3. Remove the base, screen and gasket assembly. Clean all sealing surfaces.
4. Re-install new gaskets and base, taking care not to overtighten the screws.
5. Make sure the tank has 10W-30 oil visible.
6. Pressurize the tank using an air pressure line. The tool is equipped with a 3 PSI relief valve and a pressure gauge. The reservoir should not be pressurized beyond 4 PSI.

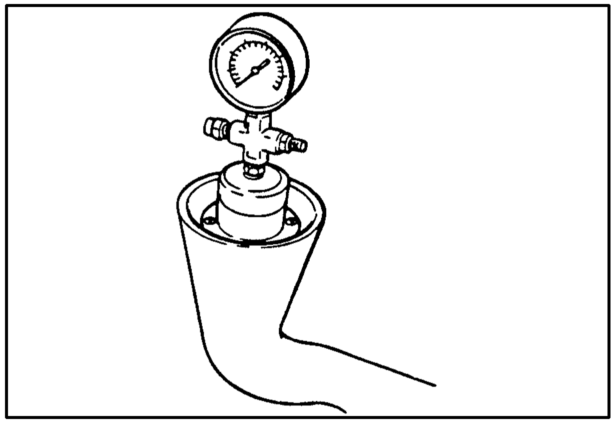
The following checks should then be performed to trace the source of the air ingress.

- Examine the suction tubes and fittings to the hydraulic gear pump and the return tubes from the filter to the reservoir.
- Examine the transmission case drain tubes/hoses and fittings from the hydraulic motors and pumps to the suction side of the hydraulic pump. Also check the cam plate shaft seals and the pump and motor casing gaskets.
- Potential leakage areas could also be input shaft seals in the engine bell housing, gearbox or output shaft seals in motors and gearboxes and the chain case.

- It may be necessary in some instances (where leakage is occurring on shaft seals into gearboxes or bell housing) to pressurize the reservoir for 2 to 4 hours and monitor the oil level in the gearboxes.
- If the prior checks do not locate the source of the leak, it may be necessary to pressurize each hydrostatic component individually.

  To do this it will be necessary to disconnect each case drain line in turn and pressurize using an air line to a maximum pressure of 10 PSI.

***NOTE:** A check valve can be installed in the case drain tube which maintains a 5 PSI pressure in the pump and motor cases. This helps prevent air ingress into the system.*



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CONTROL VALVE

Specifications

Type . . . . 3-spool open center

Relief Valve . . . . 170 - 177 bar (2500 - 2600 PSI)
Nonadjustable

Circuit Relief (boom) . . . . 172 bar (3500 PSI)

Electrical Solenoid Spool Locks . . . . Bucket and Boom

Torque Specifications

Control Valve Retaining Hardware . . . . 24 N·m (18 ft. lbs.)

Control Valve Plugs (large) . . . . 38 N·m (28 ft. lbs.)

Control Valve Plugs (small) . . . . 31 N·m (23 ft. lbs.)

Circuit Relief Valve (boom) . . . . 38 N·m (28 ft. lbs.)

Spool Lock Solenoids . . . . 15 N·m (11 ft. lbs.)

Main System Relief Valve . . . . 51 N·m (38 ft. lbs.)

Spool Cap Assembly Hardware . . . . 16 N·m (12 ft. lbs.)

Plugs, BYD Port . . . . 38 N·m (28 ft. lbs.)

Labor Required

Remove and Replace . . . . 1.5 hours

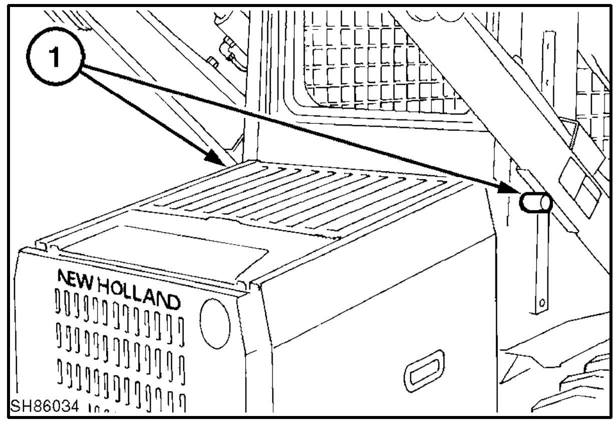
Repair . . . . 1.0 hour

CONTROL VALVE

Op. 35 724 50

REMOVAL

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins, 1. Roll the attachment plate to the fully “DUMPED” position.
2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.



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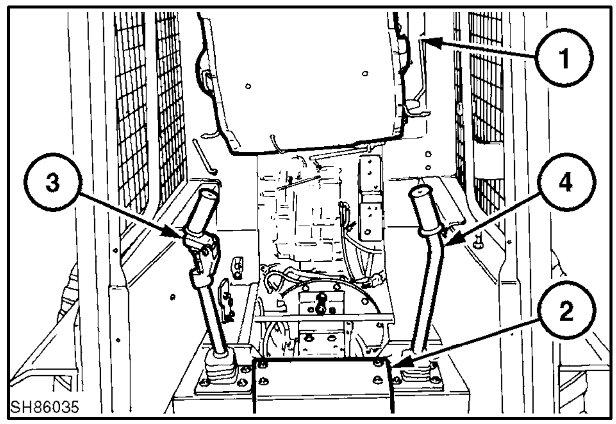
3. Raise the seat and seat pan to the raised latched position, 1.
4. Remove the step shield, 2, to access the gear pump area. For more access, remove the right or left hydrostatic control handle assembly, 3 or 4.



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CAUTION

Do not work under a raised seat unless it is securely latched in the raised latched position.

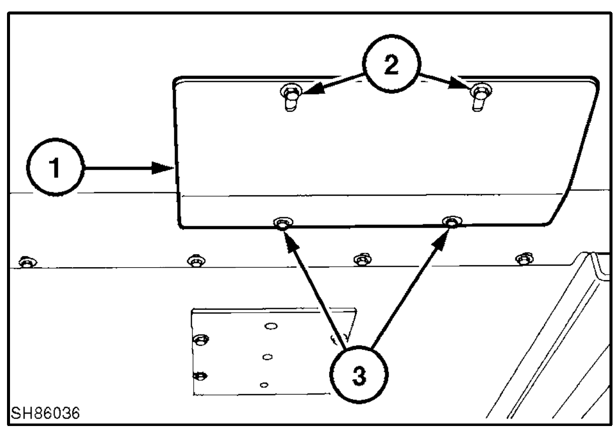
Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.

Never loosen any hydraulic lines without first relieving all pressure in the system.

Draining the hydraulic oil reservoir is not required if the suction and return lines are capped to prevent loss of oil. Drain the reservoir when the hydraulic system requires cleaning.

5. To drain the system, remove the small access door, 1, at the front right corner of the engine belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



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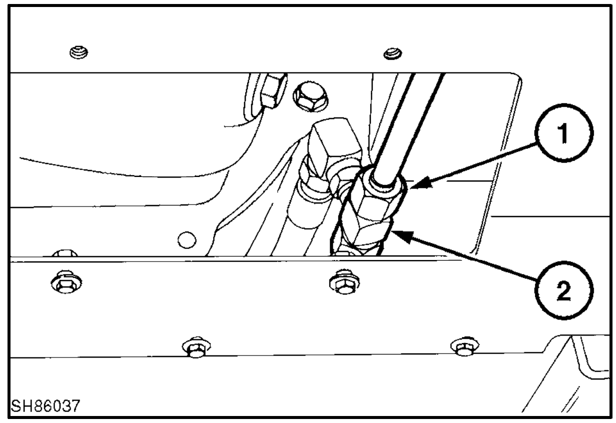
6. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.



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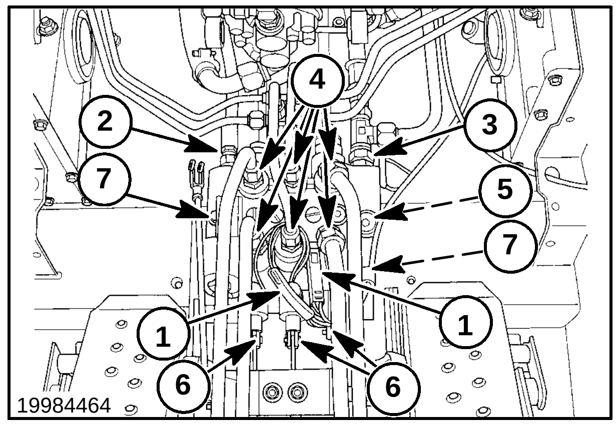
7. Unplug the spool lock solenoids, 1.
8. Remove the pressure line, 2, and return line, 3; cap both lines to prevent loss of oil and contamination from entering the hydraulic system.
9. Remove the hydraulic lines connected to the work ports of the control valve, 4, four or six lines, if unit is equipped with auxiliary boom hydraulics and cap.
10. Remove the line from the power beyond port, 5, if equipped with auxiliary hydraulics and cap.
11. Unhook the control linkage from the control valve spools at 6.
12. Remove the control valve retaining hardware, 7. Lift the control valve assembly from the skid steer.



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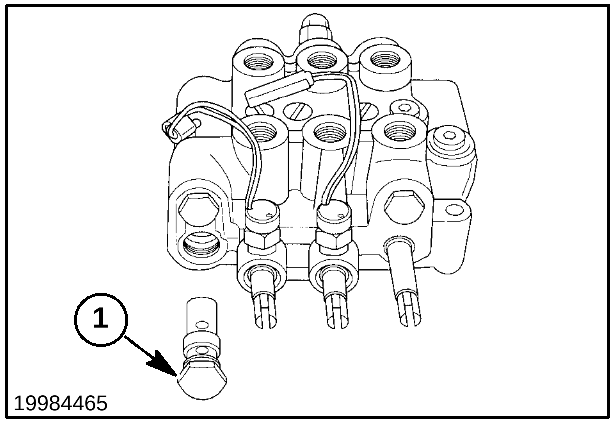
DISASSEMBLY AND INSPECTION

Main System Relief Valve

The non-serviceable, non-adjustable, cartridge- type main system relief valve, 1, is set at 170 - 177 bar (2500 - 2600 PSI). The relief valve should not be replaced with a valve of a higher pressure setting, as structural damage to the boom and/or main frame or internal damage to hydraulic system may occur.



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CAUTION

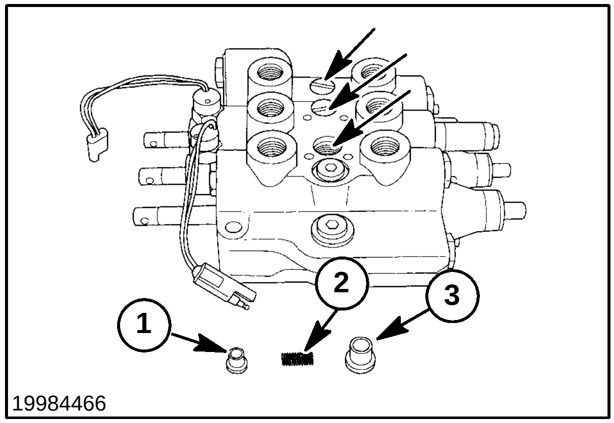
Component failure from high hydraulic pressure could result in injury.

Lift Check Valves

There is a check valve in each circuit - bucket, boom, and auxiliary.

The only time the check valves serve a function is after the control spools have been shifted. If the valves are operating properly, they prevent any movement of either the boom or bucket until pressure opens the lift checks.

Inspect the lift check components for damage to the seat, 1, spring, 2, or cap, 3.



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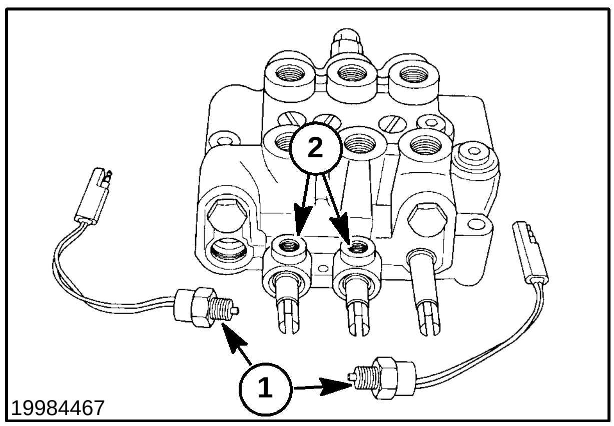
Op. 35 724 90

Spool Locks (Boom and Bucket)

Remove the solenoid plunger assemblies, 1, from the ports, 2, over the control spool ends.



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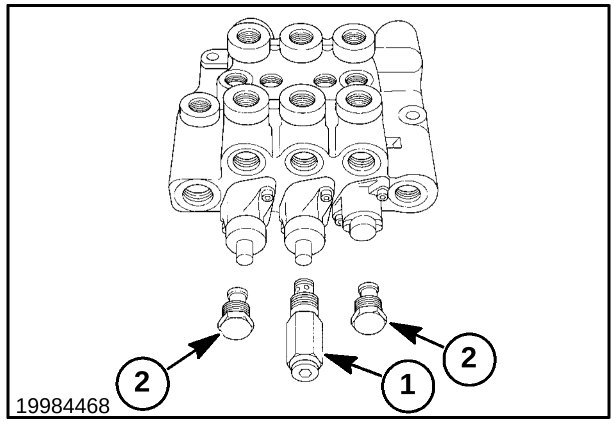
Remove the boom circuit relief valve, 1, from the valve body.

NOTE: *The boom circuit relief valve protects the lift circuit against high pressure related damage caused by external forces acting against the boom. The valve is factory set at 241 bar (3500 PSI), is non adjustable, and must be replaced if malfunctioning.*

Remove the plugs, 2, over the bucket and auxiliary spool caps.



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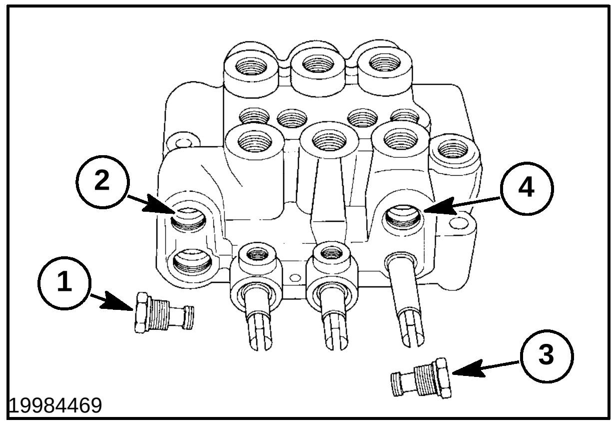
Remove the plug, 1, from the port, 2, over the main relief valve port. Remove the plug, 3, from the port, 4, over the auxiliary control spool.



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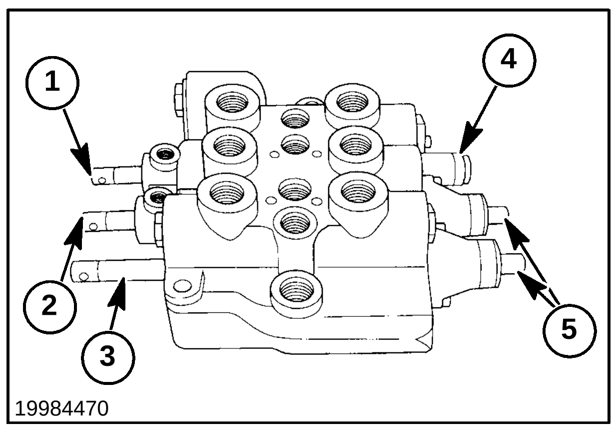
Spools, Caps, and O Rings

Oil is directed through the housing to the different ports by way of the spools: the bucket spool, 1, the boom spool, 2, and the auxiliary spool, 3.

Some oil circulates around the spools for lubrication and smooth operation. If an oil leak appears on the outside of the valve and all lines connected to the ports are tight, check the O rings on each end of the spools. The spools can be pulled from the control valve housing while the valve is still in the skid steer by disconnecting the control linkage and removing the spool caps.



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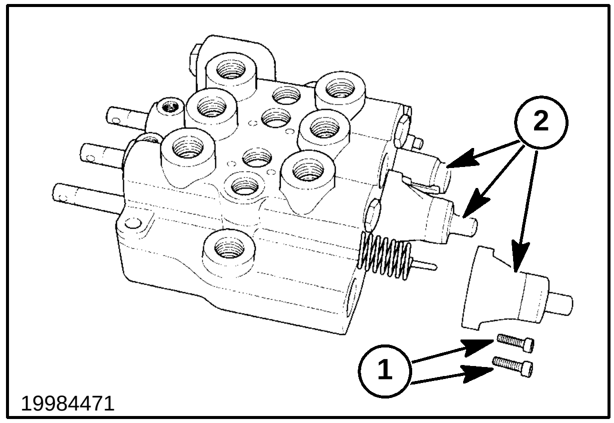
CAUTION

If removing spool caps on the tractor, make sure all system pressure has been relieved first.

Notice that the bucket spool has a plain cap, 4. The boom spool and auxiliary spools have detent caps, 5, to hold the spools in position for float position boom circuit or continuous flow auxiliary circuit operation.

1. Thoroughly clean the control valve and unscrew the allen head capscrews, 1, on the caps.
2. Remove the caps, 2, from the rear of the valve body.



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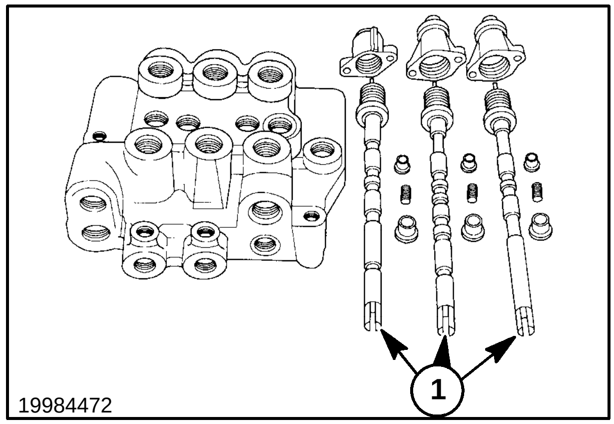
NOTE: *Before removing the spools, make sure the exposed portion of the spool is free from any paint or corrosion which could damage the internal porting of the valve.*

3. Remove the spools, 1, from the valve body.

NOTE: *Each spool is different. Make sure to replace the correct spool in the correct part of the valve body.*



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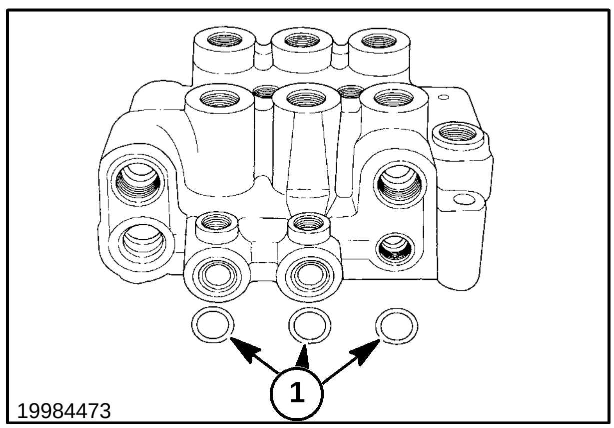
4. Remove the O rings, 1, from the spool ports. Inspect the O ring seating area for burrs, and remove them before installing new O rings.



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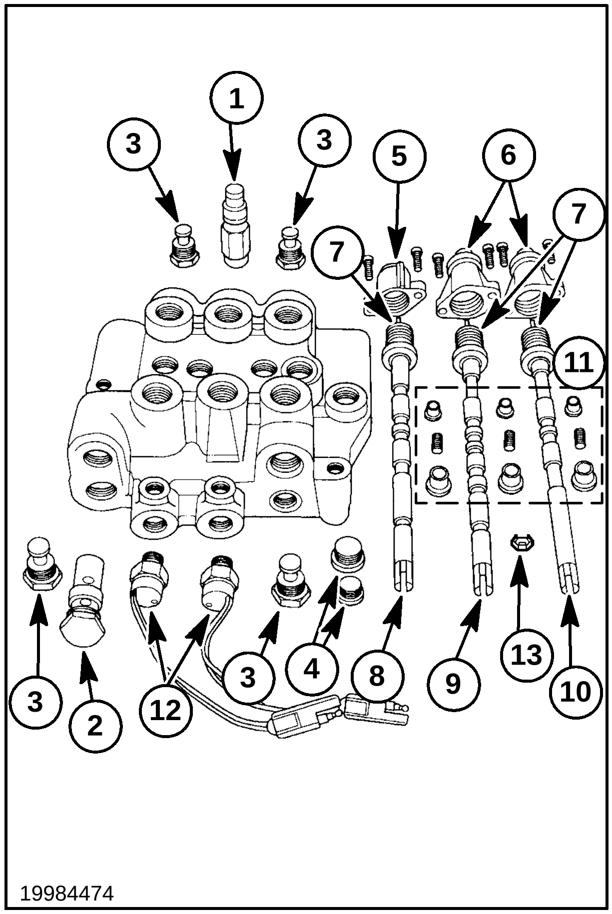
5. The complete control valve components include:
    1. Main system relief valve
    2. Boom circuit relief valve
    3. Plugs
    4. Caps
    5. Plain control spool cap
    6. Detent control spool caps
    7. Centering springs and hardware
    8. Bucket control spool
    9. Boom control spool
    10. Auxiliary control spool
    11. Lift check, springs, and caps
    12. Bucket and boom solenoids
    13. Boom lower circuit orifice plate



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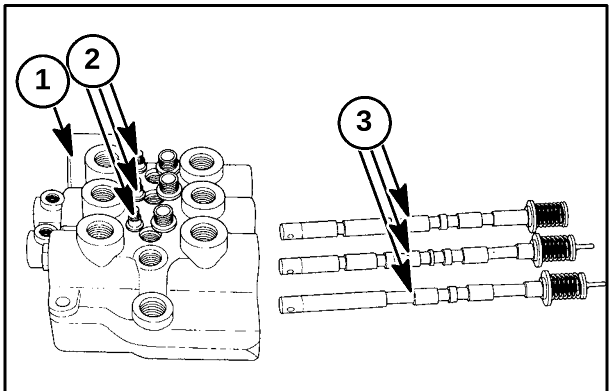
PARTS INSPECTION

Inspect the control valve components thoroughly for scratches or nicks, weak centering springs, weak lift check springs, and scored lift checks or valve seats.



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Valve Body, 1

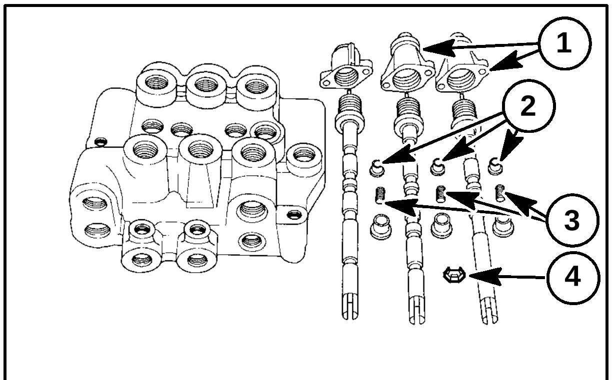
1. Check for cracks in casting that allow an oil leak.
2. Check the lift check seats, 2.
3. Check O ring seating surfaces.
4. Damaged fitting thread areas.

Control Spools, 3

1. Check the spool lands for scratches.
2. Check spool straightness.

IMPORTANT: *The spools are matched to the control valve body. If excessively worn or damaged, replace the control valve assembly.*

NOTE: *The three spools are different. Do not mix spools and return spring assemblies during reassembly.*



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Detent Caps, 1

1. Check the detent pins and springs for proper operation. All pins should move freely and return to position with spring pressure.
2. Clean the caps thoroughly and lubricate the pins with a light grease.

Lift Checks, 2

1. Check the lift check seat surface for wear or scratches.
2. Check the lift check springs, 3.
3. Check the caps to ensure free movement of lift checks into the caps.

Orifice Plate, 4 (Boom Lower Circuit)

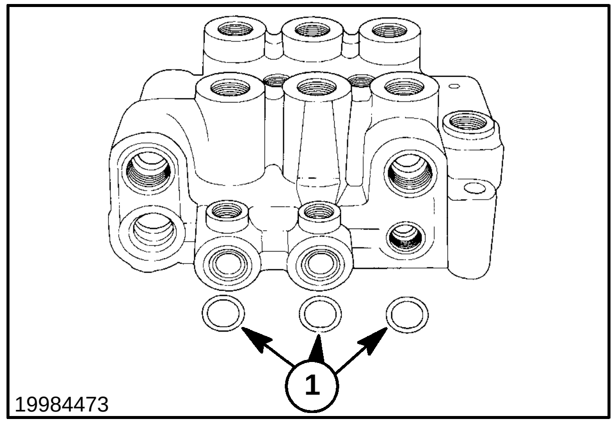
1. Check the flat surface for scratches.
2. Check the hole in the plate for dirt and clean.

Solenoid Spool Locks

1. Check solenoid operation

REASSEMBLY

1. Install O rings, 1, in the boom control spool ports, the bucket control spool ports, and auxiliary control spool ports.



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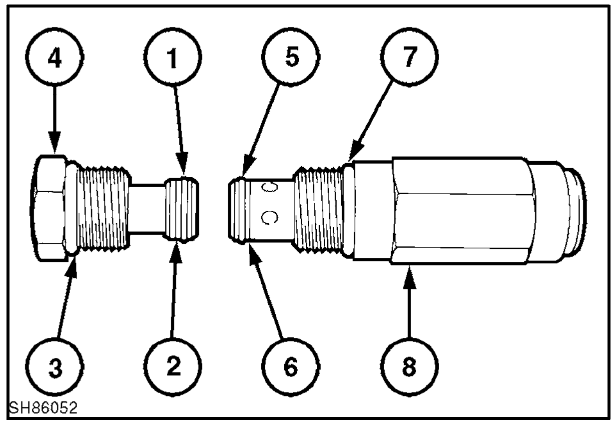
2. Install the O ring seals, 1, on the boom circuit relief valve, 2, and all the plugs, 3.
3. Install small O rings, 4, and backup rings, 5, on the relief valve and plugs.



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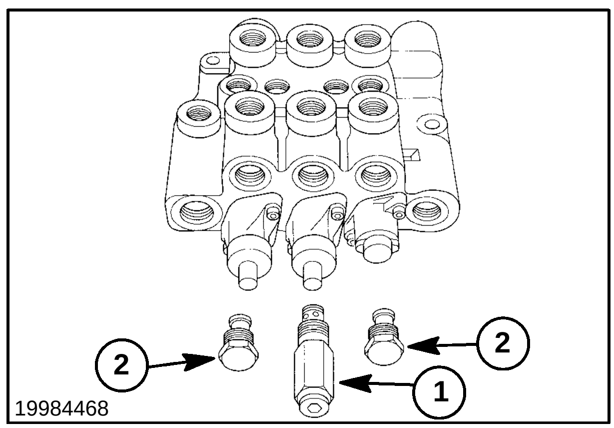
4. Install the boom circuit relief valve, 1, into the valve body.
5. Install the plugs, 2, over the bucket and auxiliary spool caps.



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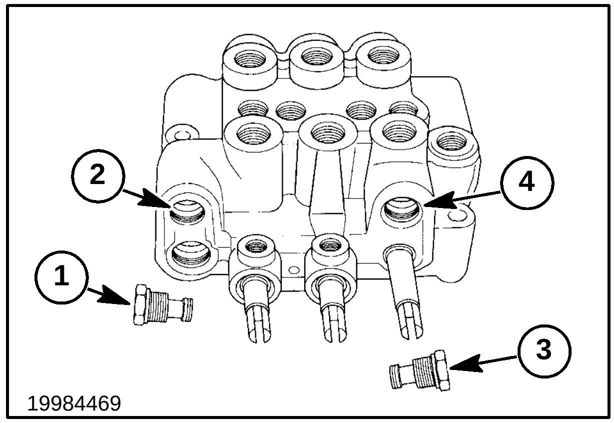
6. Install the plug, 1, into the port, 2, over the main relief valve port. Install the plug, 3, into the port, 4, over the auxiliary control spool.



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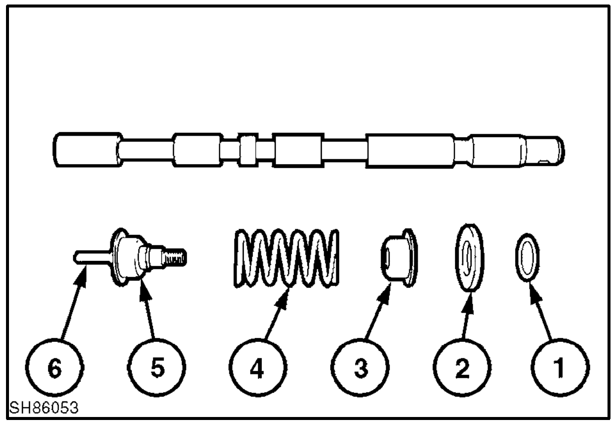
7. Install new O rings, 1, on the spools.
8. Install the washers, 2, spring retaining plate with small hole, 3, centering spring, 4, spring plate with large hole, 5, and end screw, 6, on each spool.



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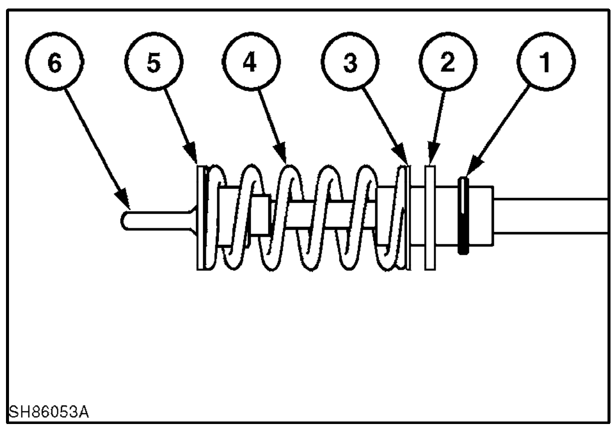
NOTE: *The spring retaining plate with the small hole must go next to the valve. The plate with the large hole, 5, must be over the end pin, 6, for proper spool.*

9. Tighten the end screw, 6, securely.



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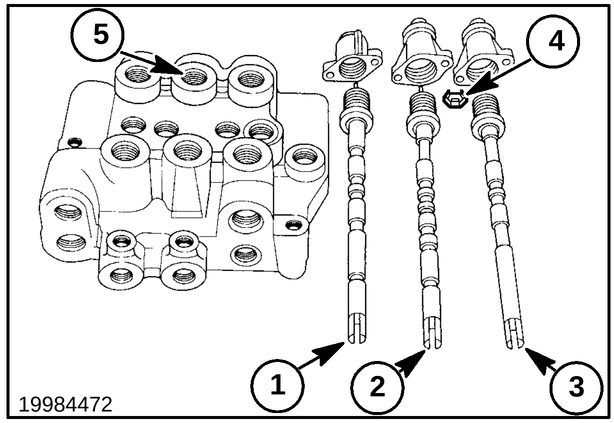
10. Install the control spools into the valve body - bucket, 1, boom, 2, auxiliary, 3.
11. Reinstall the boom lower orifice plate, 4, with the slot towards the fitting in port, 5.

NOTE: *The three spools are different. Do not mix spools and return spring assemblies during reassembly.*



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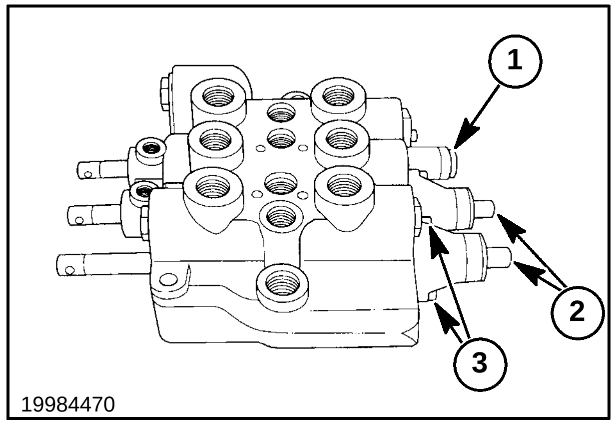
12. Install the plain cap, 1, over the bucket control spool and the detent caps, 2, over the boom and auxiliary control spools. Tighten the allen head screws, 3, securely.

NOTE: *If any spool binds in the housing, rotate the spool 180° and check it. If the spool still binds, check the end caps for proper alignment. If a spool still binds, the complete control valve must be replaced.*

NOTE: *On the tractor, binding can be caused by mounting hardware that is too tight (valve to main frame).*



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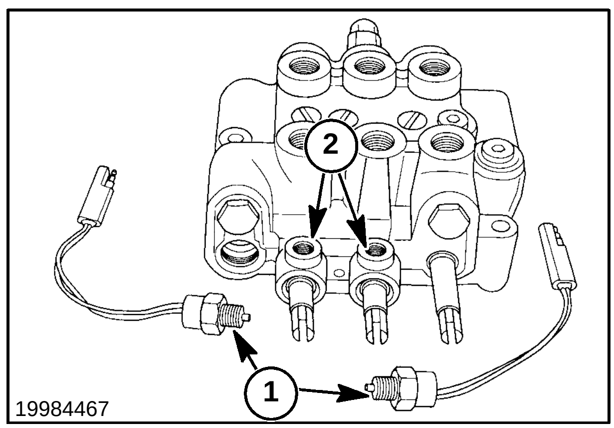
13. Install the solenoid plunger assemblies, 1, into the ports, 2, over the control spool ends.



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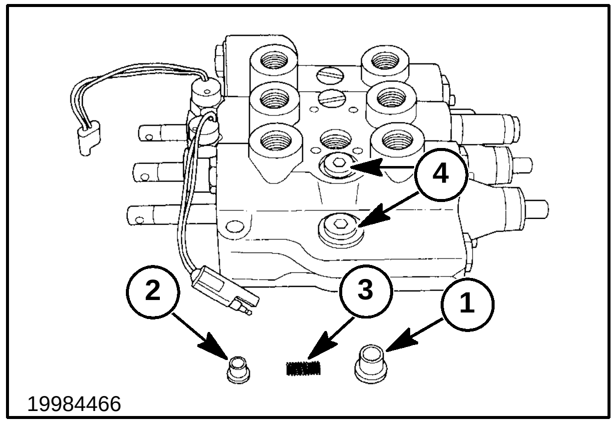
14. Add O rings to the lift check valve caps, 1. Install the lift checks, 2, springs, 3, and caps.
15. Install the two caps, 4, with O rings into the valve body.



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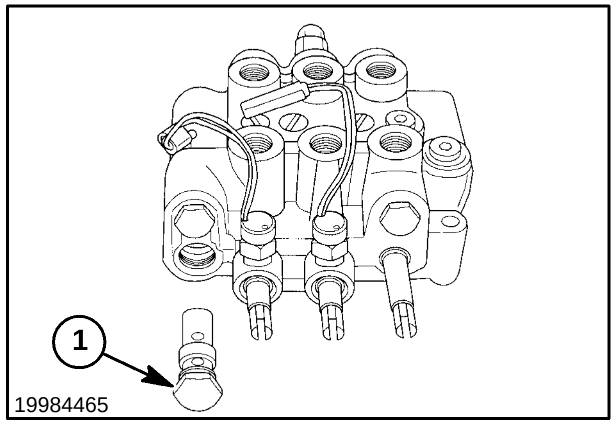
16. Install an O ring on the main system relief valve, 1, and install into the valve body.



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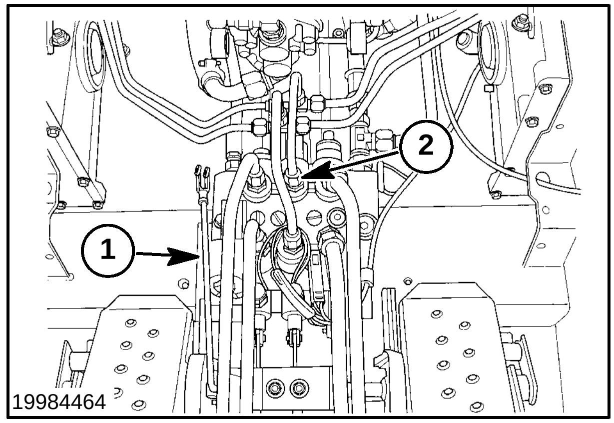
REINSTALLATION

1. Place the rubber isolation mount, 1, in place under the control valve space.
2. Reinstall the control valve into the skid steer with the retaining hardware previously removed. Align the valve with the control linkage and torque the valve retaining hardware to 24 N·m (18 ft. lbs.).
3. Reconnect the control linkage and wiring harness to the lockout solenoids.
4. Reinstall orifice plate with the flat surface towards valve body and the slotted side towards the fitting in the rear boom port at 2.
5. Reinstall the hydraulic lines and tighten to seat the fittings, then loosen the lines and retorque.
6. Refill the hydraulic reservoir with 10W-30 oil.
7. With the unit supported off the ground, start the unit and check for any oil leaks and repair.
8. Reinstall the step shield and belly pan.
9. Recheck the hydraulic oil level and add as required.



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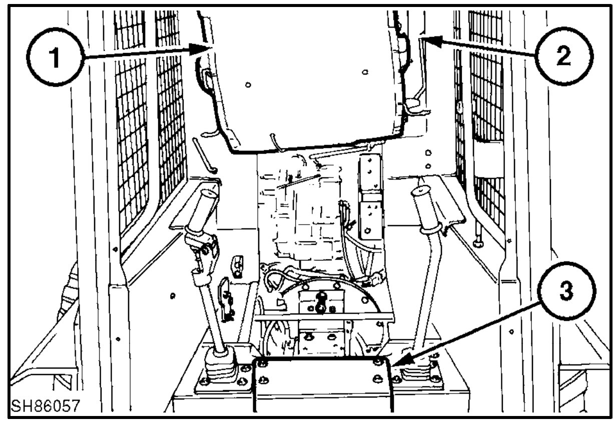
HYDRAULIC PUMP

Specifications	**26000 Series (LS180)**	**26000 Series (LS190)**
Type	Gear Pump	Gear Pump
Output @2225 RPM - 69 bar (1000 PSI)	17.6 GPM (63.2 L/min)	20.0 GPM (75.7 L/min)
Rotation (Viewed from shaft end)	Clockwise	Clockwise
Gear teeth	13 per gear	13 per gear
Wear plate	Black, powdered metal with Teflon coating	Black, powdered metal with Teflon coating
Bushings	Teflon coated	Teflon coated
Internal lubrication system	Inlet (suction) side	Inlet (suction) side
Labor Required		
R&R Pump	1.5 hrs.	1.5 hrs.
Disassembly, Inspection and Reassembly	0.5 hrs.	0.5 hrs.

Op. 35 710 10

PUMP REMOVAL

1. Lower the boom and bucket to the lowered position (resting on the ground), or remove any attachment and raise the boom and rest on the boom lock pins.
2. Stop the engine, turn the ignition key to the run position and operate the boom and bucket control pedals to relieve pressure in the boom and bucket circuits. Turn off the key.
3. Raise the seat and seat pan, 1, to the raised latched position, 2.
4. Remove the step shield, 3, to access the gear pump area. For more access remove the right or left hydrostatic control handle assembly.



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CAUTION

Do not work under a raised seat unless it is securely latched in the raised latched position.

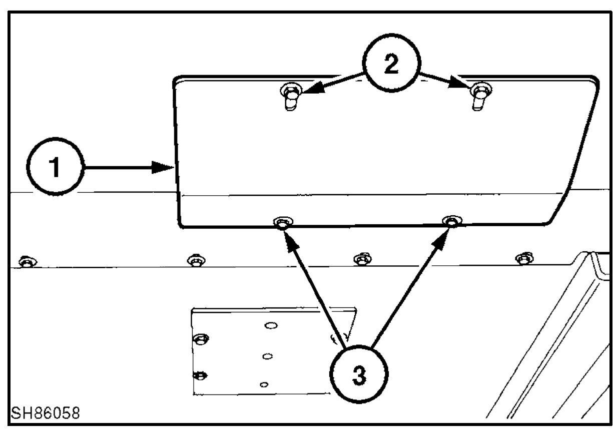
Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the skid steer.

Never loosen any hydraulic lines without first relieving all pressure in the system.

Draining the hydraulic oil reservoir is not required if the suction and return lines are capped to prevent loss of oil. Drain the reservoir when the hydraulic system requires cleaning.

5. To drain the system, remove the small access door, 1, at the front right corner of the engine belly pan by removing the two rear bolts, 2, loosening the front two bolts, 3, and sliding the door rearward.



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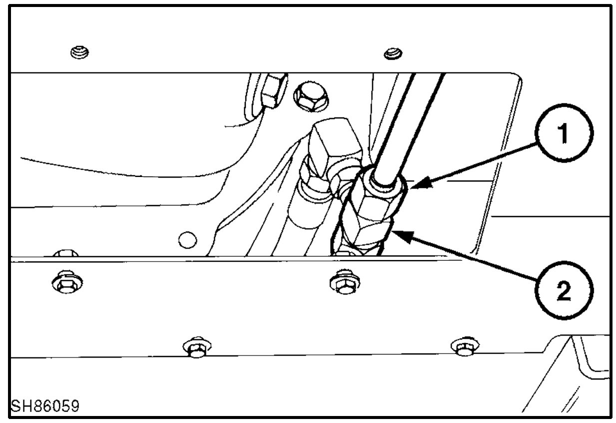
6. Drain the hydraulic reservoir by disconnecting the return line, 1, at tee, 2, and drain the oil into a suitable container.



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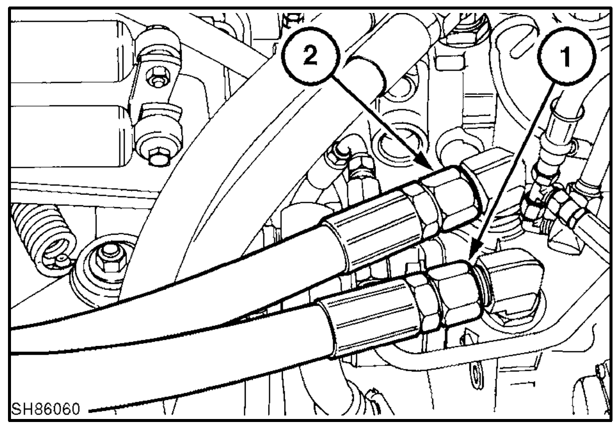
7. Disconnect the hydrostatic high pressure hoses at 1 and 2, and cap.



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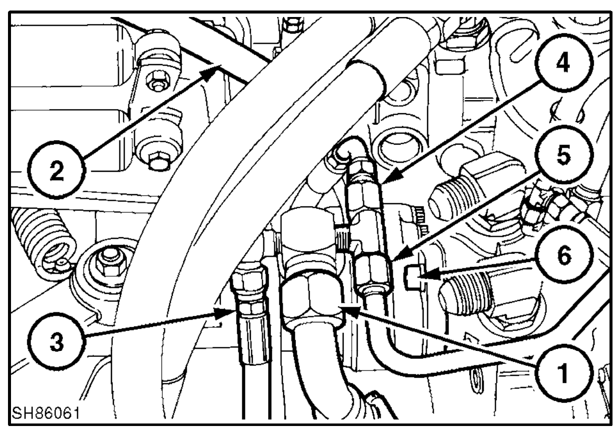
8. Remove suction line, 1, from the hydraulic reservoir, and cap to prevent oil loss.
9. Remove pressure line, 2, to the control valve, and cap.
10. Disconnect the motor case drain line, 3, the two-speed control valve return line, 4, and the pump case drain tube, 5, and cap.
11. Remove the gear pump retaining hardware, 6, and remove the gear pump from the skid steer.



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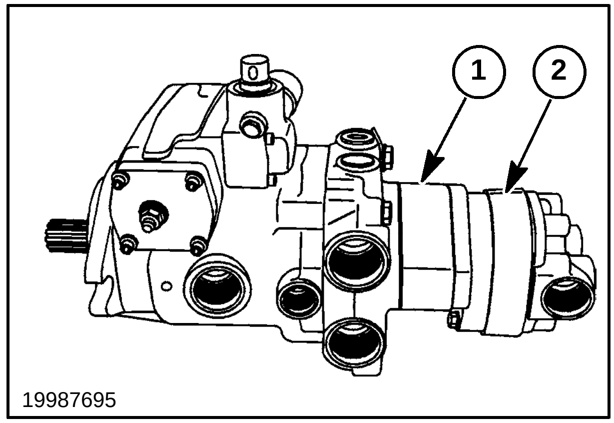
a. LS190 skid steers only - A wide spacer, 1, separates the gear pump, 2, from the hydrostatic pump on LS190 loaders.



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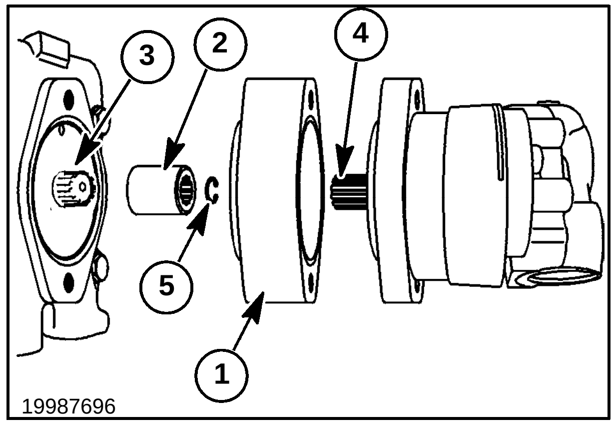
b. LS190 skid steers only - Remove the spacer, 1, and coupler, 2. Discard the O rings on the gear pump and spacer. The hydrostatic pump on LS190 loaders has a splined male shaft, 3. The coupler connects the hydrostatic pump male shaft to the gear pump splined male shaft, 4. A snap ring, 5, inside the coupler keeps the coupler from shifting position during operation. The spacer allows for the extra space the coupler requires.



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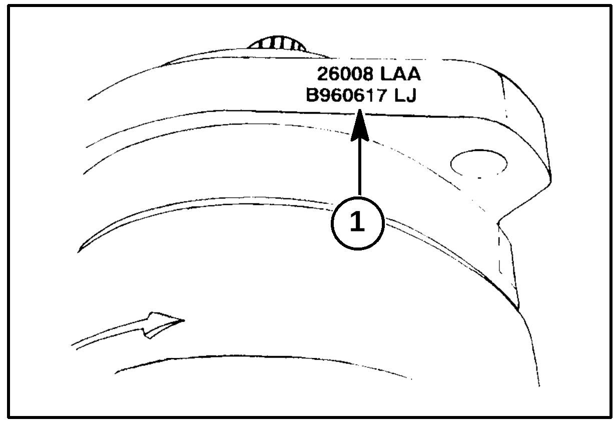
Op. 35 710 20

DISASSEMBLY

Identify the pump by the two series of numbers and letters on the pump flange at 1.



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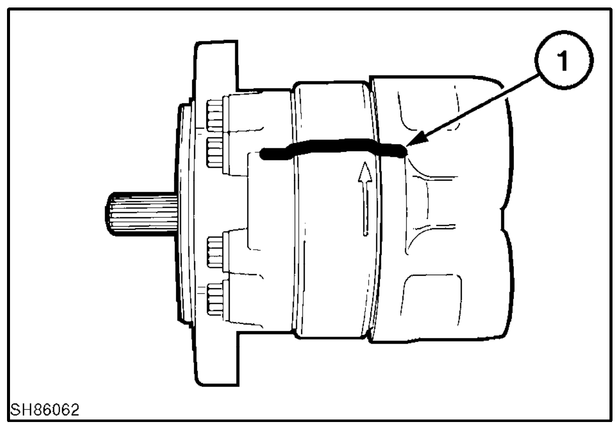
26	= Series
0	= Features 0-Standard Single Gear Pump
08	= Displacement Code
L	= Rotation (left, counterclockwise)
A	= Catalog No.
A	= Shaft, Port, Type, and Size
B	= Revision Level
96	= Year Built
06	= Month Built
17	= Day Built
LJ	= Tester

NOTE: *On any warranty work or requests for information about gear pumps, please list these two lines of information.*

Clean the pump thoroughly and mark the pump assembly, 1, to ensure proper reassembly.

Remove the pump housing hardware and separate the end plates and body section.

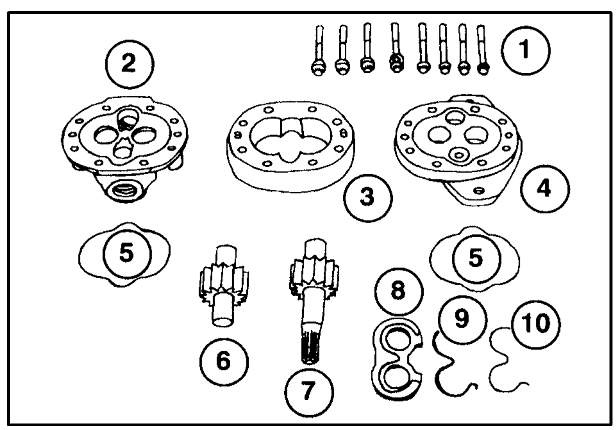


81

IMPORTANT: *The pump body is aluminum and can be easily damaged. BE CAREFUL not to damage machined surfaces. DO NOT use a screwdriver or other hard, sharp objects to pry the pump from the plate.*

The 26000 gear pump consists of the following components:

1. Capscrews
2. Pump front plate (drive end)
3. Pump body
4. Pump back plate
5. End cap O ring seals (2)
6. Pump idler gear assembly
7. Pump drive gear assembly
8. Wear plate
9. Backup gasket
10. Seal



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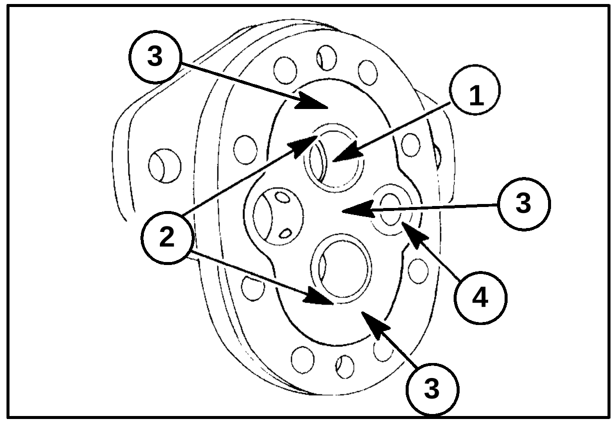
PARTS INSPECTION

1. Inspect the pump front plate (drive end) for excessive wear. The oil grooves in the bushings in the front plate should be in line with the dowel pinholes and 180° apart, 1. If the bushing oil grooves are not positioned as noted, the bushings have turned in the plate - the plate should be replaced.

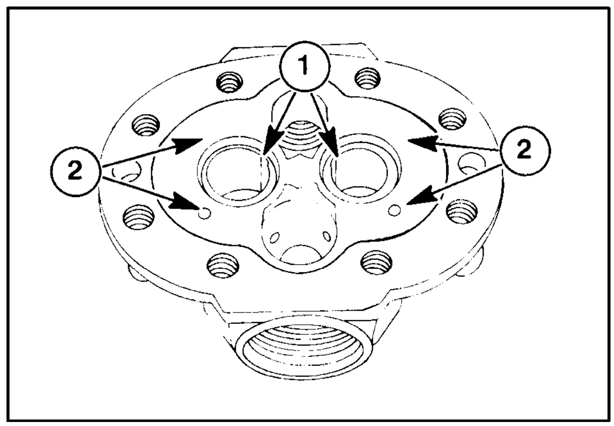
   The bushings in the front plate should be at 3.20 mm (0.126″) above the surface of the plate, 2. Replace the front plate if the I.D. of the bushing exceed 19.2 mm (0.755″).



83

2. Check the seal areas, 3, for scratches or damage that could prevent a good seal.
3. The plug, 4, does not have to be removed unless damaged. The plug can be removed by threading a 3/8″ UNC bolt into the plug center. This plug MUST be in place for proper pump operation.
4. Inspect the pump back plate for excessive wear. The oil grooves in the back plate bushings should be at approximately 37° to the pressure side, 1. If the bushing oil grooves are not positioned as noted, the bushings have turned in the plate, and the plate should be replaced.

   Replace the back plate if the I.D. of a bushing exceeds 19.2 mm (0.755″). Check for scoring on the face of the back plate, 2. Replace the back plate if wear exceeds 0.038 mm (0.0015″).



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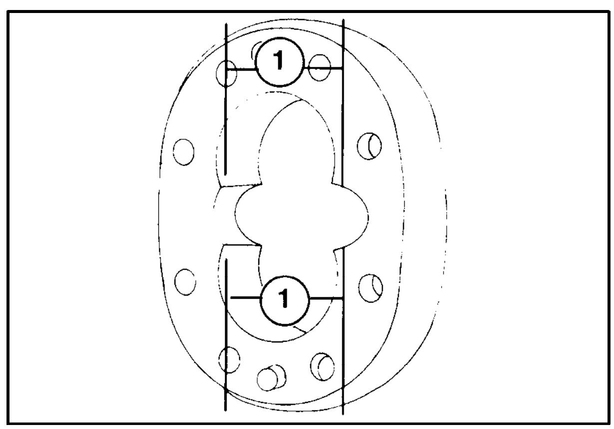
5. Inspect the pump body for excessive wear. Check the pump body inside the gear pockets, 1, for excessive scoring or wear.

   Replace the pump body if the I.D. of gear pockets exceed 43.7 mm (1.719″).



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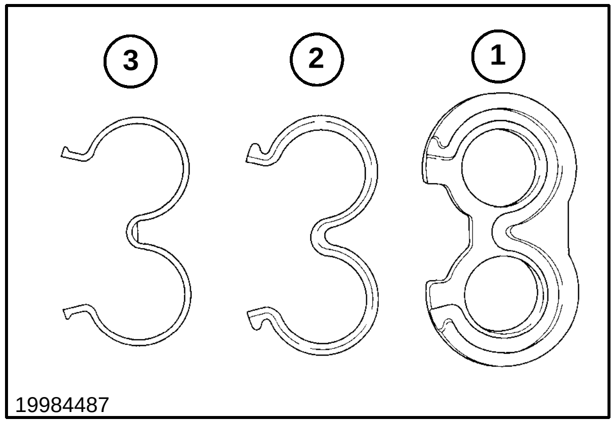
6. The wear plate, 1, should be replaced when the pump is rebuilt. The flat Teflon-coated surface towards the gears should not show any scratches or grooves that can be caught with a fingernail.
7. The wear plate, 1, has a backup gasket, 2, and a seal, 3, that should be replaced when the pump is rebuilt. Inspect for damage, such as nicks and tears, to determine if any problem exists.



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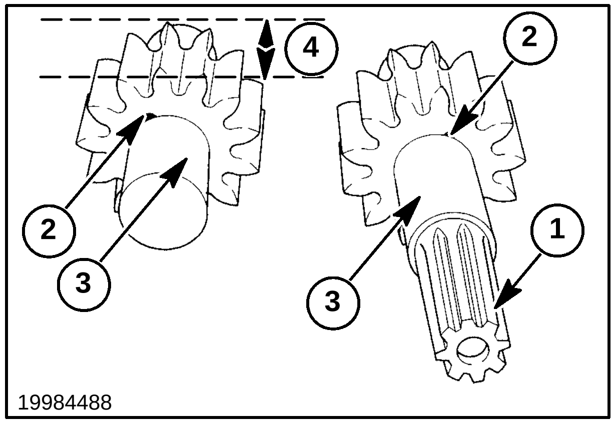
8. Inspect the pump gears for excessive wear. Check for obvious twisted or broken shaft splines, 1, on the drive gear. Replace if damage is found. Inspect the gear keys and retaining rings, 2, to ensure they are not sheared. Replace if found twisted or sheared.

   The gear shaft assemblies should measure greater than or equal to 19.0 mm (0.748″) in the bushing area, 3. If the shaft measures less then the specified diameter, replace the gear assembly.

   The gear width, 4, should be close to the following specs. If the gears measure less than the specified width, the gear pump will not develop sufficient flow or pressure for loader application.



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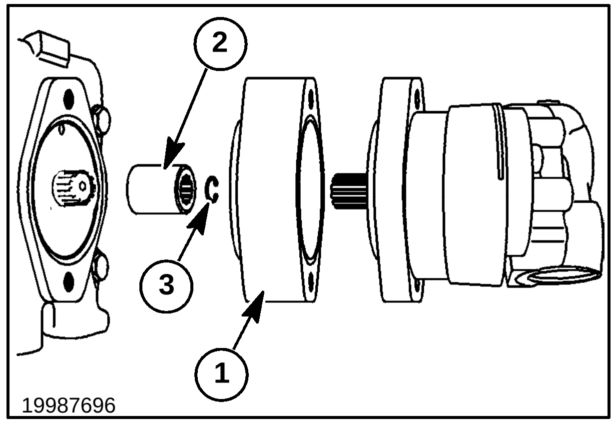
Part #	Eaton Model #	Gear Width
86528338	26005-RAQ	16.15 mm (0.636″)
86528339	26007-RAA	22.56 mm (0.888″)
86528340	26008-RAA	25.76 mm (1.014″)
86528341	26008-LAA	25.76 mm (1.014″)

NOTE: *If replacement of the gear assemblies is necessary, the gear assemblies should be replaced in pairs.*

9. LS190 skid steers only - Inspect the spacer, 1, and coupler, 2. Discard the O rings on the gear pump and spacer. Inspect the snap ring, 3, and replace if damaged.



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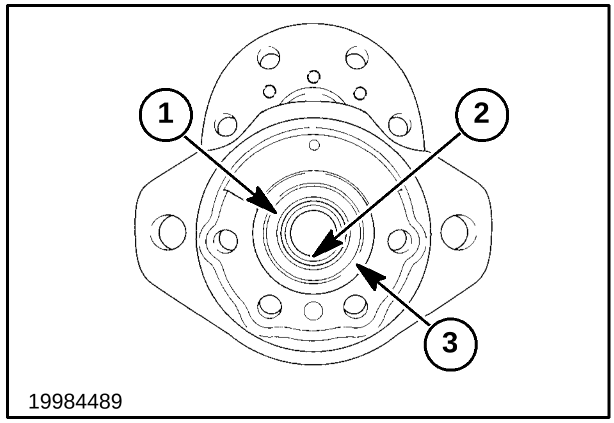
REASSEMBLY

1. Coat all parts with a thin coat of petroleum jelly or oil to aid in reassembly.
2. Install a new washer, 1, and shaft seal, 2, in the pump front plate (drive end), 3. The seal is pressed into the housing to a depth of 6.35 mm (0.25″) from the outer seal housing lip.

NOTE: *Once the seal is installed, make sure that the washer can rotate freely. If the washer cannot rotate, reinstall the seal to a lesser depth to obtain freedom of movement for the washer.*



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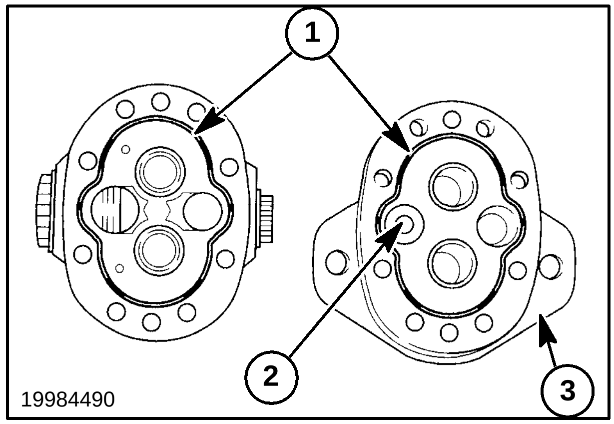
3. Install new O rings, 1, in the pump front and back plates. Ensure that the plug, 2, is installed on the pressure side of the pump front plate (drive end), 3.



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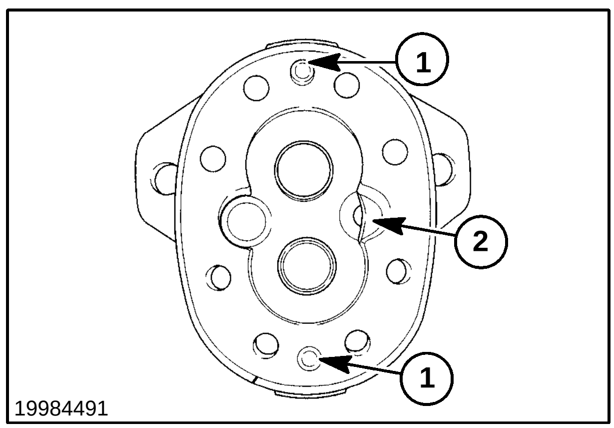
4. Make sure the dowel pins, 1, are in place and install the body on the pump front plate (drive end) with the half-moon cavities in the body facing away from the pump front plate. Check that the reference marks made during disassembly align correctly.

NOTE: *The small half-moon cavity, 2, must be on the pressure side (plugged side) of the pump.*



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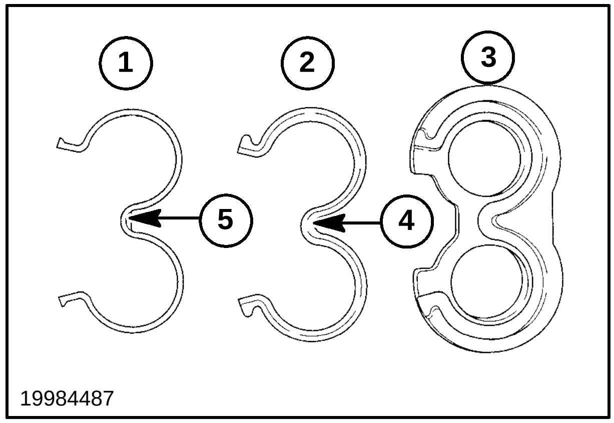
5. Install the seal, 1, and backup gasket 2, on the wear plate, 3. BE SURE that the flat area, 4, on the gasket AND seal, 5, are properly aligned and lay flat when installed in the wear plate.



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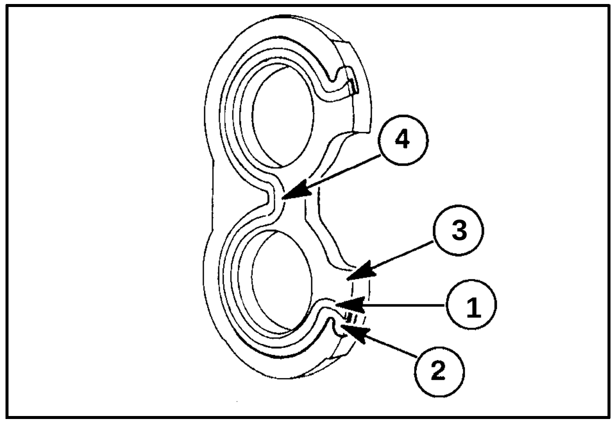
NOTE: *The gasket AND seal must align and lay flat at 4 when installed in the wear plate.*



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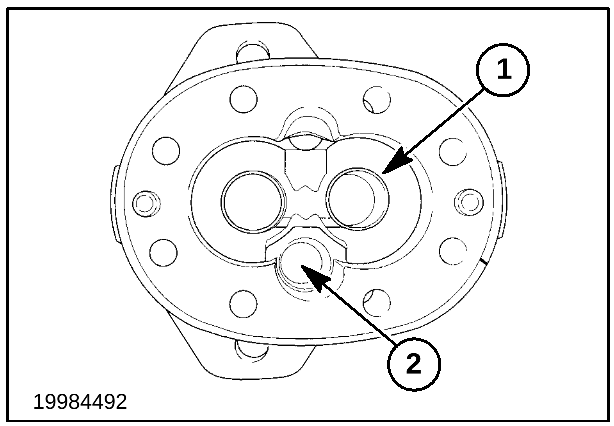
6. Install the wear plate assembly, 1, with the gasket/seal side towards the pump front plate, into the body cavity with the mid section cut away on the suction side (large half moon cavity), 2, of the pump.

NOTE: *To best accomplish the installation of the wear plate, hold the pump body/front plate assembly upside down while sliding the wear plate assembly up into the housing until it is seated against the front plate. This helps ensure that the seal and backup gasket stay in place.*



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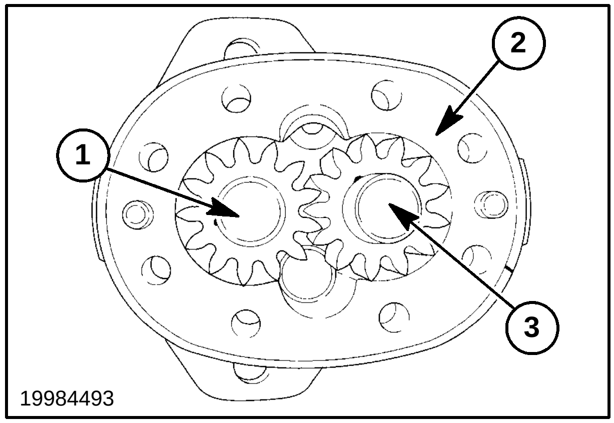
7. Install the drive gear, 1, into the housing, 2. Install the idler gear, 3, into the housing. Rotate the gears to help slide them into the gear pockets.



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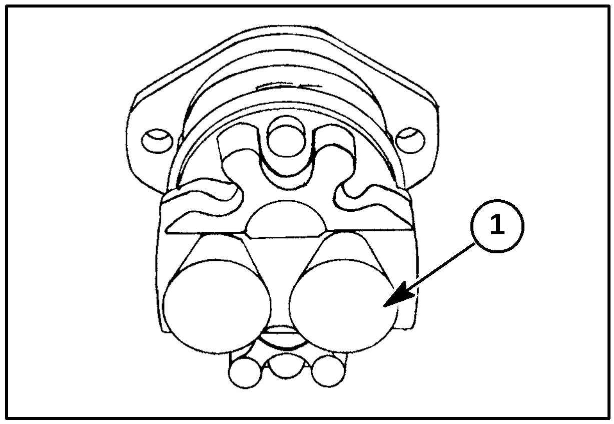
8. Install the pump back plate, 1, over the gear shafts. Check that the reference marks made during disassembly align correctly.



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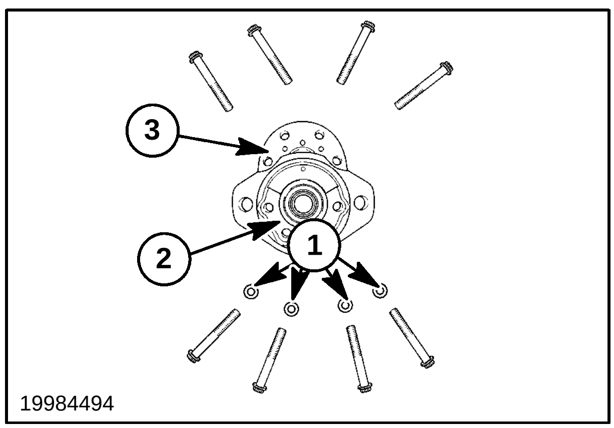
9. Install the housing hardware with the four bolts with sealing washers, 1, on the inside bolt holes, 2, with the remaining bolts installed in outside holes, 3. Torque the bolts evenly in a criss-cross pattern to 34 - 38 N·m (25 - 28 ft. lbs.).



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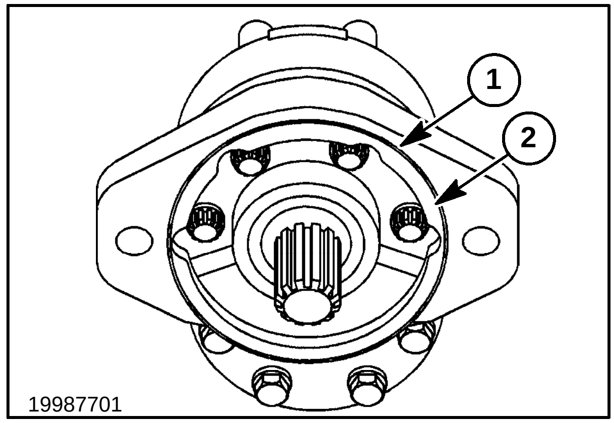
INSTALLATION

1. Install a new O ring, 1, on the gear pump pilot, 2. For LS180 skid steers, install the gear pump onto the hydrostatic pump, mating the splines on the input shaft. Tighten the mounting hardware to 39 N·m (29 ft. lbs.).



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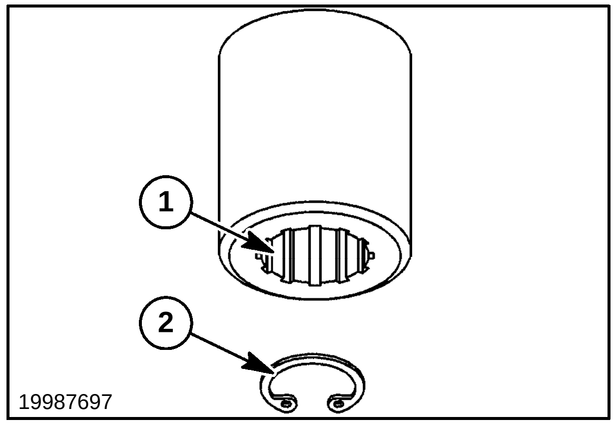
2. LS190 skid steers only - Install the snap ring, 1, into the groove in the center of the coupler, 2. Make sure the snap ring is secure inside the coupler.



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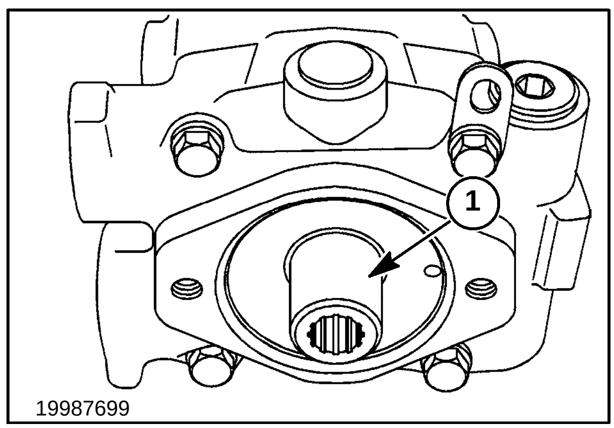
3. LS190 skid steers only - Install the coupler, 1, on the hydrostatic pump shaft.



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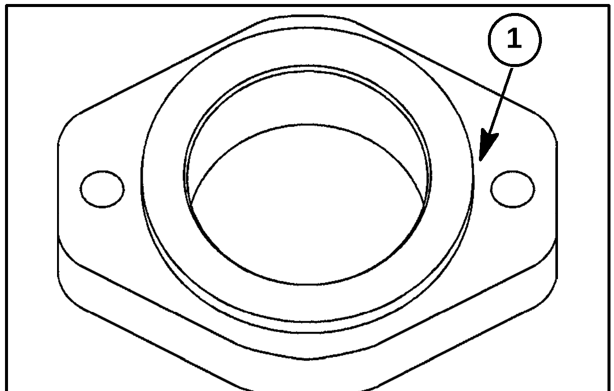
4. LS190 skid steers only - Install an O ring, 1, on the spacer.



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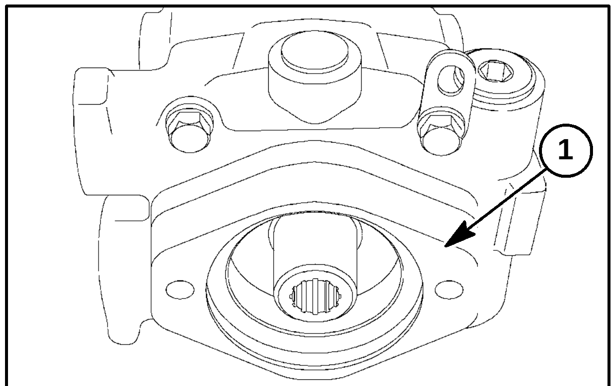
5. LS190 skid steers only - Place the spacer, 1, in place on the hydrostatic pump pilot.



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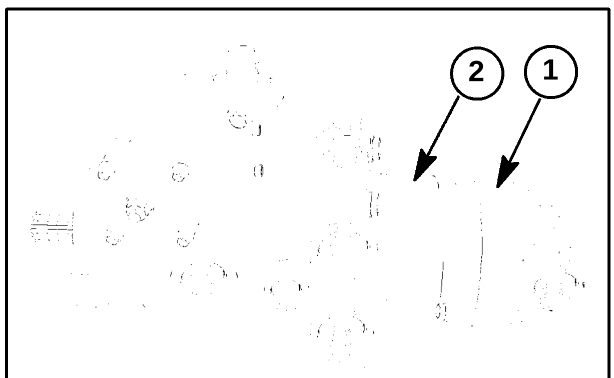
6. LS190 skid steers only - Place the gear pump, 1, with O ring on the spacer, 2. The assembly should be tight when assembled. The O rings on the pump pilots should form a solid seal to the spacer. Install the pump capscrews and tighten to 37 - 42 N·m (27 - 31 ft. lbs.).



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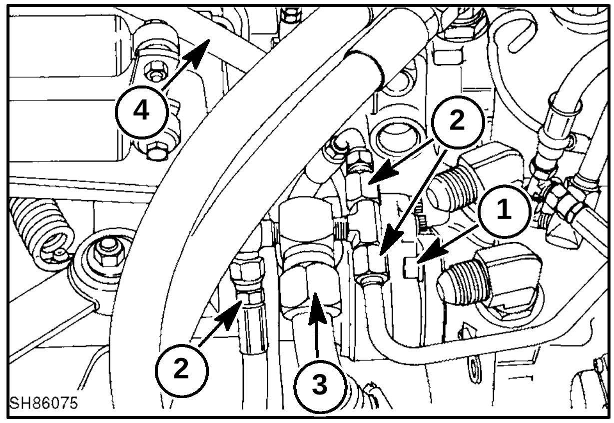
7. Connect hydraulic lines, 2, pressure line, 3, and suction line, 4. Make sure that when lines are tightened they are positioned to prevent contact with other components.

NOTE: *Make sure all hoses are tightly clamped to fittings where clamps are used. Make sure all fittings are properly seated and tight. Loose fittings on suction hoses can cause oil aeration. Loose pressure lines will cause an external oil leak.*



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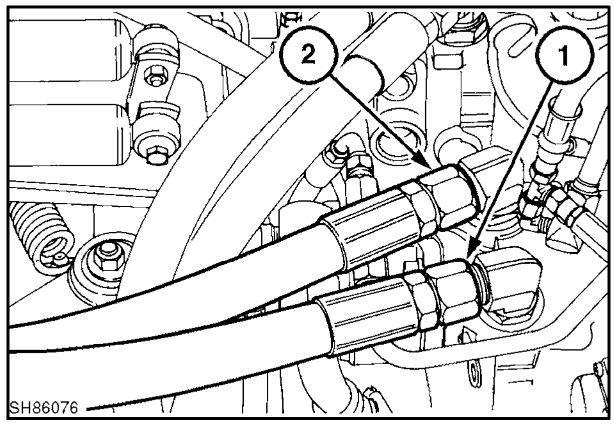
8. Connect hydrostatic lines, 1 and 2, previously removed for pump access.



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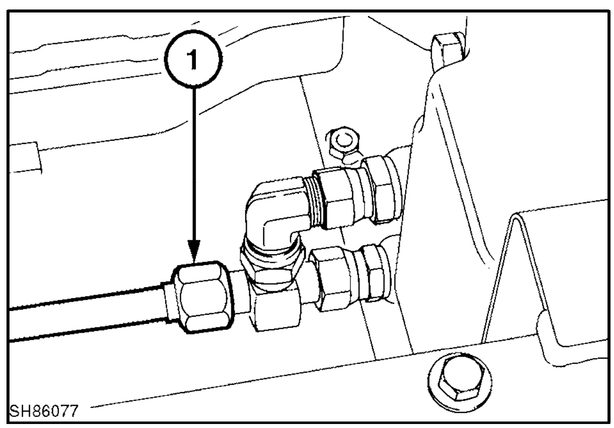
9. Reconnect hydraulic line, 1, previously removed to drain the reservoir.
10. Fill the reservoir with SAE 10W-30 oil to the proper level.
11. Reinstall the hydrostatic control lever assemblies, if removed, and install the step shield.



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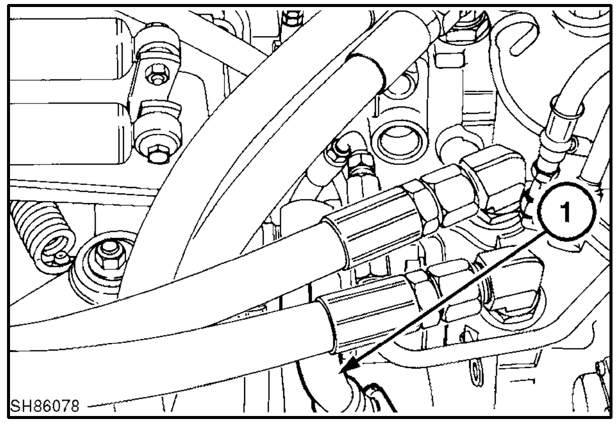
Gear Pump Start-up Procedure

This procedure must be performed if the gear pump has been removed for repair purposes or any gear pump hydraulic lines have been removed.

1. Fill the reservoir with SAE 10W-30 oil to the proper level.
2. Loosen suction line, 1, at the gear pump. When oil flows from the connection, tighten the connection.
3. Start the engine and run it at 1500 RPM. Operate all hydraulic controls to remove remaining air from the system.
4. Check reservoir level and add oil as necessary.



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CYLINDERS, BOOM AND BUCKET

BOOM CYLINDERS - LS180
Specifications

Bore Diameter . . . . 63.5 mm (2.5″)

Stroke . . . . 611 mm (24.06″)

Rod Diameter . . . . 38.1 mm (1.5″)

Cycle Times (seconds)
- Raise 3.6
- Lower 1.5

Torque

Piston Locknut Torque . . . . 230 N·m (170 ft. lbs.)

Cylinder Head (gland) . . . . 306 N·m (225 ft. lbs.)

Lower Pivot Pin Hardware . . . . 338 N·m (250 ft. lbs.)

Upper Pivot Pin Hardware . . . . 38 N·m (28 ft. lbs.)

Labor Required

Remove and Replace (1) . . . . 0.5 hour

Repair (1) . . . . 0.5 hour

BUCKET CYLINDERS - LS180
Specifications

Bore Diameter . . . . 63.5 mm (2.5″)

Stroke . . . . 447 mm (17.6″)

Rod Diameter . . . . 31.8 mm (1.25″)

Cycle Times (seconds)
- Curl Back 1.8
- Curl Down (dump) 2.4

Torque

Piston Cap Screw . . . . 306 N·m (225 ft. lbs.)

Cylinder Head (gland) . . . . 306 N·m (225 ft. lbs.)

Lower Pivot Pin Hardware . . . . 38 N·m (28 ft. lbs.)

Upper Pivot Pin Hardware . . . . 108 N·m (80 ft. lbs.)

Labor Required

Remove and Replace (1) . . . . 0.5 hour

Repair (1) . . . . 0.5 hour

BOOM CYLINDERS - LS190
Specifications

Bore Diameter . . . . . 70.0 mm (2.75″)

Stroke . . . . . 611 mm (24.06″)

Rod Diameter . . . . . 38.1 mm (1.5″)

Cycle Times (seconds)
- Raise 4.0
- Lower 2.7

Torque

Piston Locknut Torque . . . . . 230 N·m (170 ft. lbs.)

Cylinder Head (gland) . . . . . 306 N·m (225 ft. lbs.)

Lower Pivot Pin Hardware . . . . . 338 N·m (250 ft. lbs.)

Upper Pivot Pin Hardware . . . . . 38 N·m (28 ft. lbs.)

Labor Required

Remove and Replace (1) . . . . . 0.5 hour

Repair (1) . . . . . 0.5 hour

BUCKET CYLINDERS - LS190
Specifications

Bore Diameter . . . . . 63.5 mm (2.5″)

Stroke . . . . . 447 mm (17.6″)

Rod Diameter . . . . . 31.8 mm (1.25″)

Cycle Times (seconds)
- Curl Back 2.1
- Curl Down (dump) 2.4

Torque

Piston Cap Screw . . . . . 306 N·m (225 ft. lbs.)

Cylinder Head (gland) . . . . . 306 N·m (225 ft. lbs.)

Lower Pivot Pin Hardware . . . . . 38 N·m (28 ft. lbs.)

Upper Pivot Pin Hardware . . . . . 108 N·m (80 ft. lbs.)

Labor Required

Remove and Replace (1) . . . . . 0.5 hour

Repair (1) . . . . . 0.5 hour

BOOM CYLINDER

Op. 35 710 10

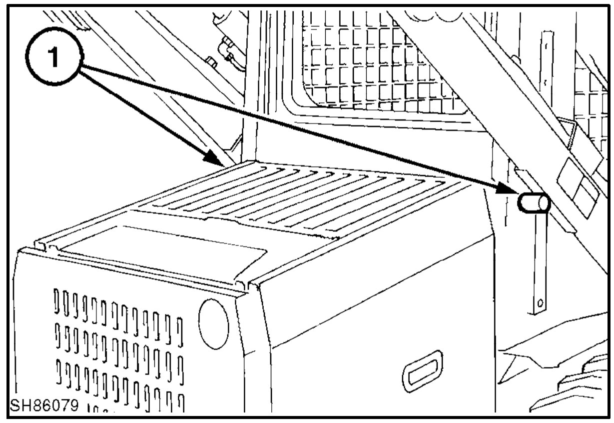
REMOVAL

CAUTION

Before removing the boom cylinders, the boom must be in the up, locked position supported by the boom lock pins.

Never loosen any hydraulic lines without first relieving all pressure in the system.

1. Remove any attachment from the skid steer boom attaching plate, bucket, etc.
2. Raise the boom above the boom lock pins, extend the boom lock pins, and lower the boom on the boom lock pins, 1.
3. After stopping the engine and before removing the seat belt and dismounting from the skid steer, turn the ignition switch to the “RUN” position.
4. Push both the boom and bucket pedals to relieve all residual hydraulic pressure in both hydraulic circuits.



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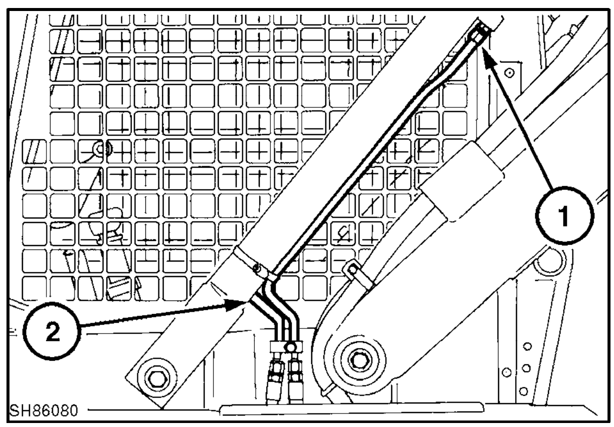
5. Turn off the ignition switch.
6. Disconnect both the upper, 1, and lower, 2, boom hydraulic hoses from the cylinder.



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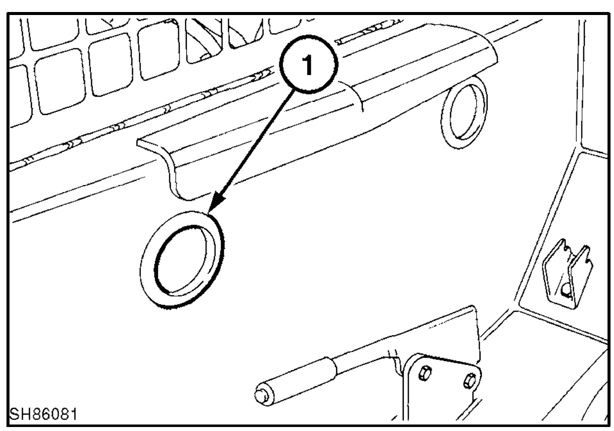
7. Using a screwdriver, remove the plastic plug, 1, from inside the cab to access the lower cylinder pivot retaining hardware.
8. Loosen the LOWER boom pin retaining hardware.

NOTE: *DO NOT remove the retaining hardware at this time.*



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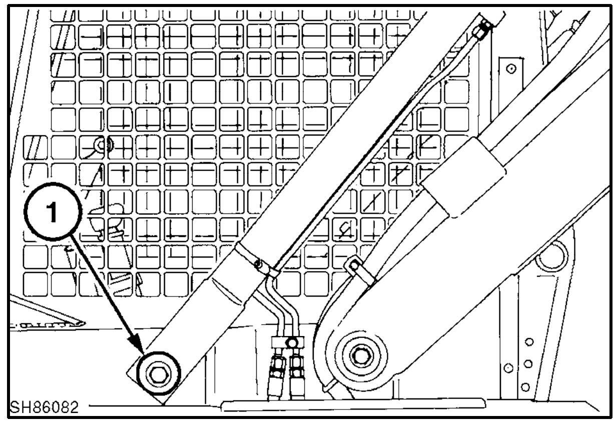
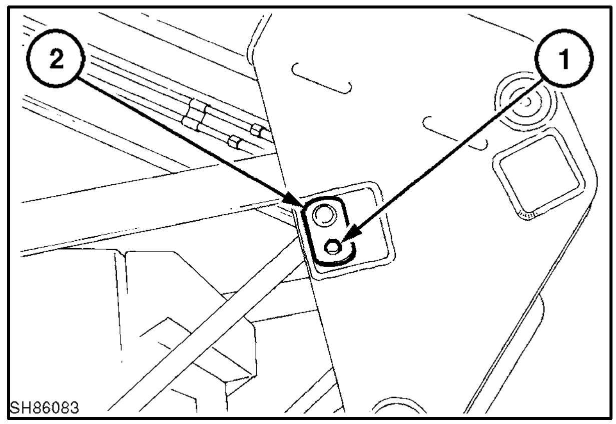
9. Support the cylinder and with a hammer strike the cylinder at the base area, 1, to loosen the tapered pivot pin from the skid steer main frame.



111

10. Remove the UPPER boom pin retaining bolt, 1, and boom pin, 2.
11. Remove the cylinder.



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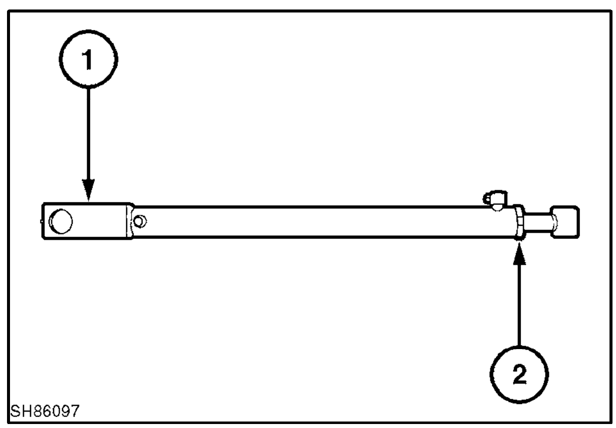
Op. 35 730 18

DISASSEMBLY

1. Thoroughly clean the outside of the cylinder.
2. Pull the piston rod out slowly, and drain the oil from the barrel into a suitable container.
3. Clamp the base of the cylinder in a vise at 1, and unscrew the cylinder head (gland), 2.

NOTE: *Do not clamp the cylinder barrel in the vise to unscrew the cylinder head. Flattening of the barrel will cause damage to the piston and piston seals.*



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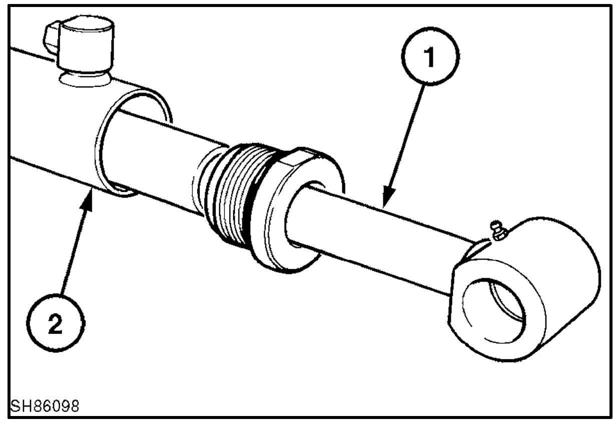
4. Remove the piston rod assembly, 1, from the barrel, 2.



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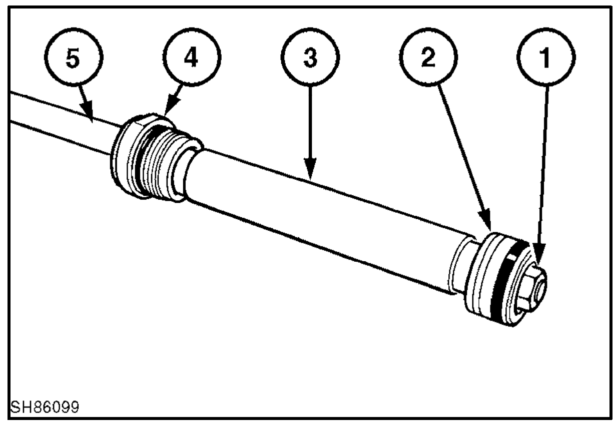
5. Remove the piston retaining nut, 1; the piston, 2; spacer, 3; and cylinder head (gland), 4, from the piston rod, 5.



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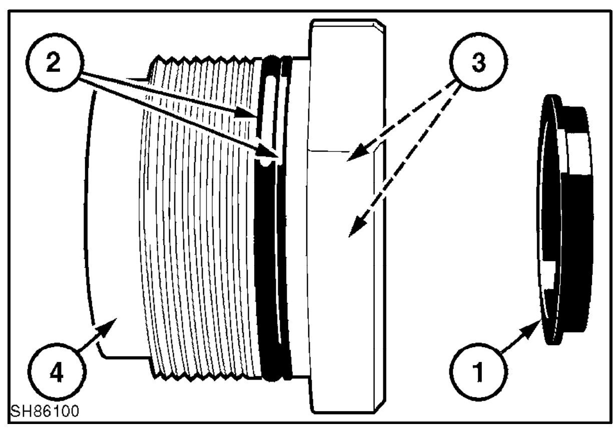
6. Remove the wiper seal, 1; O ring and backup washer, 2; and inner seal and wear ring, 3, from the cylinder head (gland), 4.



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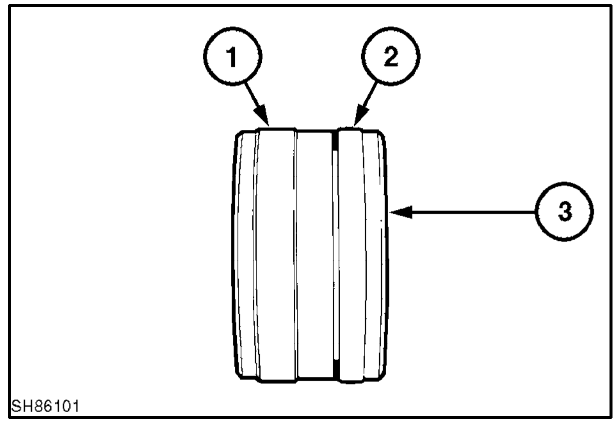
7. Remove the wear ring, 1, and seal, 2, from the piston, 3.



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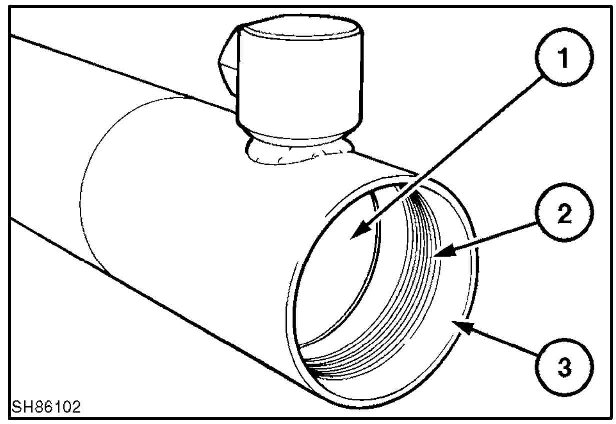
PARTS INSPECTION

1. Thoroughly clean all parts and remove any nicks or burrs with a fine emery cloth.
2. Inspect the inner diameter of the barrel, 1, for excessive wear or scoring.
3. Inspect the threaded area of the barrel, 2, for damaged threads that would prevent proper tightening of the cylinder head.
4. Inspect the O ring seal area, 3, and remove any burrs or nicks that could damage or prevent the O ring from sealing properly.



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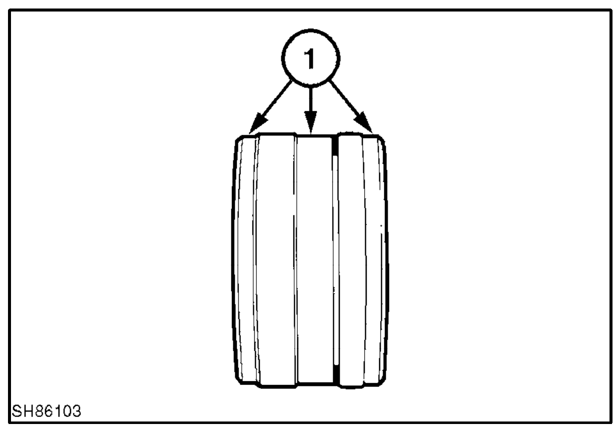
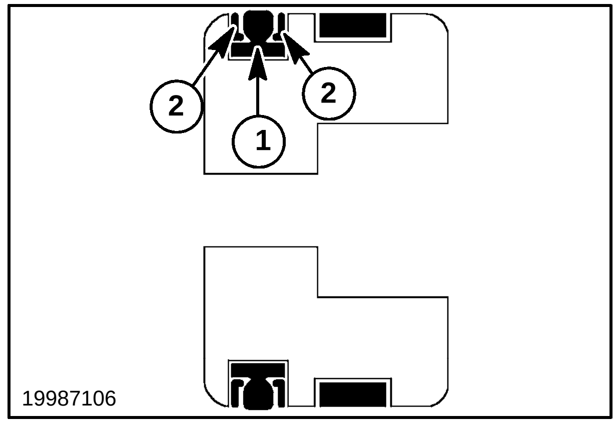
5. Inspect the outer diameter of the piston, 1, for excessive wear or scoring. If the piston is damaged, the inner surface of the barrel will also most likely be damaged. Inspect the barrel thoroughly. If the piston is not damaged, do not replace.



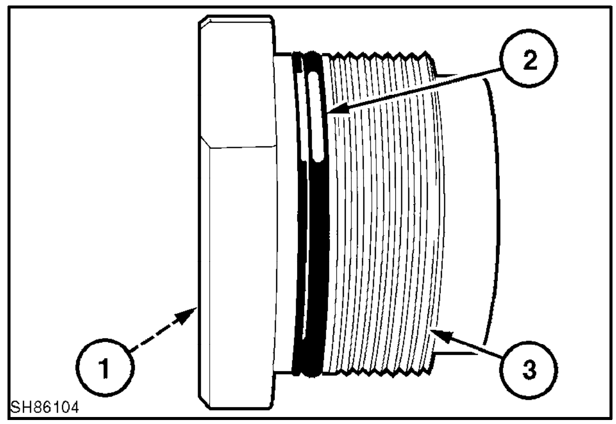
119

Make sure the new “T” seal, 1, and two backup seals, 2, are installed correctly.



120

6. Inspect the cylinder head (gland) inner and outer seal areas, 1 and 2, for sharp edges and scoring. Inspect the threaded area of the gland, 3, for damaged threads that would prevent proper tightening of the retaining nut. Replace the gland if necessary. All seals should be replaced during reassembly.



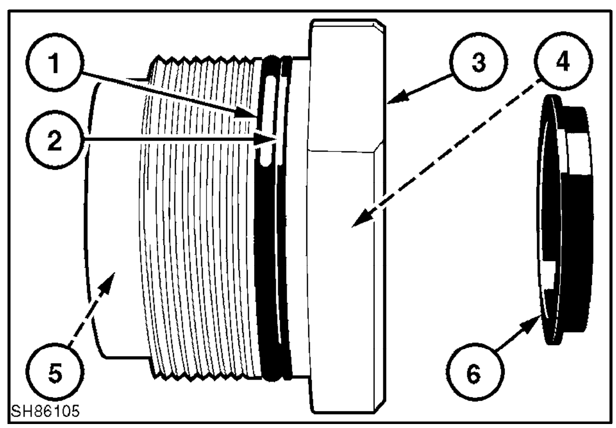
121

REASSEMBLY

1. Clean and dry all parts. The metal parts should be lightly oiled prior to assembly.
2. Install a new O ring, 1, and backup washer, 2, in the outer groove of the cylinder head, 3. Install a new shaft seal, 4, and wear ring, 5, in the inner grooves.

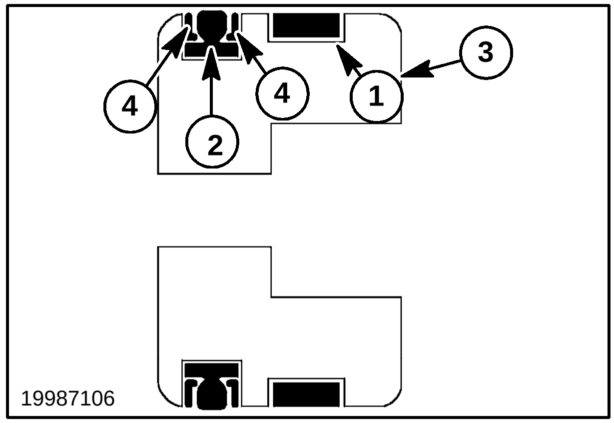
NOTE: *Install the shaft oil seal, 4, with the lip of the seal facing the piston.*

3. Install a new shaft wiper seal, 6, into the cylinder head. The seal lip should face outward.



122

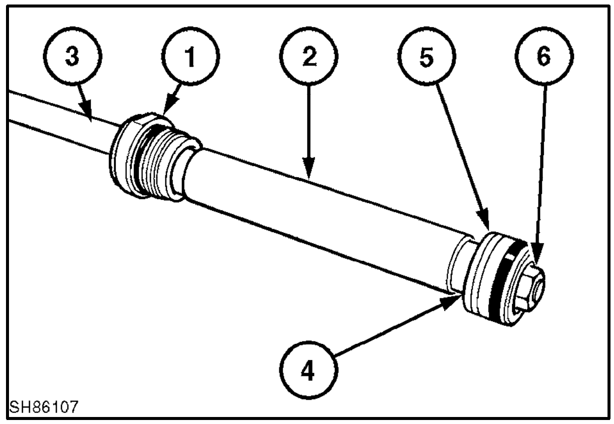
4. Examine the piston assembly prior to installation. The wear ring, 1, and T-seal, 2, should be firmly in their groove and snug against the piston, 3. Insert the L shaped back-up rings, 4, on both sides of the T-seal with the short leg of the L shaped back-up rings towards the T-seal as shown.



123

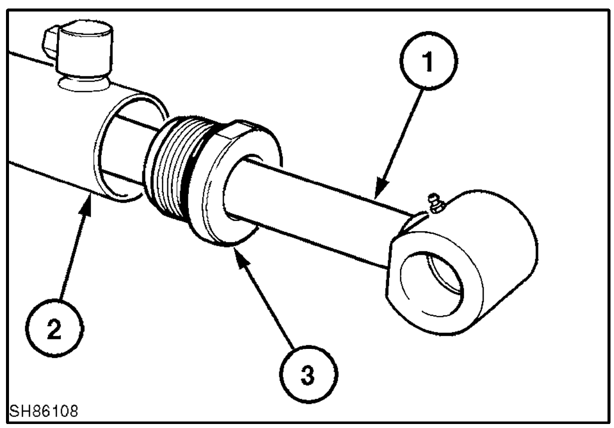
5. Install the cylinder head assembly, 1, and spacer, 2, onto the piston rod, 3.
6. Prior to installing the piston, clean and apply a bead of hydraulic sealant between the piston and piston rod at 4. Install the piston assembly, 5, and new locknut, 6. The wear ring on the piston should be toward the threaded end of the rod.

NOTE: *The flat side of the piston must face the spacer, and the recessed side must face toward the end of the rod. The effective length of the piston rod must be maintained, with the locknut fitting into the recessed area of the piston.*



124

7. Torque the locknut to 230 N·m (170 ft. lbs.).
8. Lubricate the piston and cylinder head assemblies with 10W-30 oil and install the piston rod assembly, 1, into the barrel, 2.
9. Prior to threading the cylinder head into the barrel, apply a coat of grease around the cylinder head, in the area between the backup washer and the cylinder head flange at 3.
10. Torque the cylinder head assembly to 306 N·m (225 ft. lbs.).

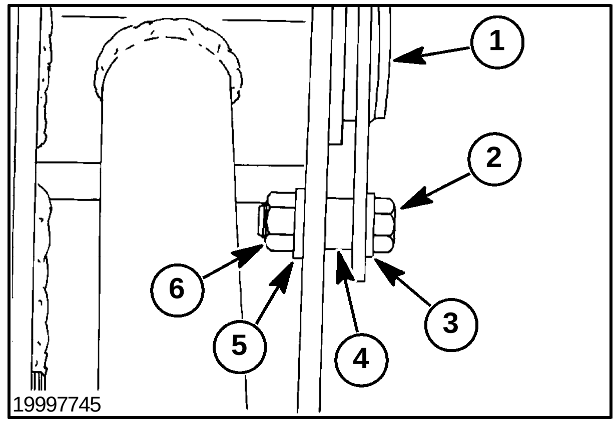


125

REINSTALLATION

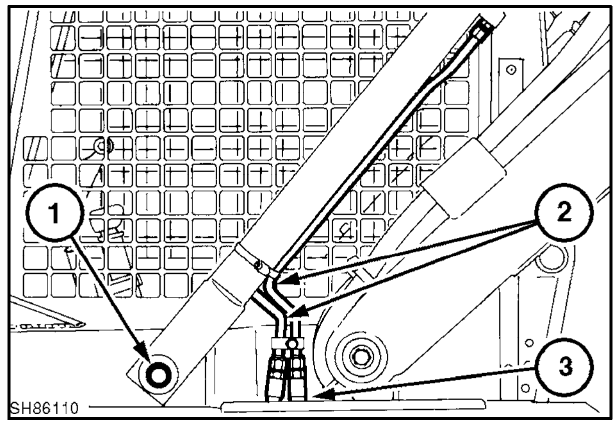
1. Lubricate the boom pivot pins, 1, with an anti-seize-type lubricant.
2. Install the cylinder onto the skid steer.

NOTE: *Refer to Service Bulletins 5/96 - I6 and 7/96 - I6 for updated pivot pin support information and proper pin, spacer, and bolt part numbers.*



126

3. Install a 3/8″ bolt, 2; flat washer, 3; and spacer, 4, through the pivot pin retaining strap and boom side plate. Secure with flat washer, 5, and lock-nut, 6.
4. Torque the upper pivot pin hardware to 38 N·m (28 ft. lbs.).
5. Install the lower pivot pin and 3/4″ hardware at 1, and torque to 338 N·m (250 ft. lbs.).
6. Using a six-pound hammer and a piece of 2x4 hardwood to protect the pivot pin, place the board over the end of the pin and hit briskly to properly seat the tapered pin in the side frame. Retorque the hardware to 338 N·m (250 ft. lbs.).
7. Reinstall the hydraulic tubes, 2, and position to prevent contact with other components, fenders, etc. at 3.
8. Reinstall the plastic plug on the side of the cab inner shell.
9. Start the skid steer and cycle the boom several times to remove trapped air from the system and check the cylinder for leaks.



127

BUCKET CYLINDER

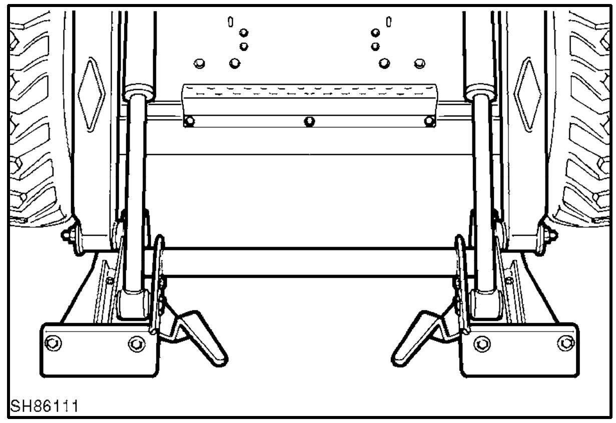
Op. 35 730 10

REMOVAL

CAUTION

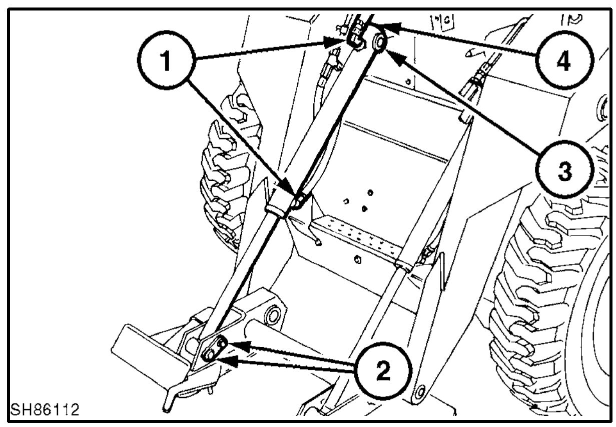
Never loosen any hydraulic lines without first relieving all pressure in the system.

1. Remove any attachment, bucket, etc. from the boom attaching plate and lower the boom to the lowered position.
2. Extend the cylinder to the fully extended position.
3. After stopping the engine and before removing the seat belt and dismounting from the skid steer, turn the ignition switch to the "RUN" position.
4. Push both the boom and bucket pedals to relieve all residual hydraulic pressure in both circuits.
5. Turn off the ignition switch.



128

6. Remove the hydraulic hoses from both ends of the cylinder, 1, and cap the lines to prevent loss of oil.
7. Remove the retaining bolt and pin, 2, from the lower end of the cylinder.
8. Loosen the upper tapered pivot pin retaining hardware, 3.
9. Support the cylinder and, with a hammer, strike the cylinder at the base area, 4, to loosen the tapered pivot pin.
10. Remove the cylinder.

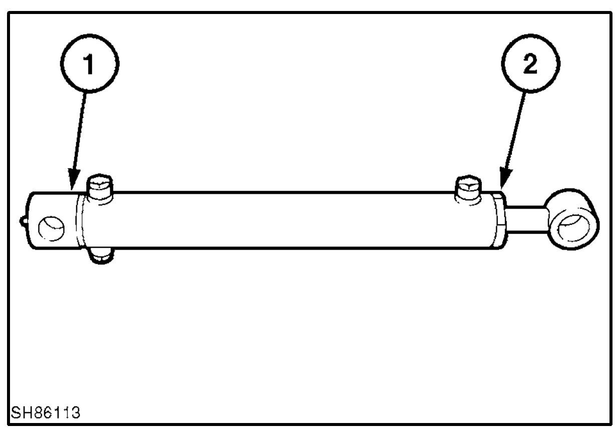


129

Op. 35 730 13

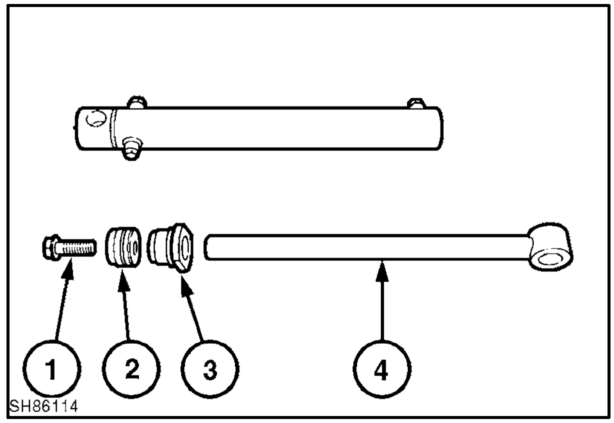
DISASSEMBLY

1. Clean the outside of the cylinder and clamp the cylinder base, 1, in a vise.
2. Use a spanner wrench to remove the cylinder gland, 2. The gland is threaded into the cylinder.
3. Pull the cylinder rod assembly from the barrel.



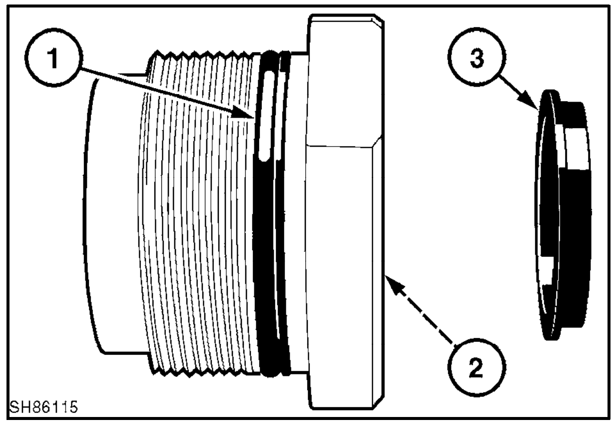
130

4. Remove piston retaining stud, 1, piston, 2, and gland, 3, from the piston rod, 4.



131

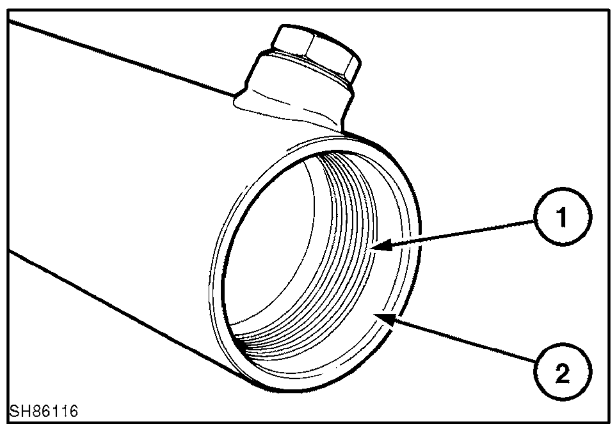
5. Remove seals from the gland; the outer O ring seal and backup ring, 1, the inner shaft seal, 2, and the wiper seal, 3.



132

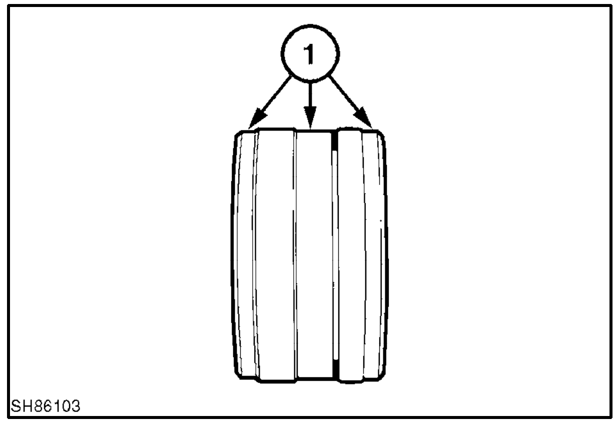
PARTS INSPECTION

1. Thoroughly clean all parts and remove all nicks and burrs with a fine emery cloth.
2. Inspect the inner diameter of the barrel for excessive wear or scoring.
3. Inspect the gland thread area, 1, for damaged threads that would prevent proper tightening of the gland.
4. Inspect the O ring seal area, 2, and remove burrs or nicks that would prevent the O ring from sealing properly.



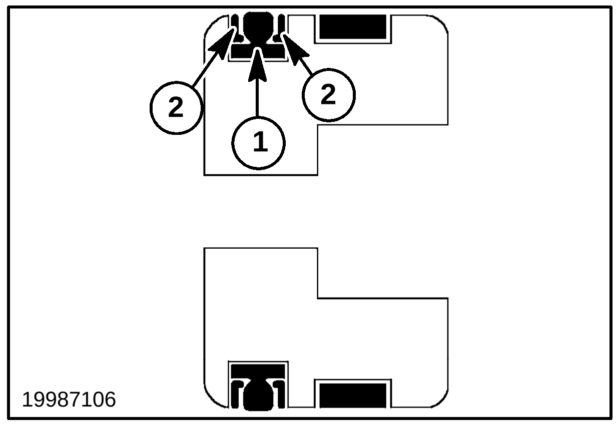
133

5. Inspect the outer diameter of the piston, 1, for excessive wear or scoring. If the piston is damaged, the inner surface of the barrel will also most likely be damaged. Inspect the barrel thoroughly. If the piston is not damaged, do not replace.



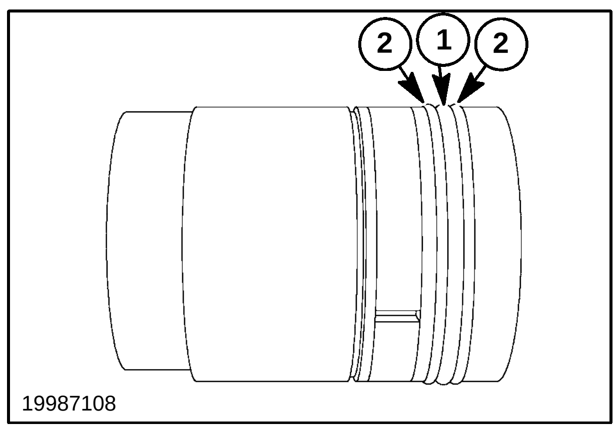
134

Make sure the new “T” seal, 1, and two backup seals, 2, are installed correctly.



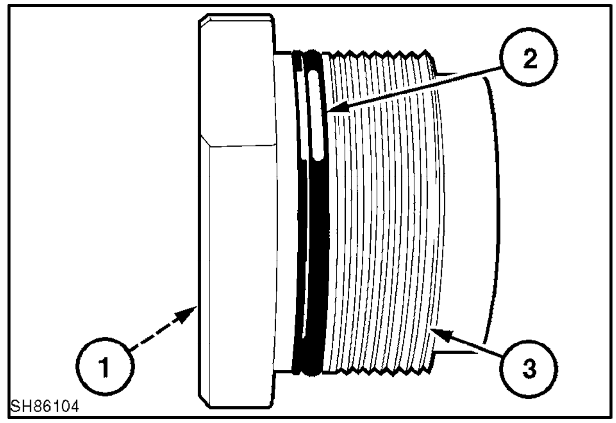
135

LS190 only - The pistons on LS190 bucket cylinders are a wider design, but also have the “T” seal, 1, and two backup seals, 2.



136

6. Inspect the cylinder head (gland) inner and outer seal areas, 1 and 2, for sharp edges and scoring. Inspect the threaded area of the gland, 3, for damaged threads that would prevent proper tightening of the retaining nut. Replace the gland if necessary. All seals should be replaced during reassembly.

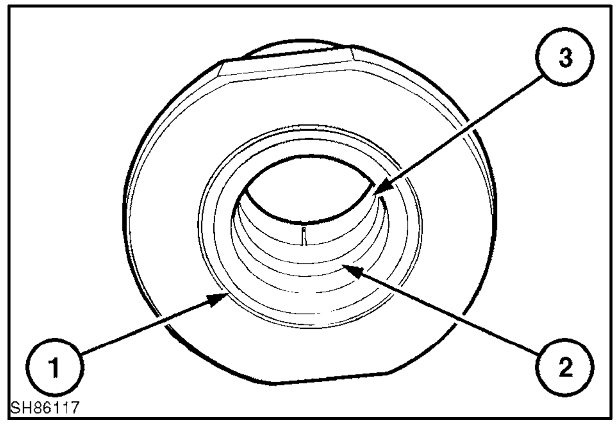


137

REASSEMBLY

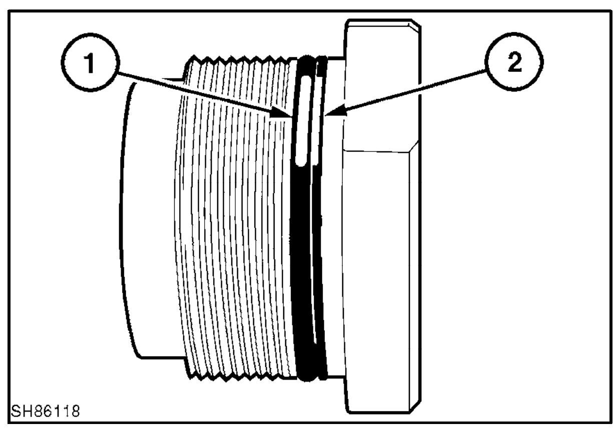
1. Clean and dry all parts. The metal parts should be lightly oiled prior to assembly.
2. Install a new shaft seal, 2.
3. Install a wiper seal, 1, and wear ring, 3.

NOTE: *Install shaft seal, 2, with the lip of the seal facing the piston.*



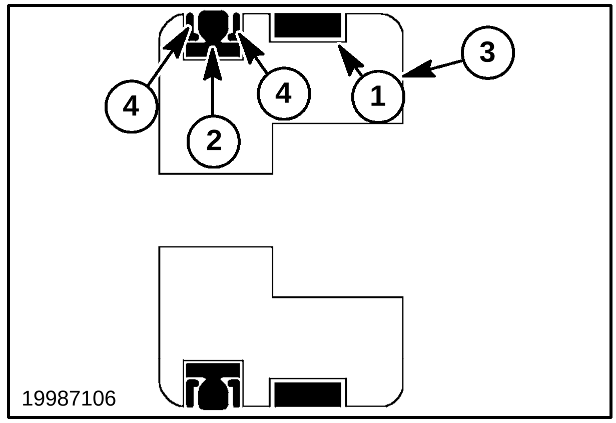
138

4. Install O ring, 1, and backup washer, 2, on the cylinder gland.



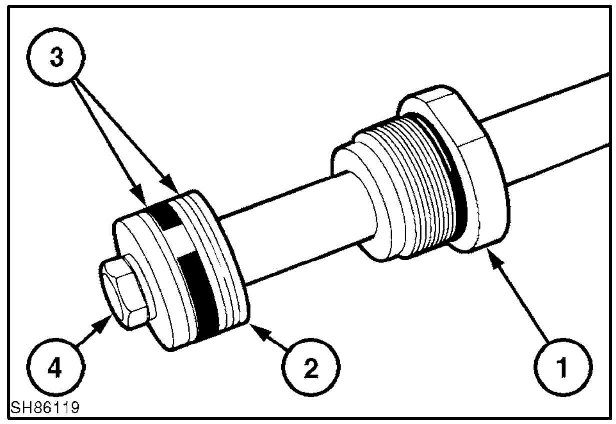
139

5. Examine the piston assembly prior to installation. The wear ring, 1, and T-seal, 2, should be firmly in their groove and snug against the piston, 3. Insert the L shaped back-up rings, 4, on both sides of the T-seal with the short leg of the L shaped back-up rings towards the T-seal as shown.



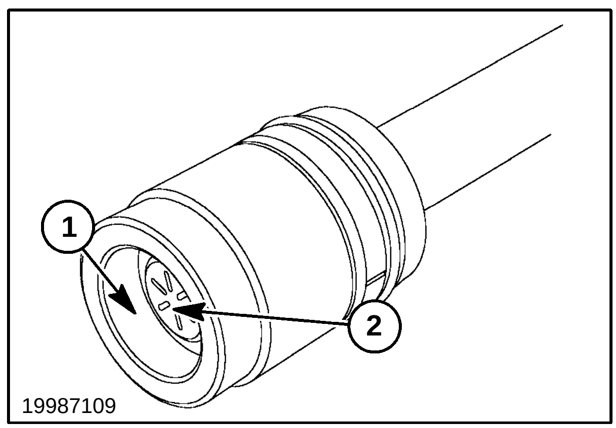
140

6. Slide cylinder gland, 1, and piston, 2, with seals installed, 3, onto the piston rod.
7. Use a hydraulic sealant to seal the piston and rod. Install piston retaining stud, 4, with medium-strength 242 Loctite® and torque to 386 N·m (285 ft. lbs.).



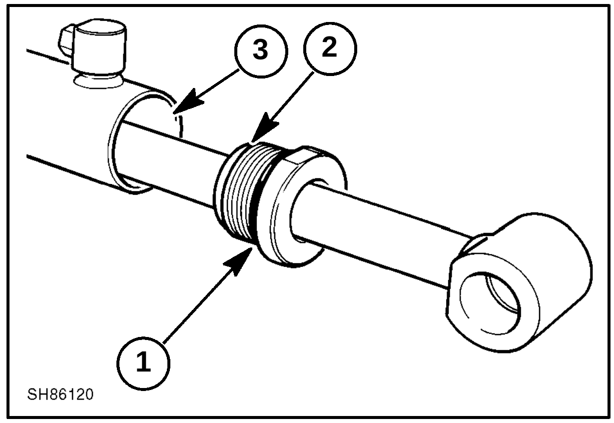
141

NOTE: *On LS190 pistons, the flat side of the piston must face the piston rod, and the recessed side, 1, must be toward the end of the piston, with the locknut, 2, in the recessed area of the piston.*



142

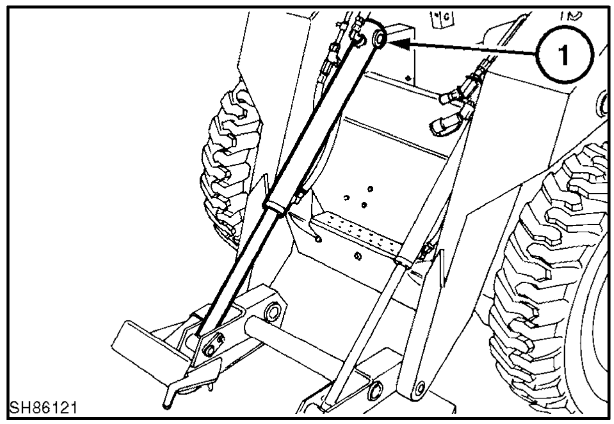
8. Liberally oil the piston and place it inside the barrel, being careful not to damage the seals.
9. Apply a coat of grease around the gland at 1.
10. Thread the cylinder gland, 2, into the barrel, 3, and torque to 285 N·m (210 ft. lbs.).



143

REINSTALLATION

1. Lubricate the pivot pins with an antiseize-type lubricant.
2. Install the cylinder on the skid steer.
3. Torque the upper pivot pin hardware to 108 N·m (80 ft. lbs.).
4. With a hammer and using a piece of 2 x 4 hardwood to protect the pin, hit the pivot pin and retaining hardware at 1, to properly seat the tapered pin and retorque to 108 N·m (80 ft. lbs.).
5. Torque the lower pivot pin hardware to 38 N·m (28 ft. lbs.).
6. Cycle the boom several times to remove the air from the system and check the cylinder for leaks.
7. Check the hydraulic oil level and add 10W-30 oil as required.



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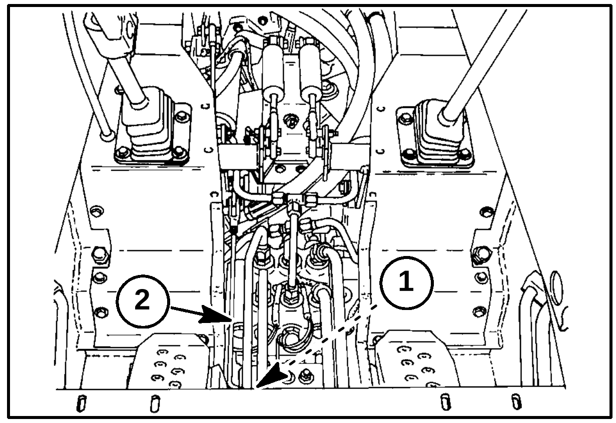
PEDAL CONTROLS

Op. 35 724 16

REMOVAL

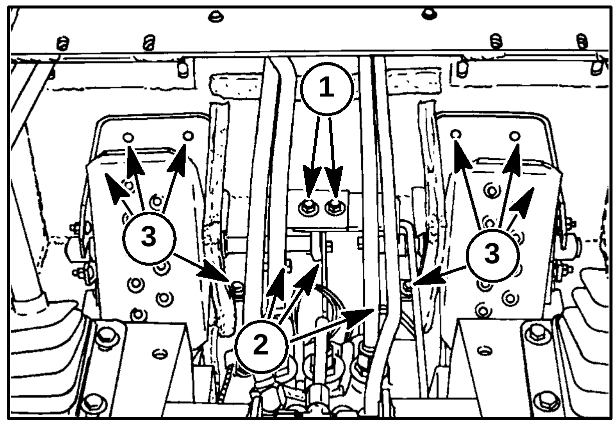
With Boom and Bucket Pedal Controls

1. Remove the step shield hardware and step shield.
2. Remove the clip washer, 1, that connects the control rod, 2, to the pedal hub arm.



145

3. Remove the bolts, 1, connecting the two bracket halves.
4. Disconnect the control valve links, 2, at the control valve.
5. Remove the pedal mounting bolts, 3, and remove both pedals from the loader.

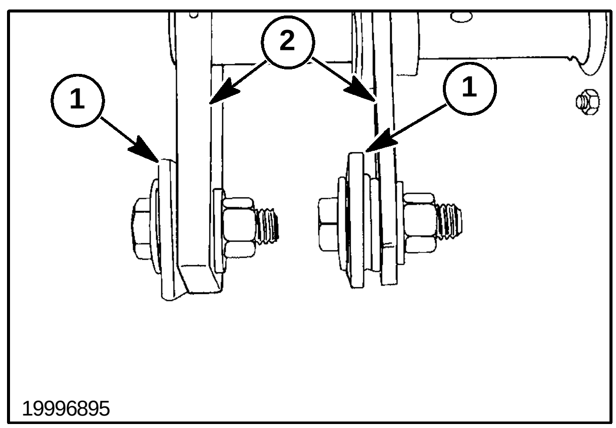


146

PEDAL INSPECTION

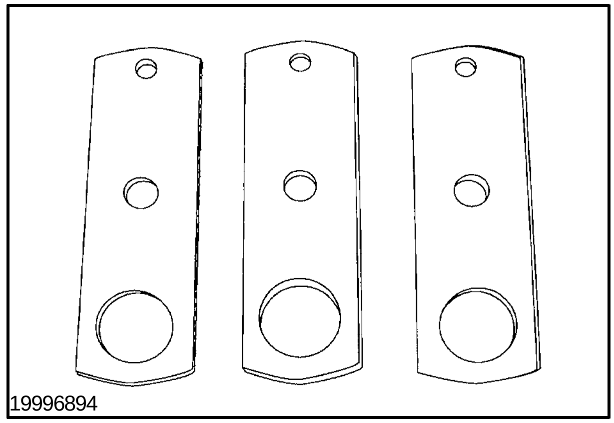
With Boom and Bucket Pedal Controls

1. Remove the control valve links, 1, from the hub control arms, 2.



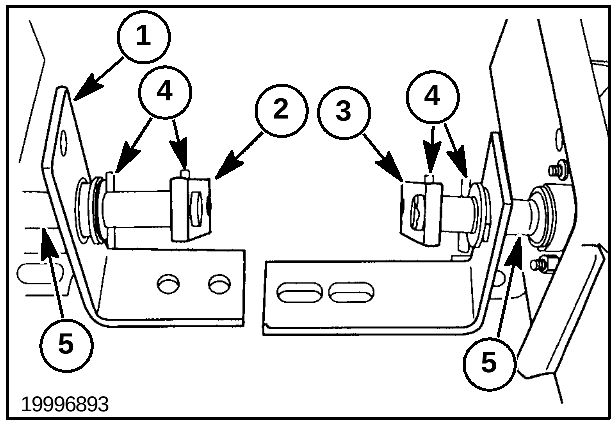
147

2. Inspect the control valve links for any obvious damage, bends or twisting.



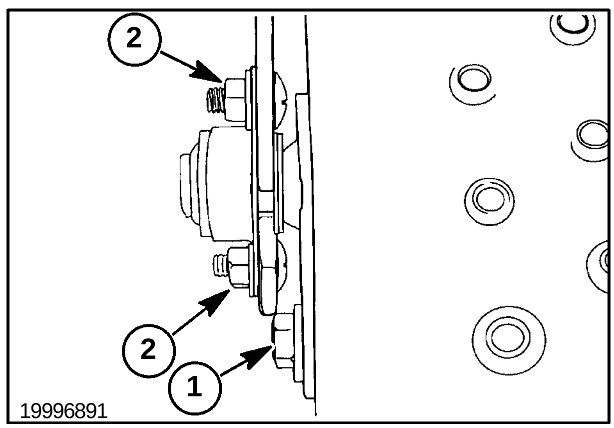
148

3. Inspect the auxiliary hydraulic hub arm, 1, the boom hub arm, 2, and the bucket hub arm, 3, for any deformation or cracks.
4. To disassemble hub arms, remove the roll pins, 4, from the hub arms and control shaft.
5. Inspect the control shafts, 5, for any obvious damage or bends.



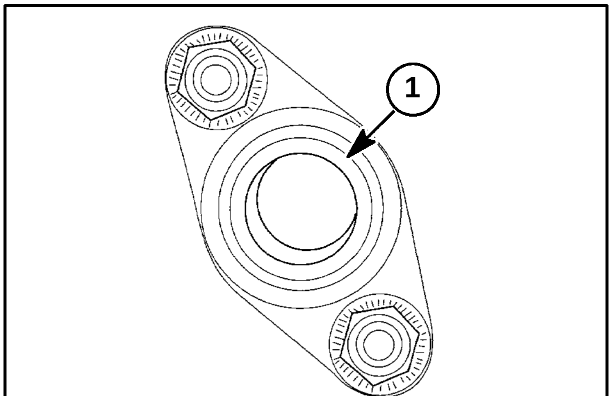
149

6. To remove control shafts, remove bolt, 1, securing shaft arm to pedal. Take note of the position and number of any spacer washers or shims. Remove the nuts, 2, holding the bearings on the pedal support. Separate the shaft from the pedal and bearing.



150

7. Inspect the shaft bearings, 1, for excessive wear. If bearings do not move easily, replace.



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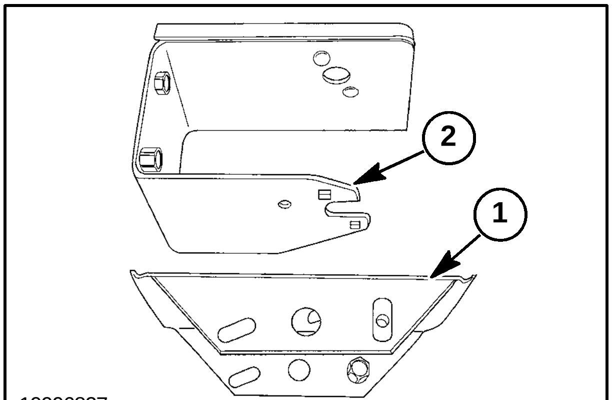
151

8. Inspect the pedals, 1, and pedal supports, 2, for any excessive wear or deformation.



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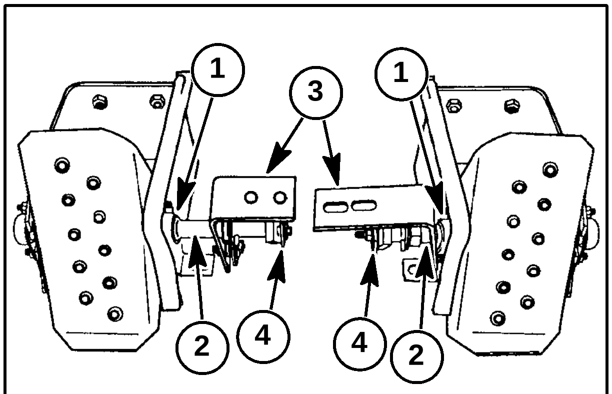
PEDAL REINSTALLATION

With Boom and Bucket Pedal Controls

1. Reinstall the bearings, 1, shafts, 2, brackets, 3, and control arms, 4, using the same number and position of washers or shims.



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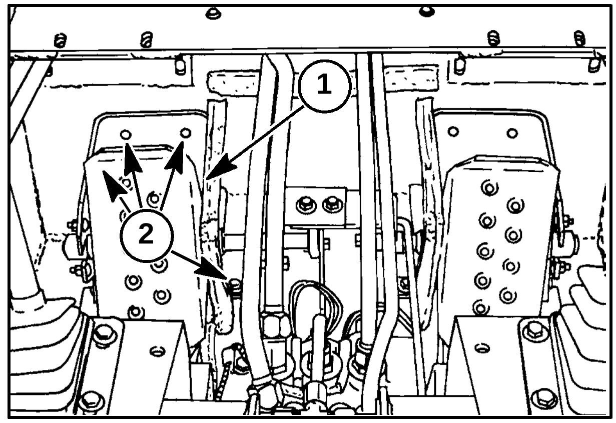
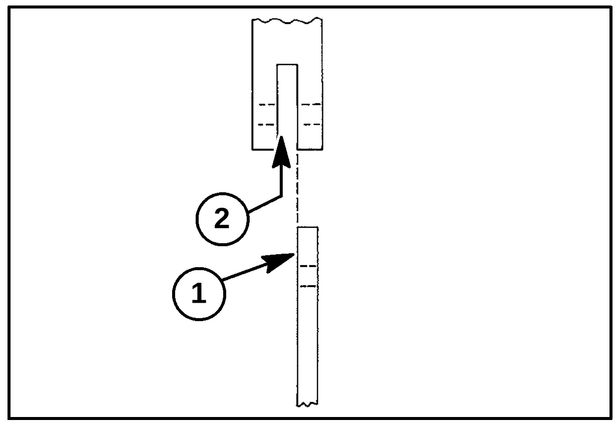
153

2. Install the left pedal assembly, 1, and attach the front plate with hardware, 2, previously removed. Do not tighten the hardware at this time.



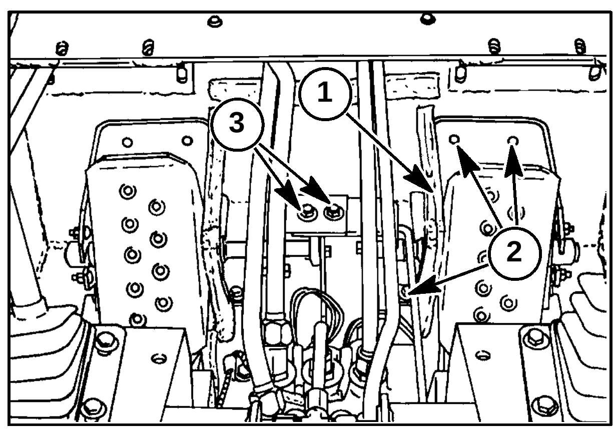
154

3. Slide the pedal assembly to align the auxiliary boom hydraulic hub arm and boom hub arm as shown. Align the inside edge of each hub arm, 1, with the slot in the control valve spool, 2. Tighten the pedal mounting hardware.
4. Recheck the alignment of the hub arm and spool.



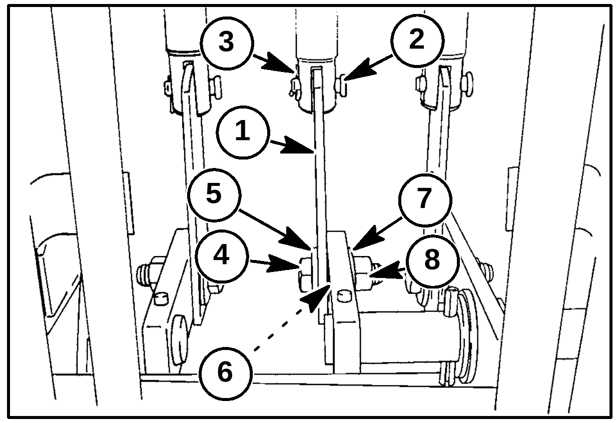
155

5. Install the right pedal, 1, adding shim washers as necessary so pedal mounting holes line up correctly. Check that the inside edge of the bucket hub arm aligns with the slot in the control valve spool as described above. Install the pedal with hardware, 2, previously removed, and tighten securely. Connect the two-piece bracket with the two bolts, 3, washers and nuts.
6. Check for free operation of the foot pedals and hub control arm assemblies. If any components are binding, adjust or reshim the pedal assemblies.



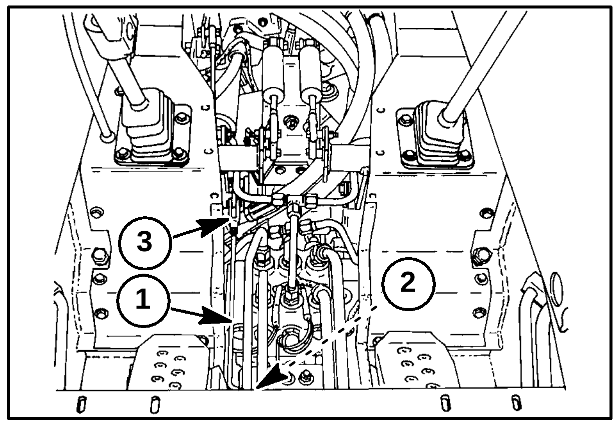
156

7. Install the control spool links, 1, with clevis pins, 2, and cotter pins, 3.
8. Attach each link to each hub arm with 3/8″ hex head bolts, 4, flat washer, 5, two link washers, 6, lock washer, 7, and nut, 8.



157

9. Connect the auxiliary hydraulic control rod, 1, to the pedal hub arm, 2, with the clip washer removed during disassembly.
10. Install the step shield and hardware.



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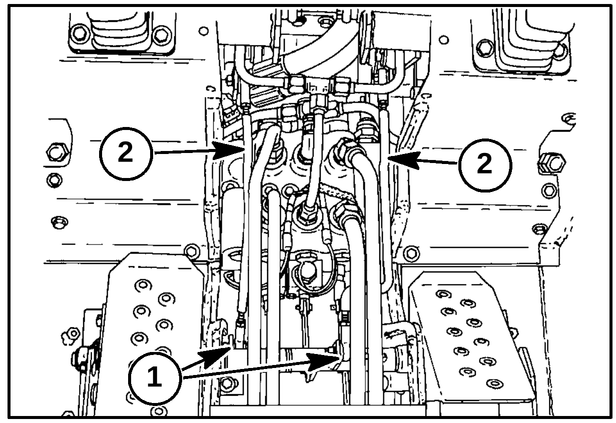
Op. 35 724 16

PEDAL REMOVAL

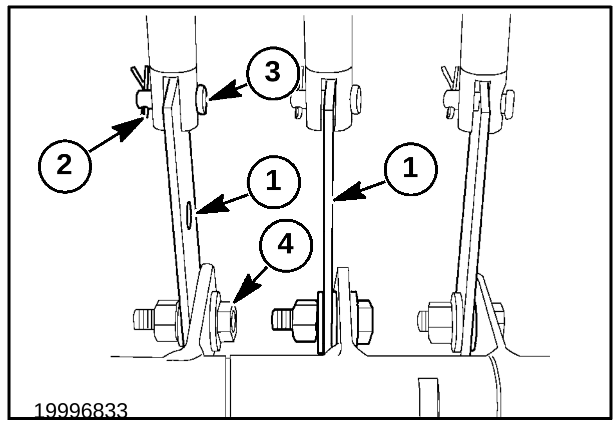
With Boom and Bucket Hand Controls

1. Remove the step shield hardware and step shield.
2. Remove the bolts, 1, washers, lock washers and nuts, that connect the control rods, 2, to the pedal hub arms.



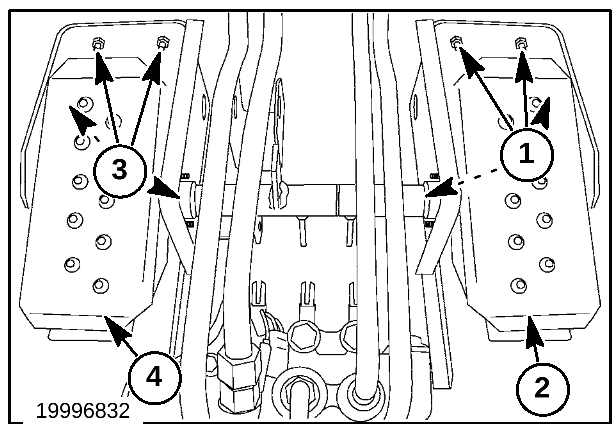
159

3. Disconnect the control valve links, 1, from the control valve spools by removing the cotter pins, 2, and clevis pins, 3.
4. Disconnect the control valve links, 1, from the control hub arms by removing the bolts, 4, washers, lockwashers, and nuts.



160

5. Remove the right pedal mounting bolts, 1, and remove the right pedal, 2.
6. Remove the left pedal mounting bolts, 3, and remove the left pedal, 4.



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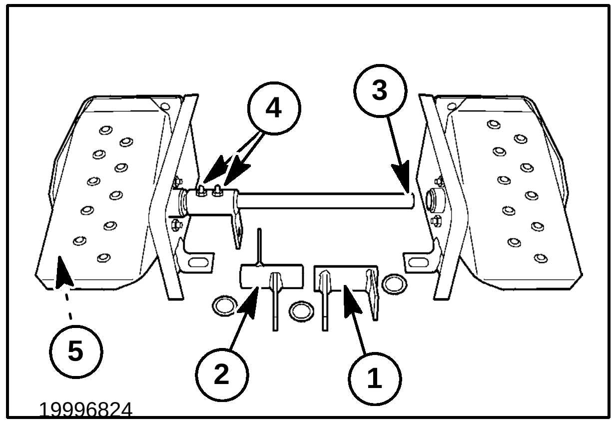
PEDAL INSPECTION

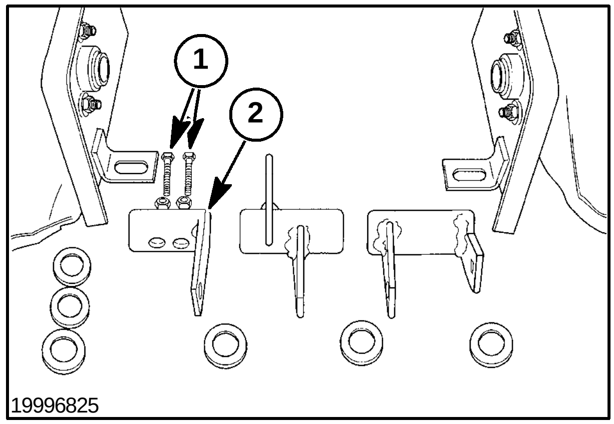
With Boom and Bucket Hand Controls

1. Remove the bucket hub arm assembly, 1, and the boom hub arm assembly, 2. Inspect the hub arm assemblies for any deformation or cracks.
2. Inspect the control shaft, 3, for any obvious damage or bends. To remove control shafts, remove the two allen screws, 4, securing the auxiliary hydraulic hub, 2, to the control shaft. Then remove the bolt, 5, securing shaft arm to pedal. Take note of the position and number of any spacer washers or shims.



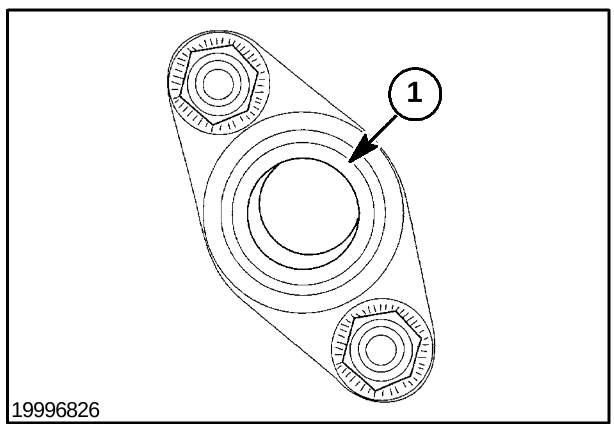
162

3. Remove the two allen screws, 1, securing the boom hydraulics hub, 2, to the control shaft. Inspect the boom hydraulics hub for any deformation or cracks.



163

4. Inspect the shaft bearings, 1, for excessive wear. If bearings do not move freely, replace.



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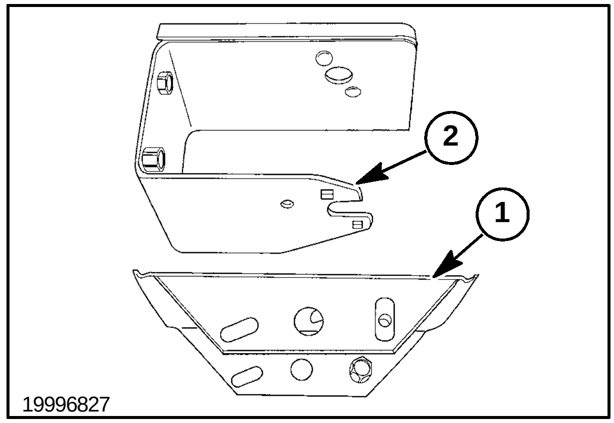
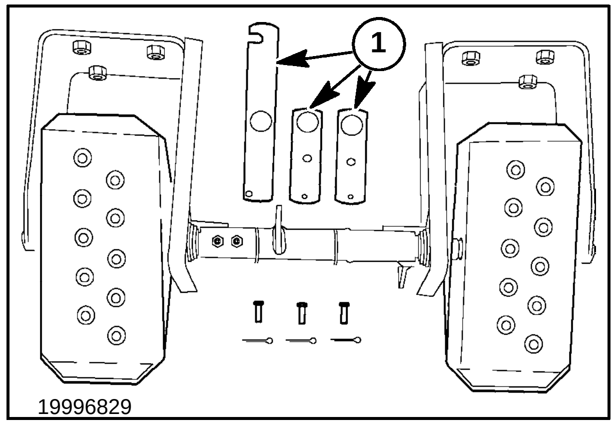
5. Inspect the pedals, 1, and pedal supports, 2, for any excessive wear or deformation.



165

6. Inspect the control valve spool links, 1, for bends or excessive wear.



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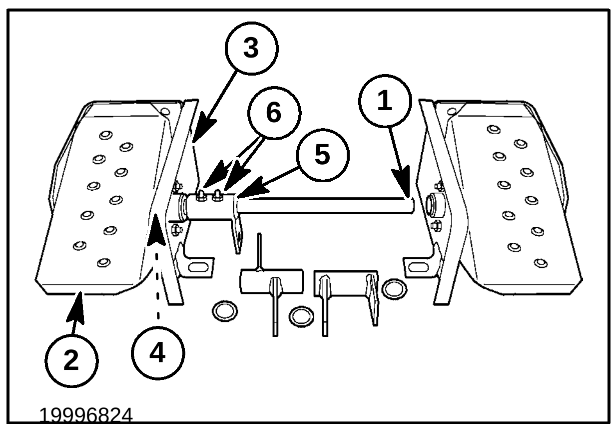
PEDAL REINSTALLATION

With Boom and Bucket Hand Controls

1. Insert the control shaft, 1, through the left pedal, 2, and left pedal support, 3, fitting three washers, 4, between the pedal and support.
2. Slide the auxiliary boom hydraulic hub assembly, 5, onto the control shaft and secure with allen screws, 6.



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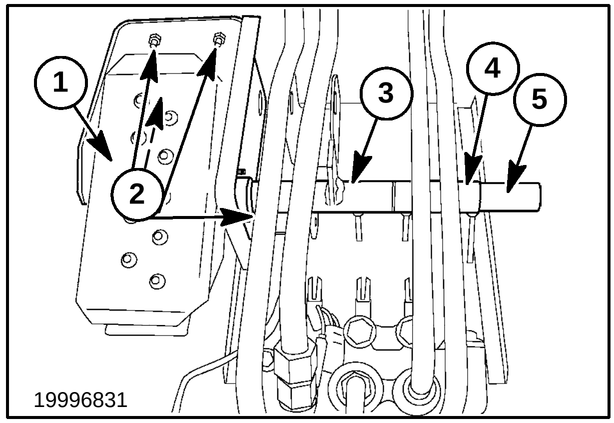
3. Install the left pedal assembly, 1, and attach the front plate with hardware, 2, previously removed. Do not tighten the hardware at this time.
4. Install the boom hub assembly, 3, and bucket hub assembly, 4, onto the pivot shaft, 5.



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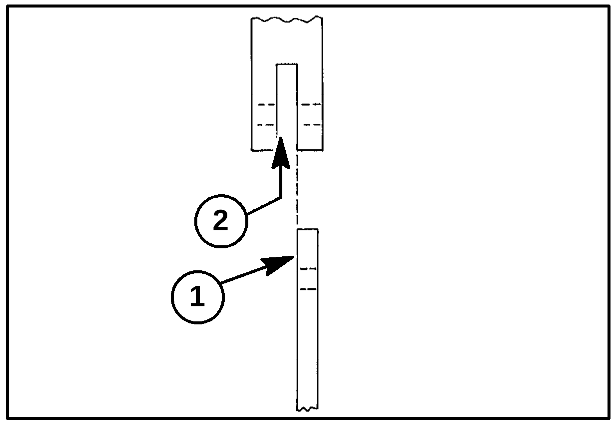
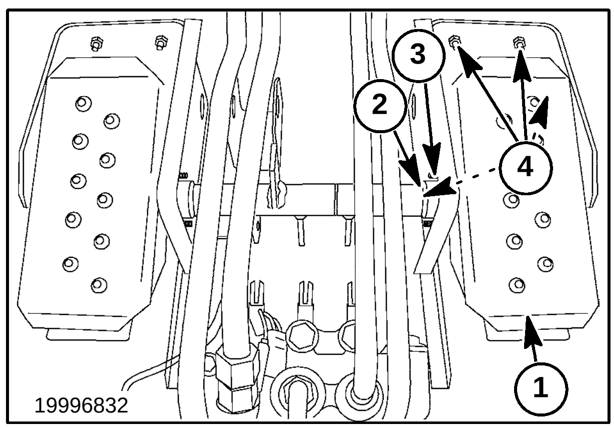
5. Slide the pedal assembly to align the auxiliary hydraulic hub arm as shown. Align the inside edge of the hydraulic hub arm, 1, with the slot in the control valve spool, 2. Tighten the pedal mounting hardware.
6. Recheck the alignment of the hub arm and spool.
7. Check the alignment between the hub arms and control valve spools. Add shim washers if necessary to correct alignment.



169

8. Install the right pedal, 1, adding shim washers as necessary at 2, fitting inside the bearing, 3, so pedal mounting holes line up correctly. Install the pedal with hardware, 4, previously removed, and tighten securely.
9. Check for free operation of the foot pedals and hub assemblies. If any components are binding, adjust or reshim the right pedal assembly.



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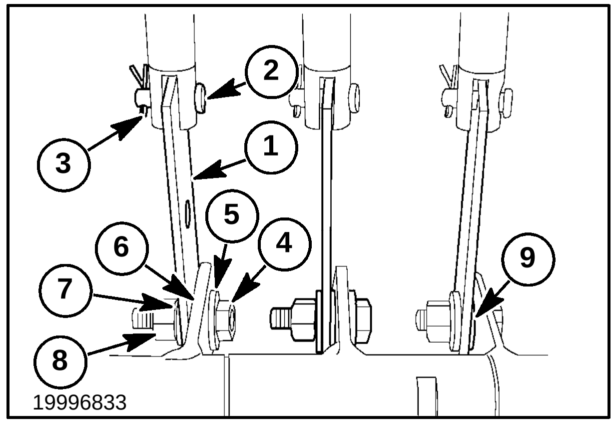
10. Install the control spool links, 1, with clevis pins, 2, and cotter pins, 3.
11. Link the boom valve link and the bucket valve link to the hub arms with 3/8″ hex head bolts, 4, flat washer, 5, thick link washer, 6, lock washer, 7, and nut, 8.
12. Install the auxiliary hydraulic link with 3/8″ hex head bolts, flat washer, two flat washers, 9, lock washer, and nut.



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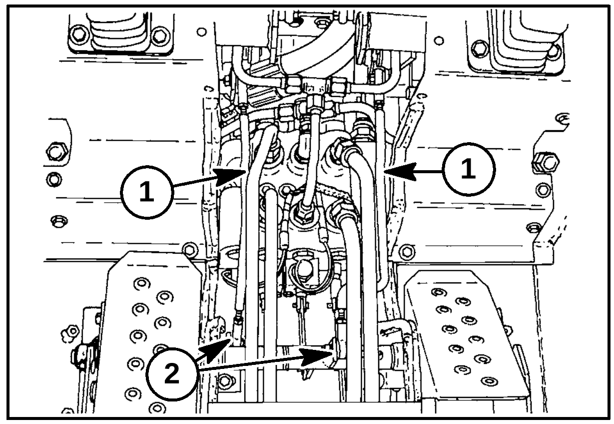
13. Install control rods, 1, to the pedal hub arms, 2, with the bolts, washers, lock washers and nuts removed during pedal removal.
14. Install the step shield and step shield hardware.



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HYDRAULIC COOLING, FILTER, RESERVOIR SYSTEM

Specifications

Filter (spin-on canister) . . . . 10 micron (NH #9842392)

Reservoir (filter screen at fill cap) capacity . . . . 22.7 L (6 gal.)

Labor Required

Remove and replace oil filter . . . . 0.5 hour

Remove and replace filter and base . . . . 1.0 hour

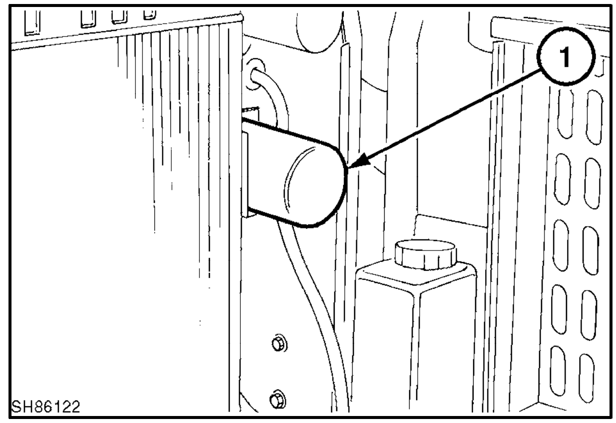
Remove and replace oil cooler . . . . 3.0 hours

Remove and replace reservoir . . . . 2.5 hours

Op. 35 705

FILTER SYSTEM

The skid steer is equipped with a single spin-on filter canister type located at 1, to the right of the engine radiator. The filter is a 10-micron element.



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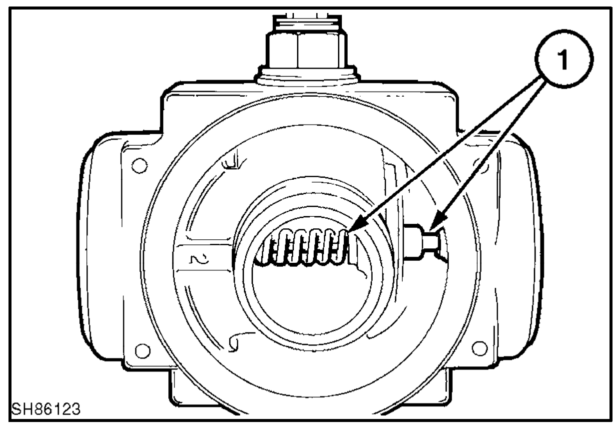
NOTE: *Allow the hydraulic oil to cool before changing the filter.*

CAUTION

The hydraulic oil filter will be under pressure when the oil is at operating temperature.

The filter base is equipped with a bypass valve, 1, to allow cold oil to bypass the filter without damaging the filter or starving the hydrostatic system of lubrication oil during cold weather start-ups.



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In cold weather start-ups, allow the hydraulic oil to warm up before operating the boom, bucket, or the hydrostatic ground drive system, to prevent possible damage to the systems.

The filter base is also equipped with a pressure sensor that is monitored by the EIC (Electronic Instrument Cluster) to signal the operator of a plugged oil filter.

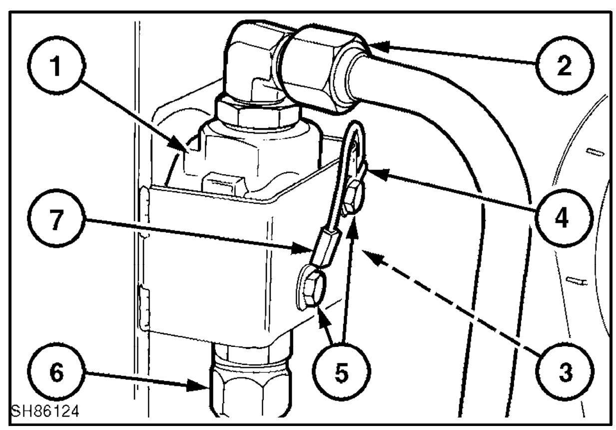
Op. 35 705 04

FILTER REMOVAL

Op. 35 705 05

BASE REMOVAL

The filter base can be removed by opening the rear door and removing the right engine side panel.



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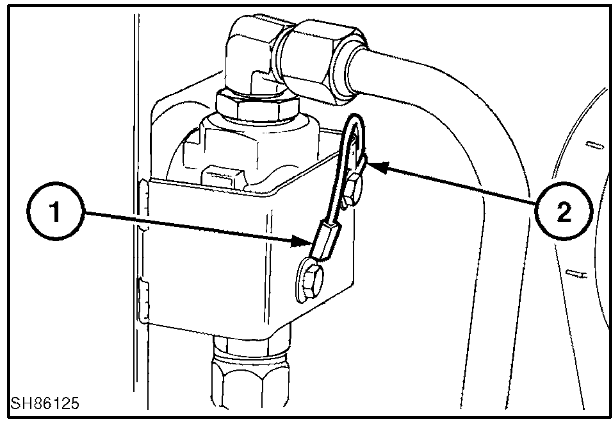
1. Remove the sensor wires, 3.
2. Remove the inlet, 2, and outlet, 6, oil lines and cap to prevent loss of oil.
3. Remove the two cap screws, 5; ground wire, 7; and wire clamp, 4.
4. Remove the filter assembly, 1, from the unit.

REASSEMBLY

1. Reinstall the filter base with the hardware previously removed and reconnect the ground wire, 1. Torque the mounting hardware to 20 N·m (15 ft. lbs.).
2. Reinstall the hydraulic lines, tighten the lines to seat line on fittings; loosen and retorque.
3. Reinstall the filter sensor and connect the sensor wires, 2.
4. Reinstall a new filter, coat the filter seal ring with 10W-30 oil, and tighten the filter unit until it contacts the base, and then tighten another half to three-quarter turn.



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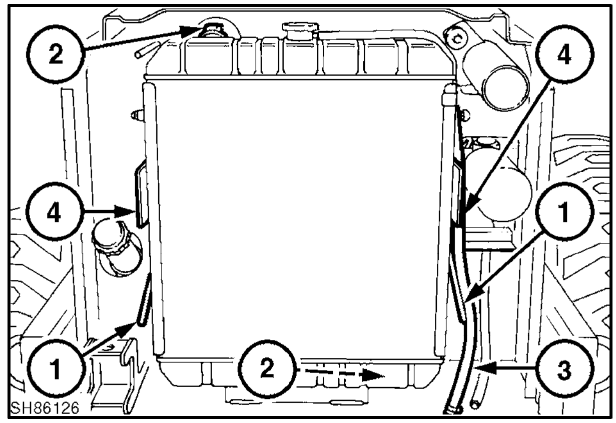
OIL COOLER

Op. 35 300 10

REMOVAL

The hydraulic oil cooler is located between the radiator and the engine cooling fan. To access the oil cooler, the radiator will have to be removed.



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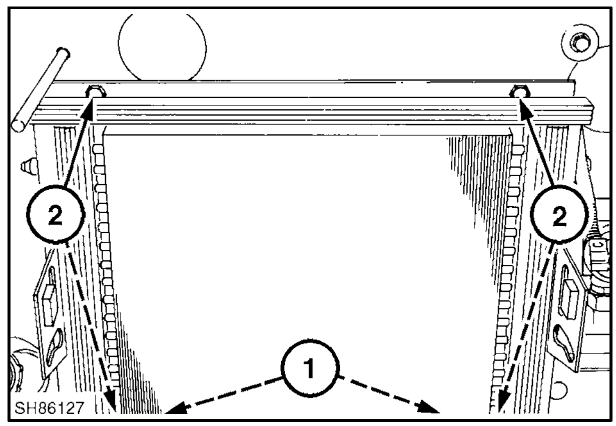
1. Drain the engine cooling system.
2. Lift up on the release handles, 1, and move the radiator rearward.
3. Disconnect the upper and lower radiator hoses, 2.
4. Remove the coolant overflow hose to the overflow tank, 3.
5. Remove the two cap screws and spacers, 4. Remove the radiator.



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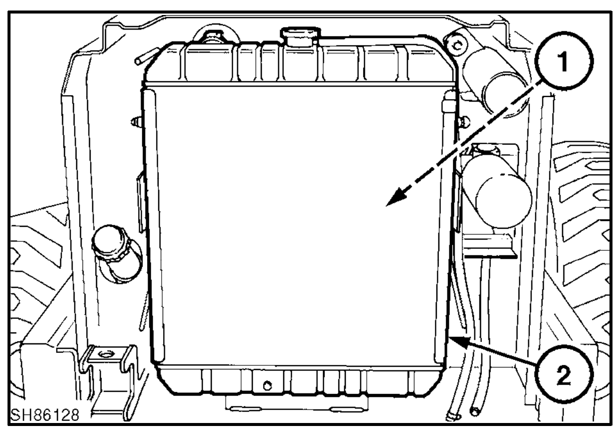
6. Disconnect the oil cooler inlet and outlet lines, 1, at the bottom of the cooler. Cap to prevent loss of oil and contamination.
7. Remove the four nuts holding the fan shroud and move it forward.
8. Remove four cap screws, 2, and remove the oil cooler from the support frame.

REASSEMBLY



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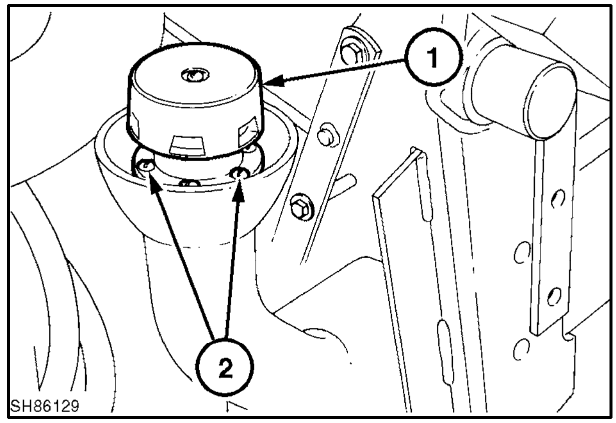
1. Reattach the oil cooler, 1, to the support bracket with the previously removed hardware.
2. Reattach the fan shroud.
3. Reconnect the hydraulic lines to the oil cooler. Tighten the lines to seat the fittings, then loosen and retighten the connections.
4. Remount the radiator, 2, reinstalling the two spacers and cap screws.
5. Reconnect the radiator hoses and fill the cooling system with a 50/50 water-antifreeze mixture with corrosion inhibitor.
6. Check the hydraulic oil level and fill with 10W-30 oil as necessary.
7. Start the unit, operate the hydraulic system, and check for oil and coolant leaks. Repair as required.
8. Recheck hydraulic oil and coolant levels and add as required.

Op. 35 300

OIL RESERVOIR

The hydraulic oil reservoir fill is accessed through the top engine shield. The fill cap assembly is the hydraulic system breather and is equipped with a screen to help prevent contamination into the system.

To clean the breather cap, 1, remove the cap from the reservoir and back flush the cap assembly with a clean solvent. Blow dry with low-pressure air.



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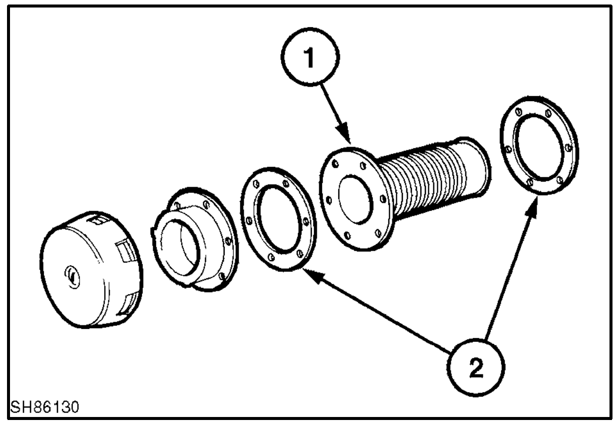
Filter/Breather Cap Cleaning

To clean the fill screen, remove the six screws and washers, 2, and lift the screen assembly from the reservoir neck. Carefully clean the filler neck area before removing the screen.

Back flush the screen, 1, with a clean solvent and blow dry with low-pressure air.

Reinstall the screen assembly making sure the screen is sealed between the screen and reservoir neck with gaskets, 2. Use of a silicone sealer with gaskets to seal between the screen and reservoir is recommended.



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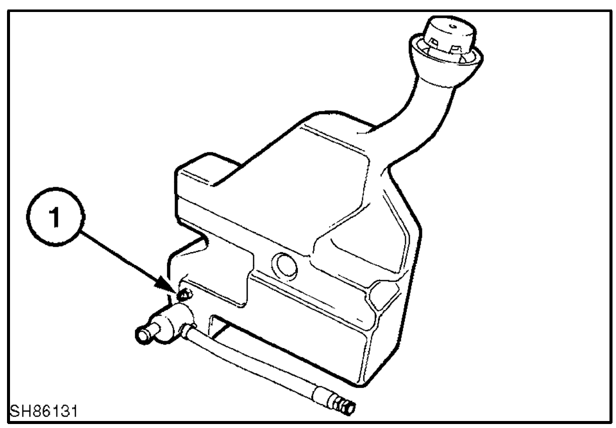
The hydraulic reservoir is equipped with a temperature sender, 1, which allows the EIC (Electronic Instrument Cluster) to monitor the hydraulic oil temperature and signal the operator of an oil overheat condition.

IMPORTANT: *Do not over tighten the sender or damage to the reservoir may occur.*



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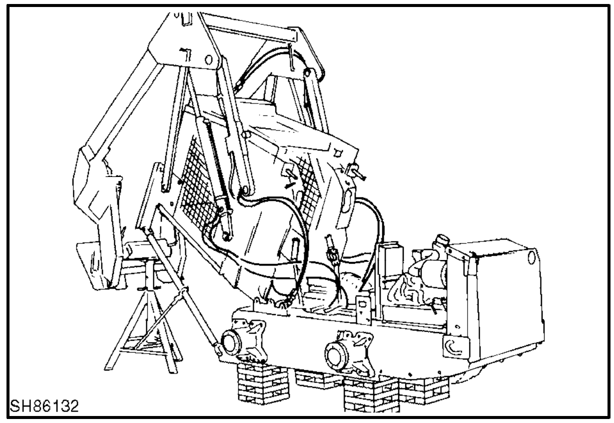
Op. 35 300 10

OIL RESERVOIR REMOVAL

To access the reservoir, open the rear door and remove the right engine side shield.

To remove the reservoir from the skid steer, the cab and boom must be tilted forward. Refer to Section 1 for cab tilting procedures.



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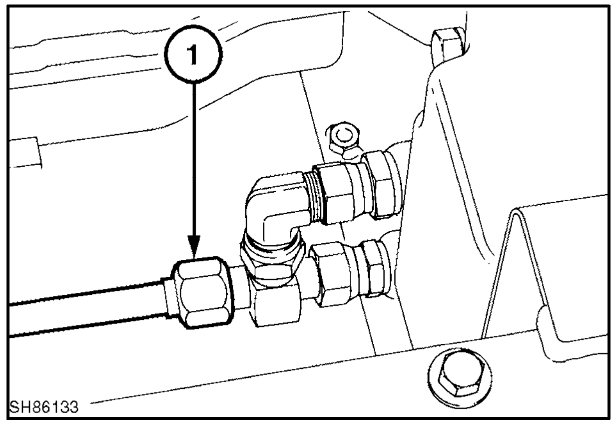
With the cab tilted forward:

1. Remove the rear engine belly pan.
2. Drain the reservoir by removing hydraulic line, 1, and allowing the oil to drain into a suitable container.



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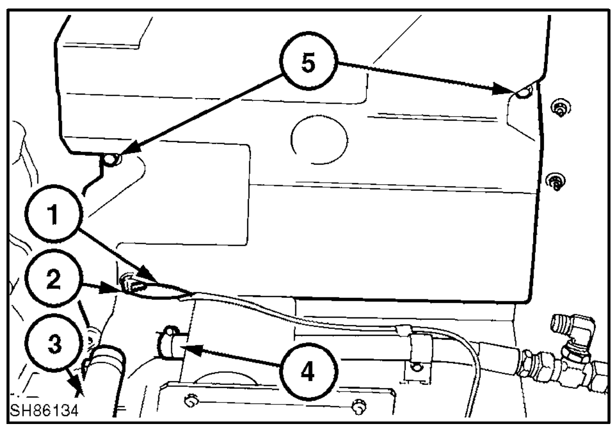
3. Remove the hydraulic oil temperature sender wires, 1 and 2.
4. Disconnect the suction and return lines, 3 and 4, from the oil tank.
5. Remove front and rear mounting hardware, 5.
6. Lift the oil reservoir from the skid steer.

NOTE: *If the reservoir should leak due to a hole or crack, DO NOT repair. Replace the reservoir.*



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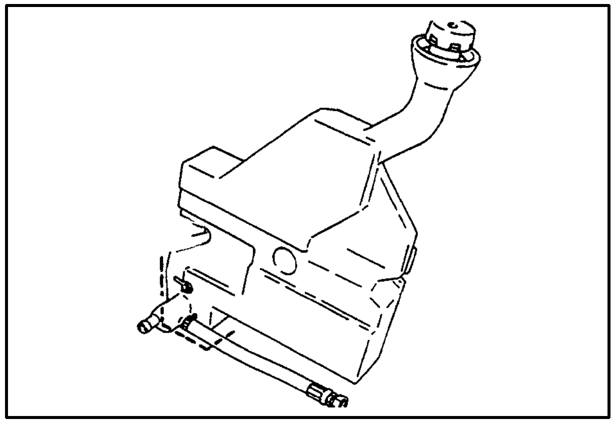
INSPECTION
Check the reservoir for cracks and leaks. Check for signs of interference or wear from the transmission control arm.



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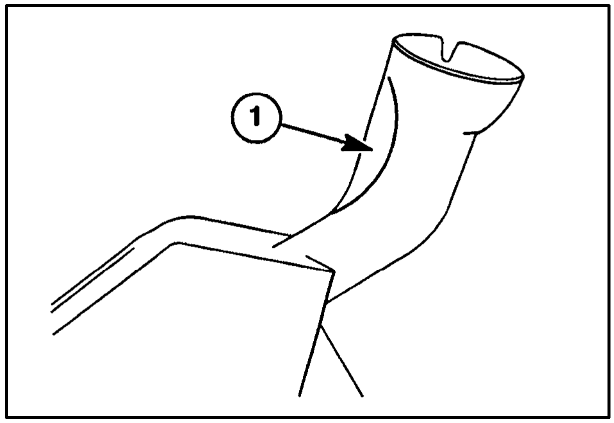
NOTE: *The reservoirs have a vent area molded into the fill neck, 1, to allow air to escape around the plastic strainer when filling the tank. This improves the rate that oil can be added to the reservoir.*

IMPORTANT: *Do not remove or modify the plastic strainer, as any material that gets past the strainer can go directly to the gear pump, control valve, cylinders, and auxiliary hydraulic attachments and cause major damage to these components.*



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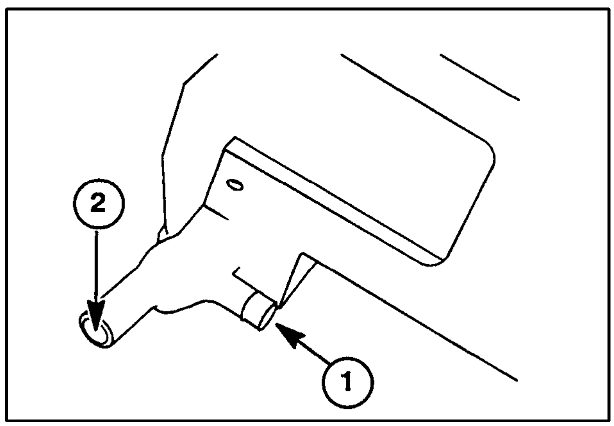
Inspect the return line port, 1, and suction line port, 2, for cracks and debris buildup.



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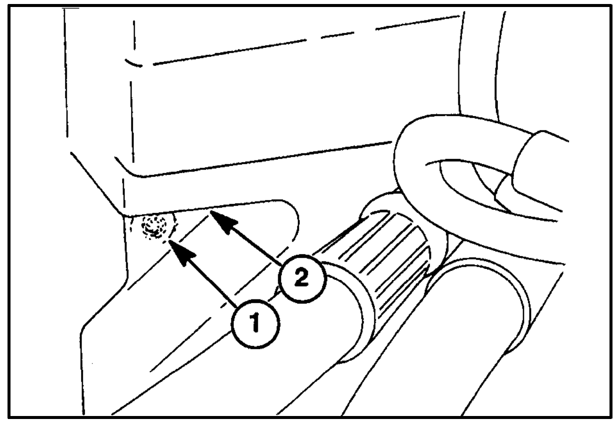
REINSTALLATION

1. To increase the reservoir clearance from the control arm, install a #80424 socket-head setscrew, 3/8″ x 5/8″, as a plug in hole, 1, in the chaincase. Apply pipe thread sealer or Loctite to the plug threads to keep chaincase oil from leaking out and to hold the plug in place.
2. Loosely reinstall the previously removed hardware with thread sealer applied into tank slot, 2, and thread into the chaincase.
3. Install the previously removed rear hardware loosely in the tank slot/chain mount, 1. Make sure the tank is positioned flat against the chaincase wall. Tighten front hardware bolt assembly and rear hardware bolt assembly securely to hold the tank in place.



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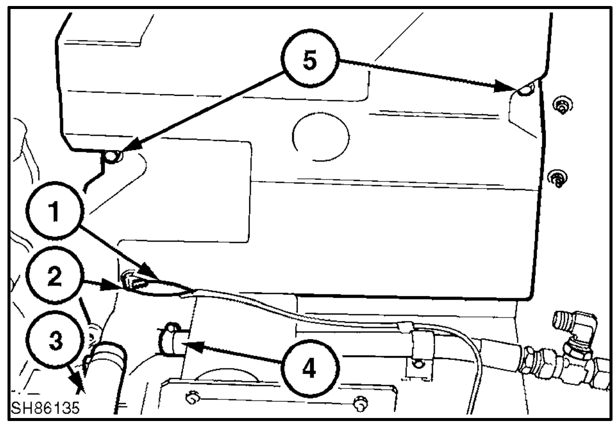
4. Install the two oil temperature sender wires, 1 and 2.
5. Connect the suction and return lines, 3 and 4, and tighten the hose clamps securely. Check the mounting hardware, 5, is tight.
6. Reconnect the hydraulic line disconnected for draining.



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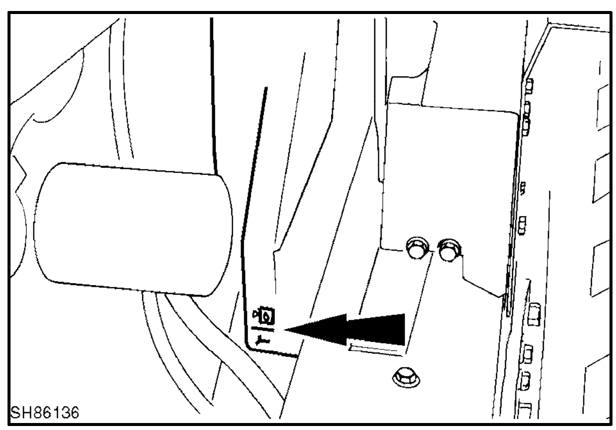
7. Fill the tank with SAE 10W-30 oil and operate the system to remove all air from the system. Check for leaks. Repair as required.
8. Install the rear engine belly pan.
9. Tilt the cab and boom back to operating position.
10. Reinstall all shields previously removed.



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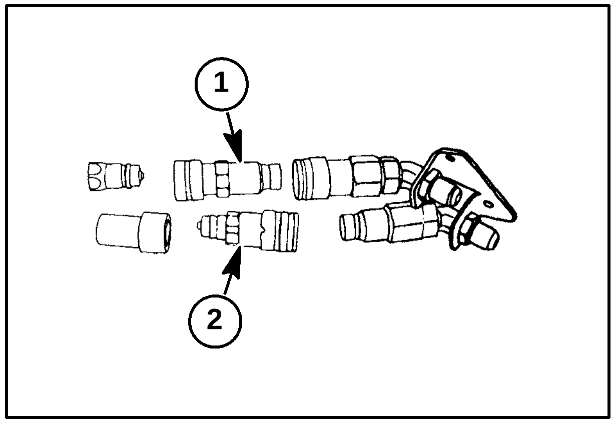
ADAPTING ATTACHMENTS WITH PREVIOUS-STYLE NH-SUPPLIED BALL/PIN COUPLERS TO FLAT-FACED COUPLERS

If the attachment to be used has the 1/2″ ball/pin-type couplers, adaptors, 1 and 2, can be used to attach to the loader flat-faced couplers.

Part Number	Description	Item #
86539404	1/2″ male flat-faced/ 1/2″ female ball/pin-type	1
86539403	1/2″ female flat-faced/ 1/2″ male ball/pin-type	2



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NOTE: *These adaptors are useful for occasionally adapting attachments; however, they significantly lengthen the coupler assembly and make assembly more likely to be damaged in usage. It is preferred for heavy attachment usage to convert the attachment quick couplers or loader quick couplers to the flat-faced style.*

LABOR GUIDE

HYDRAULIC SYSTEM

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job	Hours
Remove and replace control valve	1.5
Repair control valve	1.0
Remove and replace gear pump	1.5
Repair gear pump	0.5
Remove and replace one boom cylinder	0.5
Repair one boom cylinder	0.5
Remove and replace one bucket cylinder	0.5
Repair one bucket cylinder	0.5
Remove and replace oil filter	0.5
Remove and replace filter and base	1.0
Remove and replace oil cooler	3.0
Remove and replace hydraulic reservoir	2.5
Remove and replace auxiliary boom hydraulic hoses – boom	1.0
Remove and replace auxiliary boom hydraulics tubes – boom	0.5
Remove and replace auxiliary boom hydraulic tubes – control valve (includes tilting cab/boom forward)	2.0
Remove and replace auxiliary boom hydraulic quick couplers (1)	0.25

SECTION 37 – TOWING HOOKS AND BALLASTING

Chapter 1 – Rear Counter Weights

CONTENTS

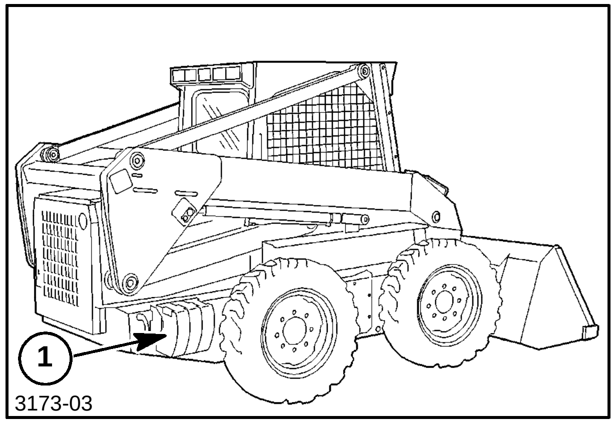
Op. 37 140 10

REAR COUNTERWEIGHTS

Counterweights can be installed to improve the stability of the loader when handling heavy loads or when operating the skid steer with a heavy front mounted attachment.

Six 27.2 kg (60.0 lbs) weights, 1, (three per side may be added to the rear of the loader as shown.

The rear counterweights should be removed when not required. Operating the skid steer with rear counterweights installed and with light front loads, may cause uneven tire wear.



1

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REAR COUNTERWEIGHT SUPPORT REMOVAL

SECTION 39 – FRAMES

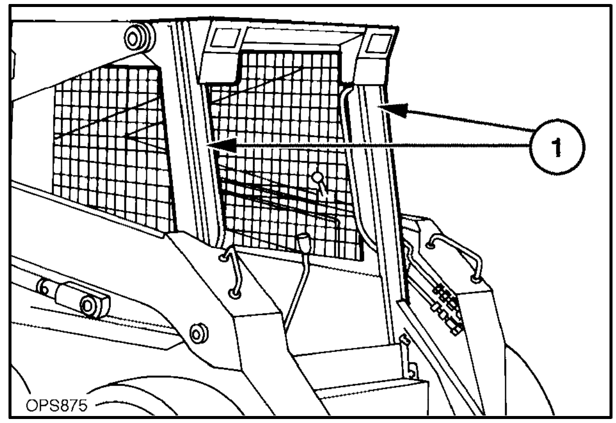
Chapter 1 – Lower Main, ROPS

CONTENTS

GENERAL INFORMATION

ROPS

The ROPS, 1, is a welded frame structure to provide rollover protection for the operator and pivot point locations for the boom assembly.



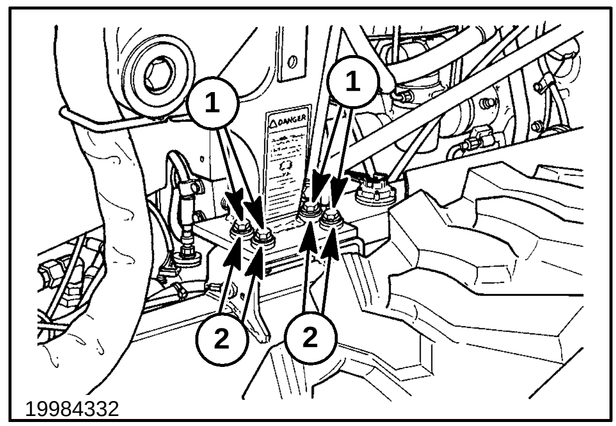
1

ROPS FRAME

Op. 90 152 46

REMOVAL

The ROPS can be removed from the lower frame with the cab inner shell and boom attached in place or removed.



2

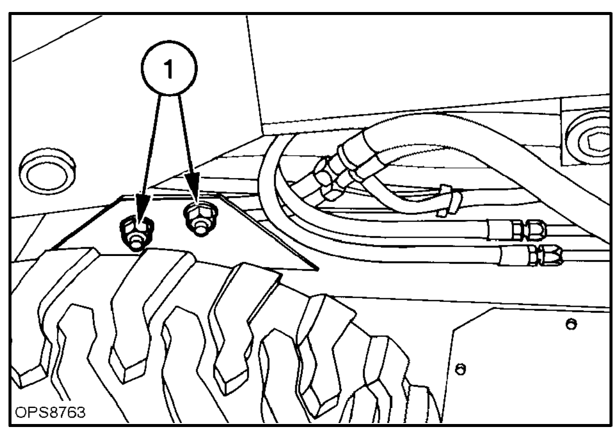
To remove the ROPS with the inner shell and boom removed:

Follow the instructions for “Cab Inner Shell Removal” in Section 90 and “Boom, Upper and Lower Link Removal” in Section 82.

1. Remove the rear attaching bolts, 1, left and right sides.

NOTE: *If the rear bolts, 1, have spacers under the bolt heads they must be reinstalled during reassembly for proper torquing.*

2. Support the ROPS with a suitable lifting device and remove the front attaching bolts, 1, two each side.
3. Lift the ROPS frame from the lower main frame and move to a level area. Lower the ROPS to the floor.



3

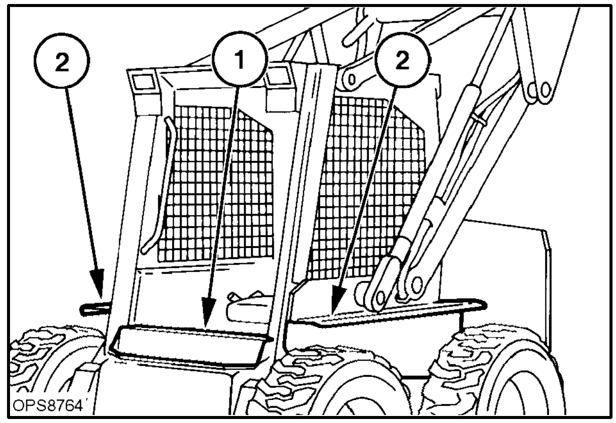
To remove the ROPS with the cab inner shell and boom attached:

1. Remove any attachment from the loader mounting plate, raise the boom and rest on the boom lock pins.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the loader.



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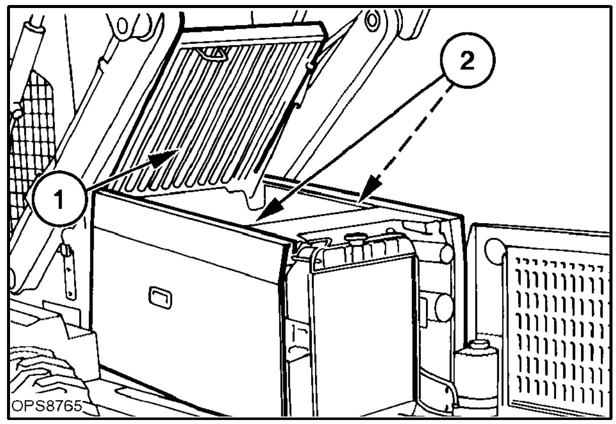
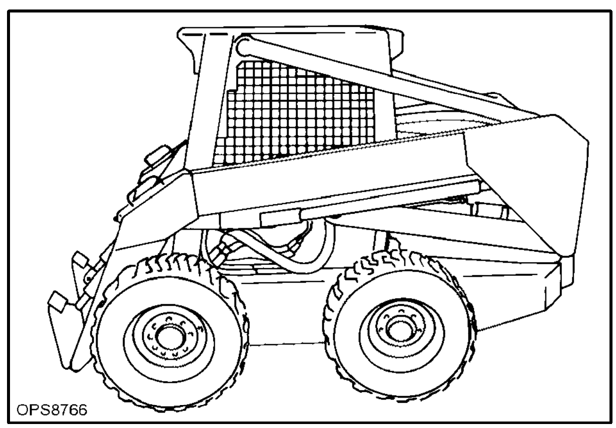
2. Remove the front step shield, 1.
3. Remove the right and left fenders, 2.
4. Raise and latch the engine top screen, 1.
5. Remove the engine side panels, 2.



5

6. Lower the boom to the lowered position and turn the ignition (key) switch to the “OFF” position. Do not unbuckle the seat belt and exit the loader.
7. Relieve the hydraulic pressure from the boom and bucket circuits.
   - Turn the ignition (key) switch to the “ON” position.
   - Operate the boom and bucket controls relieving all pressure in the system.
   - Turn the ignition switch “OFF” and exit the loader.



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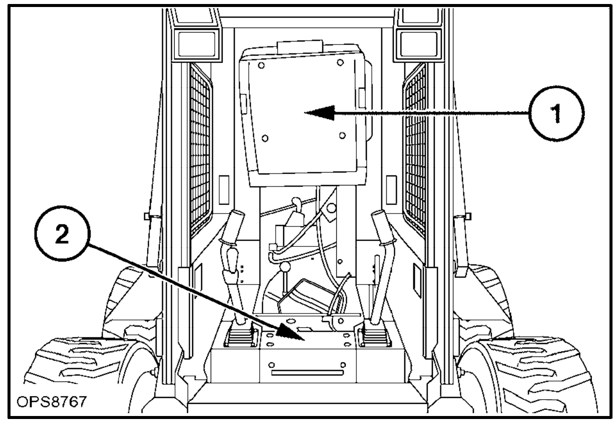
8. Raise the operator's seat/seat pan support to the raised latched position, 1. Remove step shield, 2.

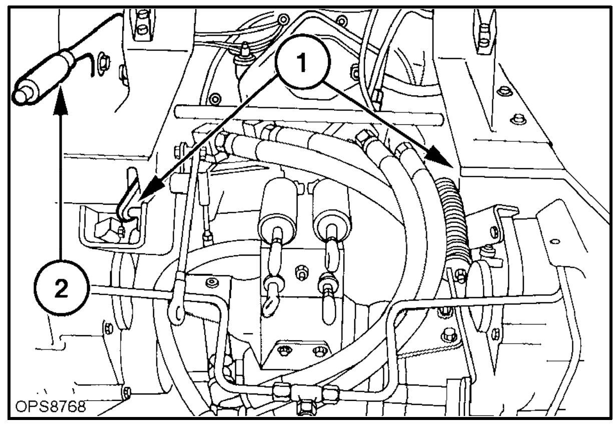
CAUTION

Do not work under a raised seat unless it is securely latched in the raised position.



7

9. Disconnect the parking brake linkage at 1.
10. Raise the parking brake control lever, 2, to the raised, engaged position.



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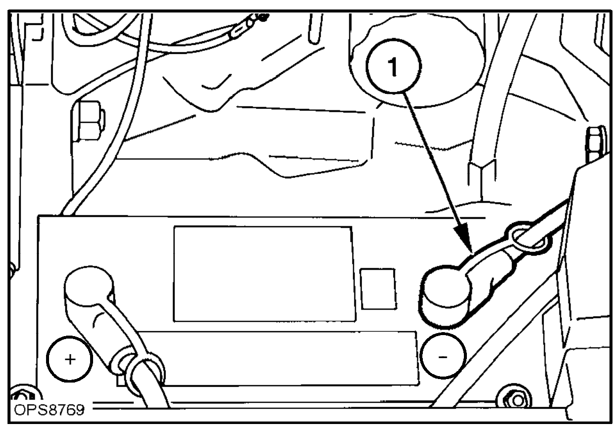
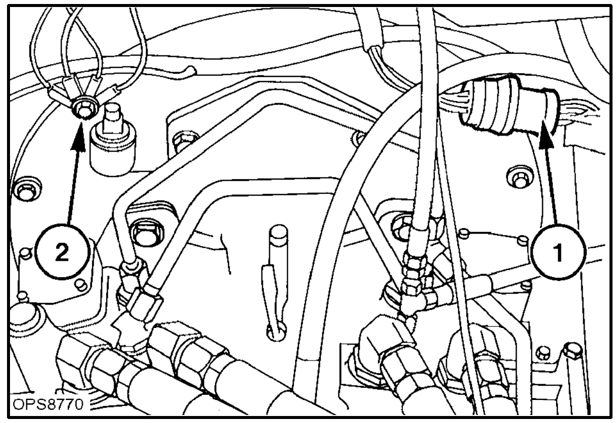
11. Disconnect the (–) negative ground battery cable, 1.



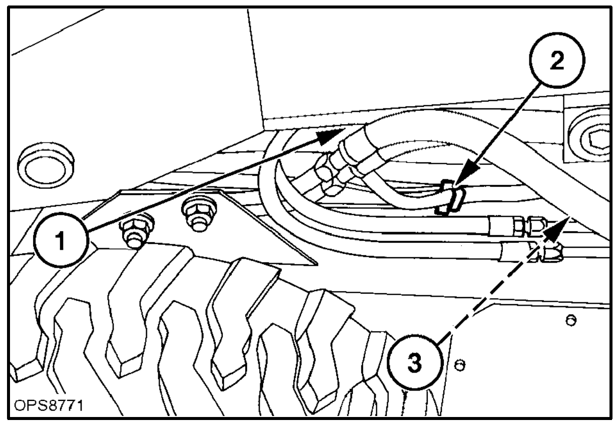
9

12. Unplug the engine wire harness from the main harness, 1.
13. Remove the ground wires from the engine bell housing, 2.
14. Remove the wire harness from along the fuel tank on the left side of the engine.
15. Remove the wires from the hydrostatic charge pressure sender, oil filter sensor, and remove the wire harness from the right side of the engine.



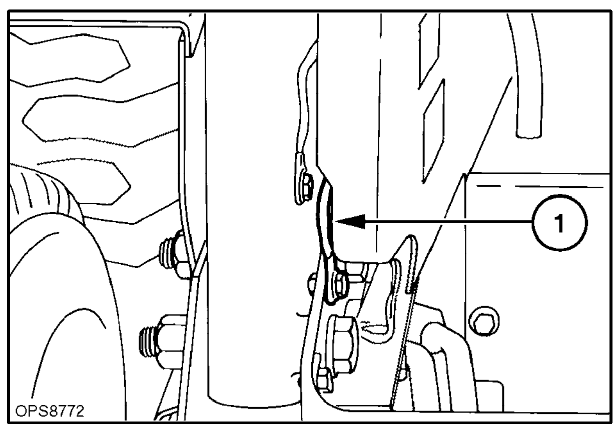
10

16. Remove the wire harness clamps and plastic ties along the left side of the lower frame at 1, 2, and 3.



11

17. Remove the ground strap, 1, from the cab inner shell and lower main frame.



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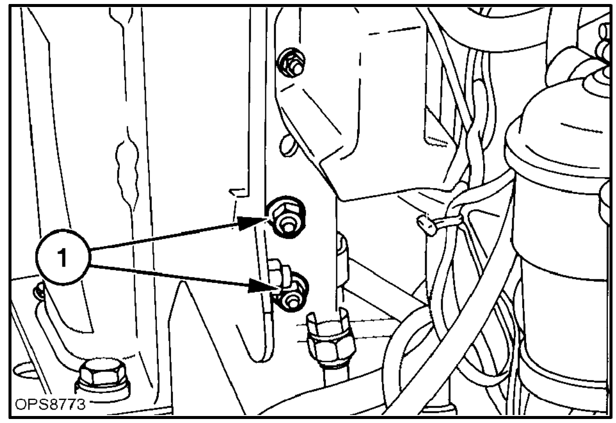
18. Remove the engine fuse/relay panel support hardware, 1, and raise and tie the panel assembly to the back of the cab.



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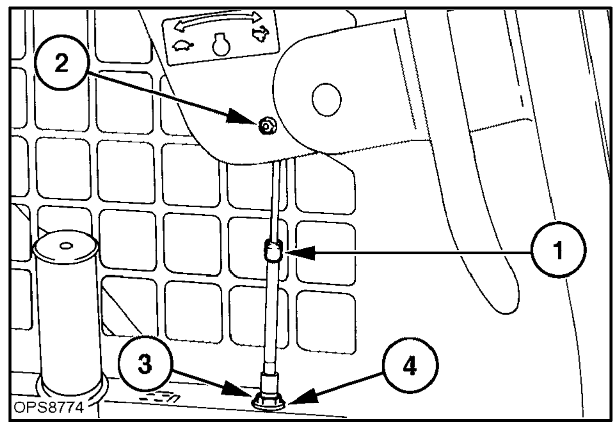
19. Remove the throttle control cable, 1, from the control lever at 2. Remove the cable retaining nut, 3, and slide the cable down through the right side shield at 4.

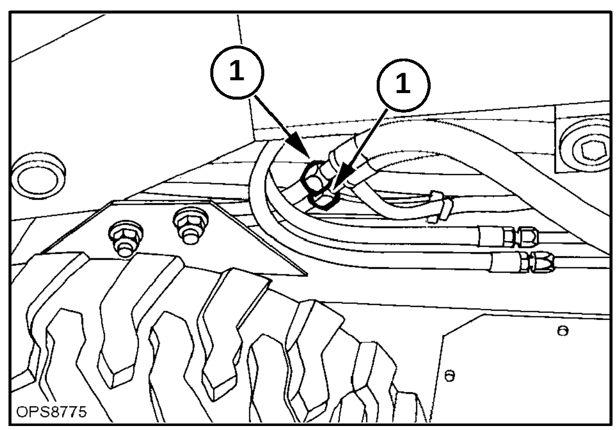


14

20. With the boom in the lowered position and the hydraulic pressure relieved in the boom and bucket circuits, disconnect the boom, bucket, and auxiliary boom hydraulics hose connections, 1, and cap all connections.

CAUTION

Never loosen any hydraulic lines without first relieving all pressure in the system.



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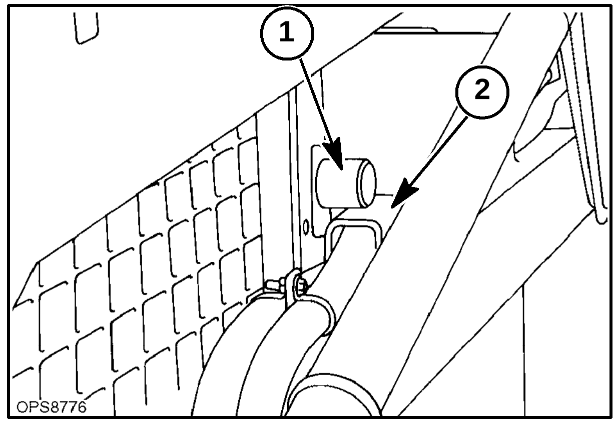
21. Rotate the boom lock pin control lever to extend (engage) the boom lock pins, 1, above the top of the lower link, 2, as shown.



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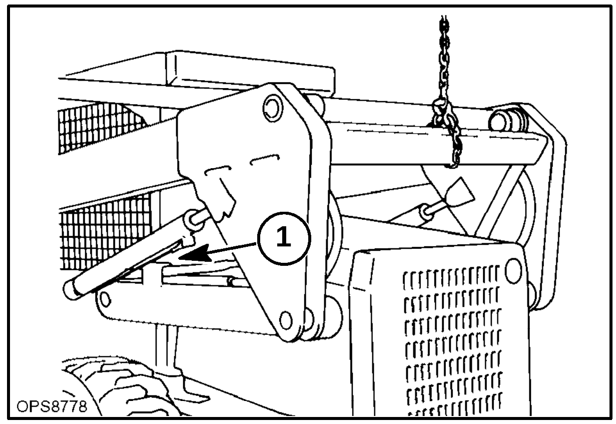
22. With a suitable lifting device, support the boom at the rear, lifting the boom assembly until it contacts the boom lock pins, 1.



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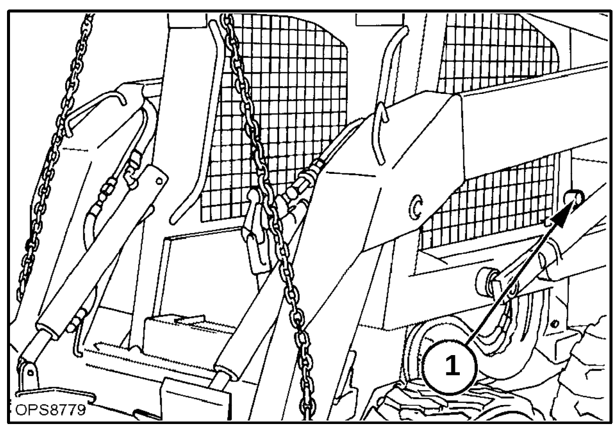
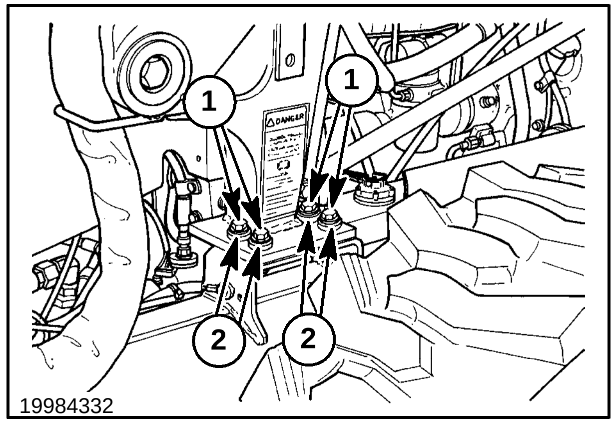
23. With a suitable lifting device, support the boom at the rear, and lift the boom assembly at the front until it contacts the boom lock pins, 1.



18

24. Remove the left and right rear attaching hardware, 1.

NOTE: *If the rear bolts, 1, have spacers, 2, under the bolt heads, they must be reinstalled during reassembly for proper torquing.*



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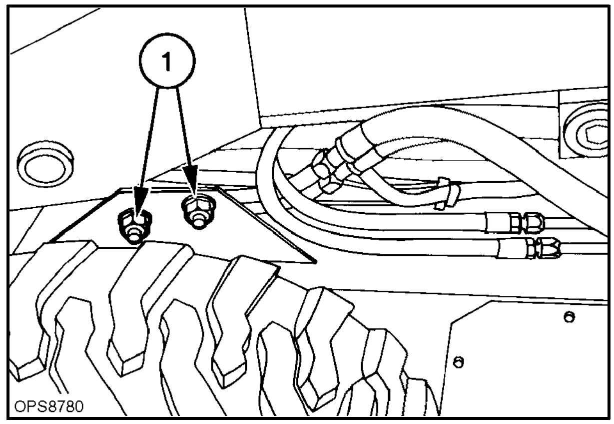
25. Remove the right and left front retaining bolts, 1.
26. Lift the ROPS and boom assembly from the lower main frame and move to a level area. Rest the assembly on the floor, lowering the boom to the floor.



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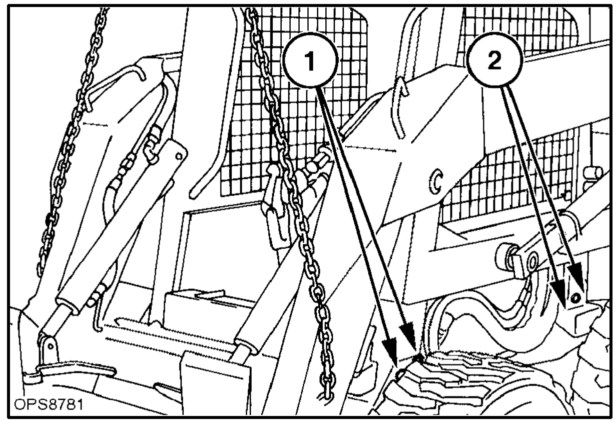
REINSTALLATION

1. Lift the ROPS and boom assembly onto the lower frame resting the rear ROPS post on the lower frame pads. Supporting the front of the ROPS, install the front retaining hardware at 1. With the front hardware installed, align the rear ROPS posts and install the rear hardware at 2.
2. Torque the front hardware, 1, to 160 ft. lbs. (217 N·m).



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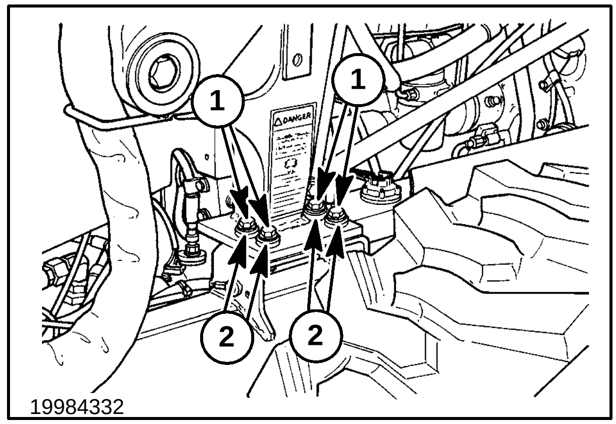
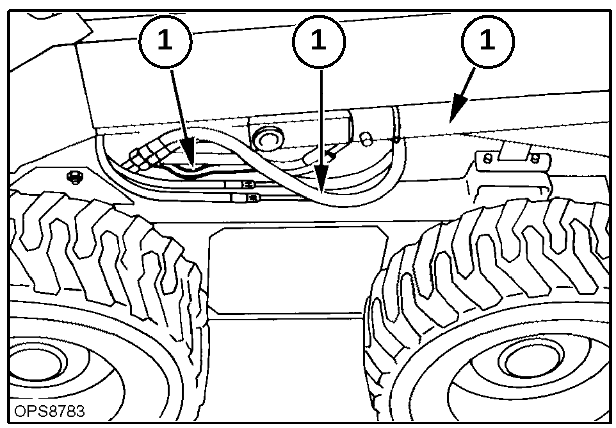
3. Torque the rear hardware, 1, to 80 ft. lbs. (108 N·m).

NOTE: *If the rear bolts, 1, had spacers, 2, under the bolt heads, they must be reinstalled during reassembly for proper torquing.*



22

4. With the ROPS and boom securely attached to the lower frame and the boom in the lowered position, remove the lifting device from the ROPS.
5. Reinstall the wire harness, 1, along the main frame and attach the engine fuse/relay panel.
6. Reconnect the main harness to the engine harness, re-route the wire harness along the fuel tank and the right side of the engine installing all clamps and ties previously removed.



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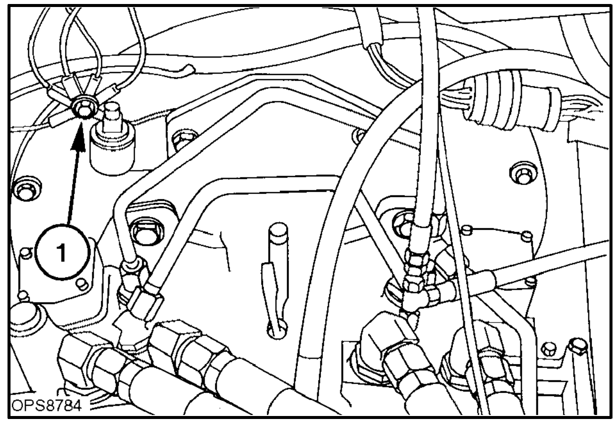
7. Reconnect the ground wires to the bell housing at 1. Place the largest wire next to the ground surface, stacking the remaining wire by size, largest to smallest, to insure proper grounding.



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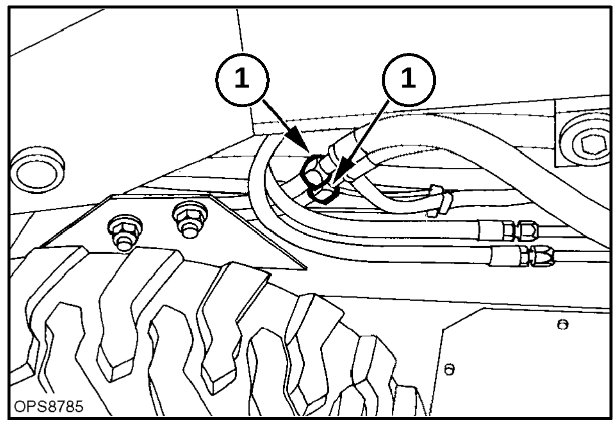
8. Reconnect all hydraulic lines, 1, and position for clearances between other components. Install any hose clamps removed.



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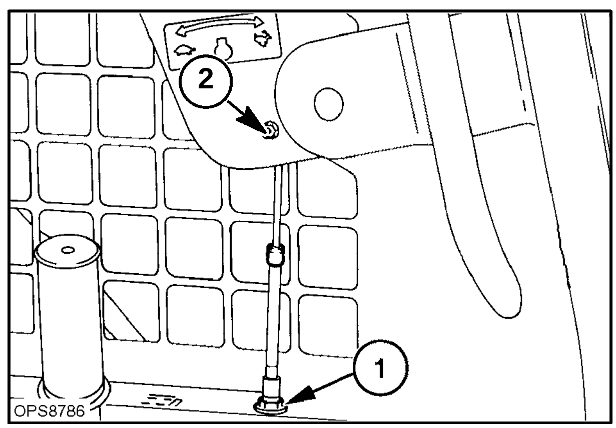
9. Slide the throttle cable up through the hole in the left cab panel and secure with retaining nut at 1. Reattach the cable to the control handle at 2.



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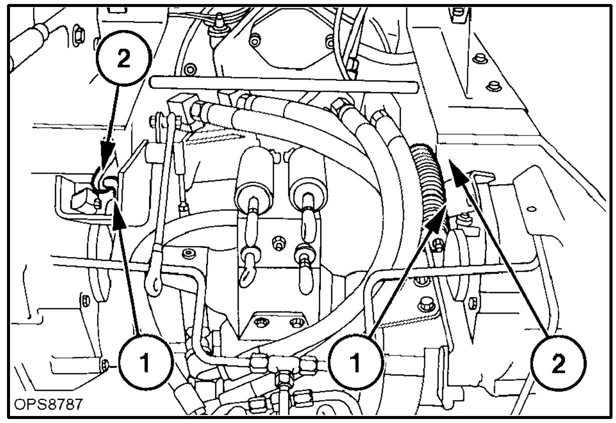
10. Reconnect the parking brake spring links, 1, to the control rod at 2, and install the cotter pins.
11. Reconnect the (-) negative ground battery cable.



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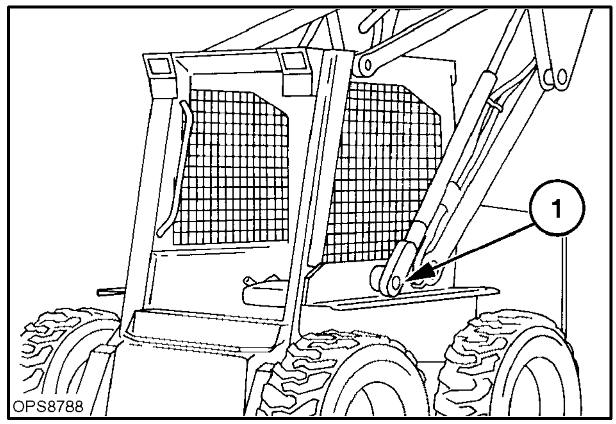
12. After all wires and hydraulic hoses are connected, start the unit, raise the boom, and check for oil leaks.

NOTE: *The boom and bucket hydraulic circuits may require cycling several times to purge the air from the hydraulic system.*

13. Reinstall all fenders, shields, etc. removed.
14. After the fenders are reinstalled, raise and lower the boom and recheck the hoses and tubes for clearance at 1. Readjust the hoses and tubes if they contact the fenders.



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LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
Remove and replace ROPS frame (Includes seat, boom lock linkage, boom removal, inner shell)	18.5 hrs.

SECTION 44 – AXLES AND WHEELS

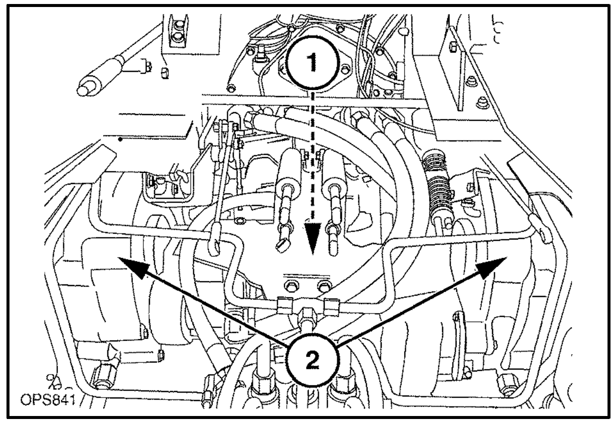
Chapter 1 – Axles

CONTENTS

Op. 44 100

GENERAL INFORMATION

Each of the two hydrostatic pumps is driven by the engine through a spur gear configuration located in the engine-to-transmission gearbox. The hydrostatic pumps then transmit hydraulic power to the hydrostatic motors, 1, which are connected to gearboxes, 2, located on the inside of the final drive cases. The left and right drives are separate from each other and are operated independently.



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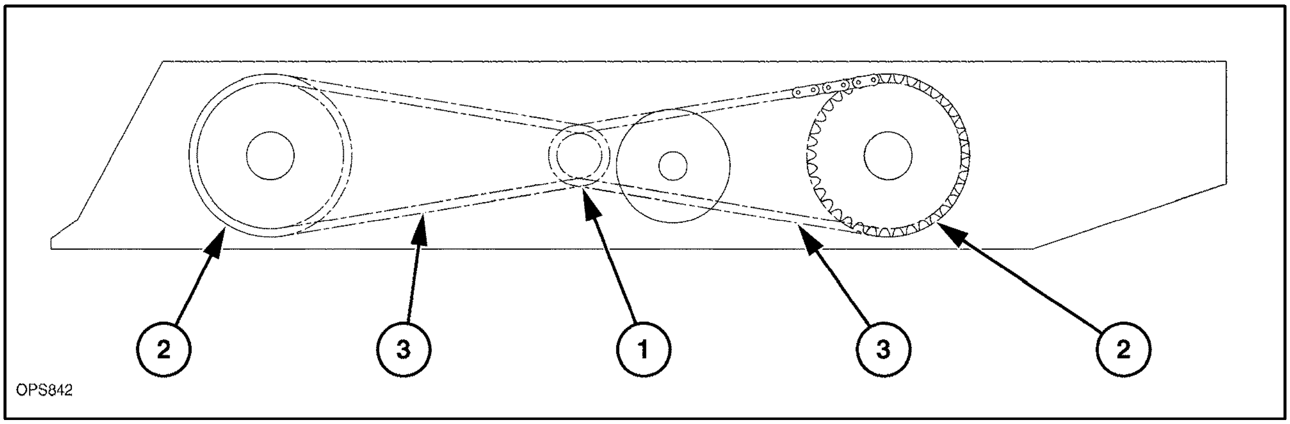

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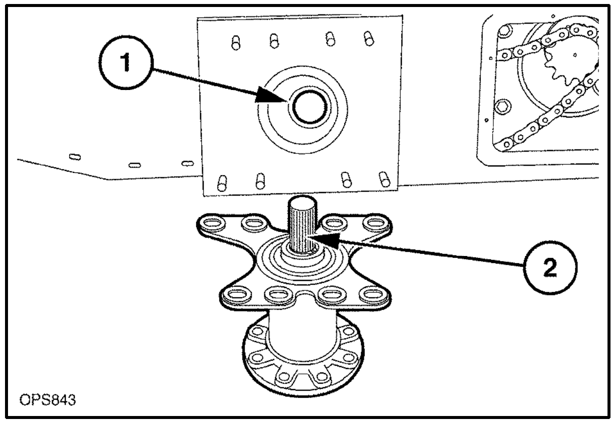
Power is then transmitted through gears to a drive sprocket, 1, in the final drive case. The drive sprocket is connected to the axle sprockets, 2, with chains, 3, one endless chain to the front axle and one endless chain to the rear axle.

The axle sprocket, 1, is splined to the axle shaft, 2, and hub assembly.



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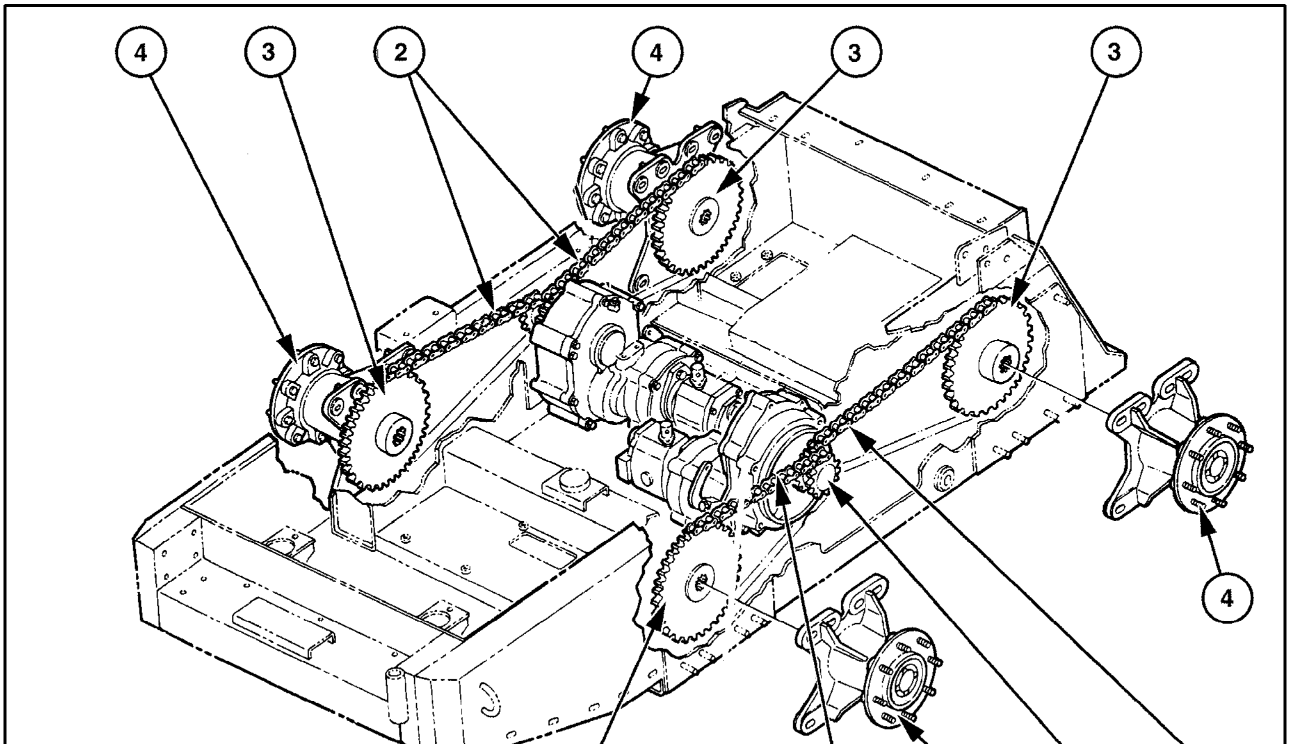


1 - FINAL DRIVE SPROCKET ASSEMBLIES (2)
2 - DRIVE CHAINS(FRONT AND REAR) (4)
3 - AXLE DRIVE SPROCKETS (4)
4 - AXLES ASSEMBLIES (4)

4

SPECIFICATIONS

Drive Axles

Wheel Nut Torque	170 N·m (125 ft. lbs.)
Mounting Bolt Torque (Axle housing to case)	190 N·m (140 ft. lbs.)
Lubrication	High temperature lithium grease

Chain Case and Gearbox

Side Cover Bolt Torque	11 ft. lbs. (15 N·m)
Drive Chain	#100
Front Chain Length (64 links)	80″ (2032 mm)
Rear Chain Length – LS180 (58 links)	72.5″ (1841.5 mm)
Rear Chain Length – LS190 (64 links)	80″ (2032 mm)
Chain Tension	0 to 6 mm (0″ to 1/4″) movement at tire tread

Other Materials

Description	Use
Ultra/Blue Silicone Sealer	Gearbox mounting bolts Axle housing bolts Chain case cover bolts Gearbox to chain case Gearbox cover and bolts
Sealing Material	NH Ultra Blue silicone sealer NH #L81724 - 3.35-oz. tube (cord) NH #L82519DS - 8-oz. tube NH #L58775 - 10.2-oz. cartridge
Gear Oil	80W-90 API Service GL-5 Gear Oil NH #9613295 - 1 qt. NH #9613294 - 5 gal. NH #9613375 - 4 L
Grease	High viscosity lithium base NH #9613310 - tube

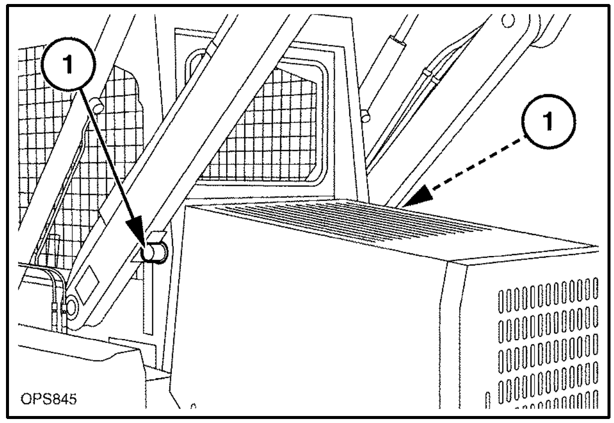
NOTE: *Always use a noncorrosive silicone sealer to seal where required to prevent corrosion during the silicone curing process.*

TROUBLESHOOTING

Before servicing or adjusting the final drive system, the skid steer should be jacked up with the wheels off the ground.

Remove any attachment from the skid steer; boom, bucket, etc. Lower the boom to the lowered position or, if servicing requires the boom to be in the raised position, support the boom on the boom lock pins.

Raise the boom and lower onto the boom lock pins, 1.



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1. Raise the boom above the boom lock pins.
2. Engage the boom lock pins.
3. Stop the engine; ignition key in the “OFF” position.
4. Turn the ignition key to the “ON” position.
5. Lower the boom onto the boom lock pins.
6. Turn the ignition key to the “OFF” position.

CAUTION

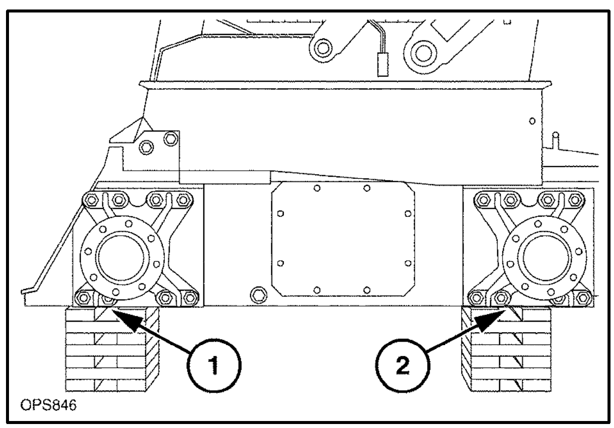
Never exit the loader with the boom in the raised position unless the boom is supported on the boom lock pins.

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment mounted. Always remove the attachment from the loader.

Jack up the loader and support the loader with the wheels off the ground. Use adequate jack stands or blocks to securely support the loader.

Support the loader at the front of the final drive cases at 1, and at the rear at 2.



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CAUTION

Never service a raised loader unless it is securely supported with adequate jack stands or blocks.

PROBLEM	POSSIBLE CAUSES	CORRECTION
Both drive wheels on one side not powered	No hydrostatic motor shaft rotation	Check for pump to motor oil flow and repair
	No gearbox output drive	Check gearbox shaft rotation and repair
	Broken drive chains	Check chains and repair
One drive wheel not powered	Broken drive chain	Check chain and repair
	Axle or drive sprocket splines worn	Check axle and sprocket; replace
Chain case noise	Loose drive chains	Check and adjust chains
	No oil in final drive	Check oil level
	Worn drive sprockets	Check sprockets and repair
	Bearing failure	Check axle and gearbox bearings and repair
Excessive axle play	Bearing failure on axle shaft	Check bearings and repair
	Snap ring failure on axle shaft	Check axle bearing preload; repair
Noise in gearbox	No or low oil in gearbox	Check oil level
	Bearing failure	Check shafts and bearings; repair
	Bearing or shaft failure in drive motor	Check drive motor and repair
	Gears in gearbox worn	Check and replace
	Parking brake not released	Release parking brake
Final drive case leaking	Oil escaping past case side sheet and reinforcing plate	Reinstall with sealant as described in Service Bulletin (7/95-I7)
	Oil escaping past studs	Remove and reseal studs
	Oil escaping around center inspection plate	Remove plate and reseal

TESTING

FINAL DRIVE

Pretest instructions:

* Operator in seat with seat belt buckled.

* Engine running at high idle (full throttle).

* Park brake in disengaged position.

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Push both drive controls forward equally and loader should move in a straight line.	YES NO	Drive system OK. Engine stalls, wheels appear locked, check parking brake for engaged. If OK, go to step 2. Slow or no power; refer to hydrostatic drive section.
2			Check final drive chain; if broken, repair.
3	Pull both drive controls rearward equally and loader should move in a straight line.	YES NO	Drive system OK. Engine stalls, wheels appear locked, go to step 1. Wheels rotate slow or no power, go to step 1. One side of loader drags, go to step 2.

Pretest instructions:

* Lower boom and attachment to the ground.

* Stop engine.

* Jack loader with wheels off the ground.

* Release parking brake.

STEP	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Rotate each tire by hand, tires move less than 1/4″ at tread.	YES NO	Drive system OK. Tires move more than 6 mm (1/4″) at tread; check chain tension.
2			One tire rotates freely, broken chain, or axle spline worn.
3			Both tires on one side rotate freely together, inspect drive gearboxes. If OK, check drive motor.
4	Tires rotate but are noisy.	YES NO	Check drive chains, axle bearings. Drive system OK.

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AXLES

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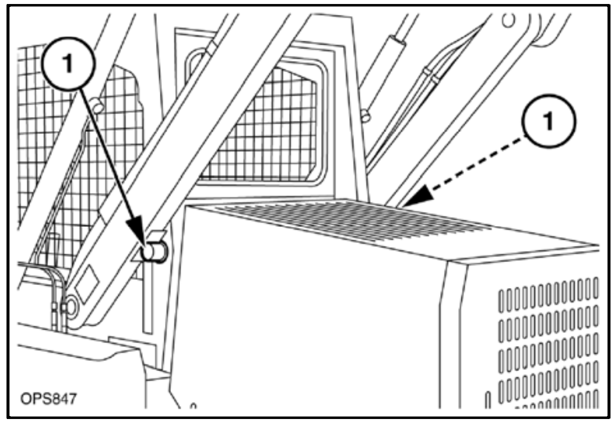
AXLE HOUSING ASSEMBLY REMOVAL

The axle housings must be removed to service the axle seals, axle bearings, drive chains, drive sprockets, and axle housing mounting bolts.

NOTE: *The axle housings may be removed without removing the final drive side cover or draining the case oil.*



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1. Lower the boom and attachment to the ground.
2. If the work is going to be done with the boom in the raised position, remove the attachment, raise the boom, and rest the boom on the boom lock pins, 1.

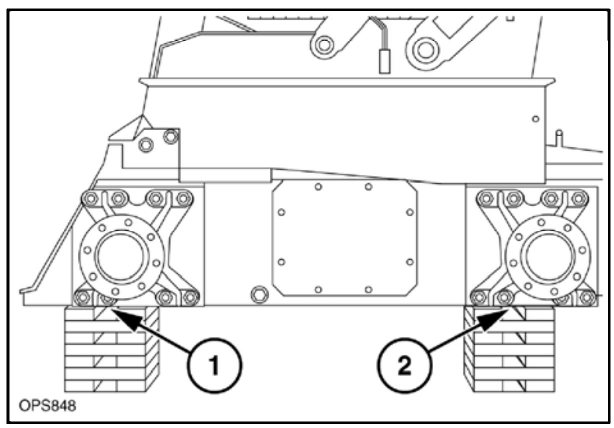
CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the loader.

3. Securely block the skid steer with all four wheels off the ground.

   Support the loader at the front of the final drive cases at 1, and at the rear, 2.



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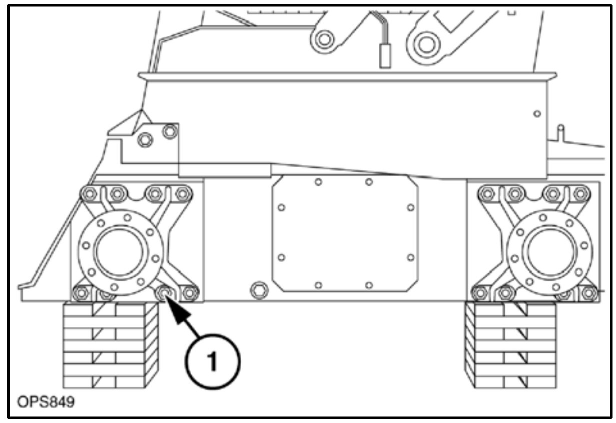
CAUTION

Failure to securely support the skid steer could result in movement of the loader causing serious injury or damage to the equipment.

NOTE: *When repairing a rear axle, the front of the unit should be supported slightly higher than the rear for easier rear axle assembly reinstallation.*

4. Remove the tire and wheel from the axle being serviced.
5. Clean the axle and final drive area to prevent debris from entering the final drive case.
6. Remove the eight axle housing retaining nuts and washers, 1.
7. Slide the axle housing from the retaining studs and lift the assembly from the final drive case.



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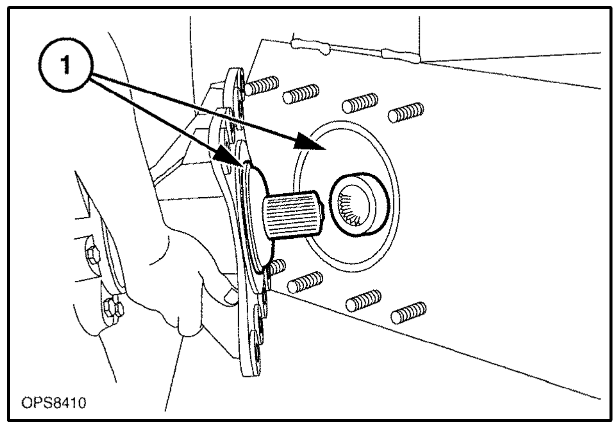
CAUTION

The axle assembly is heavy and may require two persons to adequately support if handling manually.

NOTE: *When the axle assembly is removed, the drive sprocket and chain will drop slightly to the bottom of the case.*

8. There is a large O ring at 1 that seals the axle housing to the side of the final drive case. Remove the O ring from the case or the axle housing.



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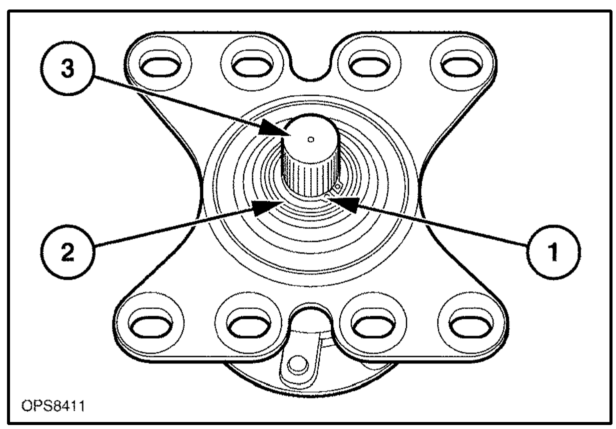
DISASSEMBLY

NOTE: *A press is required to remove the axle shaft and hub assembly from the housing.*

1. Remove the retaining ring, 1, from the axle shaft.
2. Remove the shims, 2. Note the thickness and number of shims.
3. Place the housing assembly in a press; support the housing as close to the center of the housing as possible to prevent damage to the housing.
4. Press the axle and hub assembly, 3, from the housing.



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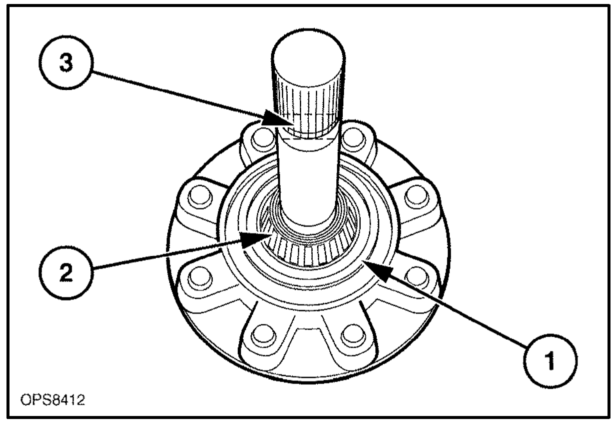
5. The outer axle seal, 1, may be replaced at this time without further disassembly. The seal can be replaced without removing the bearing, 2.
6. Install a bearing separator/puller and remove the outer axle bearing, 2.



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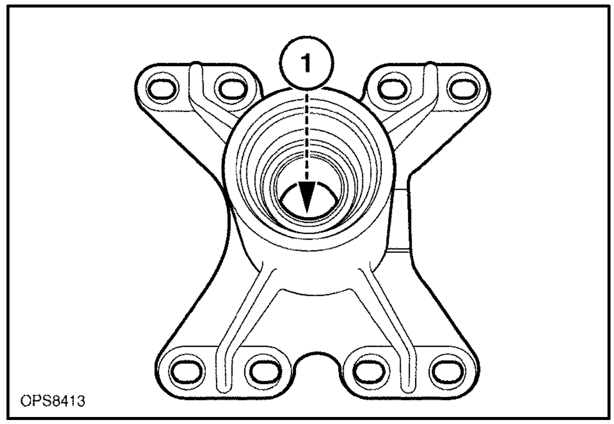
7. Remove the inner bearing race, 1, by driving it from the housing with a suitable hammer and driver.



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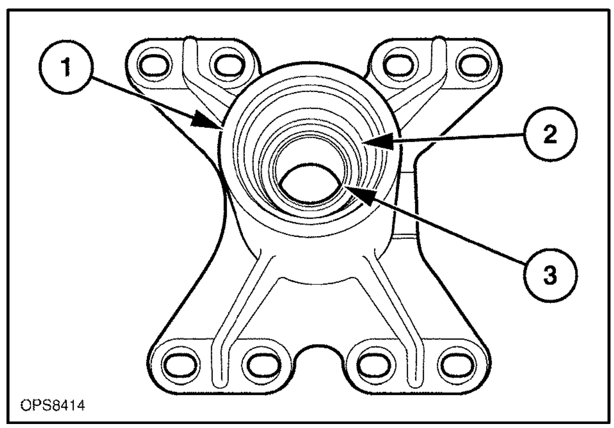
8. Remove the outer replaceable seal sleeve, 1, by prying it from the axle housing.
9. Remove the outer bearing race, 2, and seal, 3, by driving them from the housing with a suitable hammer and driver.

   Note the positioning of the oil seal before removal, as the replacement seal should be positioned in the same position.



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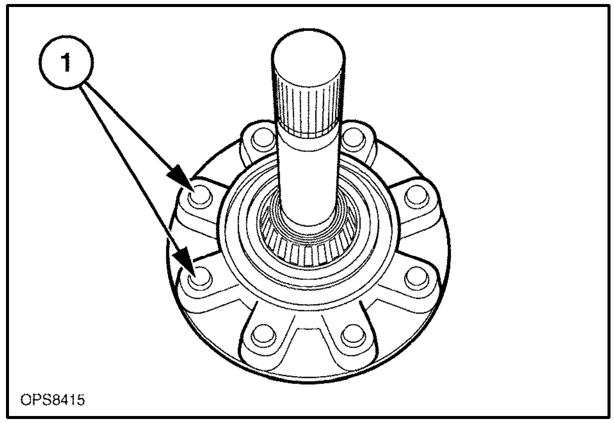
10. The axle hub wheel studs, 1, can be removed from the hub, by pressing them from the hub.



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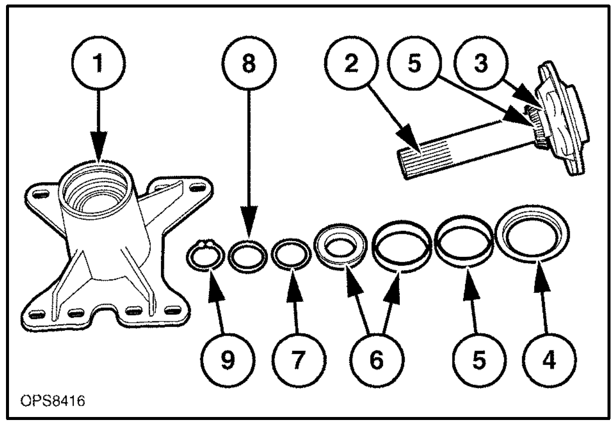
11. Shown here are the related parts used in the axle assembly.

Ref.	Description
1	Housing
2	Axle and hub assembly
3	Outer seal
4	Outer seal sleeve
5	Outer bearing assembly
6	Inner bearing assembly
7	Inner seal
8	Shims
9	Retaining ring



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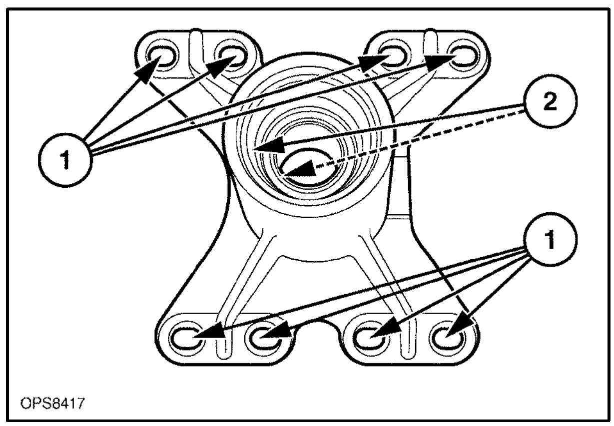
PARTS INSPECTION

Thoroughly clean all parts before inspection.

1. Inspect the housing flange, 1, and bearing race areas, 2. Replace the seals and replaceable seal sleeve if worn or damaged.



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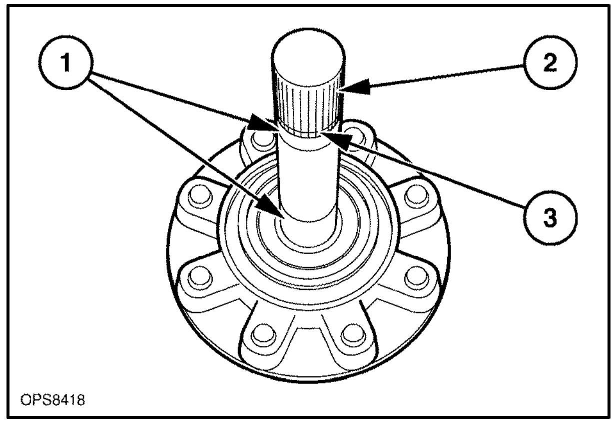
2. Inspect the axle shaft and hub assembly.
   - Inspect the bearing areas, 1, for wear.
   - Inspect the splines, 2, and retaining groove, 3, for wear.
   - Inspect the seal area.
   - Inspect the wheel lug studs for damaged threads or looseness in the hub, replace studs if required.



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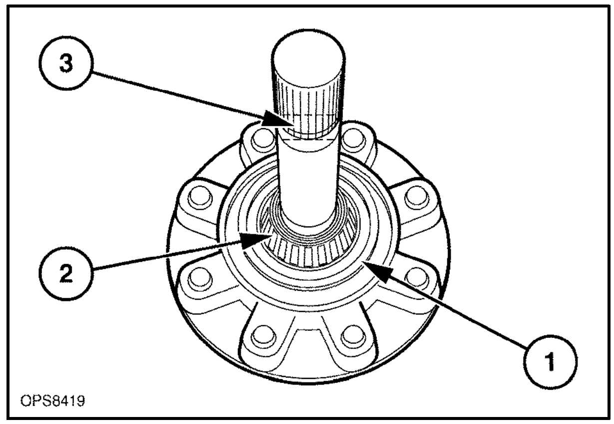
REASSEMBLY

1. Install the outer seal, 1, as shown, on the axle-hub assembly. Fill the grooves in the seal with grease.
2. Pack the bearing with grease and install the outer bearing, 2, with a suitable bearing driver.
3. Wrap the axle in the retaining ring groove area, 3, with a single layer of plastic tape to prevent damage to the seal during assembly.

NOTE: *If the bearing failed because of excessive contamination, use green Loctite 609 on the seal housing to shoulder press-fit joint. If the axle shoulder is worn from previous seal rotation, use a new axle and seal, and use loctite to seal the joint.*

When reinstalling the axle into the axle housing, be sure both bearings are packed with grease. The cavity in between the triple lip seal and axle seal, where the outer bearing is positioned, must be full of grease. If any old or hardened grease is in a housing that will be reused, be sure to clean the housing and fill it with new grease. The axle bearings should be greased every 500 hours, or if a wheel or tire is removed for repair, grease the axle bearings at that time.



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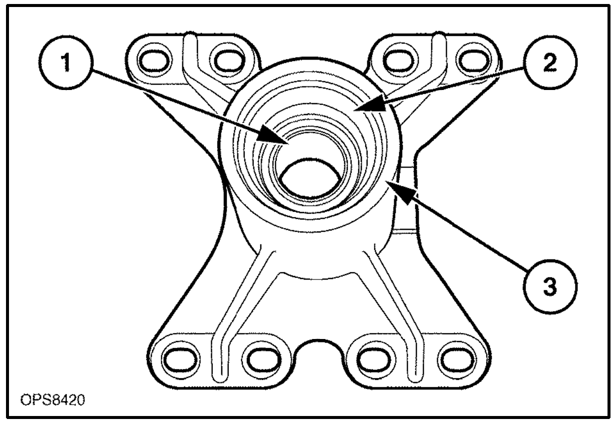
4. Install inner seal, 1, in the housing as shown with the flat side of the seal to the center of the housing and retainer and the lip of the seal to the outside.
5. Install bearing race, 2.
6. Install replaceable seal sleeve, 3, in the housing.



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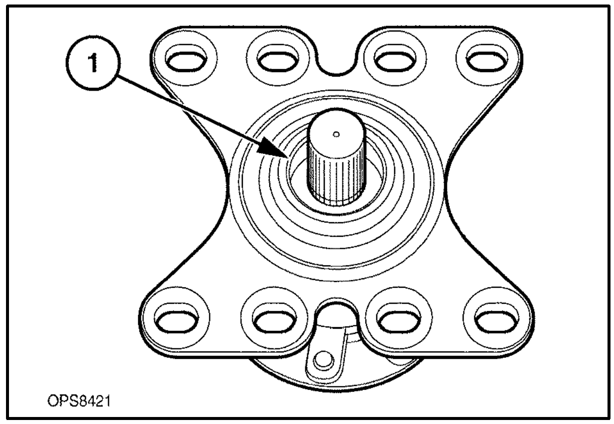
7. Place the housing over the axle and hub assembly making sure the outer bearing is properly seated in the race.
8. Remove the tape from the axle shaft.
9. Install the inner bearing race, 1, into the housing.



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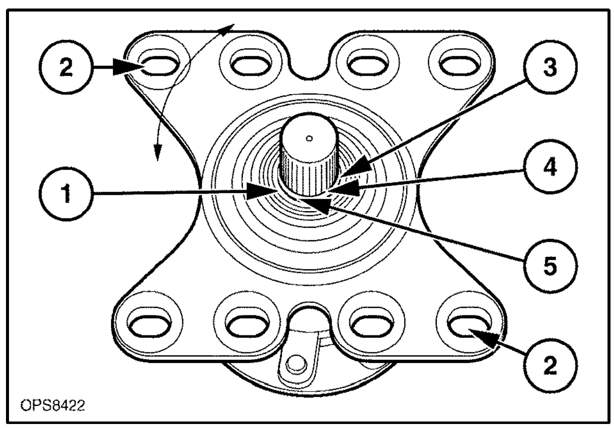
10. Pack the bearing with grease and install the inner bearing, 1.

    Press the inner bearing on the axle shaft and into the housing to obtain housing rolling torque of 9 - 15 lbs.

NOTE: *To check housing rolling torque, hook a spring scale in one of the housing flange slots, 2, and pull on the scale to rotate the housing.*

11. Add shims to fill the space between the bearing race, 3, and retaining ring, 4.
12. Install the retaining ring in groove, 5.



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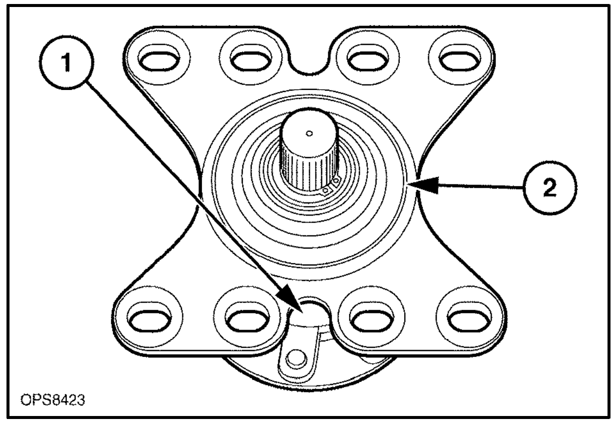
13. Fill the outer seal area with grease until the grease appears around the hub at 1; spin the axle housing while adding grease.
14. Install the O ring in the groove in the axle housing flange at 2; wipe a layer of grease over the O ring to help hold the O ring in place during assembly.



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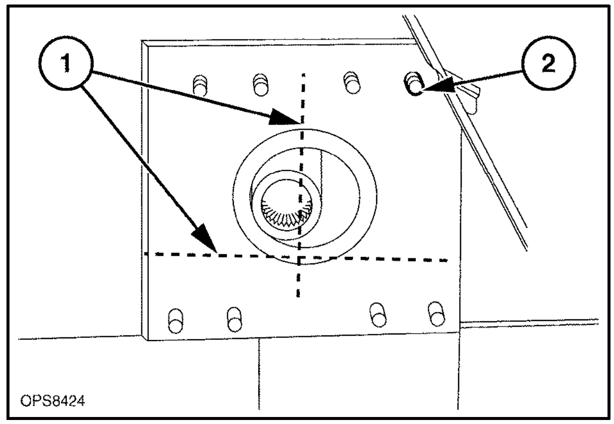
REINSTALLATION

1. Clean the final drive case.
2. Inspect the axle opening in the case to make sure it is flat for a good seal between the case and axle housing. To check surface flatness, lay a straight-edge across the axle opening in the horizontal and vertical planes, 1. Straighten if required.
3. Inspect the axle assembly retaining bolts, 2, and replace if damaged.
   - To replace a stud, the old stud can be driven out with a hammer and suitable driver.
   - Thoroughly clean the inside and outside of the case in the stud area.
   - Wipe the new stud with a wicking-type sealant. The new stud can be installed into the case by using a 3/4″ thick spacer over the stud and then using the nut and a flat washer to pull the stud in place.
   - Wipe around the stud with a wicking-type sealant to ensure an oil tight seal.



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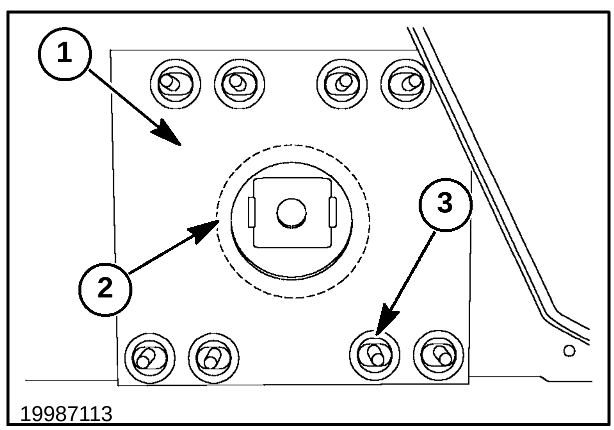
If there are signs of oil leaking out of the bottom of the axle housing, the oil may be escaping between the final drive case sheet and the outer reinforcing plate. The reinforcing plate, 1, has a narrower opening than the drive case sheet, 2. If the loader frame is welded between the reinforcing plate and drive case sheet, the case should not leak.

To seal off this area and prevent leaks, clean the final drive case around the pilot mating area, 2, and around the studs, 3, with an appropriate cleaner. Place a bead of silicone sealant (such as part #L58775), around the side sheet mating area, 2, and the studs, 3.



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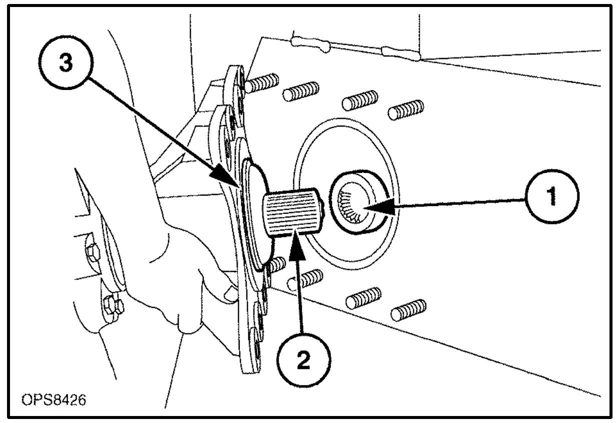
NOTE: *When installing the final drive case, the case must lay flat against the frame and the pilot must rest on the edge of the frame opening.*

4. Position the drive sprocket, 1, in the axle opening. Make sure the drive sprocket is placed in the drive chain properly.

NOTE: *When installing a rear final drive case, the rear drive sprocket will stay in place better with the front of the loader raised.*



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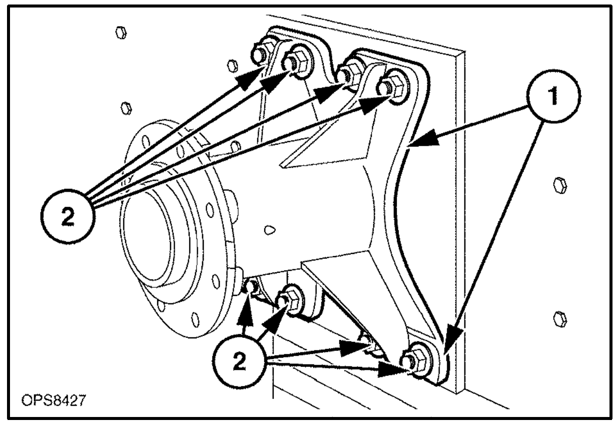
5. Lift the axle housing assembly and mate the splines on the axle shaft, 2, and the drive sprocket and slide together. Lifting the axle housing assembly over the retaining studs, pilot the center of the housing, 3, into the hole in the case and slide the housing tight against the case.



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6. With the axle housing, 1, tight against the case, install the retaining nuts and flat washers, 2, to hold the housing against the case.
7. Slide the axle housing assembly to tighten the drive chains.

NOTE: *The chains are properly tensioned when there is 0 to 6 mm (0″ to 1/4″) movement at the outer edge of tire tread.*

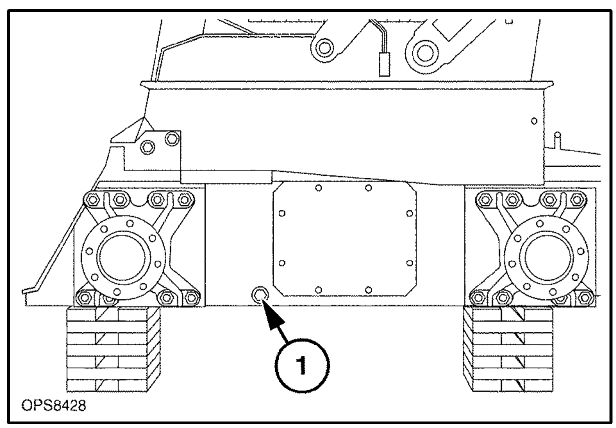
8. Torque the axle retaining hardware to 140 ft. lbs. (190 N·m).

CAUTION

When tightening the axle retaining hardware, the axle housing must be tight against the case at 1, or damage to the case may occur.

9. Check the final drive case oil level at check plug, 1; add SAE 80W-90 API Service GL-5 gear oil as required.

   Replace any shields that were removed for the repair.



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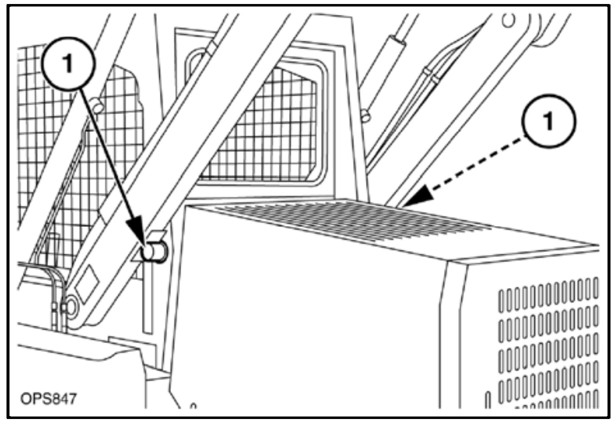
FINAL DRIVE

Op. 44 106 48

DRIVE CHAIN AND SPROCKET REMOVAL

The axle housing assemblies and final drive case cover will need to be removed to access the drive chains and drive sprockets.

The four final drive chains are an endless design, with no connector link.



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Removal

1. Lower the boom and attachment to the ground.
2. If the work is going to be done with the boom in the raised position, remove the attachment, raise the boom, and rest the boom on the boom lock pins, 1.

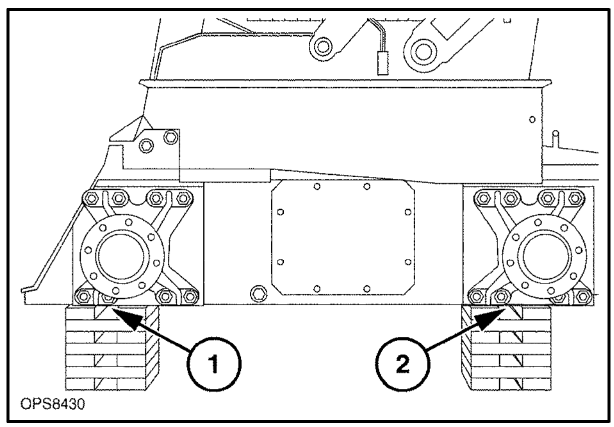
CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the loader.

3. Securely block the skid steer with all four wheels off the ground.

   Support the loader at the front of the final drive cases at 1, and at the rear at 2.



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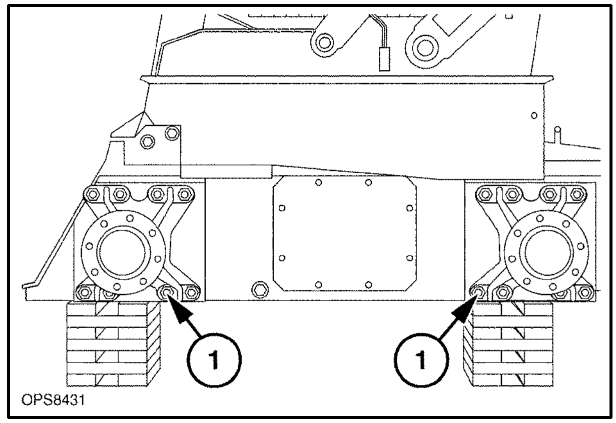
CAUTION

Failure to securely support the skid steer could result in movement of the loader causing serious injury or damage to the equipment.

4. Remove the tires and wheels from the final drive being serviced.
5. Clean the axle and final drive area to prevent debris from entering the final drive case.
6. Remove the eight axle housing retaining nuts and washers, 1, from each axle.
7. Slide the axle housing from the retaining studs and lift the assembly from the final drive case.

NOTE: *When the axle assembly is removed, the drive sprocket and chain will drop slightly to the bottom of the case.*



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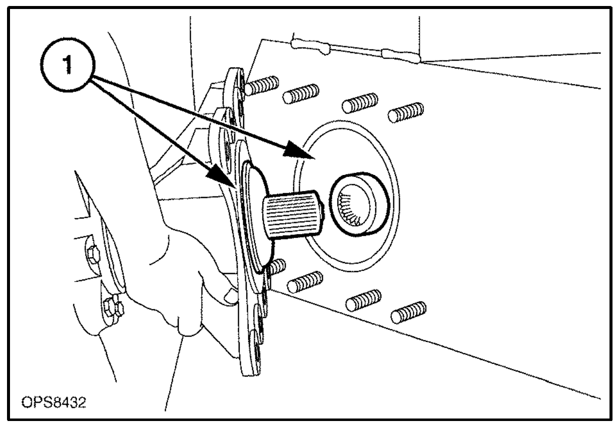
CAUTION

Axle assembly is heavy and may require two persons to adequately support if handling manually.

8. There is a large O ring, 1, that seals the axle housing to the side of the final drive case. Remove the O ring from the case or the axle housing.



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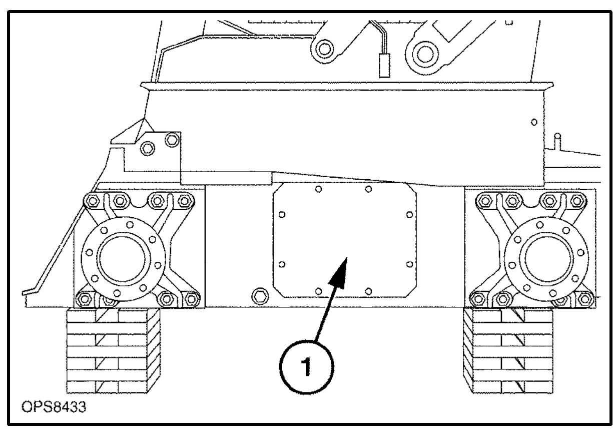
9. Remove the final drive cover, 1.



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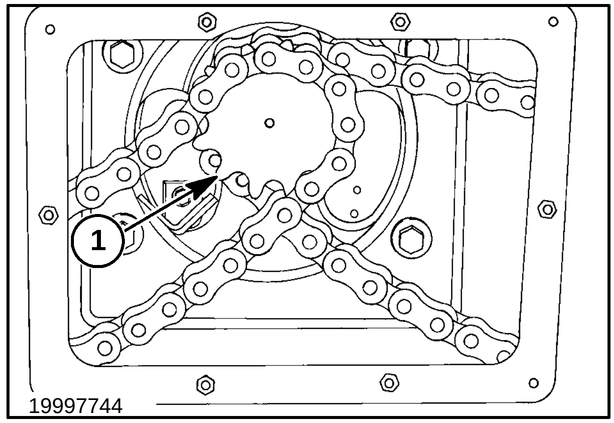
Drive Chain and Sprocket Removal

10. Remove the drive chains from the drive sprocket, 1.

NOTE: *In order to remove the chain and driven sprockets from the chain case, the gearbox must be loosened and moved toward the center of the machine. This will remove the interference of the double sprocket with the large driven sprockets. It is not necessary to remove the gearbox from the machine. Refer to "Gearbox Removal" in Section 27 for removal procedures.*



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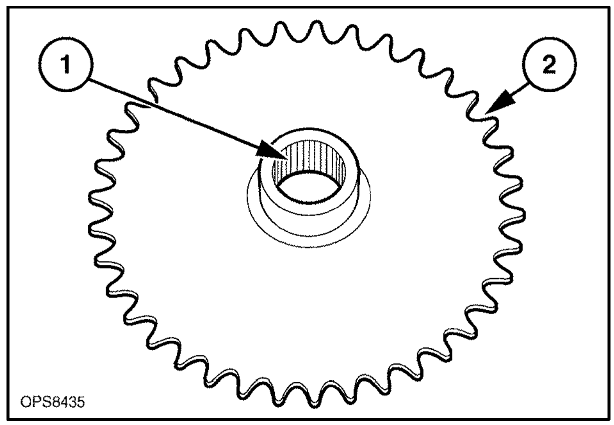
11. Roll the rear driven sprocket to the chain case opening, remove the chain from the sprocket and lift the sprocket from the chain case. Repeat for the front driven sprocket.

PARTS INSPECTION

Thoroughly clean all parts before inspection.

1. Inspect the drive sprockets in the center spline area, 1, for excessive wear and the tooth area, 2, for wear.



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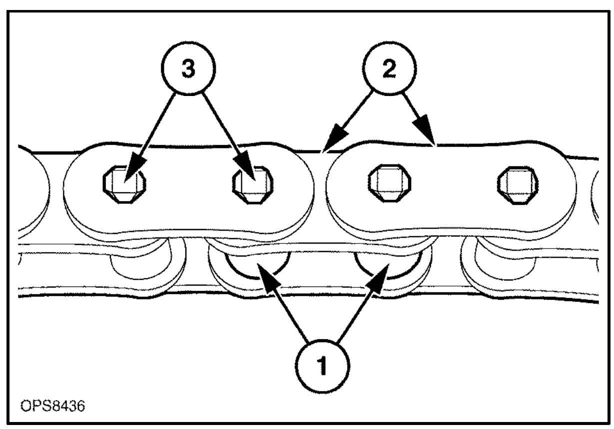
2. Inspect the drive chains for broken or cracked rollers, 1.
3. Inspect the drive chains for cracked or broken side bars, 2.
4. Inspect the side-bar-to-pin wear or looseness at 3.
5. Inspect the drive chains for excessive stretch (bushing wear).



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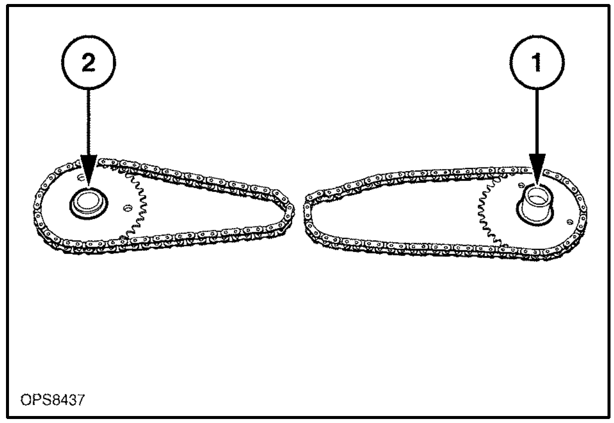
REASSEMBLY

1. Clean all surfaces which require resealing of old silicone sealer, dirt, etc.
2. If replacing the oil, it will have to be syphoned from the chain case. Thoroughly clean the inside of the case to remove all debris.
3. If removed, place the chains into the chain case. Install the front chain (the longer chain) into the case first.
4. Place the front driven sprocket into the chain case with the longer center hub, 1, to the outside of the case.

NOTE: *The driven sprockets are not centered in the chain case. The front sprocket is installed with the longer hub, 1, to the outside of the machine and the rear driven sprocket is installed with the short hub, 2, to the outside.*



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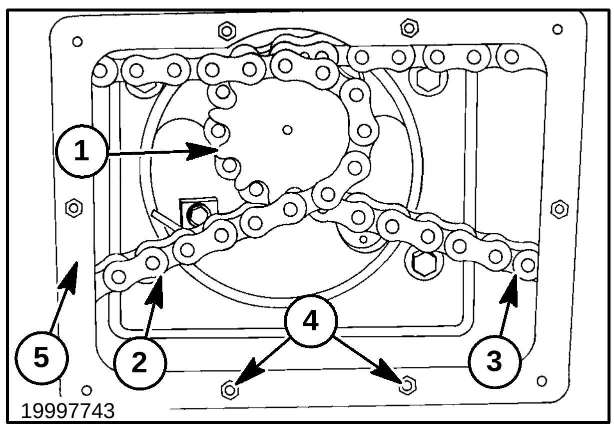
5. Install the longer chain on the large sprocket and roll it into position.
6. Place the rear driven sprocket in the chain case, install the shorter chain and roll it into position.

NOTE: *The LS180 front chains are longer than the rear chains. The LS190 front and rear chains are the same length.*

7. Reinstall the gearbox.
8. Install the drive chains onto the gearbox drive sprocket, 1 with the front chain, 2, to the inside and the rear chain, 3, to the outside.
9. Fill the chain case with SAE 80W-90 API Service GL-5 gear oil to the bottom edge of the lower two threaded holes at 4.
10. Clean all sealer and oil from the chain case cover mating area at 5.



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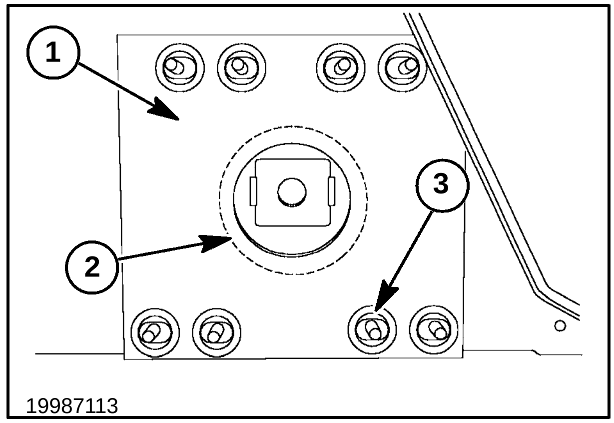
11. If there are signs of oil leaking out of the bottom of the axle housing, the oil may be escaping between the final drive case sheet and the outer reinforcing plate. The reinforcing plate, 1, has a narrower opening than the drive case sheet, 2. If the loader frame is welded between the reinforcing plate and drive case sheet, the case should not leak. To seal off this area and prevent leaks, clean the final drive case around the pilot mating area, 2, and around the studs, 3, with an appropriate cleaner. Place a bead of silicone sealant (such as part #L58775), around the side sheet mating area, 2, and the studs, 3.



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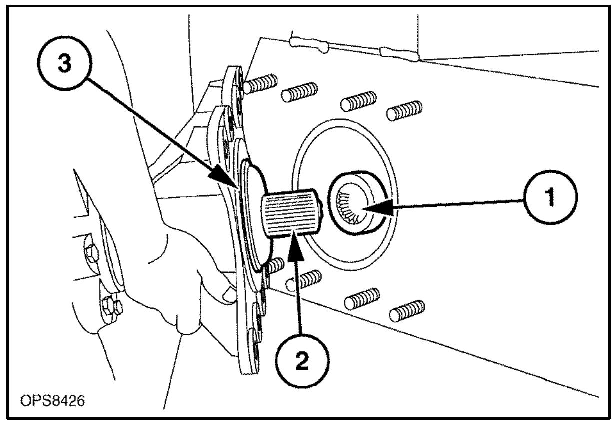
NOTE: *When installing the final drive case, the case must lay flat against the frame and the pilot must rest on the edge of the frame opening.*

12. Position the drive sprocket, 1, in the axle opening. Make sure the drive sprocket is placed in the drive chain properly.

NOTE: *When installing a rear final drive case, the rear drive sprocket will stay in place better with the front of the loader raised.*

13. Lift the axle housing assembly and mate the splines on the axle shaft, 2, and the drive sprocket and slide together. Lifting the axle housing assembly over the retaining studs, pilot the center of the housing, 3, into the hole in the case and slide the housing tight against the case.



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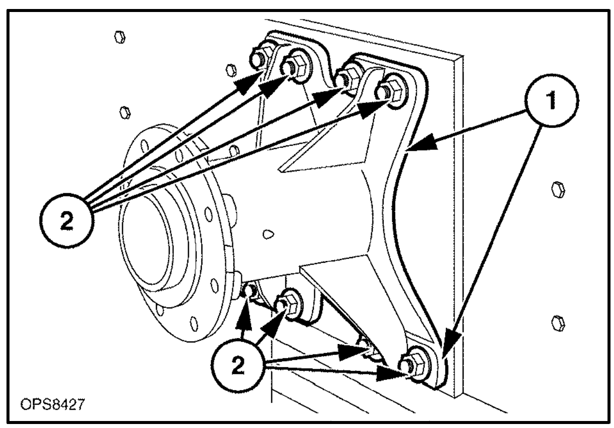
14. With the axle housing, 1, tight against the case, install the retaining nuts and flat washers, 2, to hold the housing against the case.
15. Slide the axle housing assembly to tighten the drive chains.

NOTE: *The chains are properly tensioned when there is 0 to 6 mm (0″ to 1/4″) movement at the outer edge of tire tread.*

16. Torque the axle retaining hardware to 140 ft. lbs. (190 N·m).



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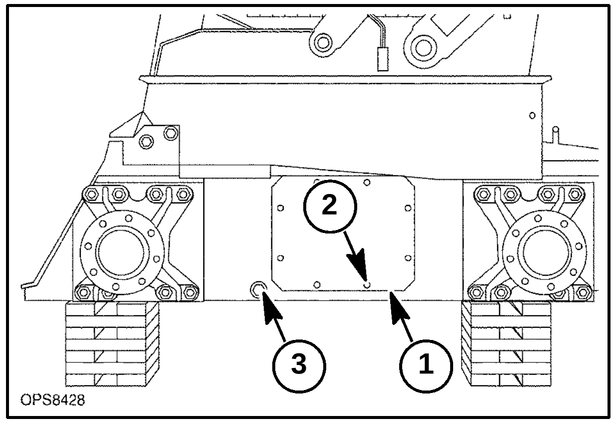
CAUTION

When tightening the axle retaining hardware, the axle housing must be tight against the case at 1, or damage to the case may occur.

17. Place a continuous bead of sealer around the perimeter of the chain case cover hole, 1, and to the bottom of the heads on the cover retaining bolts, 2. Install the cover and eight retaining bolts. Torque to 11 ft. lbs. (15 N·m).
18. Check the final drive oil level at the check plug, 3. Add SAE 80W-90 API Service GL-5 gear oil as required.
19. Reinstall all shields removed for this repair.



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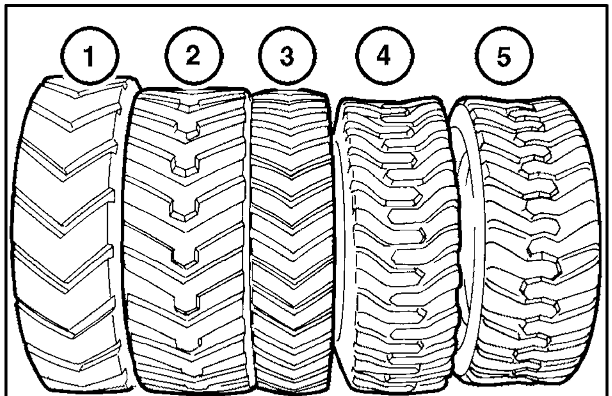
TIRES/WHEELS



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TIRE OPTIONS

1. 8.25 x 15 HST-Hollow segmented
2. 12.00 x 16.5 HST-Hollow segmented
3. 8.25 x 15 Chevron tread
4. 12.00 x 16.5 R4-Cleat tread
5. 12.00 x 16.5 PHD- Premium heavy-duty
6. 14.00 x 17.5 cleat tread (not shown)
7. Solid Tires (not shown)

NOTE: *Solid tires are available and can be obtained from your New Holland dealer.*

Tire Pressures

Tire	Pressure
8.25 x 15 Chevron tread	50 PSI (414 kPa)
7.50 x 15 HST-Hollow segmented	N/A
12.00 x 16.5 R4-Cleat tread	50 PSI (345 kPa)
12.00 x 16.5 PHD- Premium heavy-duty	50 PSI (345 kPa)
12.00 x 16.5 HST-Hollow segmented	N/A
14.00 x 17.5 - cleat tread	60 PSI (410 kPa)

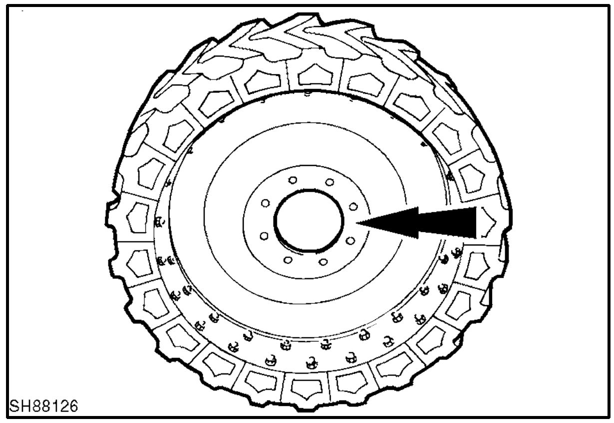
MAINTAIN PROPER TIRE INFLATION!

NOTE: *Iatco “Air Boss” segmented tires are approved for all new generation New Holland loader models. These tires must be mounted with the wheel dish “in” to the frame (narrowest wheel tread position). Reversing the wheels with the dish “out” is not recommended, as increased axle and frame loading occurs, which may lead to eventual axle bearing and/or main frame failure.*

TIRE AND TRACK INSTALLATION

Tire Installation on Loader

The 8.25 x 15 HST-Hollow segmented and the 12.00 x 16.5 HST-Hollow segmented tires must be mounted with the wheel dish “IN” to the frame (narrowest wheel tread position). Reversing the wheels with the dish “OUT” is not recommended, as increased axle and frame loading occurs. This may lead to eventual axle bearing and/or main frame failures.



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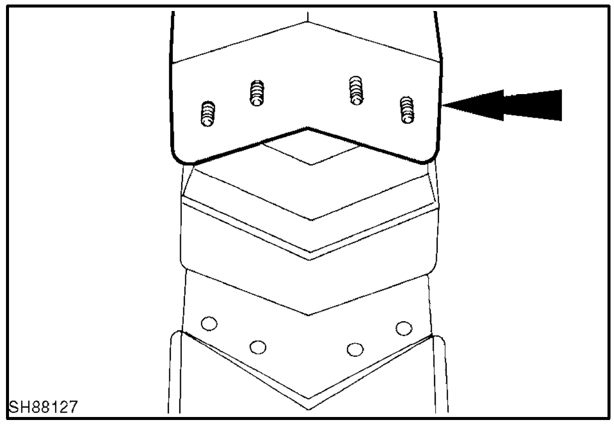
When replacing the sections of the hollow segmented tires, torque the section hardware to 10 ft. lbs. (13.6 N·m).



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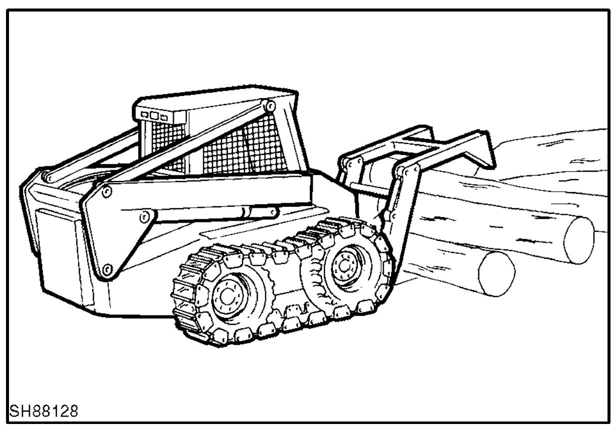
Track Installation on Loader

Correct tire/track combinations are important to prevent damage to the tracks, tires/wheels, and loader main frame.

Installing tracks on skid steers equipped with segmented tires, solid tires, foam-filled tires, or any hard-type non-pneumatic tires is not recommended. If these tire combinations are used with steel tracks, track or loader main frame damage may occur.

These tires **do not** provide a cushion when debris comes between the track and tire. A pneumatic tire will absorb this type of stress and, in severe cases, may deflate before damage to the loader or track occurs.

New Holland only recommends pneumatic tires be installed with tracks.



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IMPORTANT: *Tracks are not to be installed on the Lx985 skid steer loaders equipped with 14.00 x 17.5 tires. The tracks will interfere with the fenders, boom, and attachments.*

LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
General	
Jack up machine and secure on blocking	0.5 hr.
Axle	
Remove and replace Includes R & R wheel, axle assembly and adjust chain tension	0.5 hr.
Rebuild Includes inspecting and installing bearings and races, installing new seals, and adjusting end play	1.0 hr.
Final Drive Case	
Drive chain, sprocket (front) - replace	10 hrs.
Drive chain, sprocket (rear) - replace	10 hrs.
Drive chain, sprockets (both) - replace (includes moving gearbox)	12 hrs.

SECTION 50 – CAB CLIMATE CONTROL

Chapter 1 – Heater/Defroster

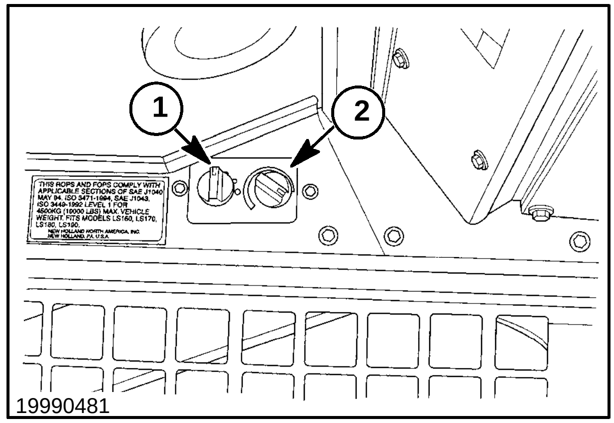
CONTENTS

Op. 50 100

HEATER/DEFROSTER (CAB)

Switch and Control Panel

1. Disconnect the negative (-) battery cable to prevent possible shorting of the electrical system.
2. Remove the retaining hardware, 1, and pull the panel from the rear support, 2.
3. Disconnect the switch wires and control cable.



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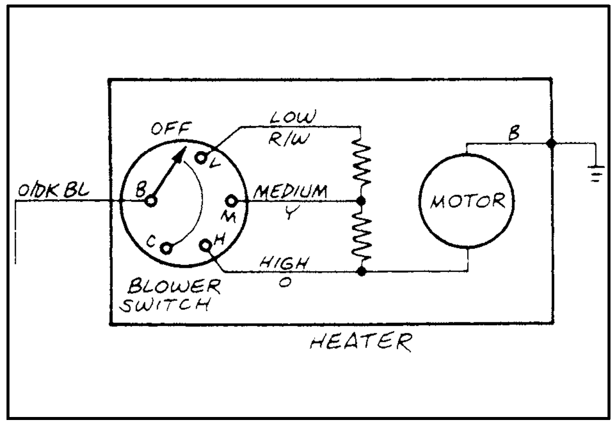
Switch Wiring

The heater switch, 1, has four terminals marked, L, M, H, and B, that the wire harness must be connected to.

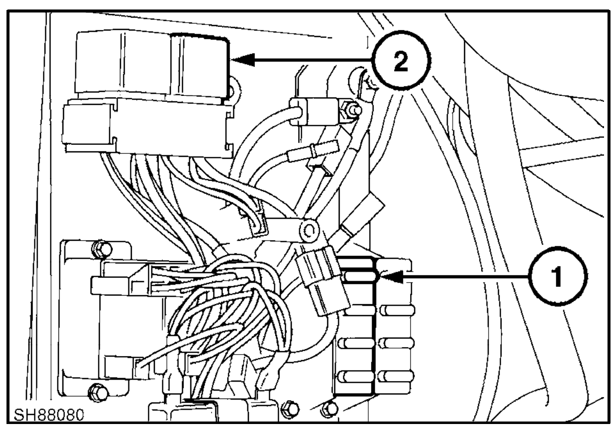


2

Relay and Fuse Block

1 - Fuse block - 20 amp

2 - Relay



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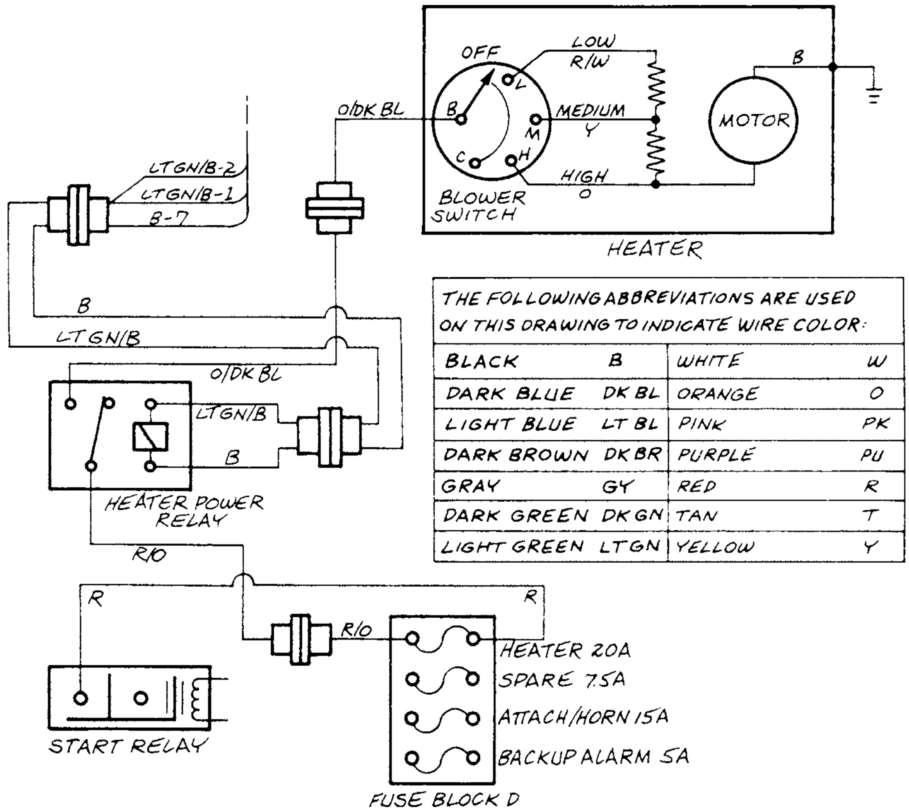


THE FOLLOWING ABBREVIATIONS ARE USED ON THIS DRAWING TO INDICATE WIRE COLOR:

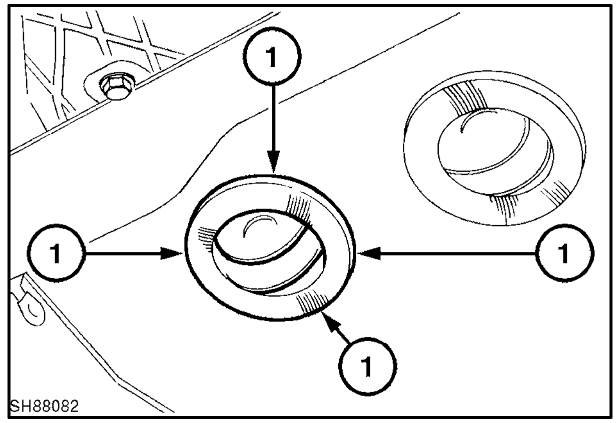
BLACK	B	WHITE	W
DARK BLUE	DK BL	ORANGE	O
LIGHT BLUE	LT BL	PINK	PK
DARK BROWN	DK BR	PURPLE	PU
GRAY	GY	RED	R
DARK GREEN	DK GN	TAN	T
LIGHT GREEN	LTGN	YELLOW	Y

Heater Wiring Diagram

4

Louver Replacement

1. To remove the louver, use a small flat screwdriver and pry the louver from the support base at 1.



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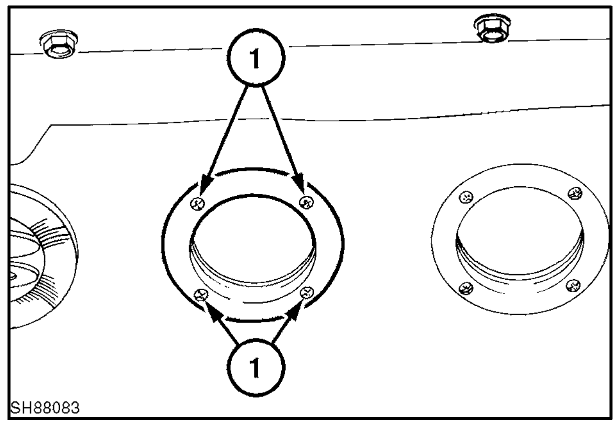
2. Remove the #6 self-tapping screws, 1, from the base and remove the base from the headliner.



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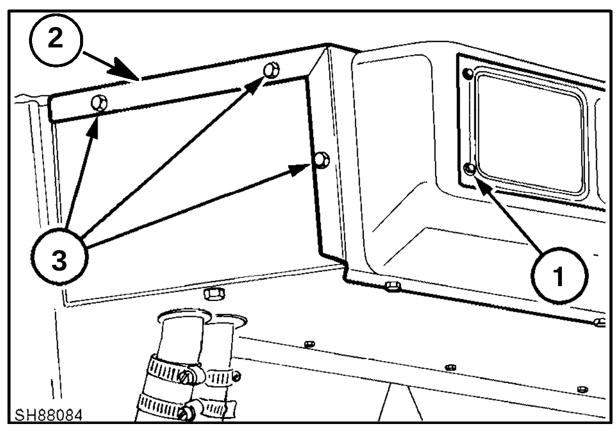
Heater Core, Shutoff Valve and Fan Assembly Access

To access the heater core and/or fan assembly, the rear light bar, 1, (if equipped with lights) and top heater cover, 2, must be removed. Remove the heater cover mounting screws, 3, to remove the cover and light bar together.



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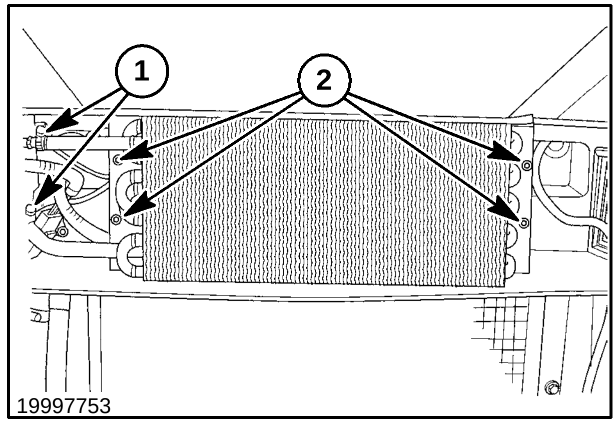
Heater Core Replacement

1. Drain the cooling system enough to drain the coolant from the core, about 2 liters (2 quarts).
2. Remove the heater hose clamps, 1, from the heater core, remove the hoses from the core and cap hoses.
3. Remove the heater core retaining hardware, 2, and remove the core from the heater support.



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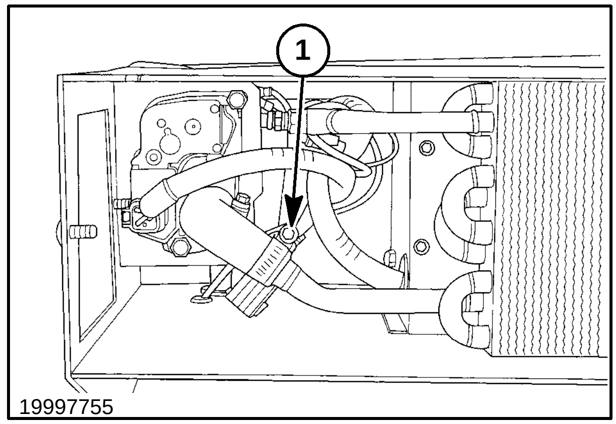
Op. 50 104 23

Heater Shutoff Valve Replacement

1. Drain the cooling system enough to drain the coolant from the core, about 2 liters (2 quarts).
2. Remove the control cable from the valve.
3. Remove the heater hose clamp, 1, from the heater shutoff valve and remove the hoses from the valve and cap hoses.
4. Remove the heater shutoff valve, 2.

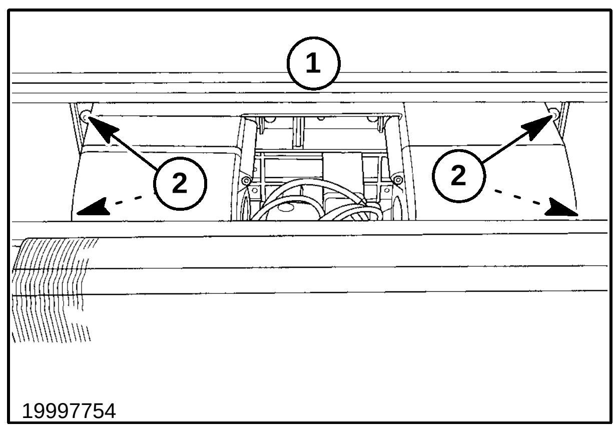


9

Op. 50 104 20

Heater Fan Assembly Replacement

1. Remove the heater core retaining hardware and pivot the core away from the fan support.
2. Disconnect the fan power wire, 1.
3. Remove the retaining hardware for the fan and motor assembly, 2.



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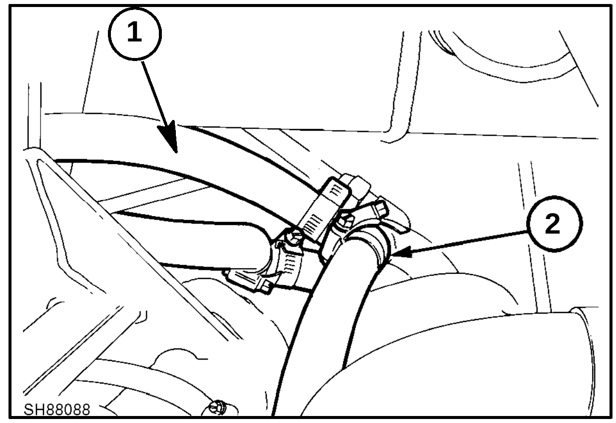
Op. 50 100 10

Heater Hose to Engine Connections

1. The pressure side heater hose, 1, tees into the engine line, 2, from the water pump to the engine oil cooler at the flywheel end of the engine.



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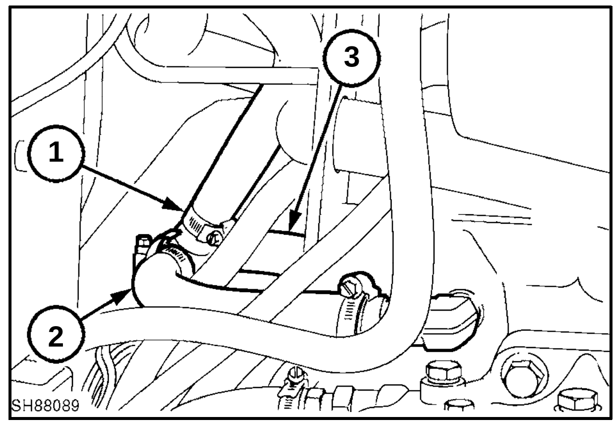
2. The return side heater hose, 1, tees into the engine line, 2, from the engine oil cooler to the engine head at the flywheel end of the engine.

NOTE: *To purge the air from the heater core and hoses, temporarily “pinch off” the oil cooler supply hose at 3. This will force coolant through the heater core and hoses, removing the air from the system.*

IMPORTANT: *Do not install a shutoff valve or orifice in the oil cooler supply hose. Restricting coolant flow to the engine oil cooler may result in overheating and engine failure.*



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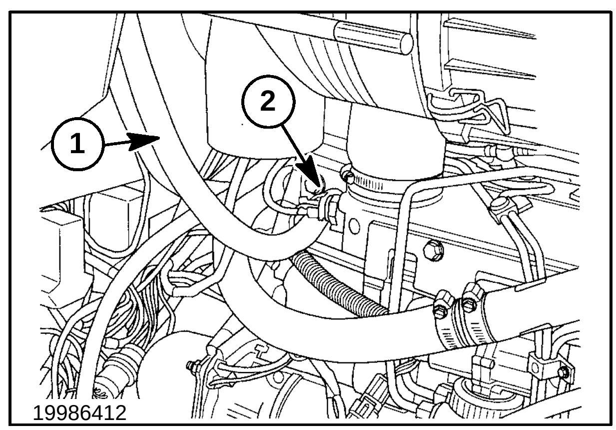
The return side heater hose, 1, attaches to the engine head, 2, with a hose adapter.

NOTE: *Use Teflon tape on the threads of the engine head adapter pipe fitting connection.*



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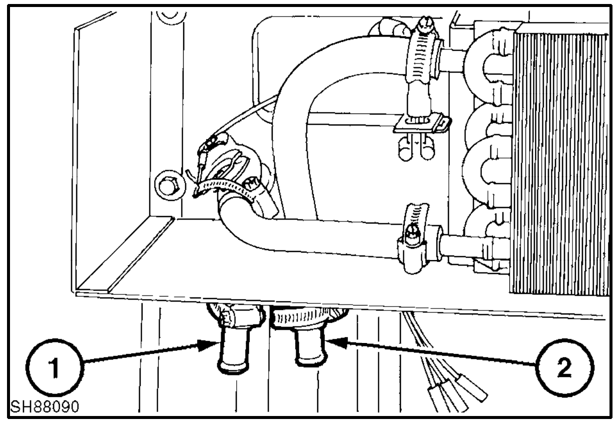
Heater Core Connections

Connect the pressure hose to the left side hose, 1, and the return hose, 2, to the right side. Secure with hose clamps. The hoses from the engine will have to be cut to length for proper fit.



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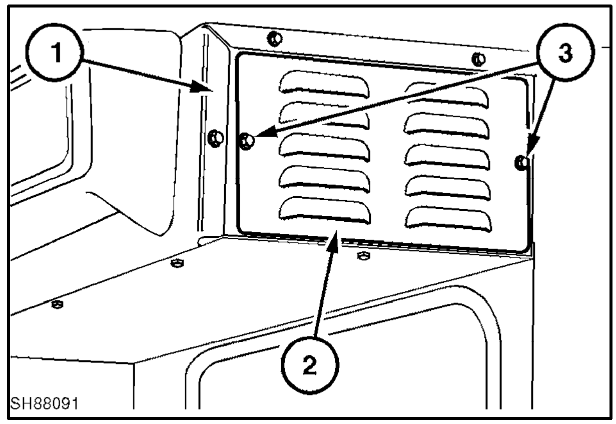
Filter

Replacement filter #86504784

The heater contains an air filter element in the rear right side at 1.

Remove cover plate, 2, by removing two self- tapping screws, 3.



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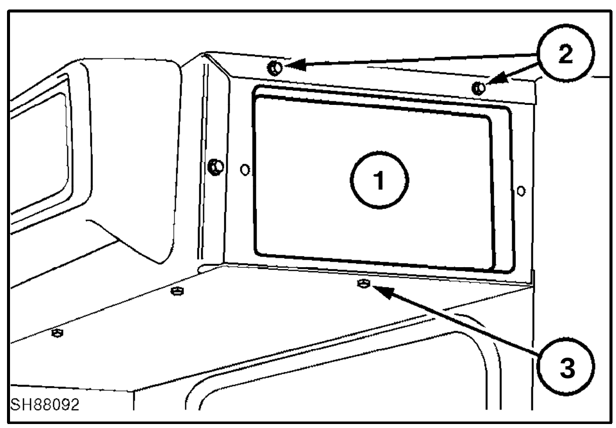
Check the filter element, 1, periodically, especially if running in dirty applications and using the fresh air ventilation. The element can be blown off with a **low-pressure** air gun and reused or replaced. The element must be placed with the rubber seal toward the heater core. Be sure the seal is behind the top clamp, 2, and lower screw, 3.



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LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
Heater/Defroster	
Remove and replace electrical switch	0.25
Remove and replace water shutoff switch	1.5
Remove and replace heater core	1.5
Remove and replace heater fan assembly	1.5
Remove and replace heater hoses (1)	0.5

SECTION 55 – ELECTRICAL SYSTEM

Chapter 1 – Advanced Warning System, Circuits, Alternator, and Starter

CONTENTS

Op. 55 000

GENERAL ELECTRICAL INFORMATION

The electrical system is a 12-volt negative (-) ground system that provides battery voltage to the Electronic Instrument Cluster (EIC), starting circuit, and other electrical components.

The electrical system is made up of the following components (with their functions):

1. Battery - Power supply and storage.
2. Alternator/Regulator - Power supply and source to maintain fully charged system.
3. Starter motor - To crank engine for starting.
4. Ignition switch - Used to control electrical circuits and direction of battery voltage.
5. Electronic Instrument Cluster (EIC)
   - Monitors engine and operator functions and signals operator of disruptions or faults in the circuits.
   - Displays monitored functions.
   - Controls engine fuel system (fuel shut off).
   - Provides engine shutdown if fault occurs in engine oil pressure or hydrostatic charge pressure circuits.
   - Provides safety interlock for the boom and bucket control valve spools.
   - Provides a diagnostic mode for checking EIC board circuits.
   - Provides an anti-theft mode to electrically lock the loader boom and bucket; the engine will start with the Service/Run switch in the “SERVICE” position.
6. Fuse blocks/ fuses/ circuit breakers, cab and engine - Used to protect the electrical circuits and manifold heater circuit.
7. Manifold Heater (Thermo-Start) - Used to provide aid in cold engine starting.
8. Fuel solenoid - Controls fuel flow and is controlled by the EIC.
9. Switches - Used to control other electrical circuits, lights, etc.

IMPORTANT: *Do not connect any electrical circuits at the ignition key switch or cab fuse block(s) unless there are written instructions telling you to do so or damage to the EIC board may occur.*

IMPORTANT: *If any servicing or adjustments require the battery to be disconnected, or welding is required on the skid steer, disconnect the negative (-) ground cable. Failure to disconnect the battery may result in damage to the EIC (electronic instrument cluster) monitoring system and other electrical components.*

IMPORTANT: *If the EIC requires removal from the dash area or the skid steer, disconnect the negative (-) ground battery cable. This will shut off power to the EIC and prevent damage to the EIC board, or prevent blowing the 5-amp fuses if the board is accidentally grounded.*

DEFINITION OF TERMS

ALTERNATING CURRENT (A.C.) - A flow of electrons which reverses its direction of flow at regular intervals in a conductor.

AMMETER - Measures the flow of electrical current in amperes. Ammeters are connected in series with the circuit to be tested.

AMPERE - A unit of measure for the flow of current in a circuit. The ampere is used to measure electricity such as “gallons per minute” is used to measure liquid flow.

CIRCUIT - A continuous, unbroken path along a conductor through which electrical current can flow from a source, through various components, and back to the source.

CIRCUIT BREAKER - A device to protect an electrical circuit from overloads and can be reset, or will automatically reset.

COLD CRANK RATING (CCA) - The cranking load capacity of a battery at low temperatures (cold cranking amperes at 0°F).

CONTINUITY - Unbroken path along a conductor through which electrical current can flow.

CURRENT - Movement of electricity along a conductor. Current is measured in amperes.

DIODE - An electrical device that will allow current to pass through itself in one direction only.

DIODE (RESISTOR TYPE) - An electrical device that will allow current to pass through itself in one direction only and will cause resistance as the electricity passes through. The electricity coming from this type diode will be less than what is going in.

DIRECT CURRENT (D.C.) - A flow of electrons moving in the same direction along a conductor from a point of high potential to one of lower potential.

FUSE - A device to protect an electrical circuit from overloads that needs to be replaced when blown.

OHM - The standard unit for measuring resistance to flow of an electrical current.

OHMMETER - An instrument for measuring the resistance in ohms of an electrical circuit.

OPEN CIRCUIT - An open circuit occurs when a circuit is broken which interrupts the flow of current through the circuit.

RELAY - An electrical switch which opens and closes a circuit automatically when activated.

RESISTANCE - The opposing force offered by a circuit. Resistance is measured in ohms.

SHORT CIRCUIT - A part of a circuit that comes in contact with part of the same circuit or unintentionally touches a metallic object.

SOLENOID - A circular coil used for producing a magnetic field.

SWITCHES - A device used to control and direct current to circuits and will remain in this position until changed.

SWITCHES (MOMENTARY) - Momentary switches are used to direct current to circuits and these switches will return to the neutral position when released.

VOLT - A unit of electrical pressure which caused current to flow in a circuit.

VOLTAGE - The force which is generated to cause current to flow in an electrical circuit. Voltage is measured in volts.

VOLTMETER - An instrument for measuring the force in volts of electrical current. Voltmeters are connected in parallel to the points where voltage is to be measured.

The following are common terms used in electrical diagnostics and how they may affect the circuit and electrical components.

The term “OPEN CIRCUIT” means there is no voltage getting from the control point to the operating point. This means the wire carrying the voltage is open/broken and voltage cannot continue to flow. The effect is the operating component will not function.

The term “SHORT CIRCUIT” means there is voltage being lost to another component wire or to ground. This could result in the wrong component being operated or the blowing of the circuit protection device (fuse or breaker).

The term “GROUNDED CIRCUIT” means the voltage is going directly to ground and usually results in no component operation and/or blown fuse-breaker.

To test for an “OPEN CIRCUIT,” use a volt/ohm meter and check from one end of the wire to the other. If voltage is not present, trace the circuit from control point to operating point until the open is found.

To test for a “SHORT CIRCUIT,” use a volt/ohm meter and check for very low resistance in different parts of the circuit or continuity between the circuit wire and ground.

To test for a “GROUNDED CIRCUIT,” use a volt/ohm meter and check for continuity between the circuit wire and ground.

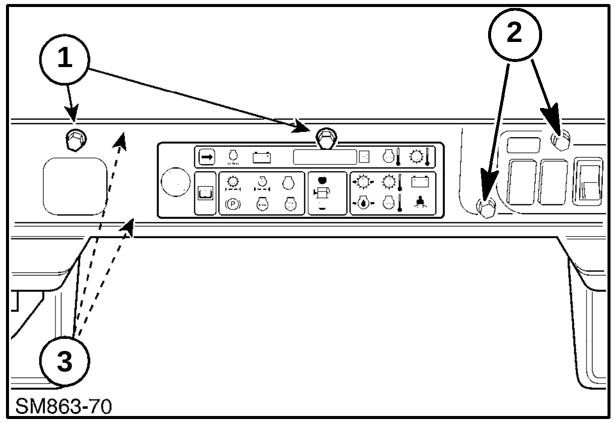
The following chart shows the abbreviations for the various wire colors used to identify the electrical circuits.

Wire Abbreviations to Indicate Wire Color

WIRE COLOR	DESIGNATION	WIRE COLOR	DESIGNATION
Black	B	White	W
Dark Blue	DKBL	Orange	O
Light Blue	LTBL	Pink	PK
Dark Brown	DKBR	Purple	PU
Gray	GY	Red	R
Dark Green	DKGN	Tan	T
Light Green	LTGN	Yellow	Y

Drilling Holes In Overhead Dash, Electronic Instrument Cluster (EIC) Board, and Ignition Switch Area

Always install the rearview mirrors as shown in the mirror instruction sheet. Otherwise, you must unhook the negative battery cable and remove the EIC board panel, 1, and ignition switch panel, 2, from the overhead dash. If holes and attaching screws are installed into the dash area, 3, make sure the screws will not contact the EIC board, the ignition switch, or wiring, as electrical system damage will occur.



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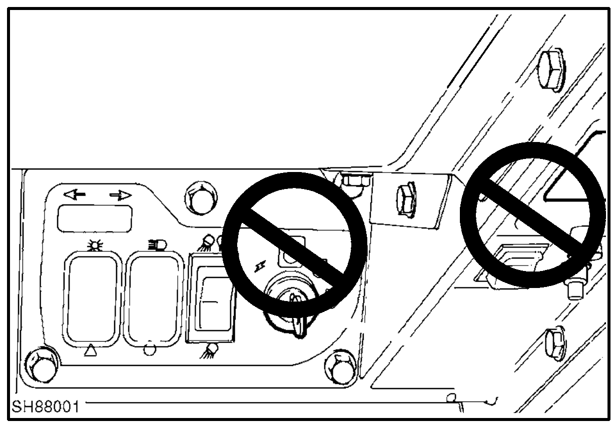
***IMPORTANT**: Failure to unhook the negative battery cable before removal of the EIC board or switch may result in an accidental grounding, causing component damage.*

***IMPORTANT**: Retaining hardware contacting the EIC board or switch may cause an electrical short, damaging the loader electrical system.*

ADAPTING ATTACHMENTS REQUIRING 12V ELECTRICAL POWER

There are important rules that must be followed when adapting attachments that require 12 volt electrical power. Proper wiring of electrical devices and power and ground connections is very important to prevent other electrical component damage. Attaching electrical connections to locations other than recommended may allow electric current to feed back through the EIC board, creating false EIC board readings and warnings, or causing EIC board damage or failure.



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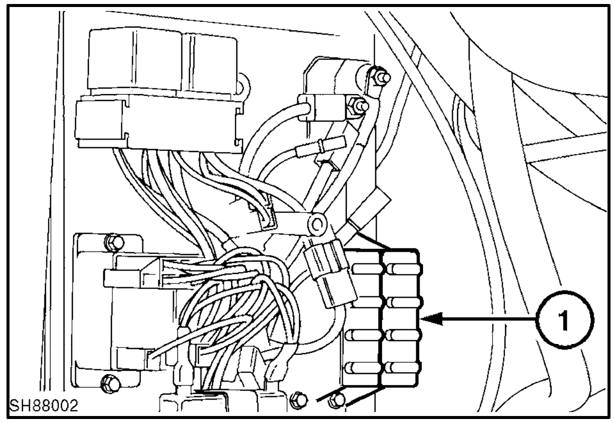
1. ALWAYS FOLLOW the instructions for New Holland kit installation to ensure proper function and operation.
2. NEVER CONNECT an electrical device to any wires, fuses, switches or grounds inside the cab area. This includes any terminals of the ignition switch, fuse panel, or ground terminal.
3. NEVER INSTALL an electrical device, music radio, two-way radio, or unapproved New Holland attachment into the cab area.
4. ONLY USE the 12-volt accessory power outlet for attachments requiring less than 10 amps. The accessory outlet is connected to the engine fuse/relay panel and protected with a 15 amp fuse.

5. ALWAYS CONNECT new electrical attachments to the engine fuse/relay panel, 1, and connect the grounds to the engine bell housing. USE ONLY vacant connections and fuses not in use for specified attachments.



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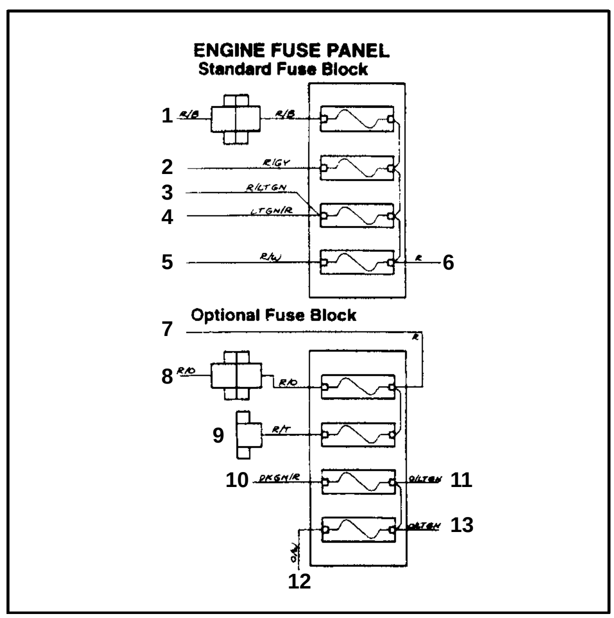
Engine Fuse Panel

The wires and connections listed below are available providing electrical attachments were not previously installed.

Ref.	Color	Destination	Fuse	Battery Voltage	Status
1	R/B	To turn signal relay	10-amp	All times	Available
2	R/GY	To accessory relay	25-amp	All times	Available
3	R/LTGN	To EIC board pin #14 P2 connector	5-amp	All times	Occupied
4	LTGN/R	To seat switch(es)	5-amp	All times	Occupied
5	R/W	To key switch (battery terminal)	15-amp	All times	Occupied
6	R	From preheat circuit breaker	20-amp	All times	Occupied
7	R	From start relay		All times	Occupied
8	R/O	To heater power relay	20-amp	All times	Available
9	R/T	Spare	7.5-amp	All times	Available
10	DKGN/R	To high flow, horn, power outlet	15-amp	Key “ON” position	Available
11	O/LTGN	From accessory relay		Key “ON” position	Occupied
12	O/W	To Back-up alarm switch	5-amp	Key “ON” position	Available
13	O/LTGN	From road/work light fuse (cab panel)		Key “ON” position	Occupied



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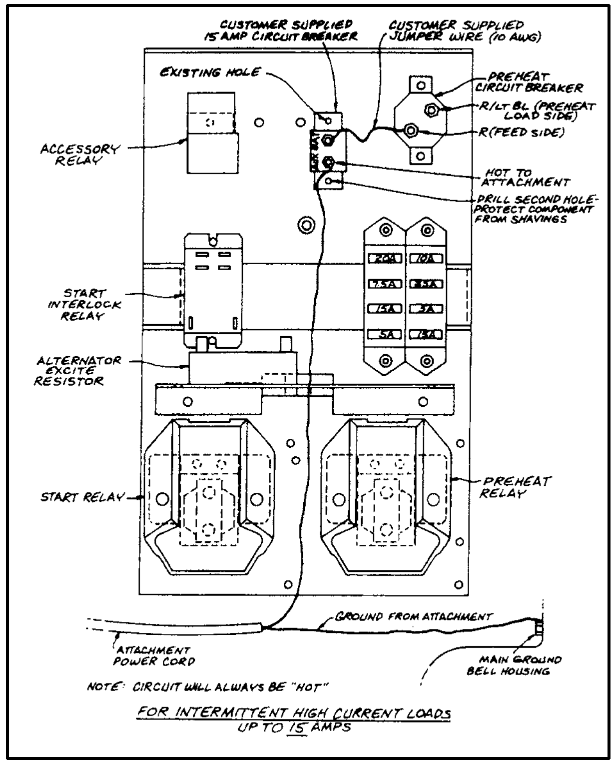
Different types of wire connectors are used on these circuits and suitable connectors will need to be used on the attachment/device for proper power supply connection.

Complete new auxiliary wiring circuits can be installed as shown here, depending on electrical requirements.

Mounting holes for the added circuit breakers must be drilled in the panel. Disconnect the battery before drilling and installing new wiring. Protect the panel parts from drill shavings that could cause electrical shorting of components.

Suggested sealed circuit breakers are:

Part Number	Capacity
9827329	15-amp
9828493	20-amp
9840279	25-amp
9840280	30-amp



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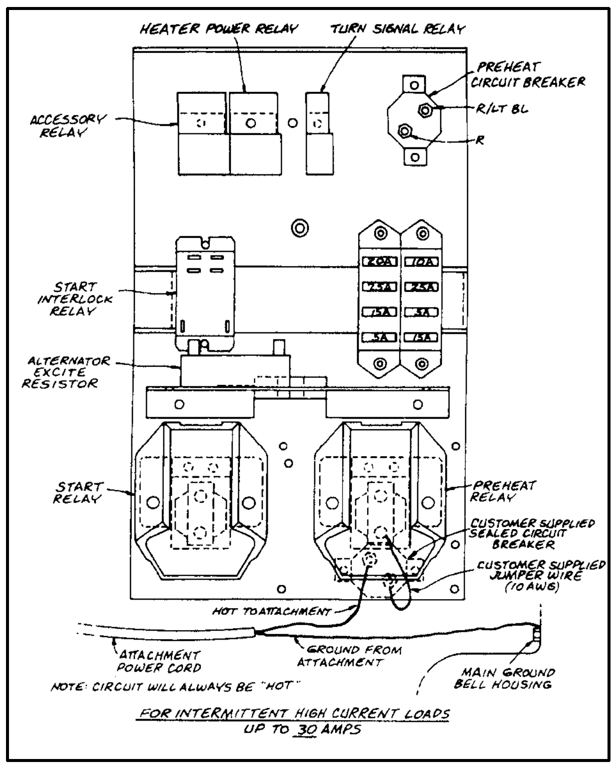

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SPECIFICATIONS

Alternator . . . . . . 45 amp

Tachometer output . . . . . . 5 to 6.5 AC Volts

LS180 Battery (1) . . . . . . BCI PC31 - 12 volt - 925 amps @ -18°C (0°F) Top stud

LS190 Batteries (2) . . . . . . BCI 35/75 - 12 volt - 650 amps @ -18°C (0°F) Top stud

System Ground . . . . . . Negative (-)

Protection . . . . . . Fuse blocks in cab and engine areas

Cab panel (standard)
- Fuel pump 7.5A
- Electronics ignition 5A
- Wiper 7.5A
- Lights (road/work) 15A

Engine panel (standard)
- Turn signals 10A
- Accessory 25A
- Electronic (EIC) 5A
- Key main 15A
- Preheat circuit breaker 50A

Cab panel (optional equipment)
- Beacon light 7.5A

Engine panel (optional equipment)
- Heater 20A
- Spare 7.5A
- Attach/Horn 15A
- Backup alarm 5A

Electronic Instrument Cluster (EIC)
- Low voltage . . . . . . EIC will fault at 11.9 volts (low)
- High voltage . . . . . . EIC will fault at 16.5 volts (high)

Fuel gauge sensor resistance
- Full tank . . . . . . 35 ohms
- Empty tank . . . . . . 240 ohms

Fuel shutoff solenoid
- Pull-in amperage . . . . . . 1.2 to 1.5 amps
- Hold-in amperage . . . . . . 1.2 to 1.5 amps

Engine air filter sensor . . . . . . Switch is normally closed
EIC will fault at 1.6″ Mercury or 22″ Water

Engine coolant temperature sensor . . . . . . EIC will read “COLD” until 0°C (32°F)
EIC will fault at 102°C (216°F)

Engine coolant temperature sensor resistance . . . . . . At 20°C (68°F) 2.21-2.69 K ohms
At 0° - 30°C (32° - 86°F) 1.65-5.88 K ohms

Engine crankcase oil pressure . . . . . . EIC will fault at 0.68 bar (10 PSI)

NOTE: *The EIC will not alarm unless coolant temperature is above 64° F or two minutes have passed since starting.*

Hydraulic oil temperature sensor . . . . EIC will read “COLD” until 0°C (32°F)
EIC will fault at 99°C (210°F)

Hydraulic oil temperature sensor resistance . . . . At 20°C (68°F) 2.21-2.69 K ohms
At 0° - 30°C (32° - 86°F) 1.65-5.88 K ohms

Hydraulic oil filter sensor (differential between in/out) . . . . Switch normally closed
EIC will fault at 2.7 ± 0.27 bar (40 ± 4 PSI)
EIC will reset at 2.0 bar (30 PSI)

NOTE: *This alarm is locked out until the oil temperature is at 110° F. The switch must be open for over 5 seconds to alarm.*

Hydrostatic charge pressure . . . . EIC will fault at 3.4 bar (50 PSI)

Manifold heater resistance . . . . 0.97 to 1.18 ohms

Solenoid (boom and bucket spool lock) resistance . . . . 15 to 18 ohms

Starter Switch . . . . Key start and relay

Headlights and rear work lights . . . . 37.5 watt halogen
NH#86533429

Taillights (road) . . . . 37.5 watt halogen
NH#86505510

Amber Flasher lights . . . . Sealed
NH#529068

Electronic Instrument panel indicator lamp . . . . 0.080 amp C-2F
NH#86502182

ALTERNATOR SERVICE SPECIFICATIONS (45 AMP)

Item	How Rated	Standard Or Service Limit
Normal Output	(V - A)	12 - 45
Polarity		Negative ground
Weight	(kg, lbs.)	3.7 kg (8.2 lbs.)
Rotational direction (viewed from the pulley)		Clockwise
Load characteristics (cold)	Terminal voltage (V)	13.5
	Current (A)	Min. 30
Brush length	Original (mm-in)	20 mm (0.80″)
	Limit (mm-in)	5.0 mm (0.20″)
Brush spring tension	Original (n-oz)	2.7 n (10 oz.)
	Limit (n-oz)	1.3 n (5 oz.)
Rotor field resistance		2.9 ± 0.5 ohms
Stator field resistance	ohms at 20°C (68°F)	0.2 ohms

TORQUE SPECIFICATIONS (ALTERNATOR)

Alternator through bolts	5.5 N·m (4.0 ft. lbs.)
Pulley retaining nut	70.0 N·m (52.0 ft. lbs.)
Rectifier retaining screws	4.0 N·m (3.0 ft. lbs.)
Regulator and brushbox screws	2.7 N·m (2.0 ft. lbs.)
Terminal nuts	2.7 N·m (2.0 ft. lbs.)

STARTER MOTOR SPECIFICATIONS (12 VOLT)

Rated voltage	12 volts
Output	3.1 kw
Motor type	Four-pole series wound motor
Engaging system	Solenoid-engaged pinion
Rotation	Clockwise (viewed from pinion side)

STARTER SERVICE SPECIFICATIONS

No load test	11.5 volts, 170 amps, 8000 RPM
Locked rotor test	6.8 volts, 1200-1400 amps, 35 N·m (26 ft. lbs.) torque
Solenoid holding voltage, minimum	8.0 volts
Commutator diameter	45 mm (1.77″) - new 42.5 mm (1.67″) - minimum
Commutator brush, minimum length	8.5 mm (0.33″)
Armature end play	0.1 - 0.3 mm (0.004″ - 0.012″)
Pinion tooth backlash	0.4 - 0.7 mm (0.016″ - 0.028″)

ELECTRICAL DIAGRAM

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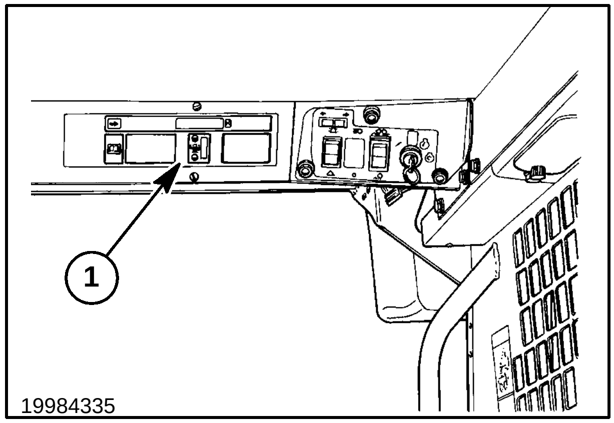
ADVANCED WARNING SYSTEM

ELECTRONIC INSTRUMENT CLUSTER (EIC)

The skid steer advanced warning system, 1, monitors engine functions and operator controls and reports conditions to the operator and provides safety interlocks to the hydraulic control valve spools to the boom and bucket.



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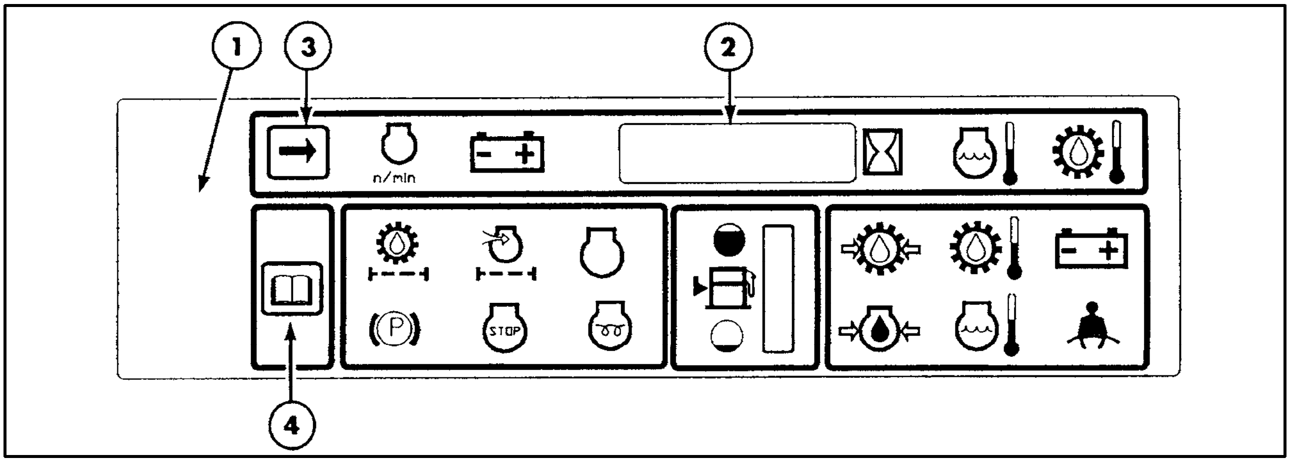
The instrument cluster has three kinds of visual displays: backlighted symbols, an LED character display, and a segmented bar graph.

The EIC (Electronic Instrument Cluster) board employs incandescent lamps to backlight symbols representing monitored functions. Active sensor symbols are backlighted with either yellow (WARNING) or red (FAULT). Inactive sensor symbols are visible as a dim gray outline when the backlighting is not active. An audible alarm accompanies most visual alarm lights.

The front panel of the instrument cluster has several components and display areas. Read the following paragraphs to understand each item and area.



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EIC (ELECTRONIC INSTRUMENT CLUSTER) FRONT PANEL

1. AUDIBLE ALARM

The audible alarm will sound if there is an unusual condition in any of the monitored areas. The audible alarm is located behind the front panel at 1.

2. CHARACTER DISPLAY

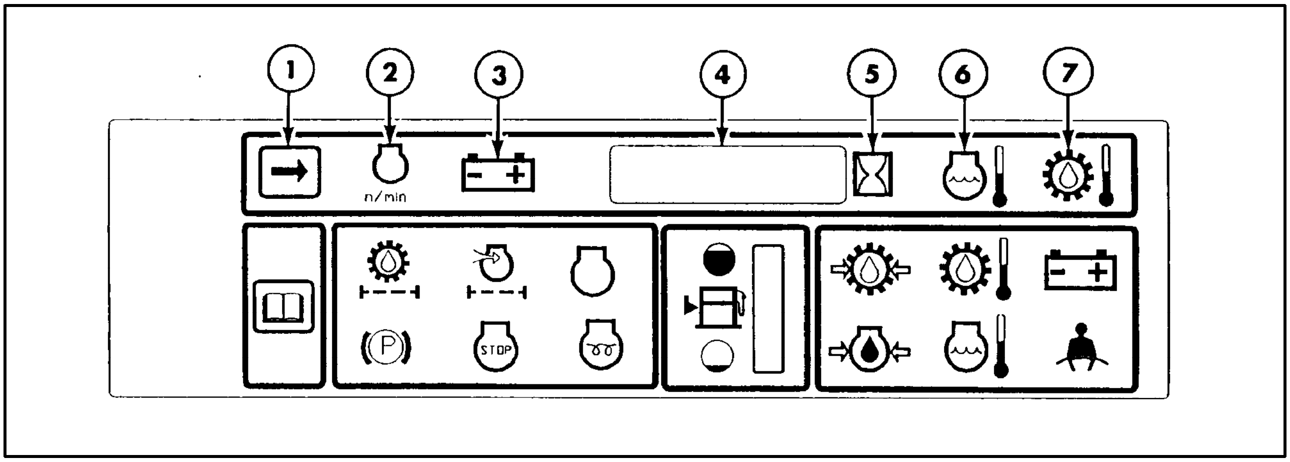
The character display will display the item that the operator has chosen to monitor. The display shows one function at a time. After the engine is started, the display defaults to the last function viewed at power off. Any of the other functions may be selected by the operator during operation by briefly pressing the “ARROW” selector switch, 3. When the EIC is turned off and then powered up, the display default will be the newly selected function.

3. RIGHT ARROW DISPLAY SELECTOR SWITCH

The display selector switch, covered with an “ARROW” symbol, will cause an audible “chirp” when pressed if the ignition key is in the “RUN” position. Pressing the “ARROW” symbol during operation will select the function that the operator chooses to monitor and will be displayed in the character display, 2. If a sensor causes a warning or fault, the appropriate lamp will flash, accompanied by an audible alarm. Pressing this switch also cancels any audible alarm that is sounding.

4. OPEN BOOK SELECTOR SWITCH

This selector switch covered with the symbol of an “OPEN BOOK” (instruction manual) is used to select other functional modes of the EIC panel. The “OPEN BOOK” switch has no function during normal operation.



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EIC FUNCTIONAL GROUPS

The EIC display panel is divided into four functional groups, 1 through 4.

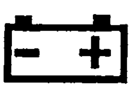
FUNCTIONAL GROUP 1

Those symbols in display group 1, backlighted white are:

1. Right arrow display selector switch. (no light)

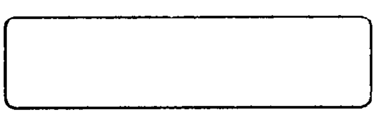
This switch is used to change the displayed function.

2. Loader engine RPM, displayed in increments of 10 RPM.



3. Battery voltage, displayed to the nearest 0.1 volt.

NOTE: *The EIC monitors battery voltage only, not alternator output.*

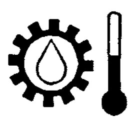


4. Character display.

The character display will display the chosen function or the function with the fault within this functional group.

5. Engine hours, displayed to 0.1 hours (no light).

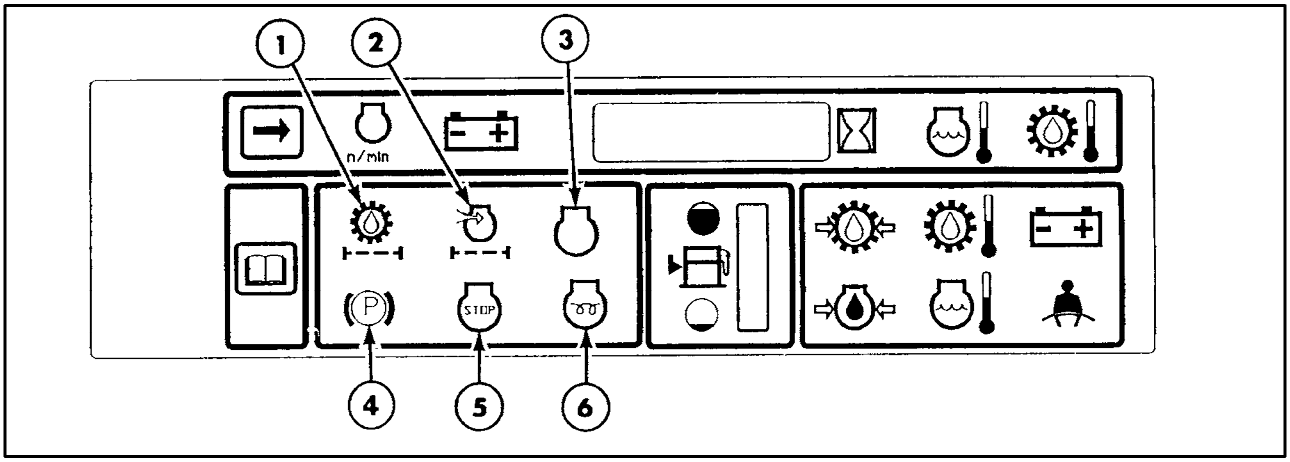
6. Engine coolant temperature displayed to the nearest degree, expressed as degrees Fahrenheit or degrees Celsius, depending on setting (C or F).



7. Transmission/hydraulic oil temperature to nearest degree, Fahrenheit or Celsius, depending on setting (F or C).

NOTE: *The monitored functions and symbols in group 1 are backlighted in white except the Engine Hours. When this function is monitored the symbol is not lit.*

NOTE: *The Engine Coolant and hydraulic oil temperatures will show “COLD” until the systems reach 32° Fahrenheit or 0° Celsius operating temperature. At that time the Character display will start reading the temperature in Fahrenheit or Celsius degrees.*



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FUNCTIONAL GROUP 2
Those symbols in display group 2, backlighted yellow are:

1. Hydraulic oil filter condition.

   The EIC continuously monitors the condition of the oil filter. A yellow warning lamp will signal a warning when the filter becomes dirty. The lamp will flash continuously, accompanied by a 5-second audible alarm, when the filter requires replacement.

2. Air filter condition.

   When the air filter requires replacement, the lamp will flash indicating a dirty element.

3. Blank (not used).

4. Parking brake.

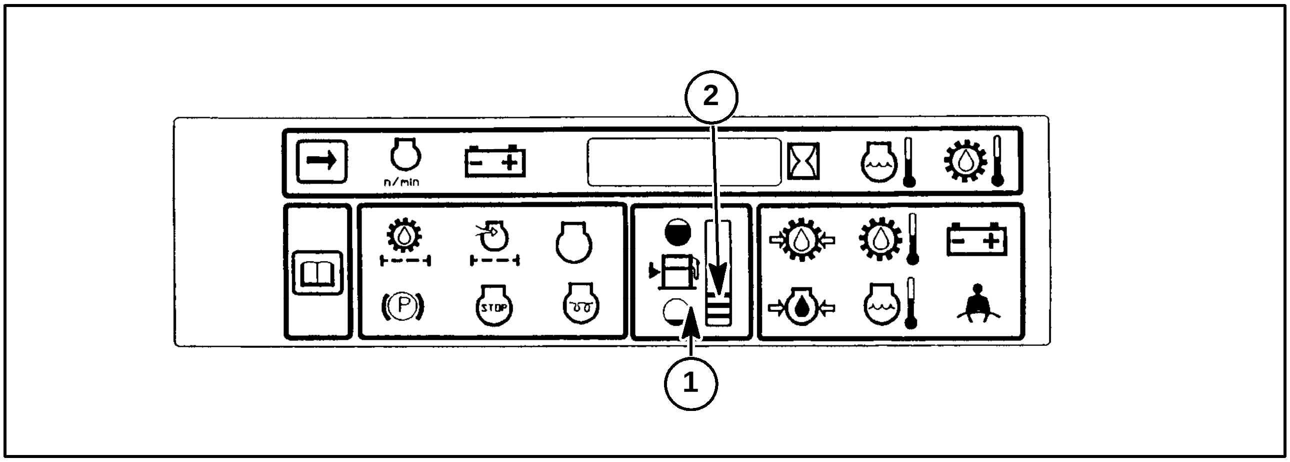
   Used to remind operator to engage the parking brake when exiting the loader. An audible alarm will sound when the operator begins to exit the machine with the engine running.

5. Stop engine warning.

   When this warning lamp flashes, stop the engine and determine the cause to prevent damage to the engine.

6. Engine preheat symbol (lights when engine is preheating).

   The EIC controls a timed preheat system for starting aid.



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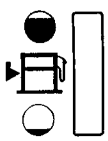
FUNCTIONAL GROUP 3

The symbol in display group 3 is:

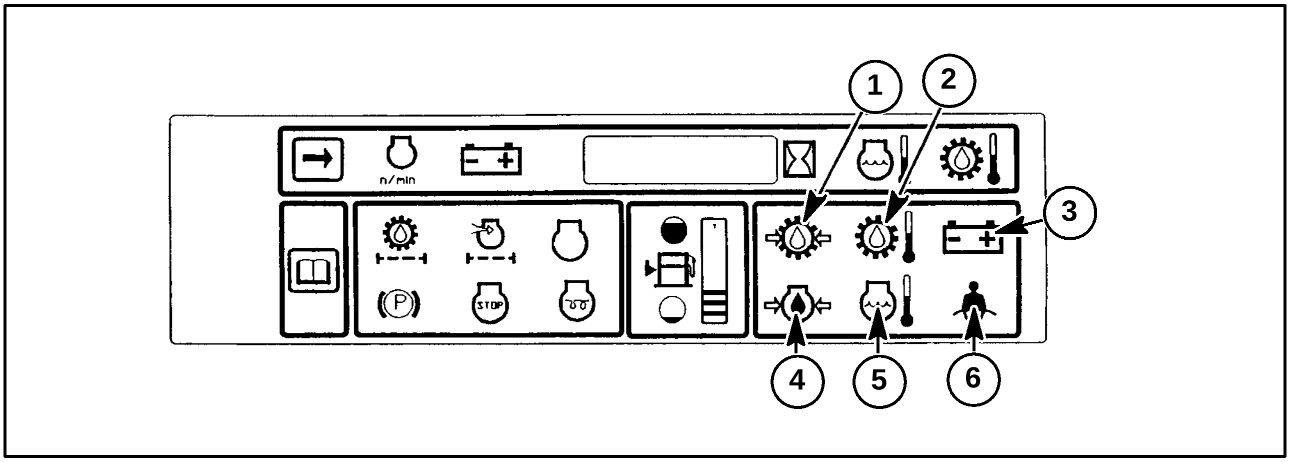


1. Fuel gauge.

   The fuel gauge, 1, is a vertical 10-segment green LED bar graph. When the fuel level reaches three bars, 2, the segments will flash accompanied by an audible alarm for about 5 seconds.

   When the fuel level reaches two bars, the EIC will signal the operator again with the segments flashing and another 5-second audible alarm.

***NOTE:** The lower fuel gauge segments accurately read the lower fuel levels so an operator is less likely to run out of fuel. However, if a machine is operated on a hillside, the fuel gauge should be monitored closely to avoid running out of fuel, as the fuel can still move freely from one end of the tank to the other.*



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FUNCTIONAL GROUP 4
Symbols in display group 4 are backlighted red.

When a fault occurs, the flashing lamp is accompanied by the audible alarm.

1. Transmission charge pressure.

   When the pressure drops below normal operating pressure, the lamp will flash with a continuous alarm.

2. Transmission/Hydraulic oil temperature.

   When the oil temperature is above operating temperature of 99°C (210° F), the lamp will flash with a 5-second alarm.

3. Battery voltage.

   When battery voltage drops below normal voltage, the lamp will flash with a 5-second alarm.

4. Engine oil pressure.

   When the engine oil pressure drops below normal pressure, the lamp will flash with a continuous alarm.

5. Coolant temperature.

   When the engine coolant temperature is above operating temperature of 102°C (216°F) the lamp will flash with a 5-second alarm.

6. Operator “FASTEN SEAT BELT” symbol.

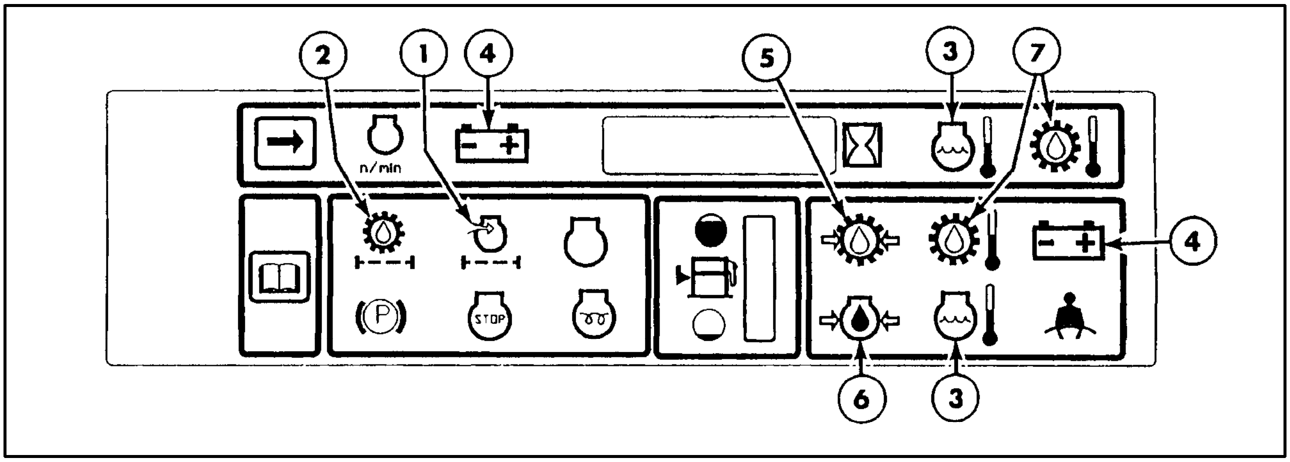
   When the operator is in the seat, the lamp will flash until the seat belt is fastened.

   These symbols are backlighted RED and are intended to complement the audible alarm should a fault occur.

7. Alternator/water pump drive belt warning.

   If the drive belt breaks, the EIC will signal the operator with the battery symbol light, 3, flashing continuously and a 5 second audible alarm.

NOTE: *If during skid steer operation the Engine Coolant or Hydraulic Oil Temperatures show an overheat condition, the EIC will default to that function and read the temperature. When this happens, back off on loader operation and allow the systems to cool down to within normal operating temperature ranges. If the temperatures don’t cool down, stop operating the unit, find the cause and correct.*



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CONTINUOUSLY MONITORED ELEMENTS

The following machine elements are continuously monitored by the EIC:

1. Engine air filter.

   Monitors the condition of the air cleaner element and will signal when the element is dirty and requires replacement.

2. Hydraulic oil filter.

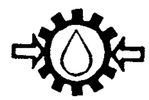
   Monitors the condition of the filter and will signal when the filter is dirty and requires replacement.

3. Engine coolant temperature.

   When the engine coolant temperature is above operating temperature of 102°C (216°F), the lamp will flash with a 5-second alarm.

4. Battery Voltage.

   When battery voltage drops below normal voltage the lamp will flash with a 5-second alarm.

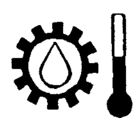


5. Hydrostatic charge pressure.

   When the pressure drops below normal operating pressure the lamp will flash with a continuous alarm.

6. Engine oil pressure.

   When the engine oil pressure drops below normal pressure the lamp will flash with a continuous alarm.



7. Transmission/Hydraulic oil temperature.

   When the oil temperature is above operating temperature of 99°C (210°F), the lamp will flash with a 5-second alarm.

Whenever the EIC senses any unusual condition in a monitored function, the associated lamp will flash. The audible alarm will “beep” continuously for 5 seconds.

ENGINE PREHEAT

The EIC controls a timed pre-heat cold start aid to assist in cold weather starting. The timed pre-heat cycle will vary from 0 to 40 seconds automatically based on engine coolant temperature. For additional pre-heat if the loader does not start, turn the ignition key to the “OFF” position. Then turn the ignition key back to the “RUN” position again. This will restart the preheat timed cycle.

AUTOMATIC SHUTDOWN

If either the engine oil pressure, or hydrostatic charge pressure fall below certain limits, the EIC will remove power from the fuel solenoid after 30 seconds, stopping the engine.

If this condition occurs, turn off the ignition key. Before unbuckling the seat belt, turn the ignition key to the “ON” position and lower the boom and attachment to the ground or rest the boom on the boom lockpins. Turn the ignition key to the “OFF” position.

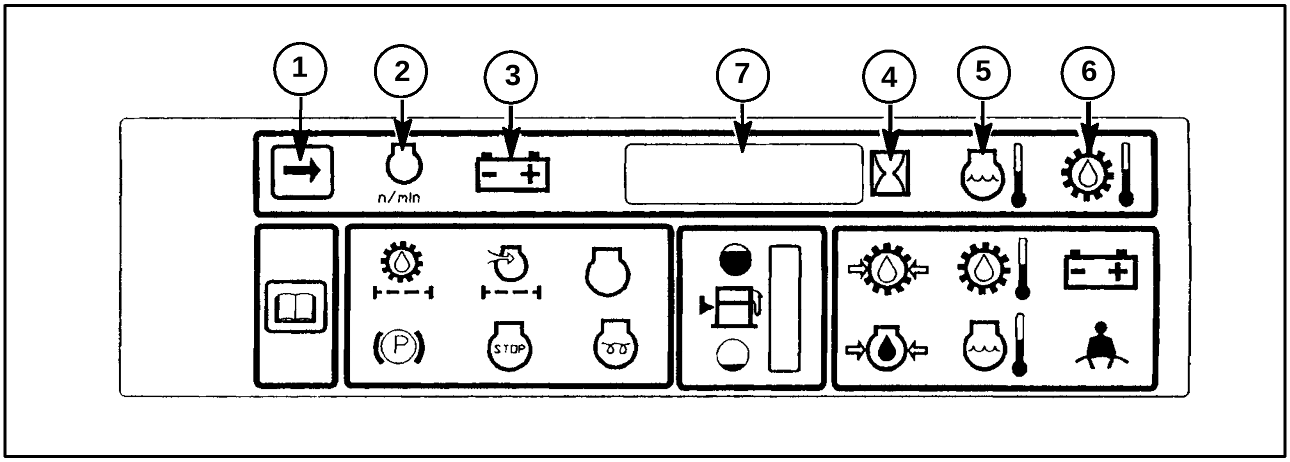
The operator may immediately restart the engine again. Should the function remain faulted, power will again be removed from the fuel solenoid in another 30 seconds and the engine will again stop. During the 30-second alarm period, the “ENGINE STOP” symbol will flash. If this condition continues, locate the fault and repair.

IMPORTANT: *Use caution when restarting the loader because of the possibility of NO LUBRICATING OILS for the engine and/or the hydrostatic transmission. DO NOT restart the loader more than once or operate the engine at high speeds. Damage to the engine and/or transmissions may occur. Contact your New Holland dealer for assistance.*

WARNING

When the engine stop symbol flashes for the 30-second period, immediately lower the boom and move the loader to a non-traffic area for problem evaluation.

If an alarm is caused by 3, 4, or 7, the CHARACTER DISPLAY will change to show the numeric value of the function that caused the alarm.



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OPERATING MODE

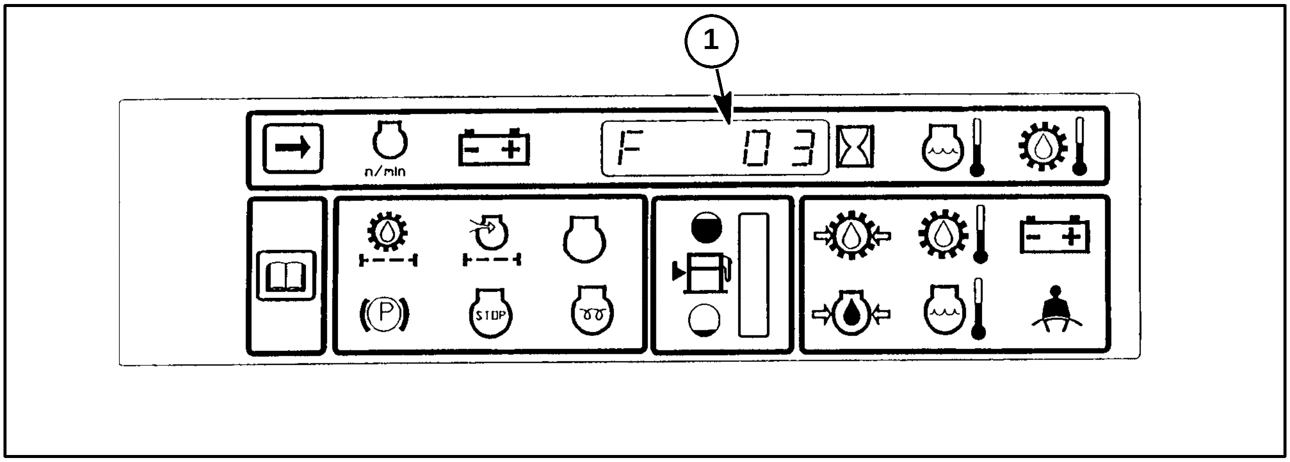
By pressing and releasing the “ARROW” switch, 1, during normal skid steer operation, the operator can select a function to be monitored. Only one function can be monitored and displayed at a time in the display, 7. By pressing and releasing the “ARROW” switch once, the EIC will select the next monitored function. Functional symbols are located across the top of the EIC display and will light up when selected. Note that the engine hour symbol, 4, is not illuminated.

Monitored functions are:

2. ENGINE RPM
3. BATTERY VOLTAGE
4. ENGINE HOURS (No Light)
5. ENGINE COOLANT TEMPERATURE – Reads COLD until 0°C (32°F)
6. TRANSMISSION/HYDRAULIC OIL TEMPERATURE – Reads COLD until 0°C (32°F)

If a fault occurs in the following monitored functions, the EIC will automatically show that function’s reading in the character display, accompanied by a flashing light and a five second audible alarm.

FAULT	READING
Battery Voltage (Low & High)	Battery Voltage
Engine Coolant (High)	Temperature in Degrees
Transmission/ Hydraulic Oil (High)	Temperature in Degrees



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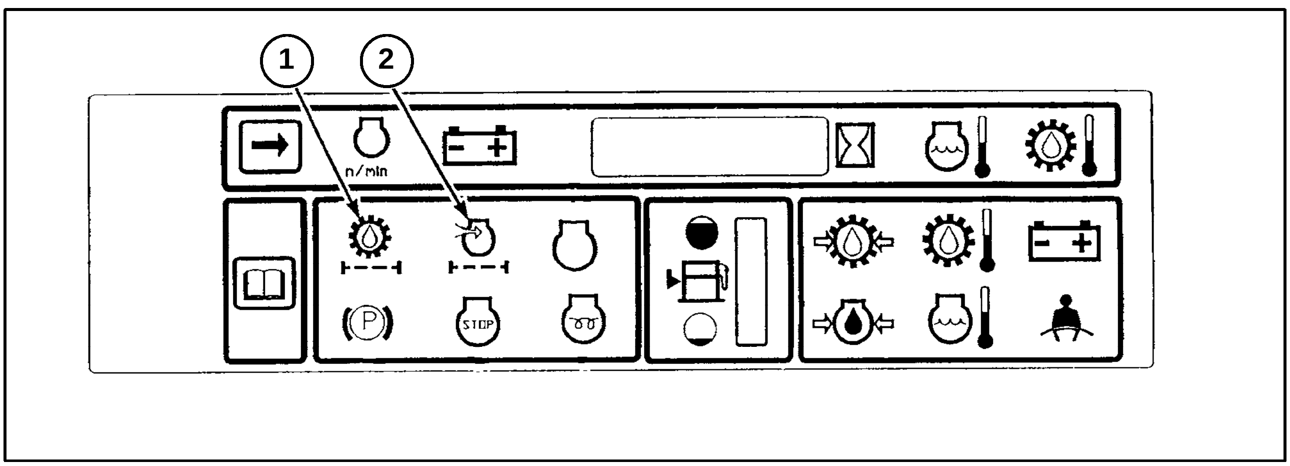
If a fault occurs in the following monitored functions a fault code will appear in the EIC character display, 1, accompanied by a five second audible alarm. By turning the ignition key switch to the “OFF” position the EIC will return to the normal operating mode. If when the loader is restarted and the fault still exists, the code will reappear with an alarm indicating there is an open or short in that circuit. Contact your New Holland dealer for assistance.

FAULT	CODE
Hydraulic Boom/Bucket Solenoid	(F0A)
Engine Preheat Relay Coil	(F03)
Fuel Solenoid	(F04)



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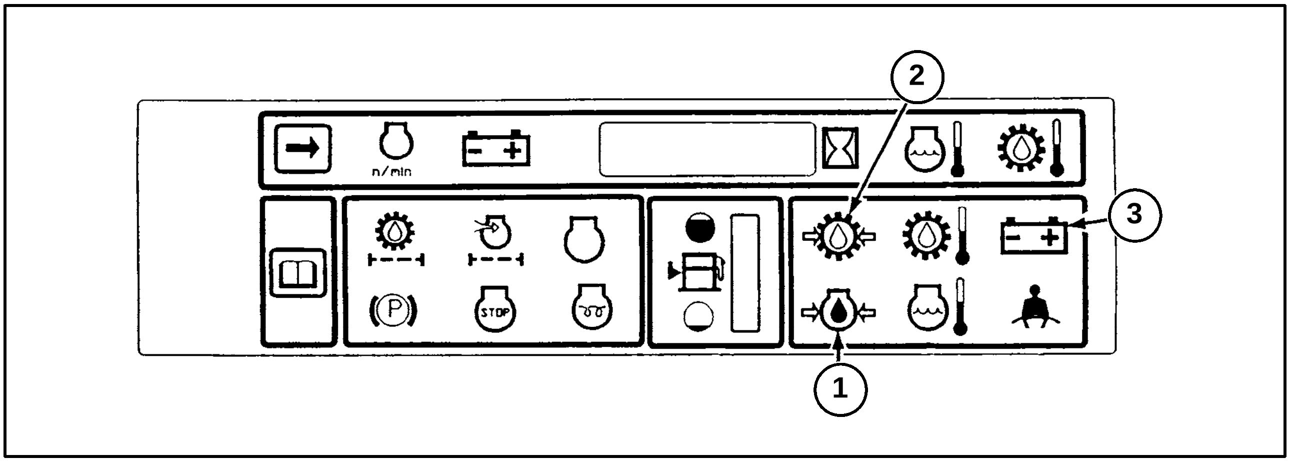
If a fault occurs in the following monitored functions the EIC will signal the operator with a flashing light accompanied by a five second audible alarm indicating the filter(s) require service.

FAULT
1. Hydraulic Oil Filter
2. Engine Air Cleaner



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If a fault occurs for more than 30 seconds in the following monitored functions the EIC will signal the operator with a flashing light, a continuous audible alarm and will stop the engine after 30 seconds of operation.

FAULT
1. Engine Oil Pressure
2. Hydrostatic Transmission Charge Pressure

If a fault occurs in one of these functions, the engine can be restarted and the skid steer moved to a safe inspection area with the boom resting on the boom lock pins or on the ground. If the fault still exists, the EIC will stop the engine after another 30 seconds.

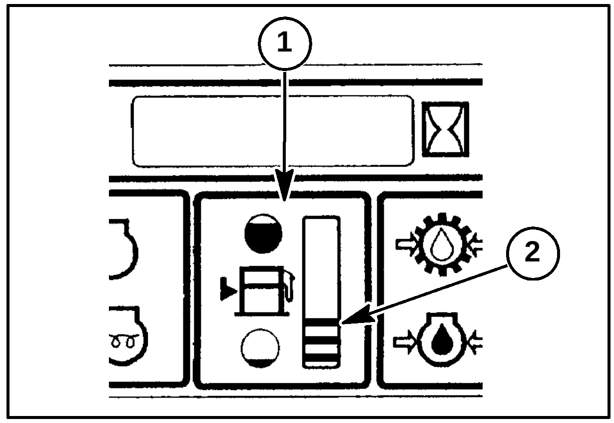
IMPORTANT*: Use caution when restarting the loader because of the possibility of NO LUBRICATING OILS for the engine and/or the hydrostatic transmissions. DO NOT restart the loader more than once or operate the engine at high engine speeds. Damage to the engine and/or transmission may occur. Contact your New Holland dealer for assistance.*

BROKEN ALTERNATOR/WATER PUMP BELT WARNING, 3
If the drive belt breaks the EIC will signal the operator with the battery symbol light, 3, flashing, accompanied by an audible alarm.

NOTE: *Shut the engine down immediately by turning the ignition key to “OFF” position to prevent engine overheating damage.*

FUEL LEVEL

Fuel level is shown to the operator by the fuel gauge bar lights located in the center of the EIC display at 1. The operator will be signaled when the level is at three bars and again at two bars. The bar lights, 2, will flash continuously accompanied by an audible alarm for about five seconds at each signal level.



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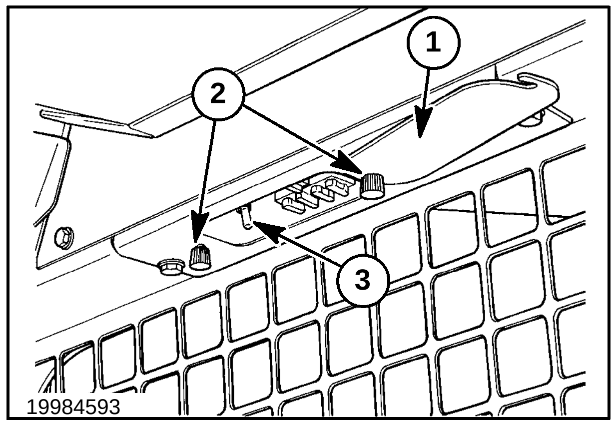
EIC INTERLOCKS

EIC controls the fuel solenoid circuit. The operator must be in the seat, with the seat belt fastened before the engine will start and continue to run.

The EIC will lock the boom and bucket control valve spools in neutral if the operator unfastens the seat belt, leaves the seat, or turns the ignition key off. If the operator is out of the seat for more than two seconds, the seat belt must be unfastened and refastened to enable the boom and bucket hydraulic systems to function.

The unit is equipped with a "SERVICE/RUN" switch for use during servicing and troubleshooting of the skid steer. To access the Service/Run switch located under the cab fuse panel cover, 1, loosen the two thumbscrews, 2, and rotate cover, 1, to the side. When the "SERVICE/RUN" switch, 3, is in the "SERVICE" position, the engine will start but the boom and bucket hydraulic system will be inoperative.



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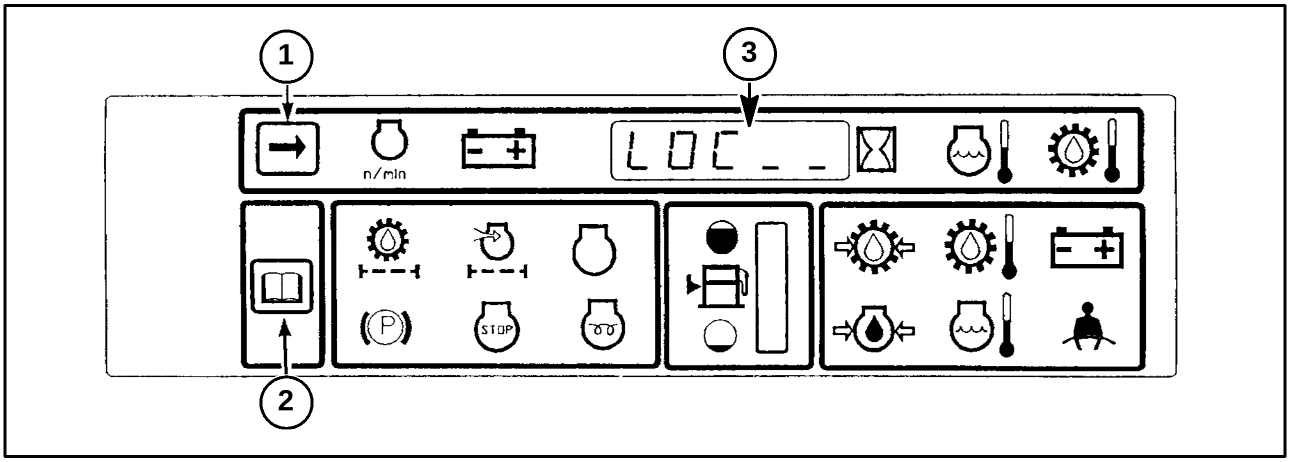

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EIC LOCK MODE

A two digit code can be entered into the EIC which will lock the boom and bucket spool lock solenoids when the spools are in the neutral position. This will prevent movement of the boom and bucket.

The same two digit code must be reentered to unlock the solenoids and return the loader to normal operation.

To enter a security code:

1. Lower the boom and bucket to the ground and position the bucket to prevent movement of the loader.
2. Turn “OFF” the ignition key.
3. Unbuckle the seat belt, raise your weight off the seat, and wait until all EIC lights are off.
4. While out of the seat, press and hold the “OPEN BOOK” switch, 2, then sit in the seat and turn the ignition key to the “ON” position; Do Not engage the starter.
5. Display, 3, will show the program level of the EIC board (example r0100). At this time release the “OPEN BOOK” switch.
6. Display, 3, will show “LOC_ _” for lock.
7. Press and hold the “OPEN BOOK” switch until two (2) zeros appear “LOC 0 0” with the left zero flashing, then release the “OPEN BOOK” switch.
8. Press and release the “OPEN BOOK” switch and enter any number from “0” to “9” for the left digit.
9. Press and release the “ARROW” switch, 1, the right zero will start to flash.
10. Press and release the “OPEN BOOK” switch and enter any number from “1” to “9” for the right digit.
11. With the two (2) digit code entered, “01 to 99”, turn the ignition key to the “OFF” position and exit the loader, allowing all the EIC board lights to go “OFF”, locking the EIC.

When the EIC board lights go off, the lock code will enter the EIC memory, locking the EIC until the same two digit code is reentered.

To reenter the same two (2) digit code to return the loader to normal operation:

1. Sit in the operator’s seat.
2. The EIC will display “LOC 0 0” with the left digit flashing.
3. Turn the ignition key switch to the “ON” position; Do Not engage the starter.
4. Press and release the “OPEN BOOK” switch and enter the left number of the code previously used to lock the loader.
5. Press and release the “ARROW” switch, the right zero will flash.
6. Press and release the “OPEN BOOK” switch to enter the right number of the code previously used to lock the loader.
7. Turn the ignition key to the “OFF” position and allow the EIC to return to the operating mode.
8. Buckle the seat belt and proceed with normal skid steer operation.

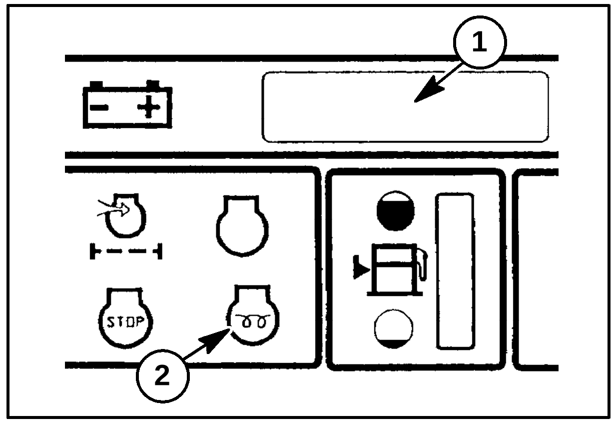
If the two digit code is forgotten, the EIC can be unlocked by using a **(MASTER CODE).** Contact your NEW HOLLAND dealer for assistance.

The dealer will require your name, address and the skid steer model and serial numbers.

EIC ENGINE PREHEAT

The engine preheat is governed automatically by the EIC based on coolant temperature and engine code. Preheat is initiated when the ignition key is turned to the "RUN" position and the cycle time will vary from 0 to 40 seconds.

Turn the ignition key to the "RUN" position, and the EIC character display, 1, will show seconds remaining for engine preheat time. The preheat indicator light, 2, will be lit during the preheat cycle. The operator should wait until the display zeros "0", the indicator light goes "off", and the audible alarm sounds to start the engine. If the loader does not start, re-cycle the engine preheat timer by turning the ignition key "OFF" then ON". This will restart the timed preheat cycle.



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TROUBLESHOOTING

ELECTRONIC INSTRUMENT CLUSTER (EIC) TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
EIC board will not light up when operator sits in seat	Service/run switch in service position	Push switch to run position
	Faulty seat switch	Replace switch
	No battery voltage to seat switch	Blown 5-amp fuse electronic battery in engine panel, replace fuse
		Open in power wire from 5-amp fuse to seat switch, repair open in wire
		No battery voltage to 5-amp fuse from supply, check and/or replace battery
	Blown 5-amp fuse (electronic battery) in engine panel	Replace fuse
	No battery voltage from seat switch to EIC board	Open in power wire from seat switch to EIC board, repair open in wire
		Poor or no connection at EIC board, repair connection
	Battery voltage from seat switch to EIC board	If battery voltage from seat to board is OK, replace EIC board
EIC board backlighting is dim	Brightness variations due to production differences between models and/or EIC board changes	None –– overlay decal material variations cause differences in brightness
	Backlights dim when the loader worklights are activated	None –– EIC board circuitry automatically dims the backlighting when the work lights are on, to reduce board glare at night
EIC board seat belt light will not go off with seat belt buckled	Seat belt not buckled	Buckle seat belt
	Faulty seat belt buckle switch	Replace seat belt assembly
	No battery voltage from seat switch to seat belt switch	Open in wire from seat switch to seat belt switch, repair open
	No battery voltage from seat belt switch to EIC board	Open in wire from seat belt switch to EIC board, repair open
		Poor or no connection at EIC board, repair connection
	Battery voltage from seat belt switch to EIC board	If voltage OK, replace EIC board

PROBLEM	POSSIBLE CAUSE	CORRECTION
EIC will not read correct engine RPMs, varies more than ± 50 RPMs	Incorrect engine configuration	Correct configuration
	No AC voltage at tachometer terminal at alternator	Repair alternator
	Loose or corroded connection at tachometer terminal at alternator	Repair connection
	No AC voltage at EIC board from alternator	Open in wire from alternator to EIC board, repair open
	AC voltage from alternator to EIC board	Repair loose or corroded connection at EIC board
	Wire connection from alternator to EIC board	If OK, replace EIC board
EIC will not unlock boom and bucket spool locks	Service/Run switch in “SERVICE” position	Push switch to “RUN” position
	Seat belt unbuckled	Buckle seat belt
	Faulty seat belt buckle	Replace seat belt assembly
	No battery voltage from seat belt switch to EIC	Open in power wire from seat belt switch, repair open
	No battery voltage from EIC to spool lock solenoids	Open in power wire from EIC to solenoids, repair open
	Battery voltage to lock solenoids	If OK, check inoperative solenoids, check solenoid coils, repair or replace

PROBLEM	POSSIBLE CAUSE	CORRECTION
Engine will not start and/or run	Seat belt unbuckled	Buckle seat belt
	Incorrect engine configuration (EIC)	Correct configuration
	No battery voltage to start relay	Open in power wire from key switch “start” to relay, or through seat/seat belt circuits to relay, repair open
	No battery voltage from EIC to fuel solenoid	Open in power wire from EIC to fuel solenoid, repair open
	Open in the W/O wire from the seat/seat belt plug to the start interlock relay	Repair open in W/O wire
	Inoperative start interlock relay	Repair or replace
	Fuel solenoid inoperative	Repair or replace fuel solenoid
	Inoperative manifold heater system	Incorrect engine configuration, correct configuration
	No power to manifold heater	Manifold heater preheat relay or LTBL/B wire open, repair or replace
		Circuit breaker open, replace
	Inoperative manifold heater	Replace manifold heater
	No fuel to manifold heater	Check fuel feed tube and fuel supply from injection pump
EIC will not read monitored circuits	Incorrect engine configuration	Correct engine configuration
	Open or short in wire from sensor to EIC	Repair open/short
	Faulty sender or sensor	Repair/replace sender or sensor

ADVANCED WARNING SYSTEM (AWS)

This skid steer is equipped with an Advanced Warning System (AWS) that provides information to the operator about the operation of the skid steer.

The AWS provides an interlock system with the seat and seat belt to prevent movement of the boom and bucket if the operator is out of the seat or the seat belt is unbuckled and the controls are in neutral.

The AWS provides an automatic engine preheat system to aid in cold weather starting.

The AWS provides information to the operator about the following monitored functions:

- Hydraulic Oil Filter
- Engine Air Filter
- Engine Preheat Relay Coil
- Fuel Level
- Fuel Solenoid
- Engine Coolant Temperature
- Hydrostatic Transmission Charge Pressure
- Transmission/Hydraulic Oil Temperature
- Battery Voltage
- Engine Oil Pressure
- Alternator/Water Pump Belt Breakage Warning
- Operator Seat and Seat Belt
- Hydraulic Boom/Bucket Solenoid
- Engine RPM
- Engine Hours

The AWS provides an engine shut down feature if the engine oil pressure or the hydrostatic transmission charge pressure are low.

The AWS will signal the operator if the alternator/water pump drive belt fails.

The AWS provides a security feature allowing the operator to enter a two digit security code, preventing starting of the engine and movement of the boom and bucket.

The AWS provides the following features for dealer technician use in diagnostics and troubleshooting of the monitored function circuits:

Diagnostics

- Test individual monitored circuits.

Fault/Warning History

- Fault occurrence with hour level of last occurrence.

Clear Faults

- Clear Faults to zero.

Engine Code

- Set EIC to loader engine model.

Select Displayed Temperature Units, Fahrenheit or Celsius

- Temperature displayed in English (Fahrenheit) or Metric (Celsius).

Adjust Engine RPM

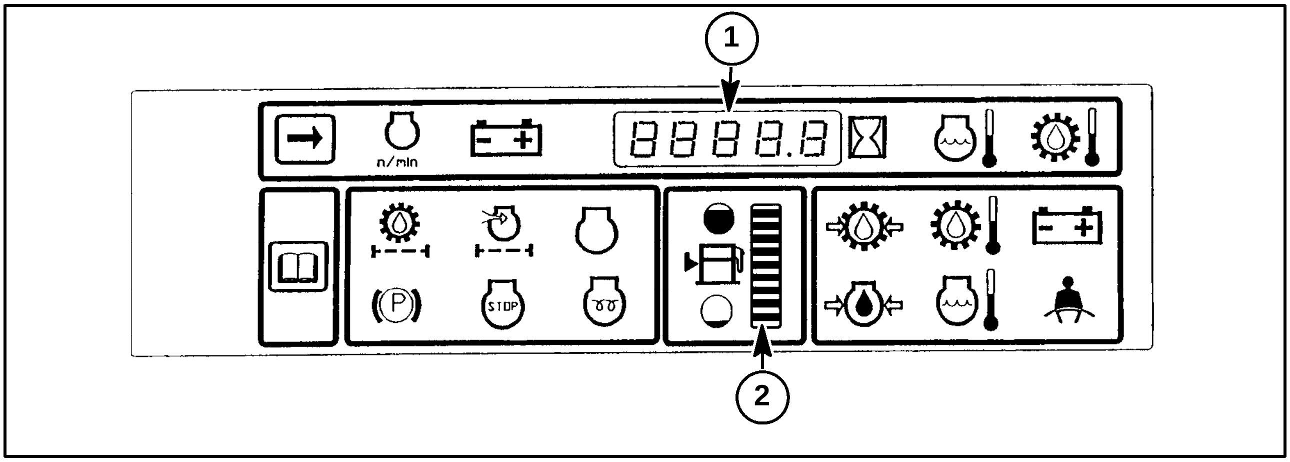
- Calibrate EIC display to external RPM tach reading.

Clear Memory

- Return EIC to original factory settings.
- Engine code reset to (01).
- Hours reset to (0000.0) zero.
- Temperature displayed (Fahrenheit).
- Engine RPM calibration cleared.

Adjust skid steer hours

- Change unit hours when installing a new EIC board in a loader.



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EIC BOARD SELF TEST

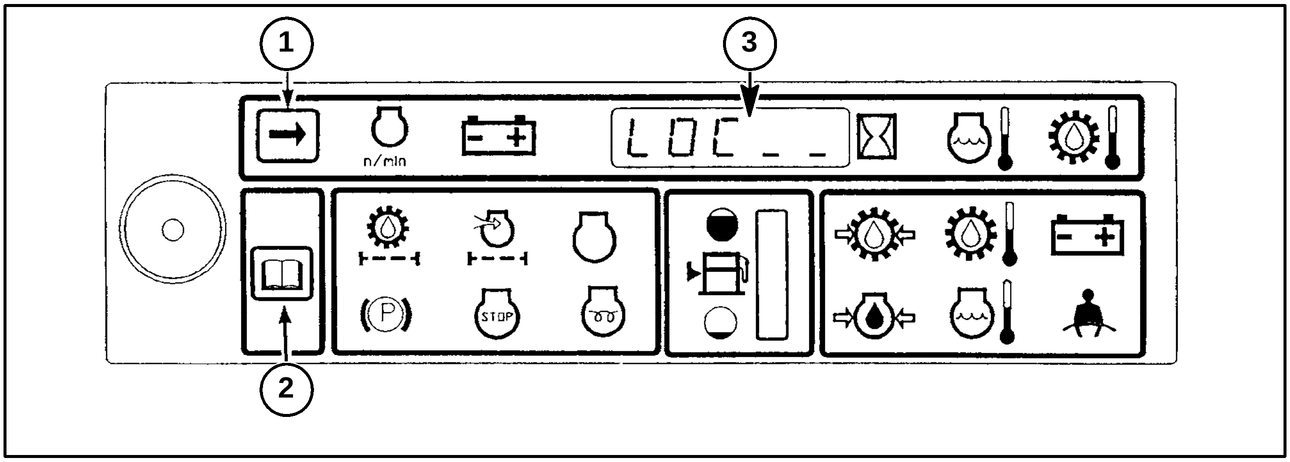
When first sitting in the operator’s seat and/or before entering Diagnostics, allow the EIC board to self test. (Service/Run switch in the “RUN” position)

Sit in operator’s seat.

1. The EIC board should light all symbol lights.
2. The character display should read “8888.8”, 1, and the fuel gauge (light bar), 2, should light showing 9 bars.
3. The EIC will enter the normal start up mode.
4. Turning the ignition key to the “ON” position will start the automatic engine preheat system (if required).

NOTE: *The preheat times will vary from 0 to 40 seconds, depending on engine temperature.*

If the EIC does not function as described, check the seat and seat belt switches for proper operation and EIC board power and ground circuits.



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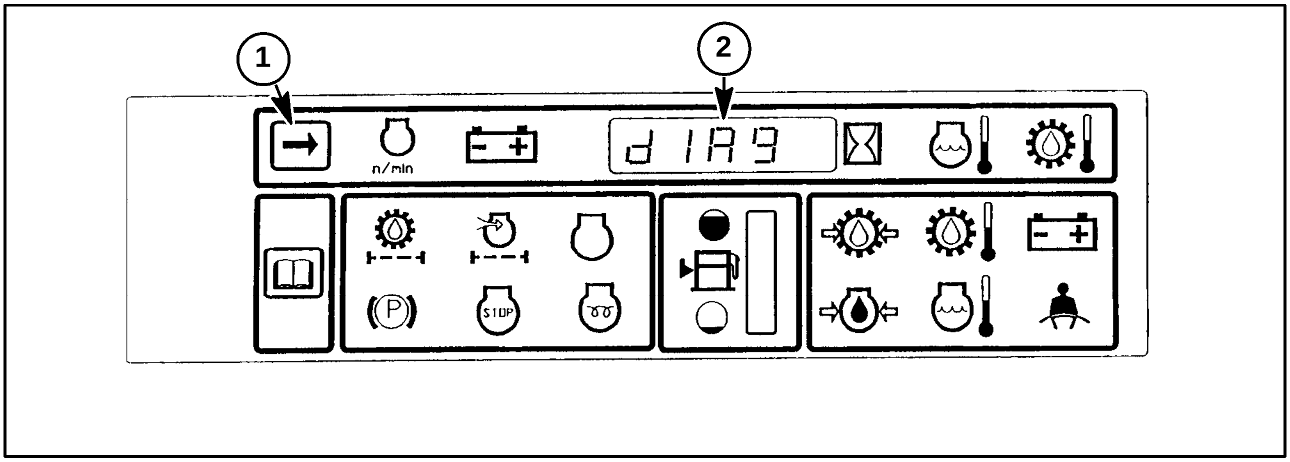
DIAGNOSTIC AND SETUP MODES

When in the Diagnostic Mode, the technician can test the individual monitored circuit wiring. When in the Setup Mode, the technician can make changes to the EIC and perform additional troubleshooting.

To Enter Diagnostic Or Setup Mode:

1. Lower the boom and bucket to the ground or remove any attachment and rest the boom on the boom lock pins.
2. Turn “OFF” the ignition key.
3. Unbuckle the seat belt, raise your weight off the seat, and wait until all EIC lights are off.
4. While out of the seat, press and hold the “OPEN BOOK” switch, 2, sit in the seat and turn the ignition key to the “ON” position; Do Not engage the starter.
5. Display, 3, will show the program level of the EIC board (example - r0100); at this time, release the “OPEN BOOK” switch.
6. Display will show “LOC_ _” for lock.
7. Press and release the “ARROW” switch, 1; “dIAg” (for Diagnostic) will appear in the character display.
8. Press and release the “ARROW” switch again will move to the “SEtUP” mode in the display.

Pressing and holding the “OPEN BOOK” switch when in either mode will enter the selected mode for tests or changes to the EIC.



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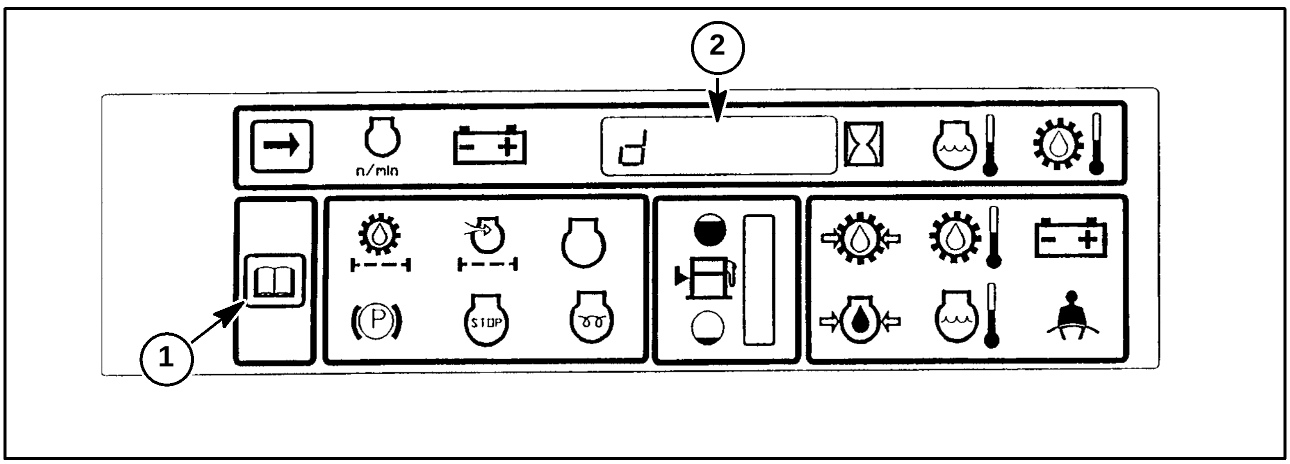
EIC Diagnostics and Setup Items

Diagnostics Mode

With display showing “LOC_ _” for lock.

1. Press and release the “ARROW” switch, 1; “dIAg” will appear in the character display, 2.



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2. Press and hold the “OPEN BOOK” switch, 1, until a low case “d” appears in the character display, 2, release the “OPEN BOOK” switch. The EIC is now in Diagnostics.

Each individual monitored circuit can now be tested for proper operation.

When in Diagnostics and any circuit is activated the EIC board will light all lights and an audible alarm will sound.

The Diagnostic test will not verify the performance of a sensor or sender. Only the EIC board and wires to the sender or sensor are tested.

The following circuits can be tested:

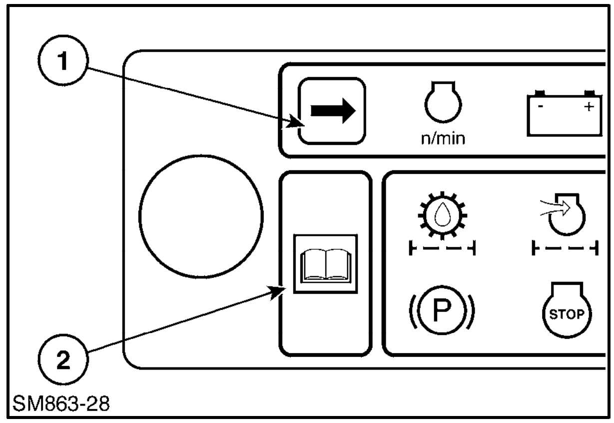
1. EIC board bulbs
2. EIC board circuits
3. EIC board arrow and open book switches
4. Audible beeper
5. Engine air filter circuit
6. Hydraulic oil filter circuit
7. Hydrostatic transmission charge pressure circuit
8. Engine oil pressure circuit
9. Engine Coolant temperature circuit
10. Transmission/hydraulic oil temperature circuit
11. Fuel level circuit
12. Seat switch(es) and circuit
13. Seat belt switch and circuit
14. Service/Run switch

ARROW, OPEN BOOK, AND AUDIBLE ALARM TEST

In this mode, by pressing the “ARROW,” 1, or “OPEN BOOK,” 2, switches, all of the display segments are turned on for verification and at the same time with an audible beep. If all segments do not light the circuit bulb or wires to the switches, sensors or senders may be defective.

To check the individual EIC board circuits and circuits to the switches, sensors, and senders, perform the following “EIC CIRCUIT TESTS”.

Whenever any of the sensors or switches are toggled on or off, the EIC board will light and the audible alarm will briefly beep. This indicates that the wire to the sensor or switch is intact, but does not yield any information about the condition of the sensor.



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DIAGNOSTIC MODE EIC CIRCUIT TESTS

To simulate a fault condition while in the diagnostic mode do the following:

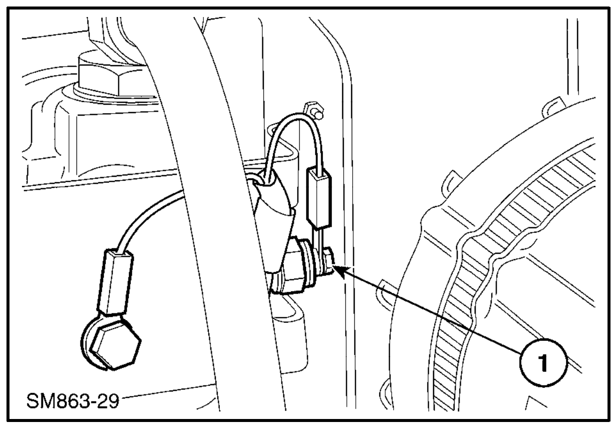
***NOTE:** When in the diagnostic mode and a circuit is triggered, all the board lights will light up accompanied by an audible beep.*

1. Hydraulic Oil Filter Restriction Switch

Remove the DKGN/O filter sensor wire, 1, from the sender.

The EIC board lights will all light up and the board will beep when this test is performed.

If the EIC board lights and beeps, the EIC and circuit wire to the sensor is OK. The problem is in the sensor; replace the sensor. If the EIC board fails to light and beep, check the wire from the sensor to the EIC board.



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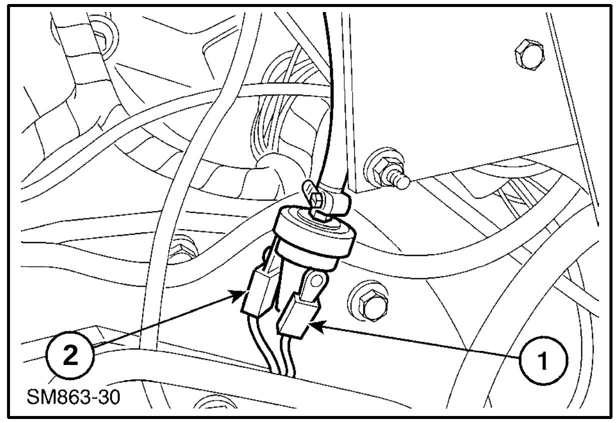
2. Air Cleaner Switch

Remove one wire at a time from the sensor switch on the air cleaner canister. Remove the B wire, 1, and the EIC board will light and beep when the wire is removed from the switch. Remove the B/Y wire, 2, and the EIC board will light and beep.

If the EIC board lights and beeps, the EIC and circuit wire to the sensor is OK. The problem is in the sensor; replace the sensor. If the EIC board fails to light and beep, check the wires from the sensors to the EIC board.



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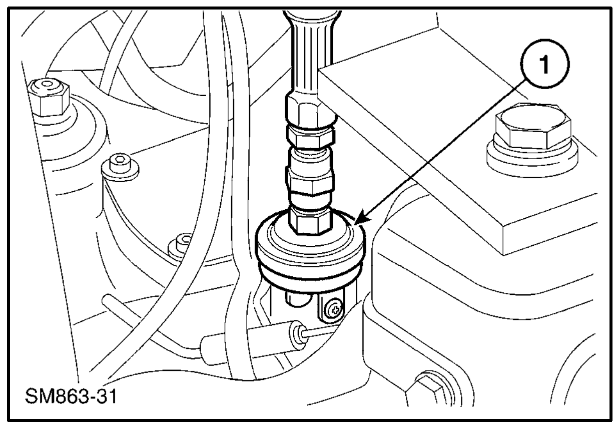
3. Hydrostatic Charge Pressure Switch, 1

Remove one wire at a time from the sensor switch at the charge check valve. Remove the Y/GY wire and the EIC board will light and beep. Remove the B wire and the EIC board will light and beep.

If the EIC board lights and beeps, the EIC and circuit wire to the sensor is OK. The problem is in the sensor; replace the sensor. If the EIC board fails to light and beep, check the wires from the sensor to the EIC board.

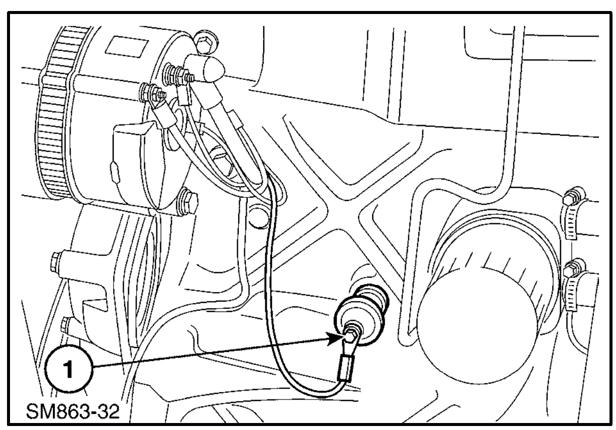


31

4. Engine Oil Pressure Sensor

Remove the Y/B wire, 1, from the sensor and the EIC board will light and beep.

If the EIC board lights and beeps, the EIC and circuit wire to the sensor is OK. The problem is in the sensor; replace the sensor. If the EIC board fails to light and beep, check the wires from the sensor to the EIC board.



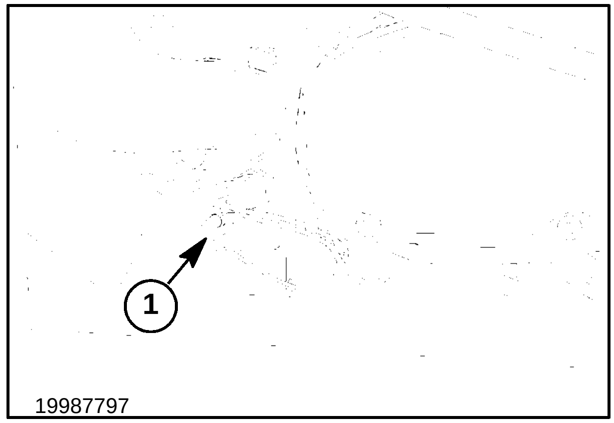
32

5. Coolant Temperature Sensor

Remove the PU/LTGN wire, 1, from the sensor and short the wire to ground.

The EIC board will light and beep when the wire is removed from the sender and grounded.

If the EIC board lights and beeps, the EIC and circuit wire to the sensor is OK. The problem is in the sensor; replace the sensor. If the EIC board fails to light and beep, check the wires from the sensor to the EIC board.



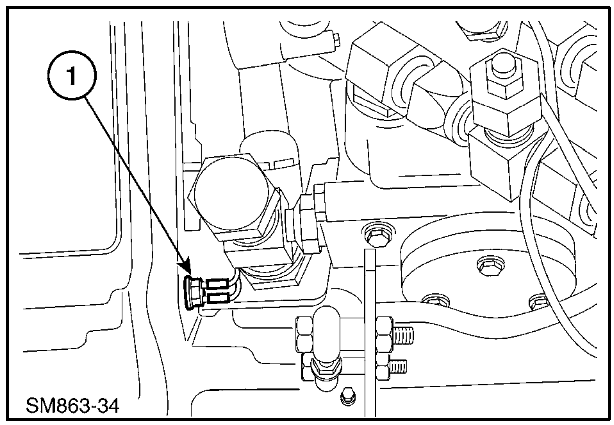
33

6. Transmission/Hydraulic Oil Temperature Sensor

Remove the PU/LTBL wire from the sensor, 1, and short the wire to ground.

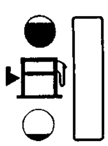
The EIC board will light and beep when the wire is removed from the sender and grounded.

If the EIC board lights and beeps, the EIC and circuit wire to the sensor is OK. The problem is in the sensor; replace the sensor. If the EIC board fails to light and beep, check the wires from the sensor to the EIC board.

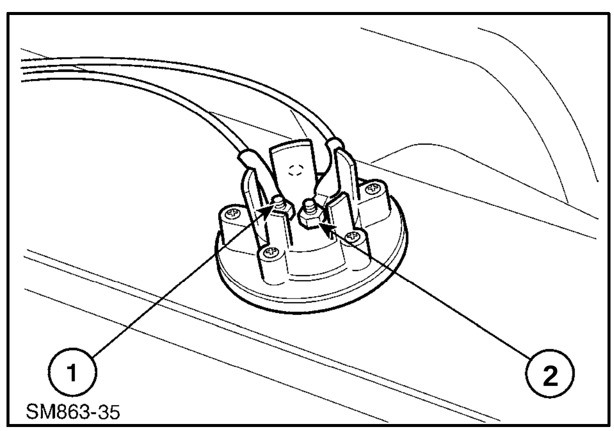


34

7. Fuel Gauge



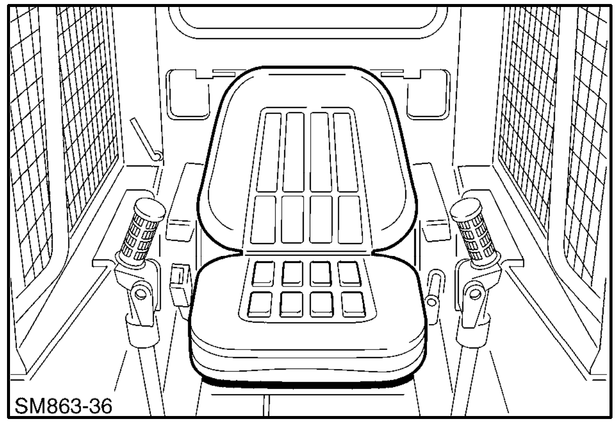
Disconnect one wire, 1, and use a jumper wire and connect sender terminal to other terminal, 2, and the EIC board will light and beep. If the EIC board lights and beeps, the EIC and circuit wires to the sender are OK. If the EIC board fails to light, check the wires to the EIC board.



35

8. Seat Switch and Circuit

   Raise your weight off the centre of the seat and then sit back on the seat. The EIC board will light and beep. If the board lights and beeps, the switch and circuit are OK. If the board fails to light and beep, check the seat switch and circuit to the seat switch for battery voltage. If there is battery voltage to the switch, check the switch for operation and the circuit from the switch to the EIC board. If there is no battery voltage to the switch, check the circuit to the switch.

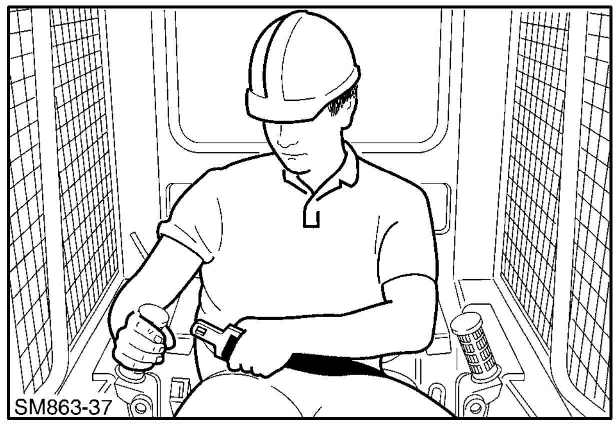


36

9. Seat Belt Switch and Circuit

   The operator must be sitting in the seat.

   Unbuckle and rebuckle the seat belt. The EIC board will light and beep. If the board lights and beeps, the switch and circuit are OK. If the board fails to light and beep, check the seat belt switch and circuit from the seat switch for battery voltage. If there is battery voltage to the switch, check the switch for operation and the circuit from the seat belt switch to the EIC board. If there is no battery voltage from the seat switch, check the seat switch for operation and the wire to the seat belt switch.

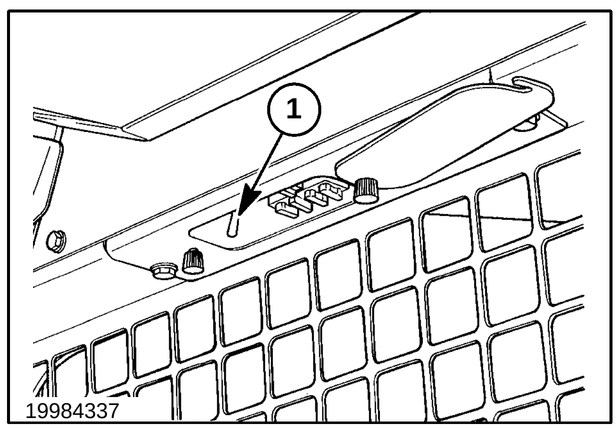


37

10. Service/Run Switch, 1

    The operator must be sitting in the seat.

    Switch between “SERVICE” and “RUN”. The EIC board will light and beep. If the board fails to light and beep, check the switch and circuit for battery voltage.



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To exit Diagnostics and move to the next item, press and hold the “ARROW” switch until “dIAg” is displayed in the character display, then release the switch. Pressing the “ARROW” switch again will move the EIC to the SETUP Mode. To exit and return to the Normal Operating Mode turn the ignition key switch to the “OFF” position.

EIC SETUP MODE

The EIC Setup Mode is made up of several items:

FAULt - Fault/Warning history

- Fault occurrence with hour level of last occurrence.

Eng 0 0 - Engine Code

- Set EIC to loader engine model.

Unit F or Unit C - Select Displayed Temperature Units, Fahrenheit or Celsius

- Temperature displayed in English (Fahrenheit) or Metric (Celsius).

r-CAL - Adjust Engine RPM

- Calibrate EIC display to external RPM tach reading.

CLr F - Clear Faults

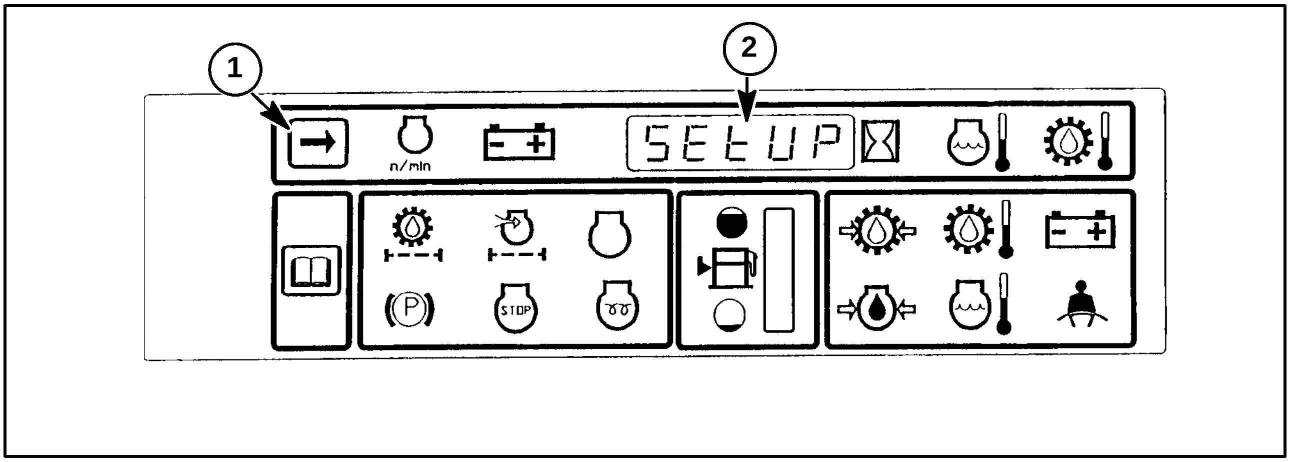
- Clear Faults to zero.

HourS - Adjust skid steer hours

- Change unit hours when installing a new EIC board in a loader.

CLr E - Clear Memory

- Return EIC to original factory settings.
- Engine code reset to (01).
- Hours reset to (0000.0) zero.
- Temperature displayed (Fahrenheit).
- Engine RPM calibration cleared.



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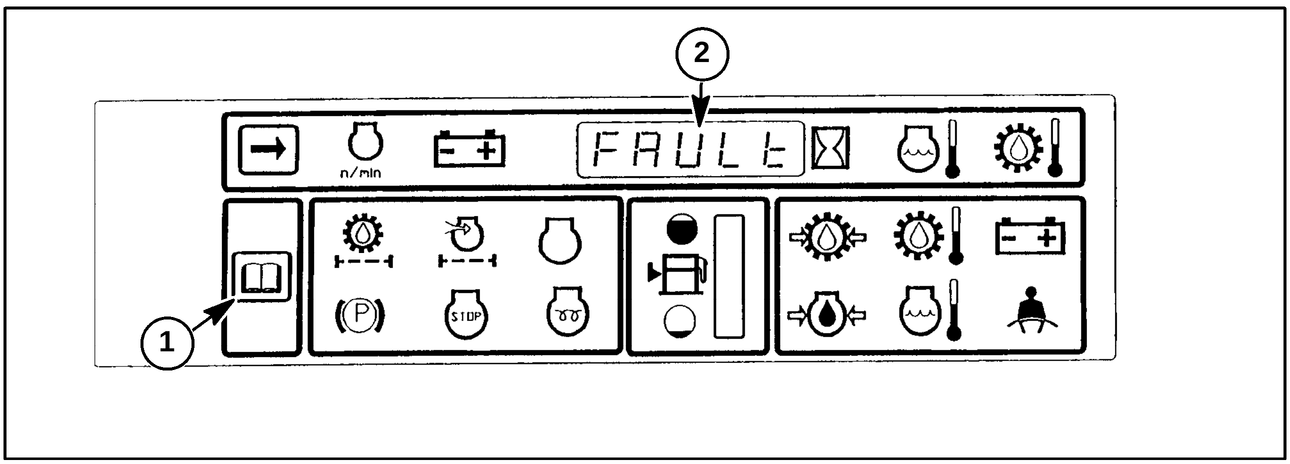
FAULt - Fault/Warning history

With display showing “LOC_ _” for lock.

1. Press and release the “ARROW” switch, 1; “dIAg” will appear in the character display. Then press and release the “ARROW” switch again; “SEtUP” will appear in the display, 2.



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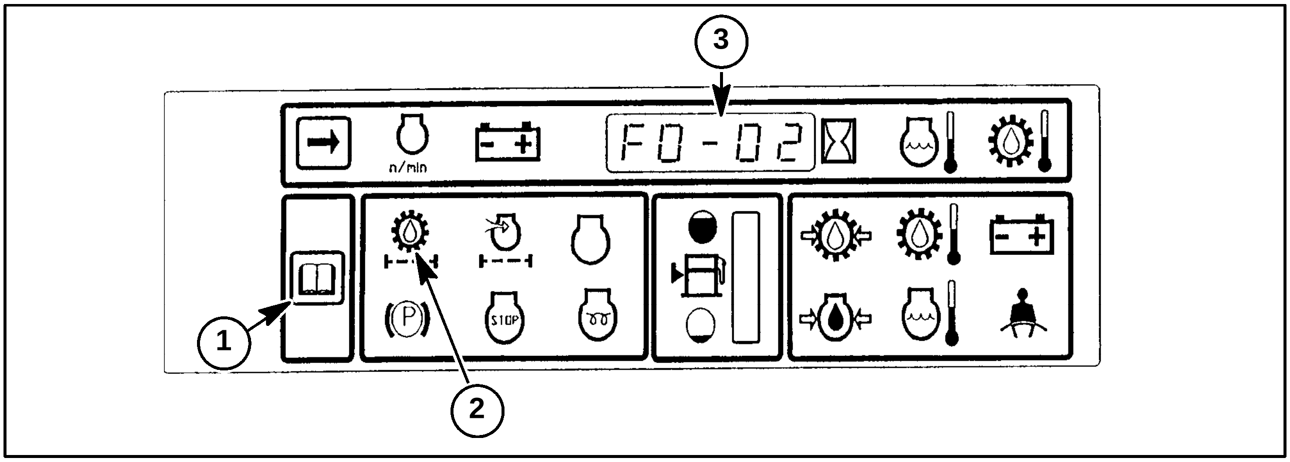
2. Press and hold the “OPEN BOOK” switch, 1, until “FAULt” appears in the character display, 2.



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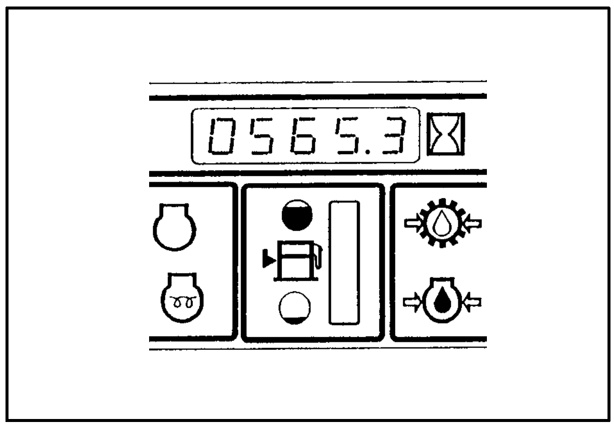
Press and hold the “OPEN BOOK” switch, 1, until “F0-XX” appears in the display. The “F0” is the fault and the “XX” is the number of occurrences of that fault since the fault memory was last cleared. The fault code display will be accompanied by an illuminated front panel symbol identifying the fault. Thus, “F0” is identified via the illuminated oil filter symbol, 2, example “F0-02” is showing in display, 3, F0 code with 02 occurrences.

Press and release the “OPEN BOOK” switch will display the hour of the last occurrence, for this code, example “0565.3” hours. Pressing and releasing the “OPEN BOOK” switch will return the EIC to the fault code.



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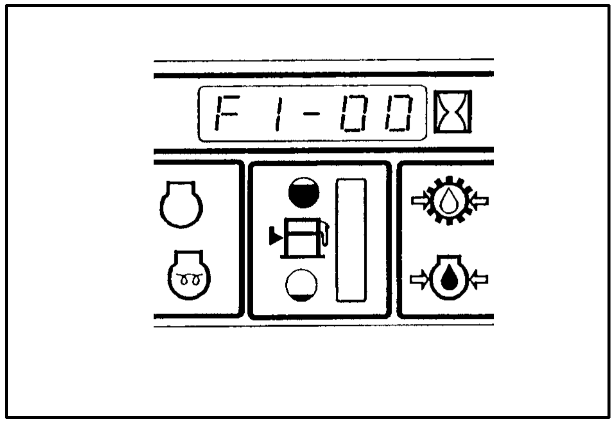
Pressing and releasing the "ARROW" switch again will forward to the next fault "F1-00" and pressing and releasing the "OPEN BOOK" switch again will display the hour of the last occurrence if any fault occurrences were shown. Use this procedure to go through all the fault codes:

FAULT CODES	FAULT	SYMBOL LIGHT
F0-00	Hydraulic oil filter	Oil filter
F1-00	Engine air cleaner	Air cleaner
F2-00	Not used	Blank
F3-00	Engine preheat	Preheat
F4-00	Fuel solenoid	Fuel level bar lights
F5-00	Engine coolant temperature	Engine coolant
F6-00	Hydrostatic transmission charge pressure	Charge pressure
F7-00	Transmission/Hydraulic oil temperature	Oil temperature
F8-00	Battery voltage	Battery
F9-00	Engine oil pressure	Oil pressure
FA-00	Hydraulic boom/bucket solenoid	Seat belt



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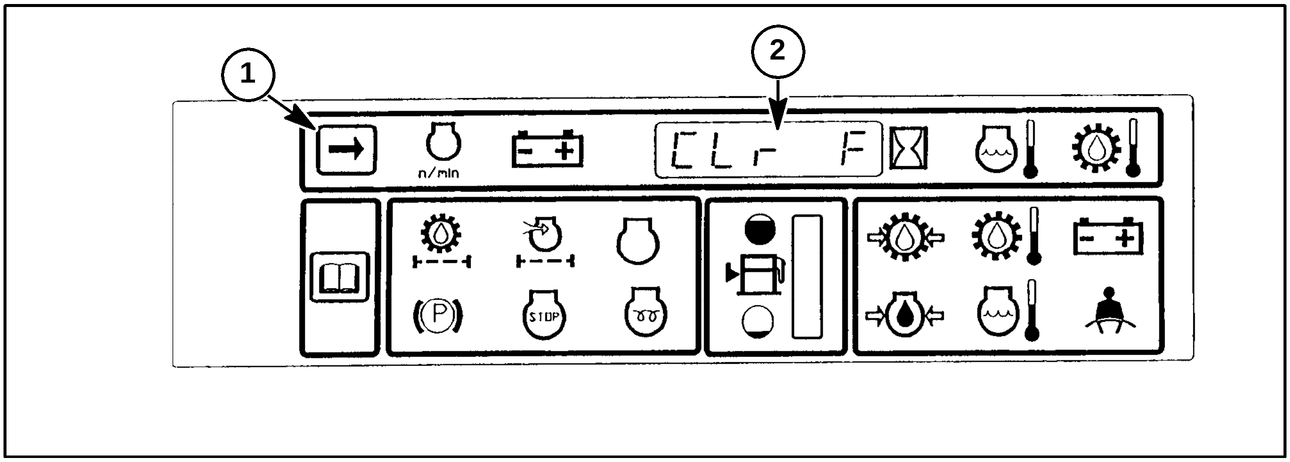

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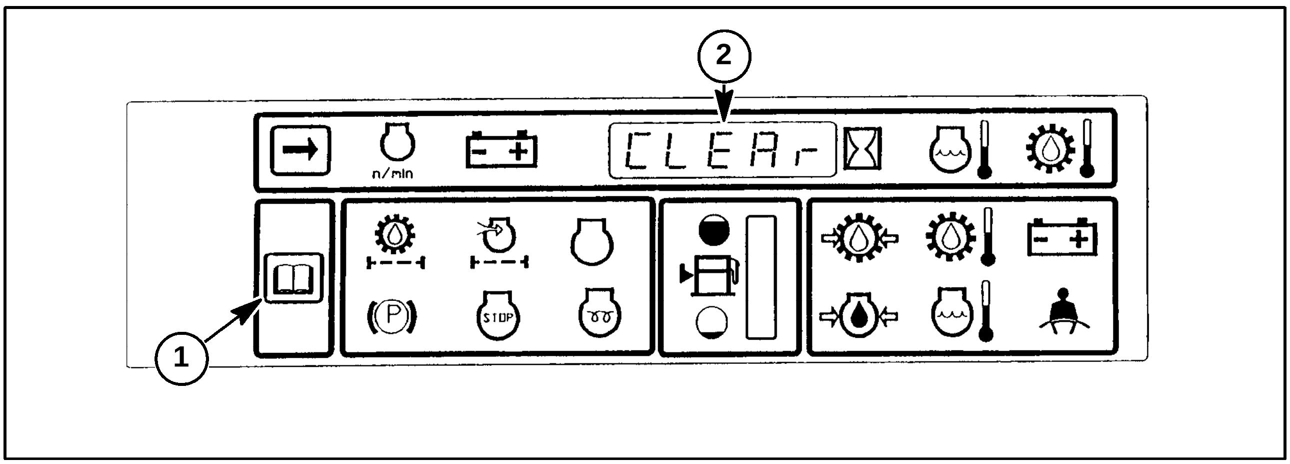
Once all faults have been identified, the fault history can be cleared to zero.

To return to “FAULt” and clear the faults, press and hold the “ARROW” switch, 1, until the original “FAULt” item is displayed in the character display.

Press and release the “ARROW” switch, 1, until “CLr F” appears in the character display, 2.



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Press and hold the “OPEN BOOK” switch, 1, until “CLEAr” appears in the display, 2. Then release the switch to clear all fault occurrences from the fault history memory.

To exit this item, press and hold the “ARROW” switch to return to the “SEtUP” mode, or turn the ignition key switch to the “OFF” position to return the EIC to the Normal Operating Mode.

Eng 0 0 - Engine Code

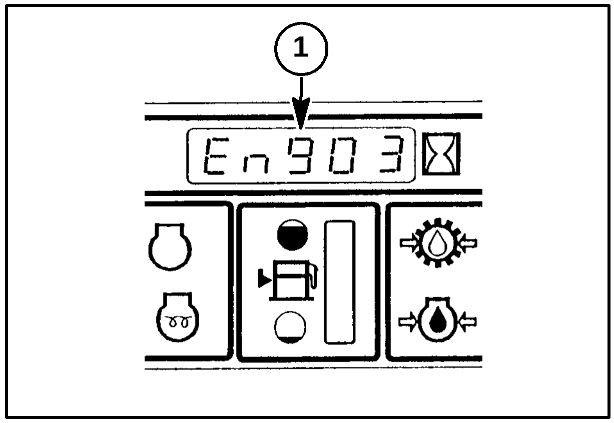
With display showing “LOC_ _” for lock:

1. Press and release the “ARROW” switch; “dIAg” will appear in the character display. Then press and release the “ARROW” switch again; “SEtUP” will appear in the display.
2. Press and hold the “OPEN BOOK” switch until “FAULt” appears in the character display; release switch.
3. Press and release the “ARROW” switch until “EngXX” (XX=current engine code) appears in the display, 1.
4. Press and hold the “OPEN BOOK” switch until the left digit starts to flash; release switch.
5. Press and release the “OPEN BOOK” to enter a zero (0) into the left digit of the engine code.
6. Press and release the “ARROW” switch; the right digit will flash.
7. Press and release the “OPEN BOOK” switch to enter the right number of the engine code. (Example Eng 03 for the LS180 skid steers is shown in display, 1.)

The engine codes are as follows.

03 - LS180
07 - LS190

To exit this item, press and hold the “ARROW” switch two times to return to the “SEtUP” mode item list, or turn the ignition key switch to the “OFF” position to return the EIC to the normal operating mode.



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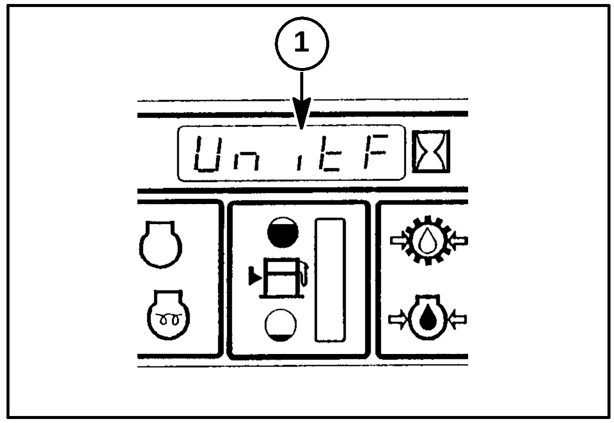
Unit F or Unit C (EIC Reading Fahrenheit or Celsius)
With display showing “LOC_ _” for lock.

1. Press and release the “ARROW” switch; “dIAg” will appear in the character display. Then press and release the “ARROW” switch again; “SEtUP” will appear in the display.
2. Press and hold the “OPEN BOOK” switch until “FAULt” appears in the character display; release switch.
3. Press and release the “ARROW” switch until “Unit F” or “Unit C” appears in the character display, 1.
4. Press and hold the “OPEN BOOK” switch until the rightmost letter flashes, then release the switch.
5. Press and release the “OPEN BOOK” to change from F to C or C to F.
   - Unit F will read temperature degrees in Fahrenheit
   - Unit C will read temperature degrees in Celsius

To exit this item press and hold the “ARROW” switch two times to return to the “SEtUP” mode item list or turn the ignition key switch to the “OFF” position to return the EIC to the Normal Operating Mode.



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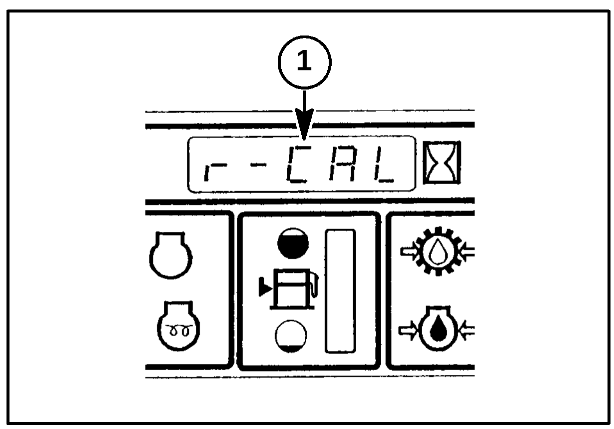
r-CAL - Adjust Engine RPMS
With display showing “LOC_ _” for lock.

1. Press and release the “ARROW” switch; “dIAg” will appear in the character display. Then press and release the “ARROW” switch again; “SEtUP” will appear in the display.
2. Press and hold the “OPEN BOOK” switch until “FAULt” appears in the character display, release switch.
3. Press and release the “ARROW” switch until “r-CAL” appears in the character display, 1.



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4. Press and hold the “OPEN BOOK” switch until all zeros are displayed in the character display. Upon releasing of the switch only the right zero will be showing in display, 1.

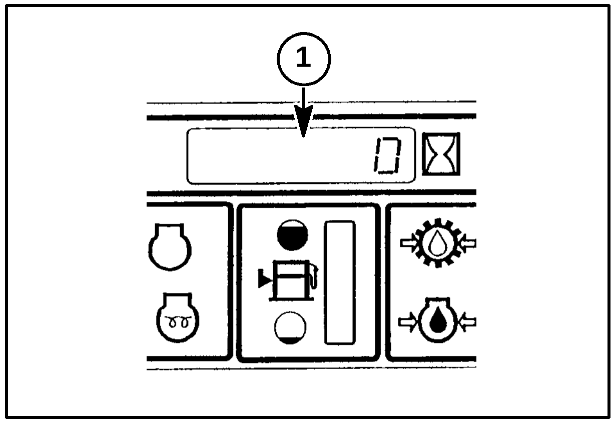
5. Buckle the seat belt and start the engine. Using a hand held photo-tach or other accurate measuring device, check the engine RPM at high idle (full throttle). Compare the hand held tach reading to the EIC RPM reading.

6. Press and release the “OPEN BOOK” or “ARROW” switches to change the EIC reading to match the tach at high idle. Pressing the “OPEN BOOK” switch will decrease the reading and pressing the “ARROW” switch will increase the reading.

   For best results, RPM should be calibrated at full throttle only.

NOTE: *The “OPEN BOOK” or “ARROW” switches may have to be pressed multiple times to change the reading, this is normal. When changing the high idle reading, the low idle reading will have a slight change.*

To exit this item, turn the ignition key switch to the “OFF” position to return the EIC to the Normal Operating Mode.



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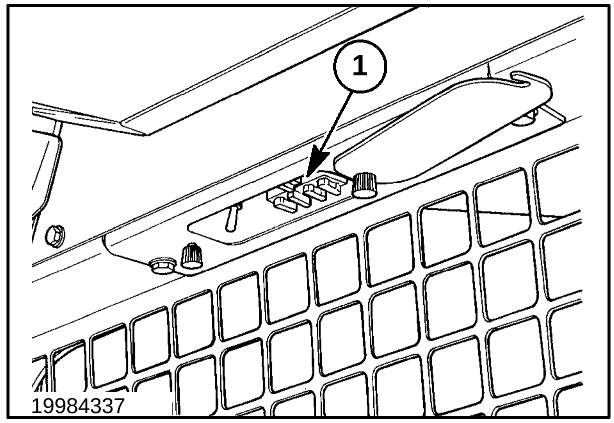
ELECTRONIC INSTRUMENT CLUSTER (EIC) AND STARTER CIRCUITS

BLOWN FUSE SYMPTOMS AND TESTING

Electronic Ignition Fuse, 1
(Cab Fuse Panel - 5A)
Service/Run Switch “Run” Position

1. Board shows self test (with operator in seat).
2. Board shows 5.2 volts.
3. Board seat belt and park brake lights will flash.
4. Board seat belt light will go off when seat belt is buckled. Park brake light will still flash.
5. Key “ON” position - board will show 5.2 volts and no preheat cycle.
6. Engine will crank but will not start.
7. Toggle Service/Run switch to “SERVICE” position - unit will start.



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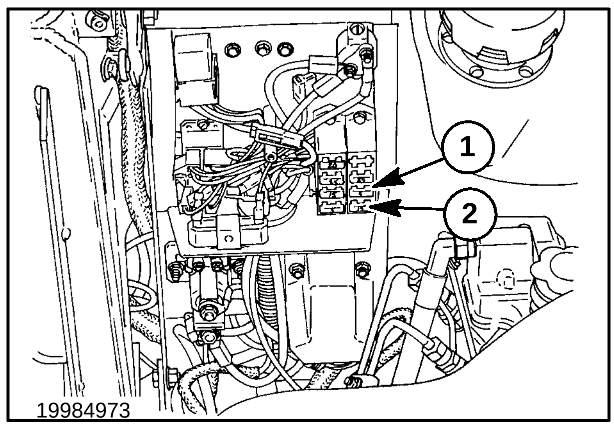
Electronic Battery Fuse, 1
(Engine Fuse Panel - 5A)
Service/Run Switch “Run” Position

1. When operator sits in seat, the board will not power up - no readings.
2. Unit will not crank.
3. Toggle Service/Run Switch to - “SERVICE” position - unit will crank and may start if engine is warm, NO preheat is available.



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Key Main Fuse, 2
(Engine Fuse Panel - 15A)
Service/Run Switch “Run” Position

1. Board will power up and self test.
2. Board seat belt and park brake lights will flash.
3. Board seat belt light will go off when seat belt is buckled; the park brake light will still flash.
4. Key on - system dead.
5. Toggle Service/Run Switch to “SERVICE” position - system dead.

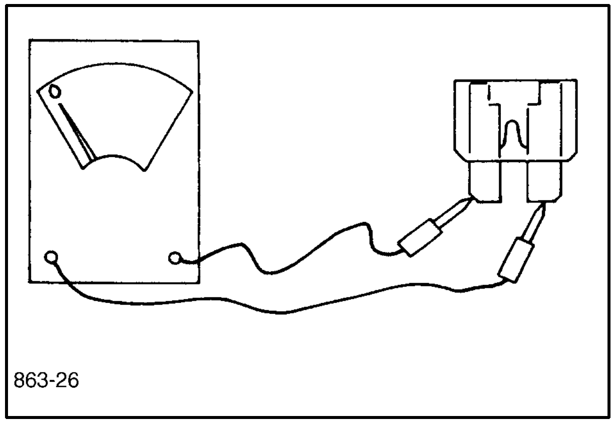
IMPORTANT: *If any servicing or adjustments require the battery to be disconnected, or welding is required on the skid steer, disconnect the negative (-) ground cable. Failure to disconnect the battery may result in damage to the EIC (Electronic Instrument Cluster) monitoring system and other electrical components.*

IMPORTANT: *If the EIC requires removal from the dash area or the skid steer, disconnect the negative (-) ground battery cable. This will shut off power to the EIC and prevent damage to the EIC board or prevent blowing the 5-amp fuses if the board is accidentally grounded.*

IMPORTANT: *Do not use magnetized tools while working around the EIC board or damage to the EIC may occur.*

To test for a blown fuse, remove the fuse from the fuse block and visually examine the fuse link. If the fuse link is blown, replace the fuse.

If the fuse link appears OK, check the fuse with an ohmmeter and check for continuity across the fuse legs; if there is continuity, the fuse is OK.



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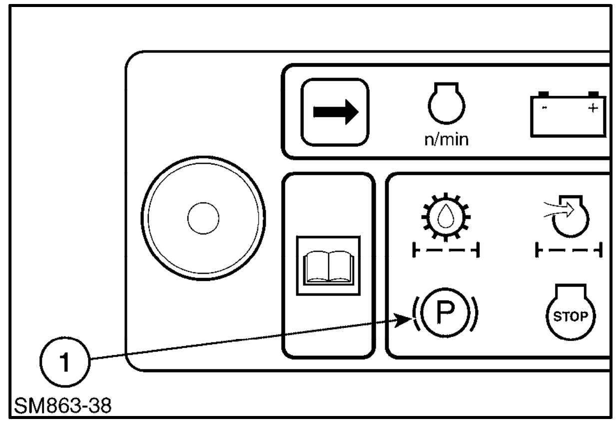
TESTING OTHER EIC FUNCTIONS

NOTE: *These tests are performed with the EIC in the normal operating mode and the “SERVICE/RUN” switch in the “RUN” position.*

1. Parking Brake Light



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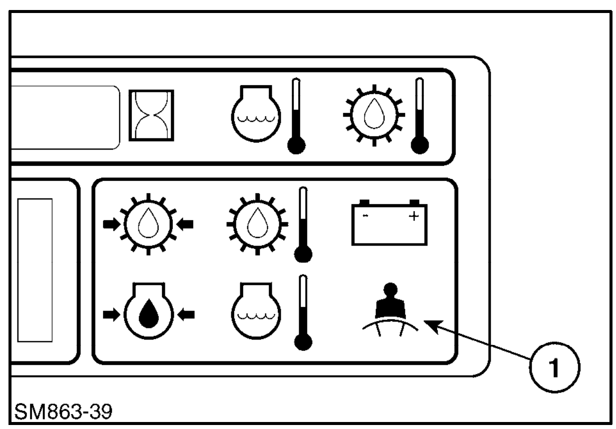
Sit in the seat with the seat belt buckled. After the EIC board self test, the parking brake light, 1, should flash. Turn the ignition key to the “ON” position and the light should go off. If the light fails to go off, check the 5-amp fuse in the cab fuse panel.

When exiting the loader with the ignition key in the “ON” position, the light should flash for about 2 seconds after the seat belt is unbuckled and the operator is out of the seat.

If the light does not flash when the seat belt is unbuckled, check operation of the seat belt switch and the seat switch.

2. Seat Belt Light



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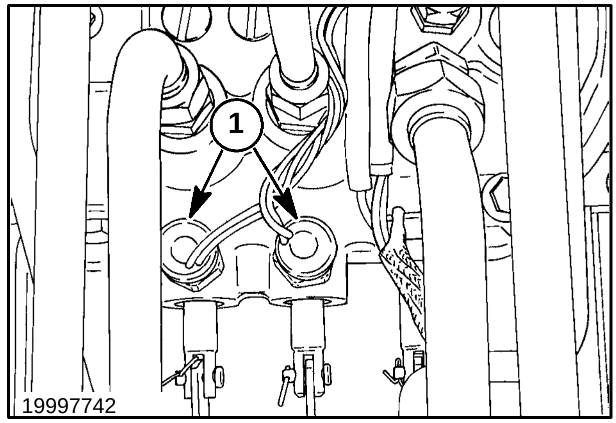
Sit in the seat. After the EIC board self tests, the seat belt light, 1, will flash until the seat belt is buckled.

If the light continues to flash after the seat belt is buckled, check operation of the seat belt switch.

3. Boom and Bucket Spool Locks, 1
   (Control valve spools in neutral and boom and bucket resting on the ground)

   - Sit in the seat. After the EIC board self tests, turn the ignition switch to the "ON" position. The boom and bucket controls should not move. If OK, go to the next step. If the controls can be moved, check the solenoids for operation and check the control linkage and valve spool centering for binding causing the spools not to center to the neutral position.
   - Sit in the seat, buckle the seat belt and try moving the boom and bucket controls. The controls should not move. If OK, go to the next step. If the controls can be moved, check the solenoids for operation and check the control linkage and valve spool centering for binding causing the spools not to center to the neutral position.
   - Sit in the seat, buckle the seat belt, and turn the ignition switch to the "ON" position. If the controls move allowing boom and bucket operation, go to the next step. If the controls do not move, check the solenoids for operation and for battery voltage at the solenoids.
   - Sit in the seat, buckle the seat belt, and turn the ignition switch to the "ON" position. Move the controls and return the controls to the centered (neutral) position. Unbuckle the seat belt. Try moving the controls; they should be locked. Rebuckle the seat belt; the controls should move allowing boom and bucket movement.



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4. Boom and Bucket Spool Lock Solenoid Test

Voltage Test

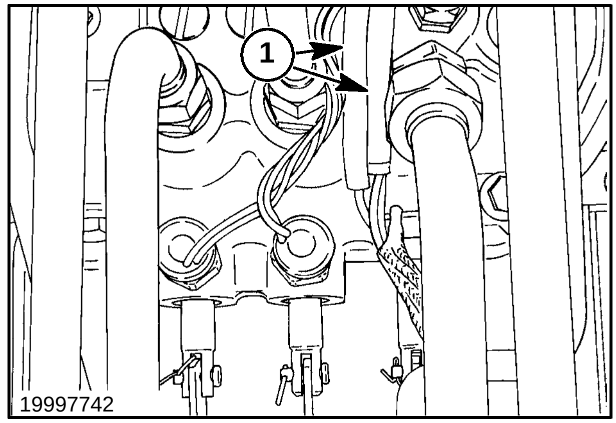
To perform the following test, the operator must be sitting in the seat, seat belt buckled, and the ignition “key” switch in the “RUN” position.

- Unplug one solenoid at a time and check for battery voltage at the main wire harness connector, 1, between the PK/LTBL wire side of the connector and the B wire side of the connector. If there is battery voltage, proceed to checking solenoid resistance.
- If there is no battery voltage between the PK/LTBL wire and the B wire, check for battery voltage between the PK/LTBL wire and frame ground. If there is battery voltage, check the “B” ground wire of the solenoid circuit for open circuit. If there is no battery voltage, check the PK/LTBL power wire for an open circuit.

Ohms Test

With the ignition “key” switch in the “OFF” position:

- Unplug one solenoid at a time, 1, and check ohms resistance of the solenoid coils, 15 to 18 ohm range.
- If solenoid coils are not within the ohms resistance range, 15 to 18 ohms, replace the solenoid coil.



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EIC BOARD READING ACCURACY

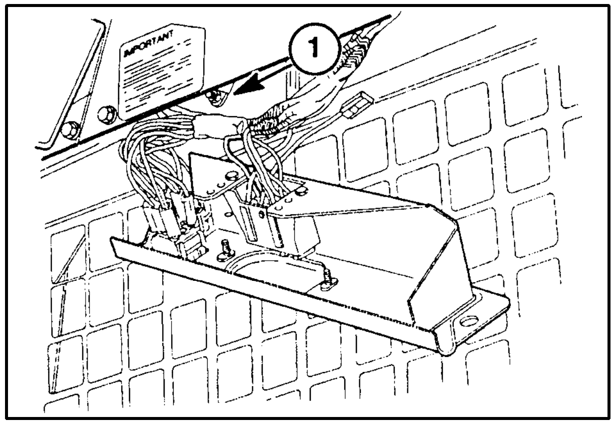
EIC board readings for the digital display, including RPM, Battery Voltage, Hourmeter, Engine Coolant Temperature, or Hydraulic Oil Temperature may not be accurate or may have no reading when selected.

Complaints usually follow installation of an optional kit or customer-installed option, or complaints can arise after a machine repair such as engine overhaul or cab tilting. However, occasionally a concern on a standard machine with no modifications is reported.

If the EIC board was operating correctly before any repair or kit installation occurred, the possible cause may be improper electrical system grounding. If working on a new machine, grounding points should be checked before any replacement of components is considered.

THE ONLY ACCEPTABLE GROUND POINTS IN THE CAB AREA ARE TO THE GROUND STUD ON THE ROPS RIGHT SIDE NEAR ELECTRICAL PANEL, 1, OR TO THE AUXILIARY POWER KIT SOCKET WHICH IS WIRED TO THE BELL HOUSING GROUND. NO ACCESSORIES MAY BE GROUNDED TO THE CAB INTERLINER ON LS180 OR LS190 SKID STEERS BECAUSE SOME OR ALL OF THE CURRENT COULD PASS THROUGH THE EIC.

NOTE: *When attaching ground wires to the cab ground stud, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to wire size, largest on the bottom and smallest last.*



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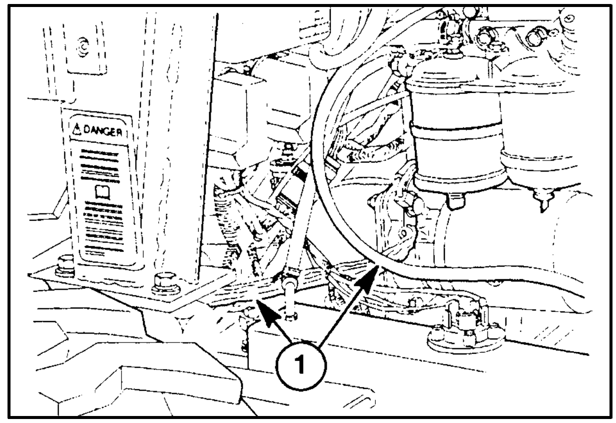
All grounding locations should be checked for tight hardware and absence of paint between parts for good connecting, as follows:

1. Check the grounding strap from the engine to main frame, 1.

   On the grounding strap from the ROPS to the main frame, be sure the strap is attached between the ROPS and the main frame (yellow lower frame). DO NOT attach the strap between the cab interliner (cab side screen sections) and the main frame, as the cab interliner on LS180 and LS190 skid steers is rubber-mounted to the ROPS and, therefore, insulated from the ROPS. However, a second strap may be added between the cab interliner and the main frame and should cause no ill effect.



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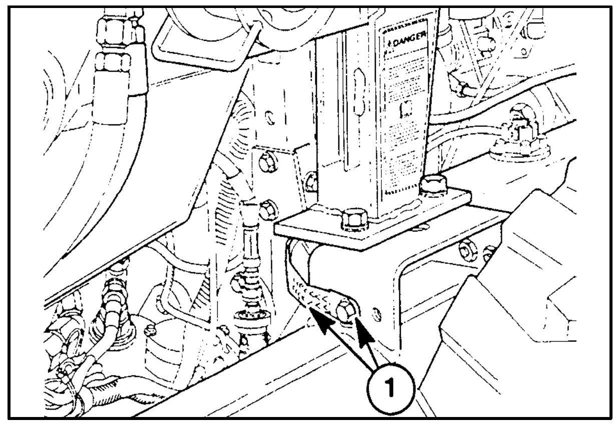

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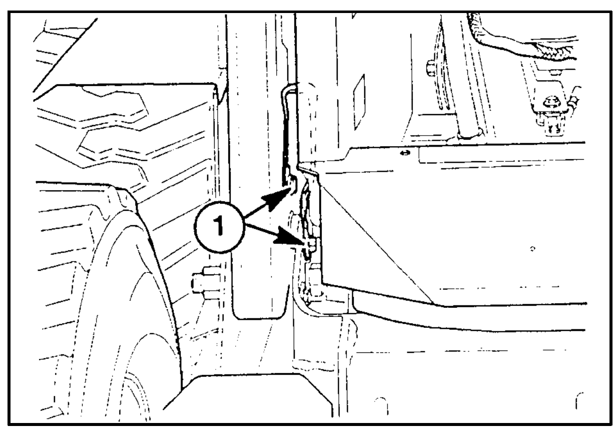
2. Check the grounding strap from the cab ROPS structure to main frame, 1.
3. Check the wiring harness from the EIC to the bell housing.



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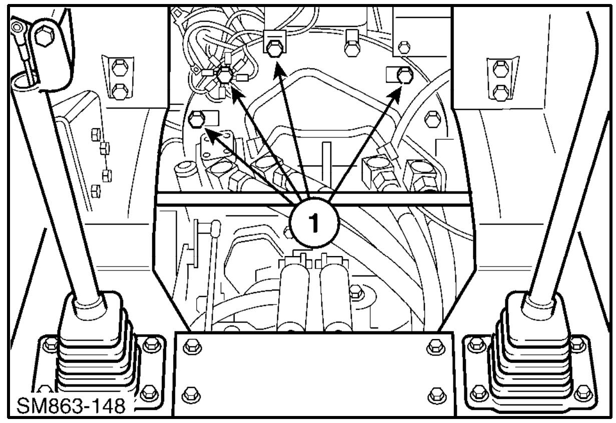
4. Check the wiring harness grounds to the bell housing, 1.

NOTE: *When attaching multiple ground wires, always place the heaviest ground wire (battery ground cable) next to the ground surface (bell housing). Stack the remaining ground wires according to wire size, largest on the bottom and smallest last. Two wires in a terminal are considered to be larger than a single wire of the same size.*



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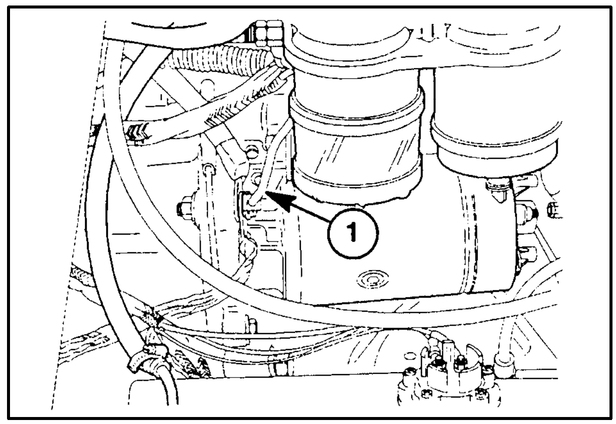
5. Check the black wire in engine harness between the bell housing and the starter mounting with negative battery cable, 1.

   Due to the distance between the bell housing ground point and the starter mounting at the attachment of the negative battery cable, a separate ground wire is used between these points to carry the current across bolted assemblies.

   Check the integrity of this wire at the bell housing ground point and its connection with the negative battery cable and braided strap (from frame) at starter mounting bolt.



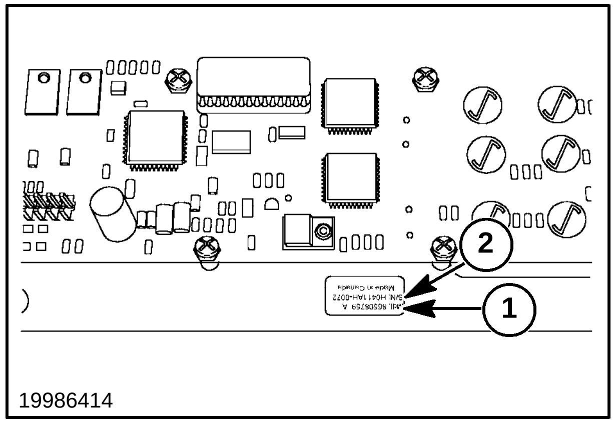
62

EIC BOARD CLAIMS WARRANTY

When filing a warranty claim for a defective EIC (Electronic Instrument Cluster) board, include the part number and serial number on the white tag of the defective board.

The EIC board part number, 1, and this number must be used as the causal part number.

Also include the EIC board serial number located at 2, in the description of failure section of the warranty claim, along with a description of the type of EIC board failure.



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Handling the EIC Board

The EIC board is shipped in an anti-static bag and box. The board must be kept in this bag and box, until required for a repair, to prevent damage to the EIC board.

When returning the EIC board for warranty or repair, it must be returned in the anti-static bag and box to prevent damage.

When installing a new EIC board, always disconnect the negative battery cable to prevent damage to the board from accidental grounding.

The board versions listed below are the EIC boards used on skid steers.

DO NOT replace a prior version board unless it is defective.

Troubleshoot any problems and only replace the board if it is determined to be the problem.

Boards returned as warranty and determined not to be defective will be debited back. All EIC boards claimed as warranty must be returned for review.

ELECTRICAL CIRCUITS

EIC (ELECTRONIC INSTRUMENT CLUSTER)

The EIC board receives power from five different points.

1. Main power circuit, 12-volt battery, from the 5-amp fuse in the engine fuse panel.
2. The ignition switch, 12-volt ignition circuit.
3. Seat switch circuit.
4. The seat belt switch circuit.
5. The ignition switch, 12-volt accessory circuit.

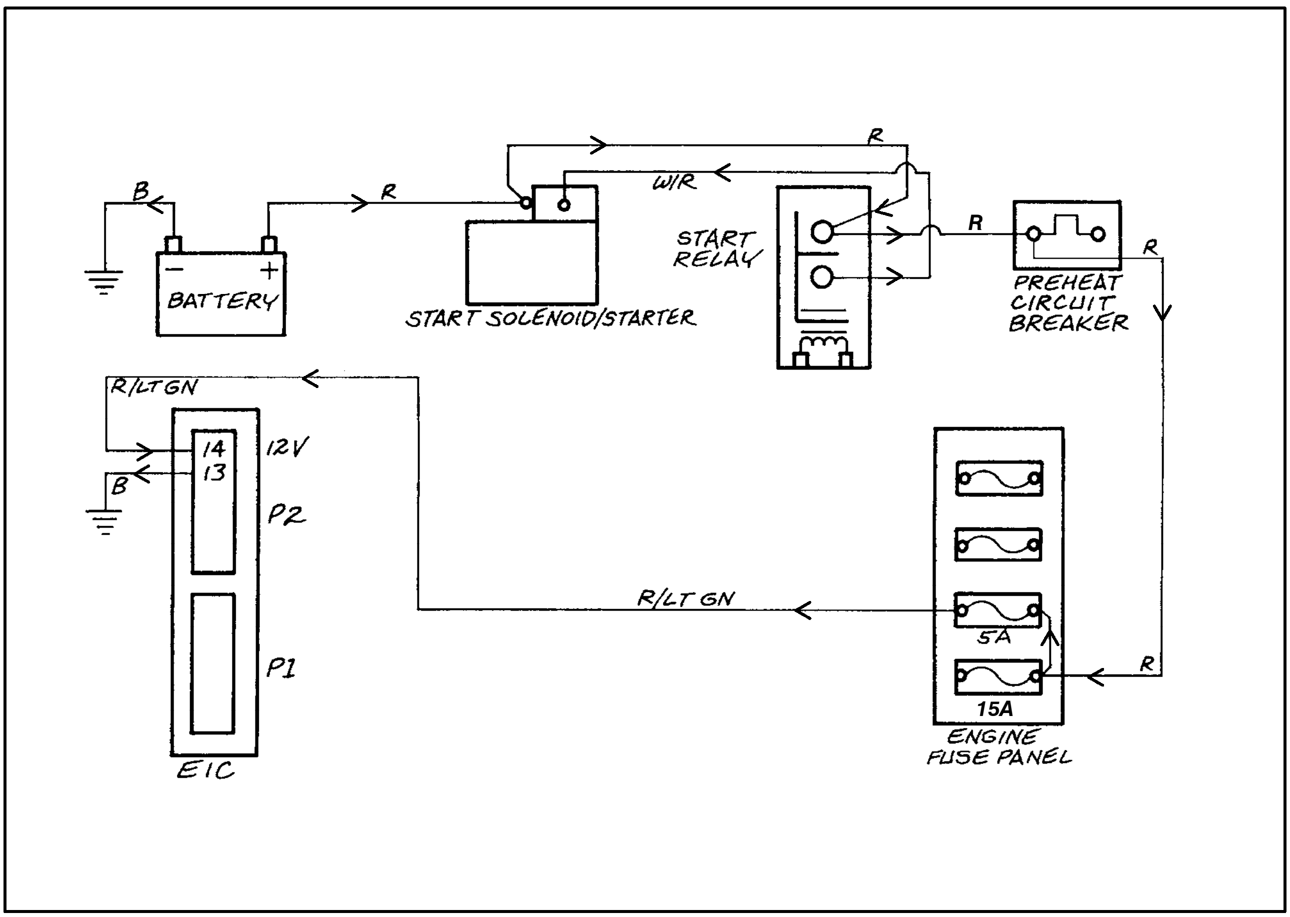
MAIN POWER CIRCUIT TO EIC BOARD

Battery voltage

The power originates at the battery and proceeds through the (R) battery cable to the starter solenoid. From there power continues through the (R) wire to the battery side of the start relay. The power continues through the (R) wire to the preheat circuit breaker, then through the (R) wire to the engine fuse panel (standard fuse block), battery side of the key main 15-amp fuse with a terminal bus to the battery side of the electronics 5A fuse. The power continues through the (R/LTGN) wire to pin number 14 of connector P2 (12-volt battery terminal) at the EIC board.

EIC BOARD GROUND CIRCUIT

The EIC board is grounded from connector P2 terminal 13 through the (B) wire to the engine ground at the bell housing.



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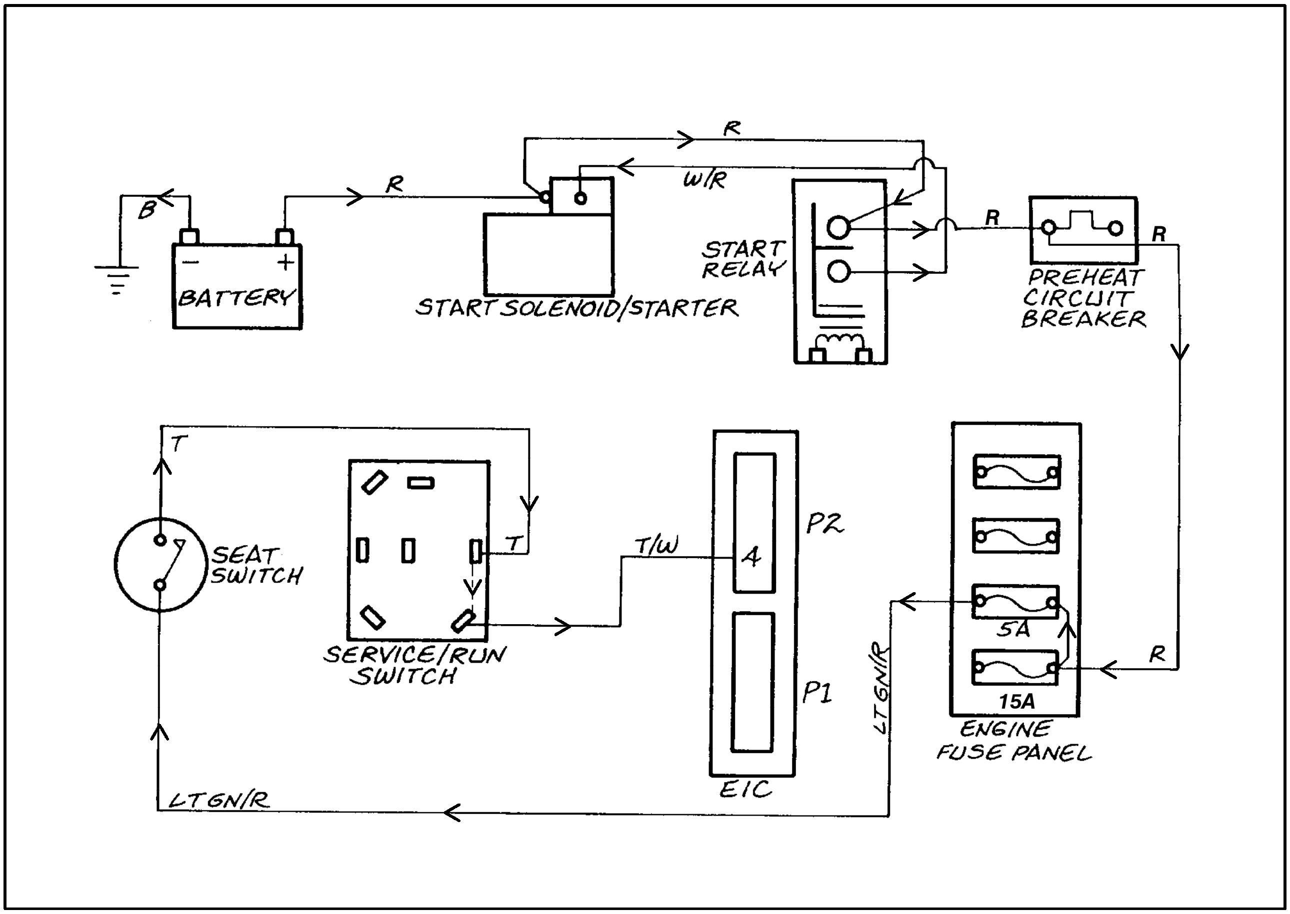

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SEAT SWITCH CIRCUIT TO EIC BOARD

Battery voltage

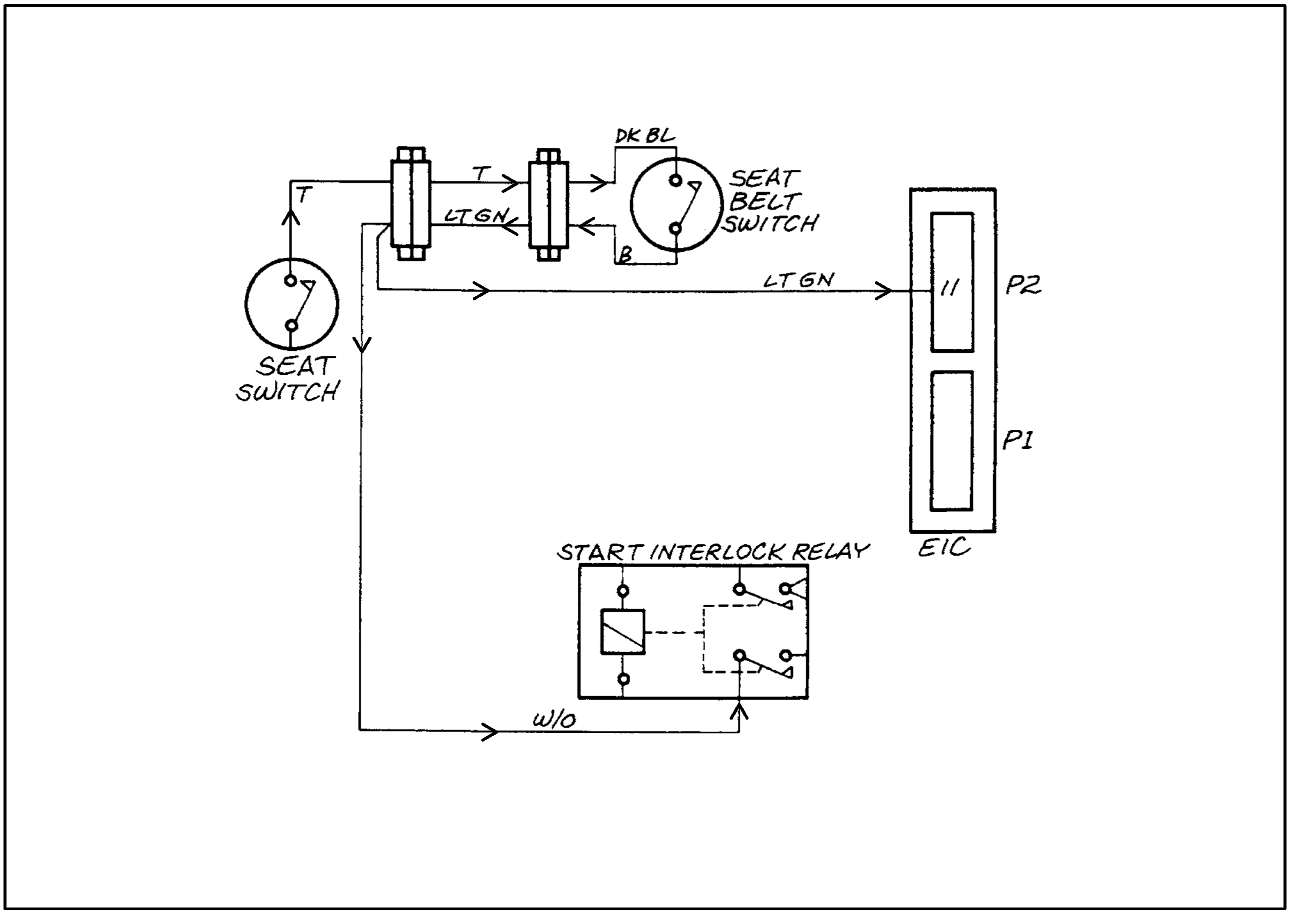
The power originates at the battery and proceeds through the (R) battery cable to the starter solenoid.

From there power continues through the (R) wire to the battery side of the start relay.

The power continues through the (R) wire to the preheat circuit breaker, then through the (R) wire to the engine fuse panel (standard fuse block) battery side of the key main 15-amp fuse with a terminal bus to the battery side of the electronics 5A fuse.

The power continues through the (LTGN/R) wire to the seat switch. When one seat switch (only 1 switch needs to be closed as switches are in parallel wiring) is pressed closed, the power then continues through the (T) wire to the Service/Run switch. When the service/run switch is in the “SERVICE” position, the power stops.

With the Service/Run switch in the “RUN” position, the power continues through the (T/W) wire to the EIC board terminal 4 of connector P2.



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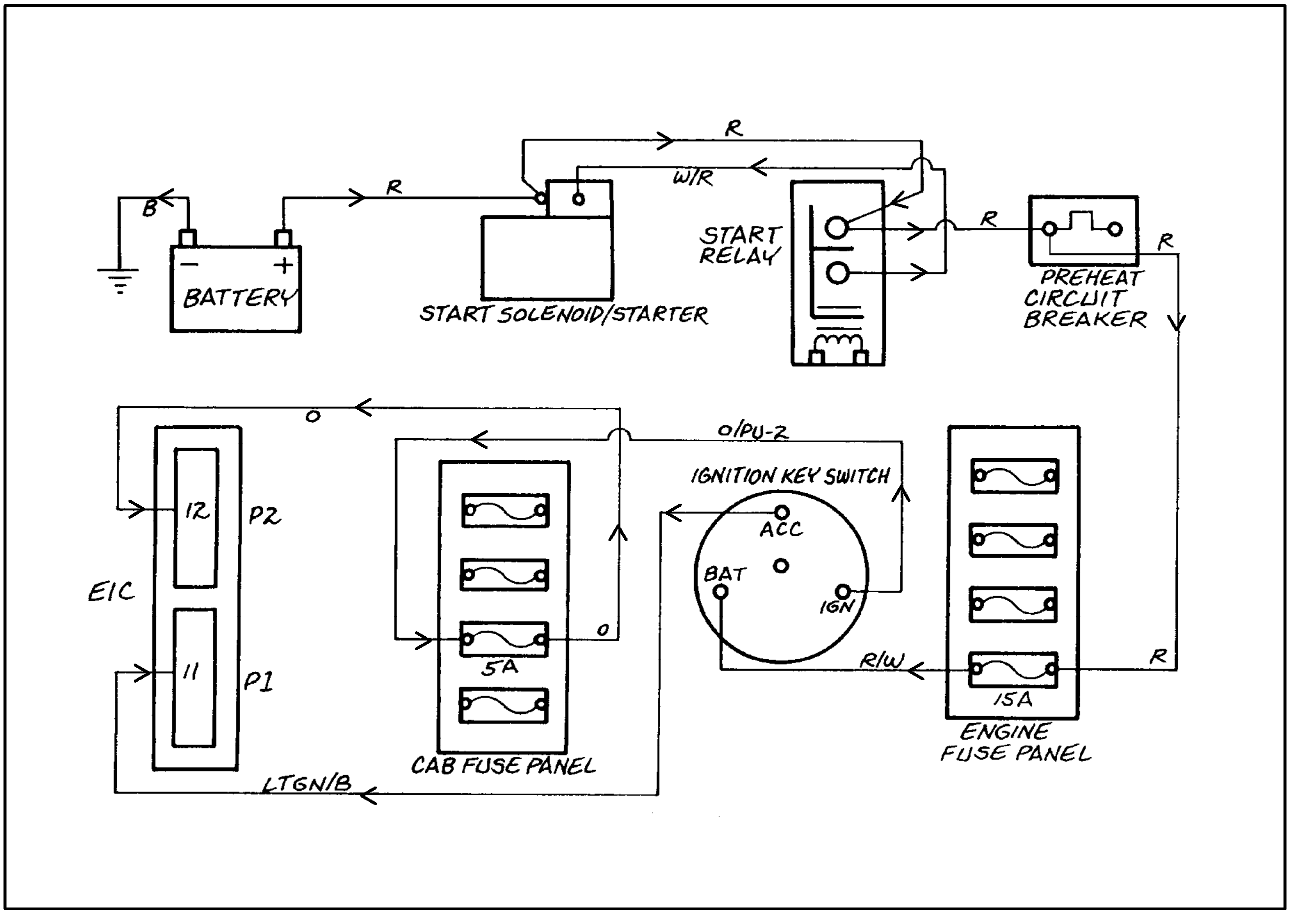
SEAT BELT SWITCH CIRCUIT TO EIC BOARD

Battery voltage
The power originates from the seat switch(es) through the (T) wire to the seat belt switch.

When the seat belt is buckled, the power proceeds through the (LTGN) wire to the EIC board terminal 11 of connector P2.

When the seat belt is buckled, power is sent through the (W/O) wire to the start interlock relay. This allows the unit to start when the seat belt is buckled.



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IGNITION SWITCH CIRCUIT TO EIC BOARD

Battery voltage
The power originates at the battery and proceeds through the (R) battery cable to the starter solenoid.

From there power continues through the (R) wire to the battery side of the start relay.

The power continues through the (R) wire to the preheat circuit breaker, then through the (R) wire to the engine fuse panel (standard fuse block) battery side of the key main 15-amp fuse.

The power continues through the (R/W) wire to the battery terminal of the ignition switch.

When the ignition key switch is turned to the “ON” position, power continues through the (O/PU-2) wire to the Electronics 5-amp fuse in the cab fuse panel.

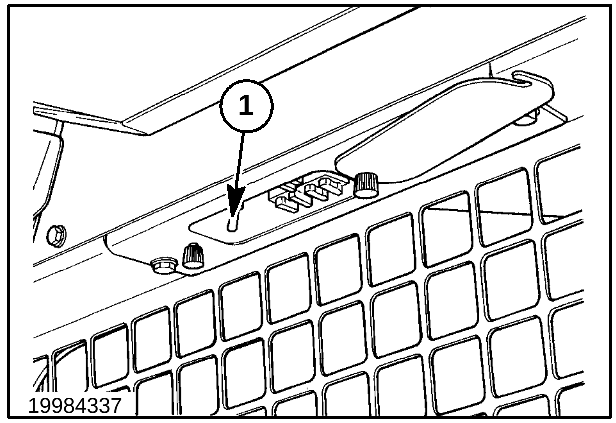
The power continues through the (O) wire to terminal 12 of connector P2 at the EIC board.

NOTE: *Also, with Key Switch “ON” Engine “OFF,” voltage travels from the switch “ACC” terminal via the LTGN/B wire to terminal 11 of connector P1 to provide a warning of Key “ON” should the operator exit the loader.*

CRANKING CIRCUIT (STARTER MOTOR)

Operating conditions with “SERVICE/RUN” switch in the “RUN” position:

To start the engine with the “SERVICE/RUN” switch in the “RUN” position, 1, the operator must be in the seat with the seat belt buckled. Then turn the key switch to the “START” position to activate the starter.



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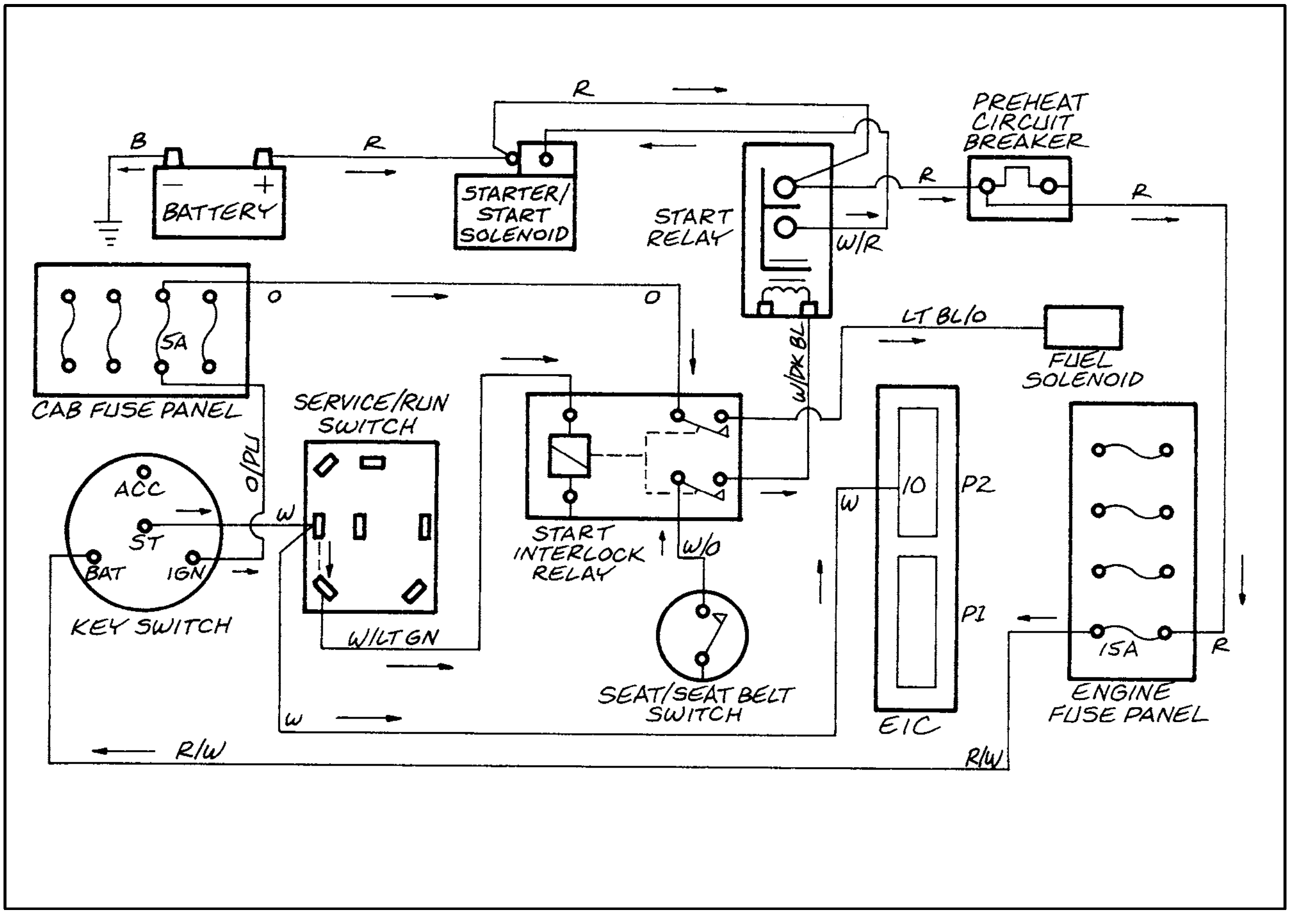

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"SERVICE/RUN" SWITCH IN THE "RUN" POSITION

The power originates at the battery and flows through the (R) positive battery cable to the starter solenoid. From here the power flows through the (R) wire to the battery side of the start relay.

The power then flows through the (R) wire to the preheat circuit breaker and to the engine fuse panel to the 15A key main fuse.

The power then flows through the (R/W) wire to the battery terminal on the ignition key switch.

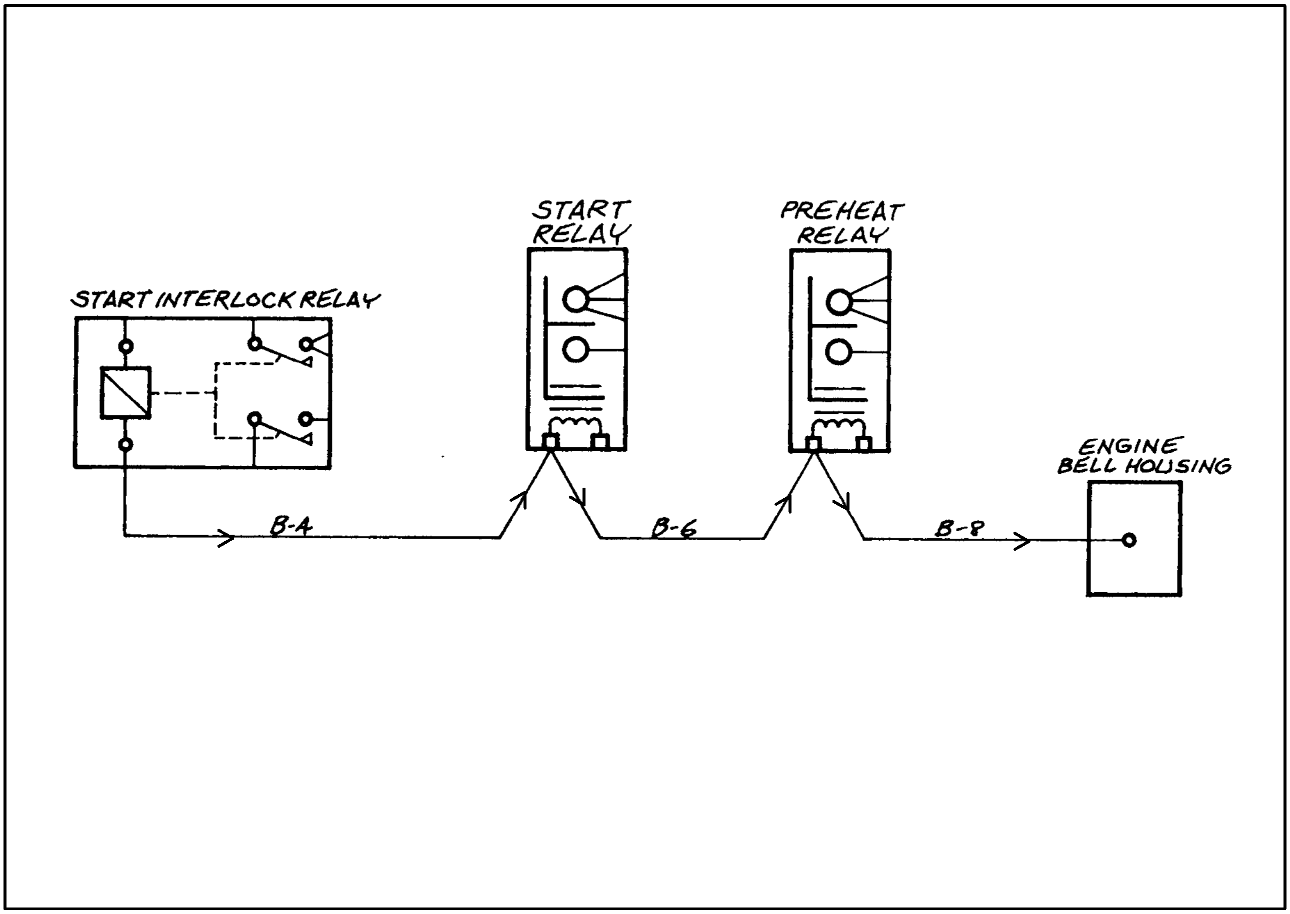
With the key switch in the "START" position, current flows through the (W) wire to the service/run switch. Power also flows through the (W) wire to connector P2 terminal 10-key start at the EIC board.

Power then flows from the service/run switch through the (W/LTGN) wire to the start interlock relay coil terminal.

With the interlock energized, the power from the seat/seat belt circuit (W/O) wire flows through the (W/DKBL) wire to the start relay to activate the relay.

Power also flows from the start interlock relay through the LTBL/O wire to the fuel solenoid to open the solenoid, allowing fuel flow to the injection pump.

When the start relay is activated, power goes through the (W/R) wire to the starter solenoid, which connects battery power to the starter motor.



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CRANKING CIRCUIT GROUND

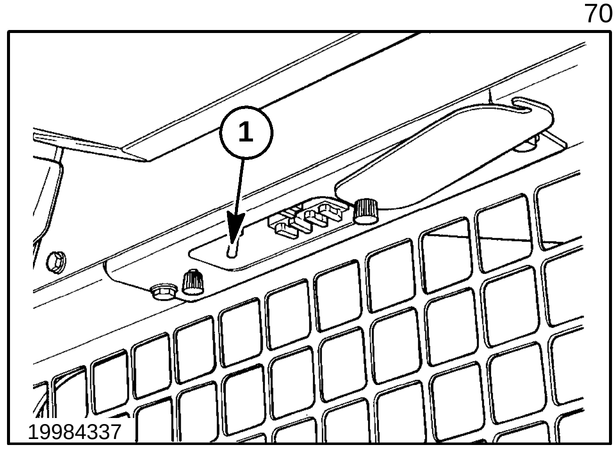
The start interlock relay is grounded through the (B-4) wire to the ground terminal on the start relay. The system ground (B-6) wire then goes to the ground terminal of the preheat relay. The system ground (B-8) wire then goes to the engine ground at the bell housing.

Operating Conditions “SERVICE/RUN” switch in the “SERVICE” position

To start the engine with the “SERVICE/RUN” switch, 1, in the “SERVICE” position, the starter will be activated any time the key switch is turned to the “START” position.

NOTE: *If manual preheat is required, the operator must be in the seat.*

NOTE: *The boom and bucket control valve spool locks will remain inoperative with the “SERVICE/RUN” switch in the “SERVICE” position.*



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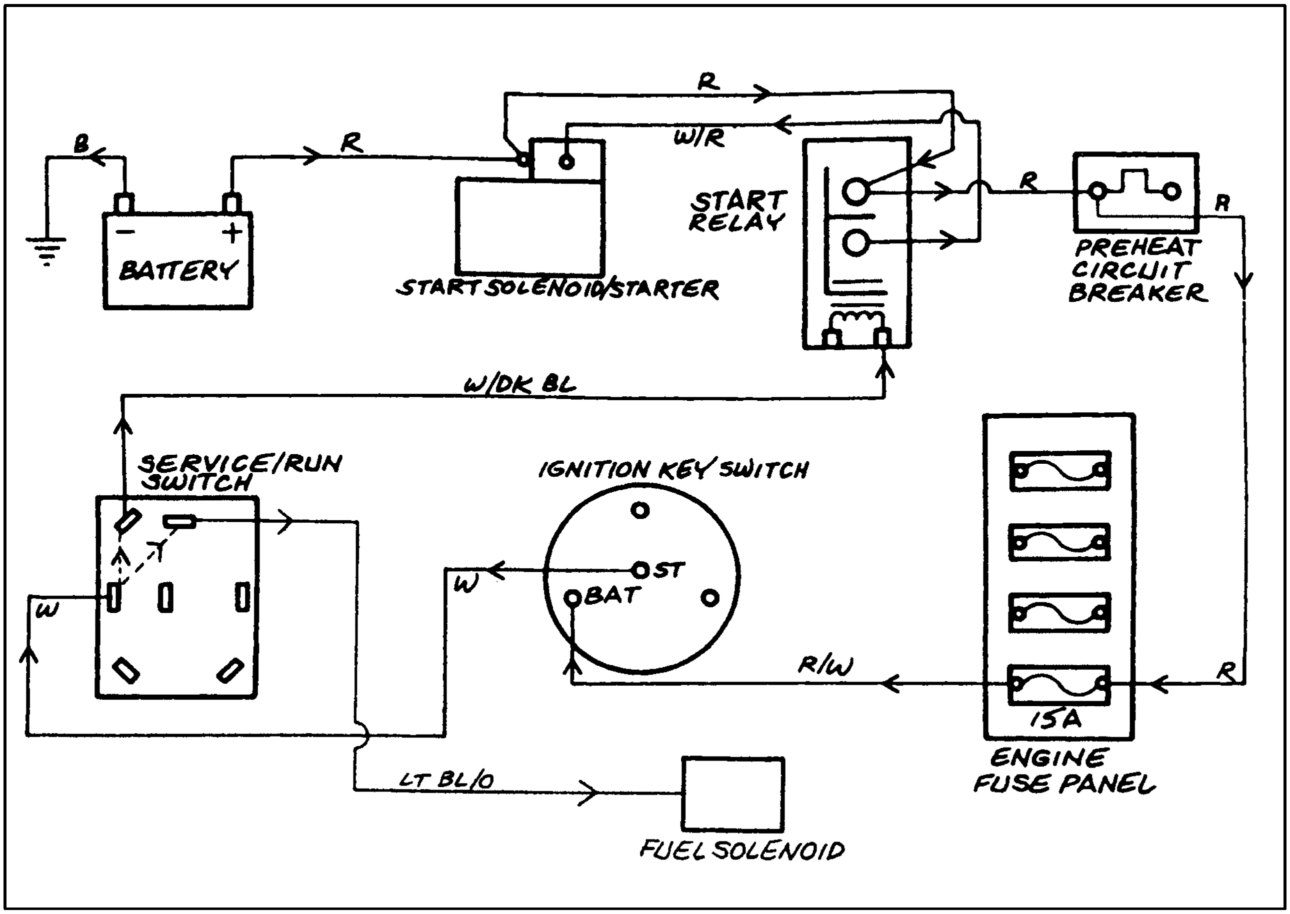

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SERVICE/RUN SWITCH IN THE “SERVICE” POSITION

The power originates at the battery and flows through the (R) positive battery cable to the starter solenoid. From here the power flows through the (R) wire to the battery side of the start relay.

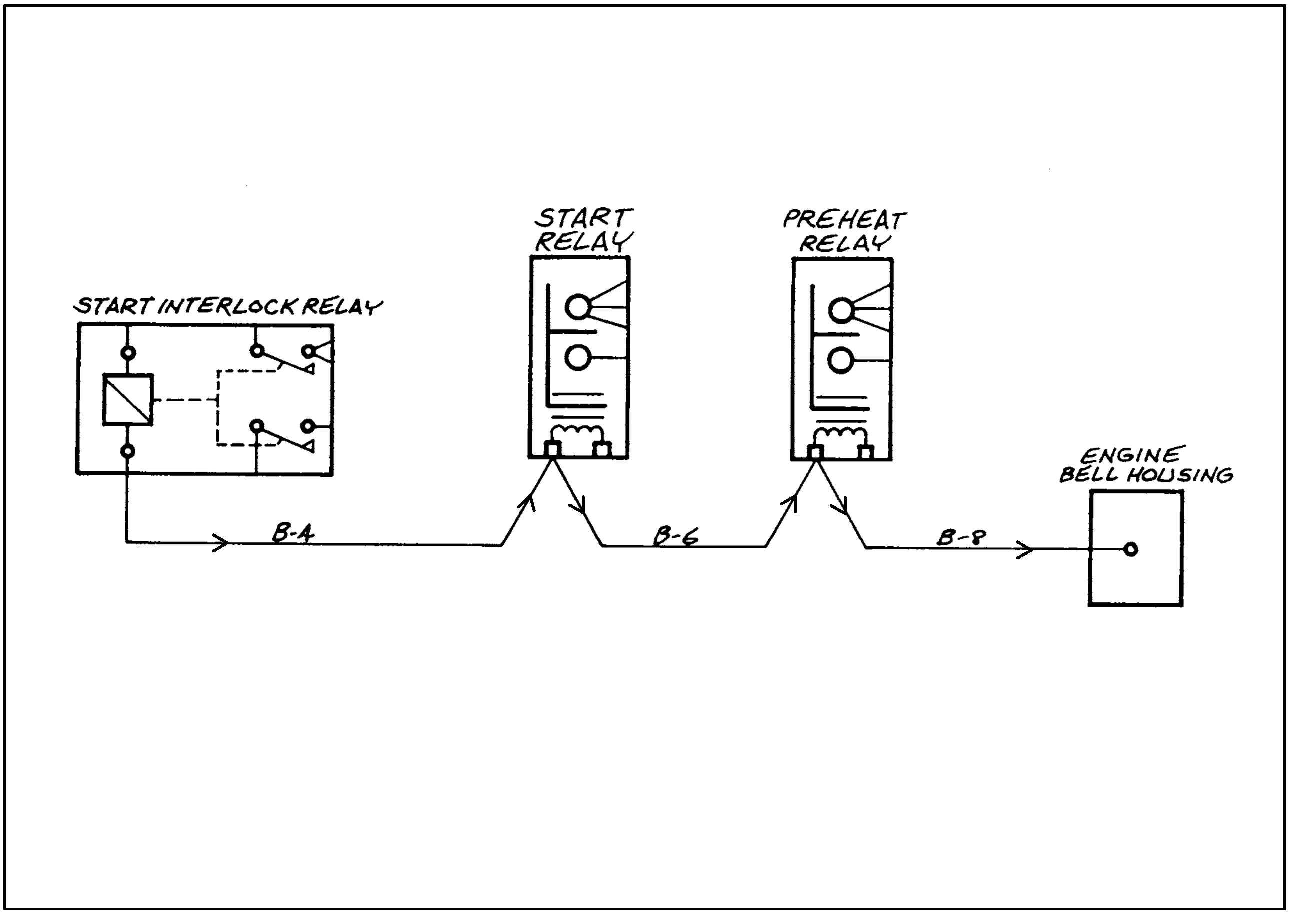
The power then flows through the (R) wire to the preheat circuit breaker and to the engine fuse panel to the 15A key main fuse.

The power then flows through the (R/W) wire to the battery terminal on the ignition key switch.

With the key switch in the “START” position, current flows through the (W) wire to the service/run switch.

With the service/run switch in the “SERVICE” position, power goes through the (W/DKBL) wire from the service/run switch to the start relay to activate the relay.

When the start relay is activated, power goes through the (W/R) wire to the starter solenoid, which connects battery to the starter motor.



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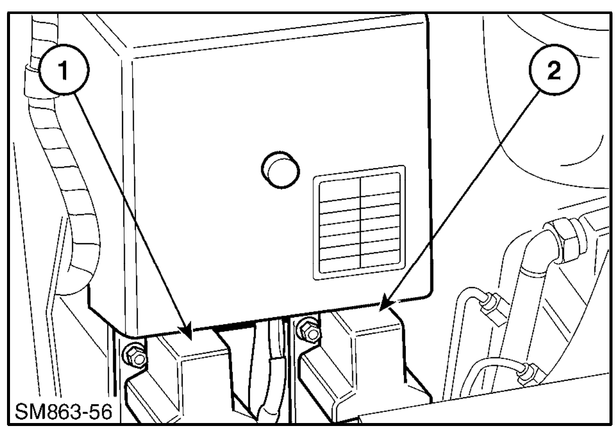
CRANKING CIRCUIT GROUND

The start interlock relay is grounded through the (B-4) wire to the ground terminal on the start relay. The system ground (B-6) wire then goes to the ground terminal of the preheat relay. The system ground (B-8) wire then goes to the engine ground at the bell housing.

START RELAY OPERATION

The start relay allows for smaller wires to be used in the switch circuits. The larger wires are then only used between the power supply, start relay, and starter motor. The start relay provides a short path for the high current required to pull in the starter solenoid with minimal voltage drop.

The start relay, 1, and the preheat relay, 2, may be wired in either position. Check wire colors for proper relay location.



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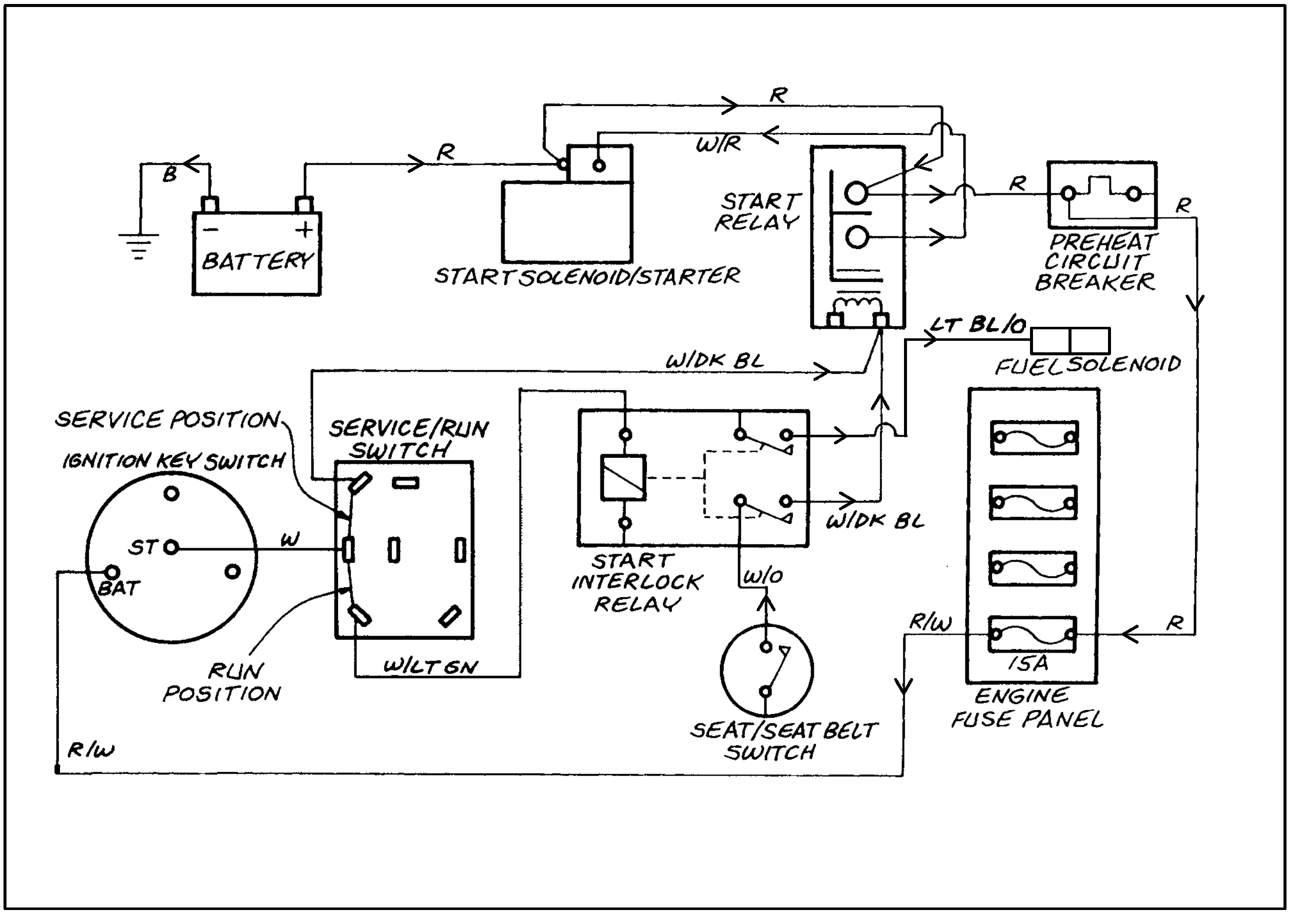

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START RELAY CIRCUIT

The power originates at the battery and flows through the (R) positive battery cable to the starter solenoid. From here the power flows through the (R) wire to the battery side of the start relay.

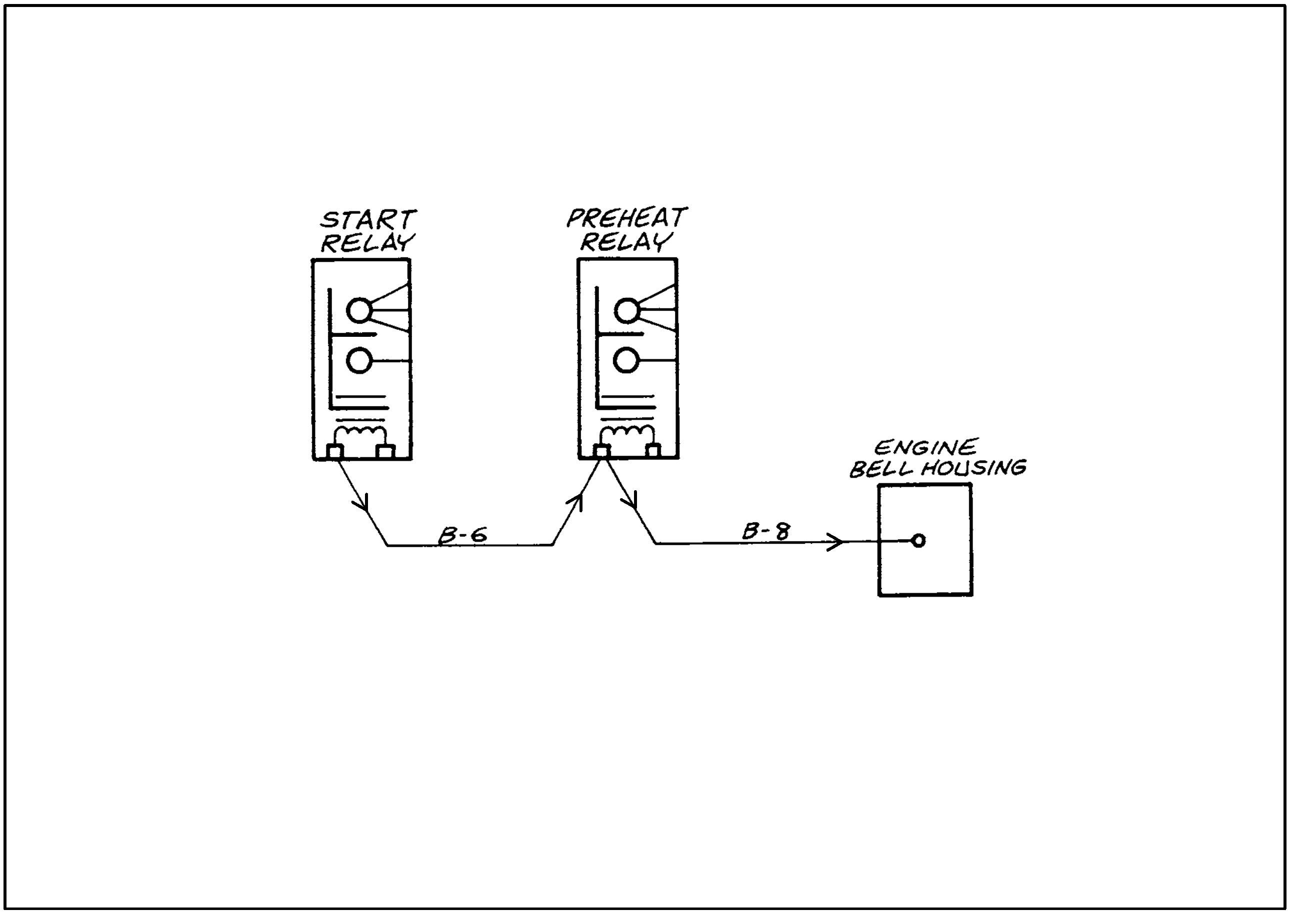
The power then flows through the (R) wire to the preheat circuit breaker and to the engine fuse panel to the 15A key main fuse.

The power then flows through the (R/W) wire to the battery terminal on the ignition key switch.

When the service/run switch is in the “RUN” position, the operator is in the seat with the seat belt buckled, and the start interlock relay is energized by the W/LTGN wire from the service/run switch, the start relay receives energizing power from the seat/seat belt circuit via the W/O wire, then the (W/DKBL) wire from the start interlock relay.

When the service/run switch is in the “SERVICE” position, the start relay receives energizing power through the (W/DKBL) wire from the service/run switch.

When the start relay is activated, it connects the battery side of the relay to the start side and sends power to the starter solenoid through the (W/R) wire, activating the starter motor.



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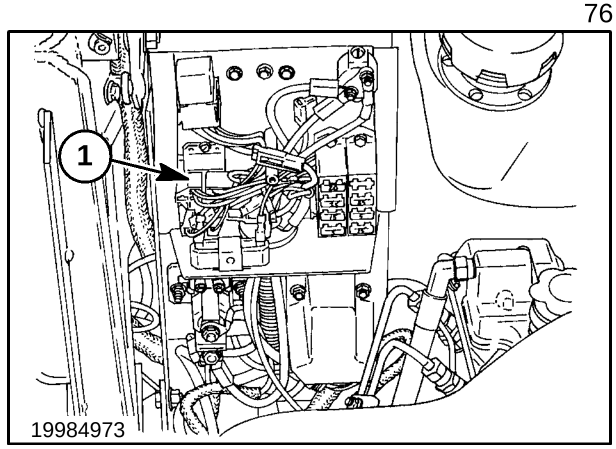
START RELAY GROUND CIRCUIT

The start relay is grounded through the (B-6) wire to the ground terminal on the preheat relay and then through the (B-8) wire to the engine bell housing.

START INTERLOCK RELAY OPERATION

The start interlock relay, 1, controls the starting circuit when the “SERVICE/RUN” switch is in the “RUN” position, allowing the engine to start.



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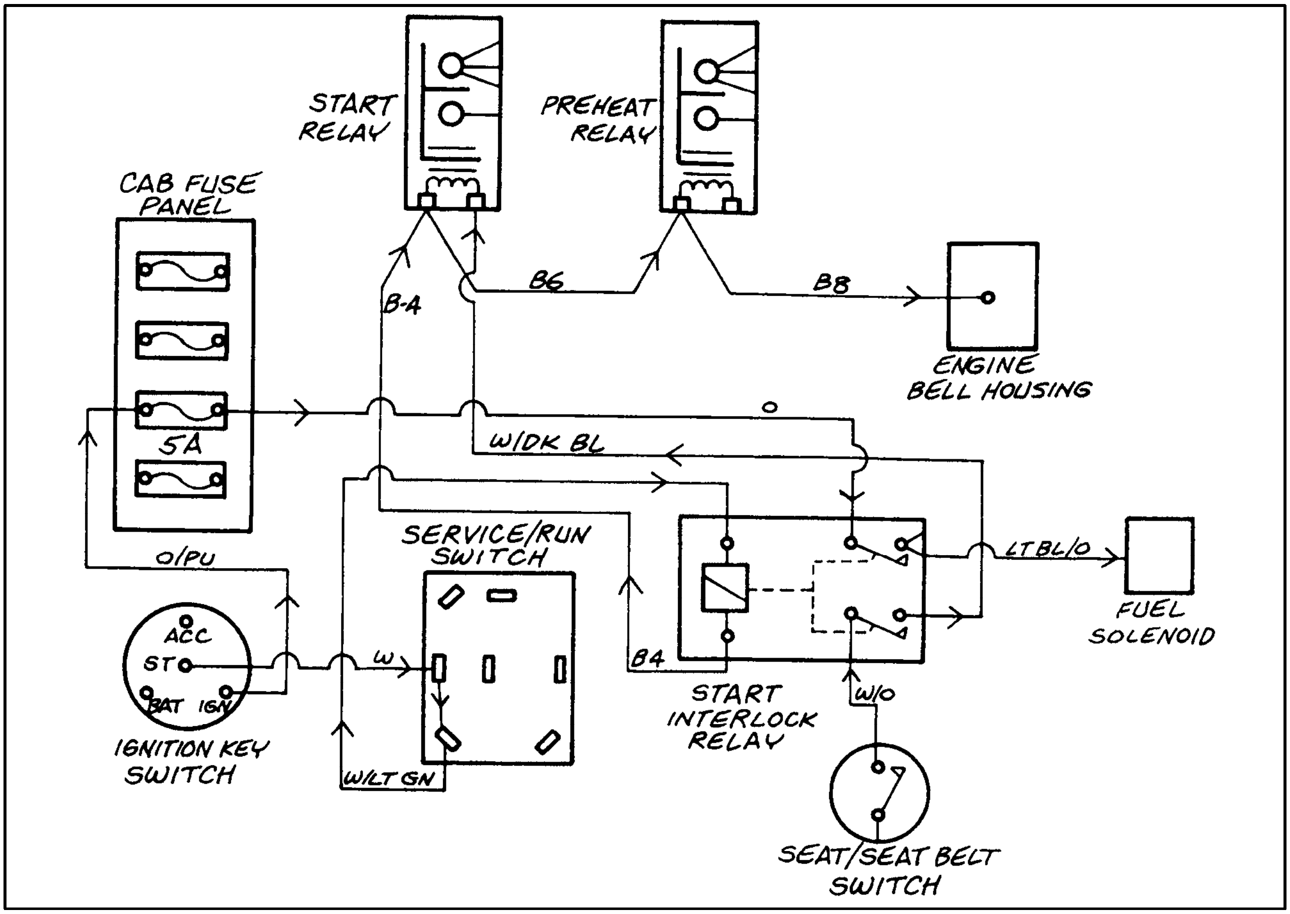

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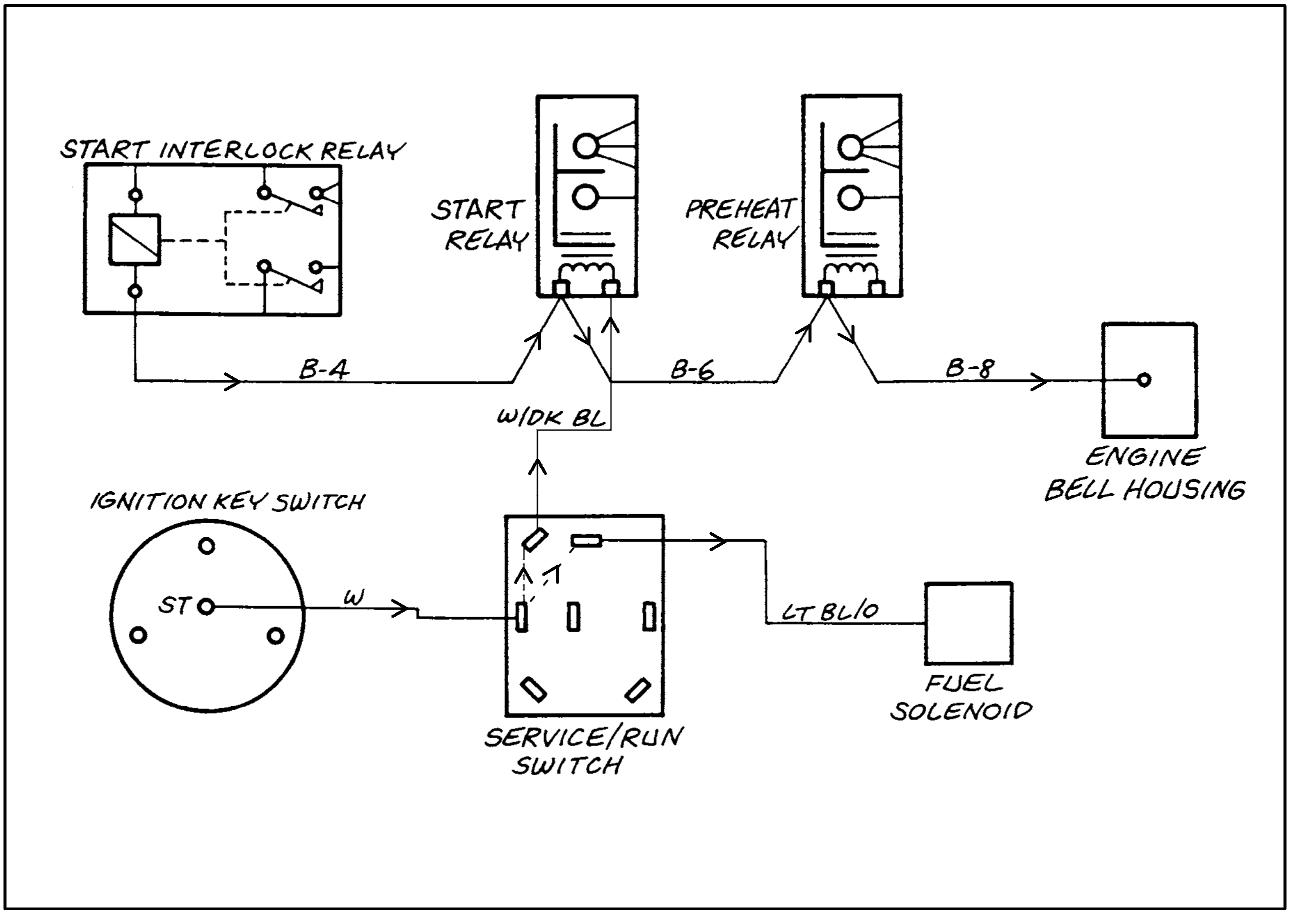
START INTERLOCK CIRCUIT

“SERVICE/RUN” switch in the “RUN” position.

The start interlock relay coil receives power from the service/run switch, with the switch in the “RUN” position, through the W/LTGN wire. The interlock receives power from the seat/seat belt plug when the operator is sitting in the seat with the seat belt buckled through the W/O wire.

When the interlock is “satisfied” that the service/run switch is in the “RUN” position and the operator is sitting in the seat with the seat belt buckled, power will travel through the W/DKBL wire to the start relay and through the LTBL/O wire to the fuel solenoid, allowing the engine to start. The source for the fuel solenoid power is from key switch “Ign,” then through the O/PU wire to the cab 5-amp fuse, then via the O wire to the relay.



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START INTERLOCK GROUND CIRCUIT

The interlock is grounded through the B-4 wire to the start relay, through B-6 wire to the preheat relay, through B-8 wire to the engine bell housing ground.

START CIRCUIT

“SERVICE/RUN” switch in the “SERVICE” position.

The interlock relay is not functional with the service/run switch in the “SERVICE” position. With the switch in the “SERVICE” position, power flows from the key switch “START” terminal via the W wire to the service/run switch, then through the LTBL/O wires to the fuel solenoid, allowing the engine to start and continue to run. The start relay receives power from the service/run switch via the W/DKBL wire to activate the start relay. The EIC plays no supporting role in this mode.

Op. 55 100

REMOVAL, INSTALLATION AND WIRING OF ELECTRICAL COMPONENTS

This section will show and explain the correct wiring of switches and relays, and when and where battery voltage should be with the key switch (ignition) “ON” or “OFF” for the electrical components.

This section will also explain the removal and installation of the switches, relays, EIC board, and main wire harness.

Before servicing, changing or adding any electrical components, read the following precautionary statements.

IMPORTANT: *Do not connect any power or ground electrical circuits at the ignition key switch, the cab electrical fuse panel, or the cab ground terminal in the fuse panel area unless there are written instructions from New Holland telling you to do so or damage and false readings with the EIC board may occur.*

IMPORTANT: *If any servicing or adjustments require the battery to be disconnected, or welding is required on the skid steer, disconnect the negative (-) ground cable. Failure to disconnect the battery may result in damage to the EIC (Electronic Instrument Cluster) monitoring system and other electrical components.*

IMPORTANT: *If the EIC requires removal from the dash area of the skid steer, disconnect the negative (-) ground battery cable. This will shut off power to the EIC and prevent damage to the EIC board or blowing the 5-amp fuses if the board is accidentally grounded.*

IMPORTANT: *Do not service the EIC board with magnetized tools (wrenches, screwdriver, etc.) or magnets. Severe damage to the EIC board may occur.*

BATTERY - LS180

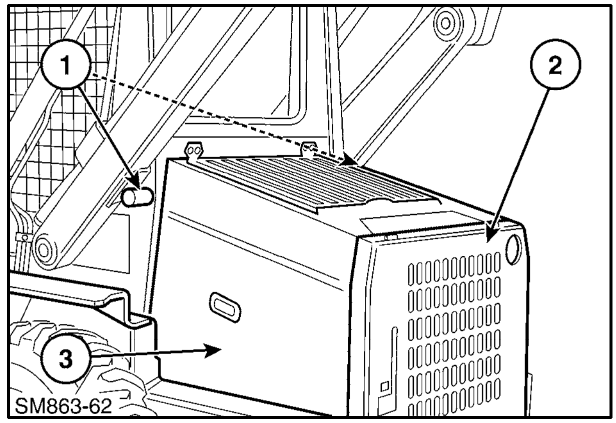
Op. 55 301 40

REMOVAL - LS180

1. Raise the boom and rest on the boom lock pins, 1.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.



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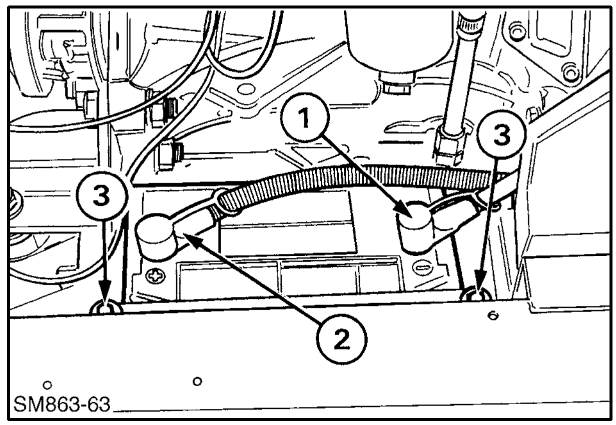
2. Open the rear door, 2, and remove the right engine side shield, 3, to access the battery.
3. Disconnect the negative (-) battery cable, 1.
4. Disconnect the positive (+) battery cable, 2.
5. Remove the battery hold-down hardware, 3, and remove the battery from the loader.



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INSTALLATION - LS180

1. Orient the battery with the positive post, 2, toward the rear of the loader. Install the battery and the hold-down strap and hardware. Position the hold-down strap to clear other components.
2. Connect the positive (+) RED cable to positive (+) terminals and negative (-) BLACK cable to negative (-) terminals. Do not over tighten. Observe the tightening specifications on the battery label.

IMPORTANT: *Crossing of terminals may cause damage to the electrical system, alternator and Advanced Warning System (EIC).*

3. Install protective caps over the battery terminals and cable connections.

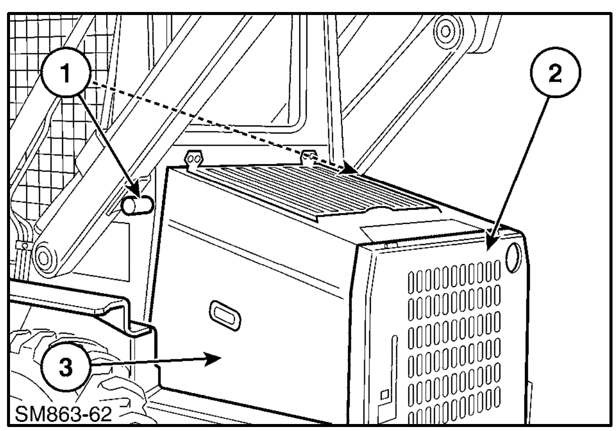
Op. 55 301 40

REMOVAL - LS190

1. Raise the boom and rest on the boom lock pins, 1.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.



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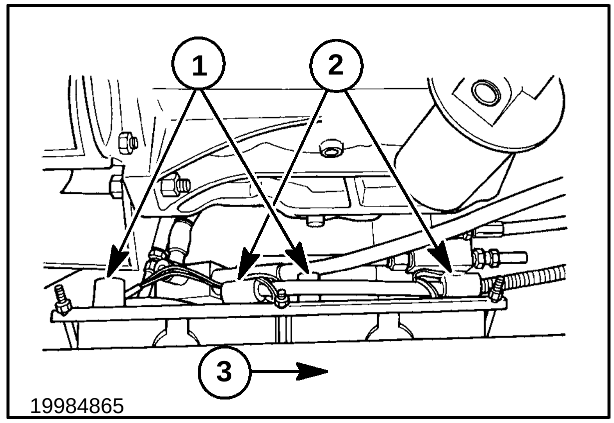
2. Open the rear door, 2, and remove the right engine side shield, 3, to access the battery.

3. Disconnect the negative (-) battery cables, 1.
4. Disconnect the side positive (+) battery cables, 2.
5. Remove the side shield, 3.



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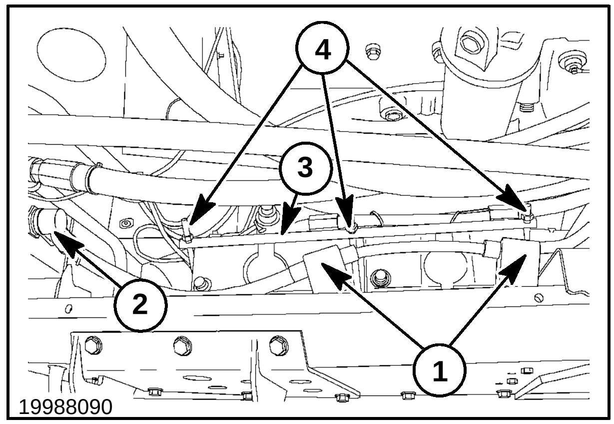
6. Remove the top positive (+) battery cables, 1.

NOTE: *The top positive battery terminals connect to the remote jump positive terminal on the rear frame, 2.*

7. Remove the retaining bracket, 3, by loosening the three nuts, 4.



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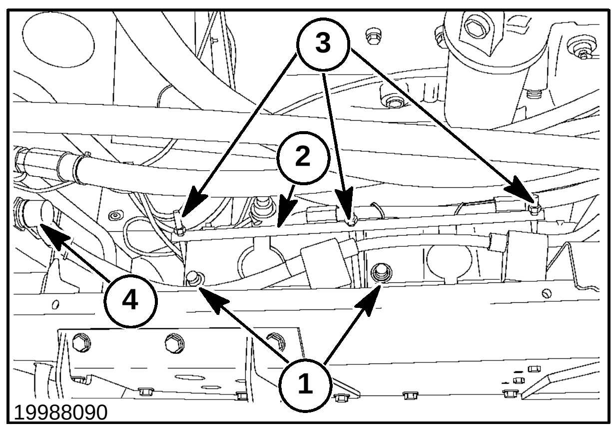
BATTERY INSTALLATION - LS190

1. Orient the batteries with the negative posts, 1, toward the rear of the loader. Install the batteries and the retaining bracket, 2, and hardware, 3.
2. Connect the top positive (+) cables to the top positive (+) terminals and to the remote jump terminal on the rear frame, 4. Connect the side positive (+) RED cables to positive (+) terminals and negative (-) BLACK cables to negative (-) terminals. Do not over tighten. Observe the tightening specifications on the battery label.

IMPORTANT: *Crossing of terminals may cause damage to the electrical system, alternator and Advanced Warning System (EIC).*

3. Install protective caps over the battery terminals and cable connections.
4. Reinstall the side shield.



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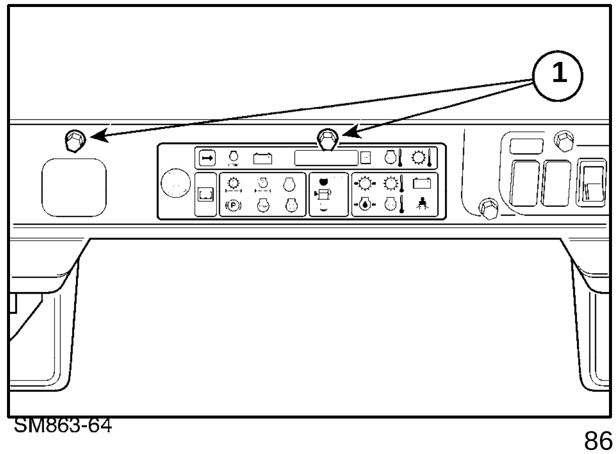
Op. 55 418 10

EIC (ELECTRONIC INSTRUMENT CLUSTER) BOARD REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the retaining hardware, 1, and remove the EIC board from the overhead dash area.



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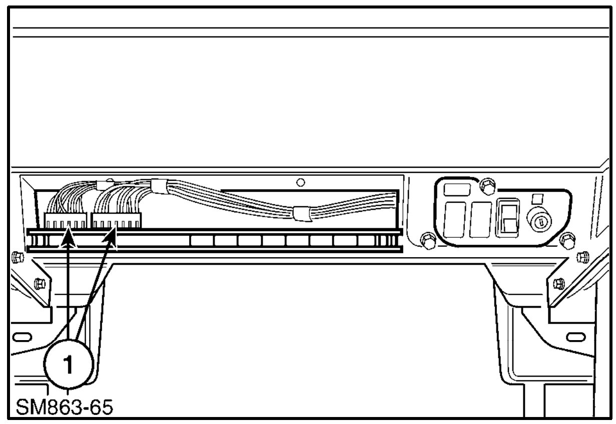
3. Unplug the two wire harness connectors, 1, from the EIC, taking care to not stress or bend the plastic locking ramps on the connectors.

NOTE: *Note the positioning of the connectors to the EIC board and reconnect to the new board in the correct position. If the connector is not connected properly, damage to the EIC may occur.*



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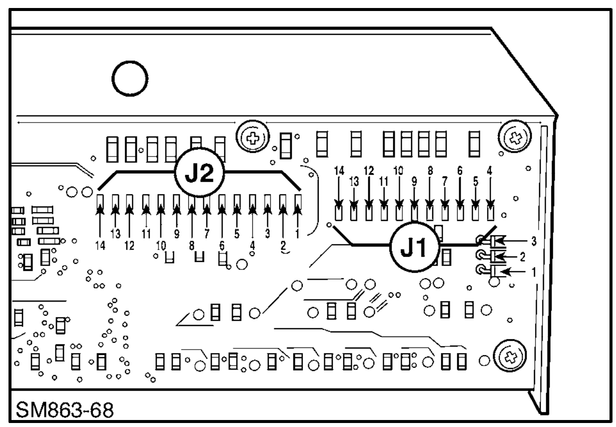
EIC (ELECTRONIC INSTRUMENT CLUSTER) WIRING

Board Connector #1(J1) Pin Number	Wire Color	Harness Connector #1(P1) Pin Number
1	NOT USED	-
2	NOT USED	-
3	NOT USED	-
4	PU/W	1
5	PU/LTGN	2
6	PU/LTBL	3
7	PU/R	4
8	NOT USED	5
9	Y/LTGN	6
10	Y/B	7
11	Y/GY	8
12	DKGR/O	9
13	B/Y	10
14	LTGN/B	11

Board Connector #2(J2) Pin Number	Wire Color	Harness Connector #2(P2) Pin Number
1	NOT USED	1
2	LTBL/Y	2
3	PK/LTBL	3
4	T/W	4
5	LTBL/O	5
6	NOT USED	6
7	NOT USED	7
8	NOT USED	8
9	PK	9
10	W	10
11	LTGN	11
12	O	12
13	B	13
14	R/LTGN	14



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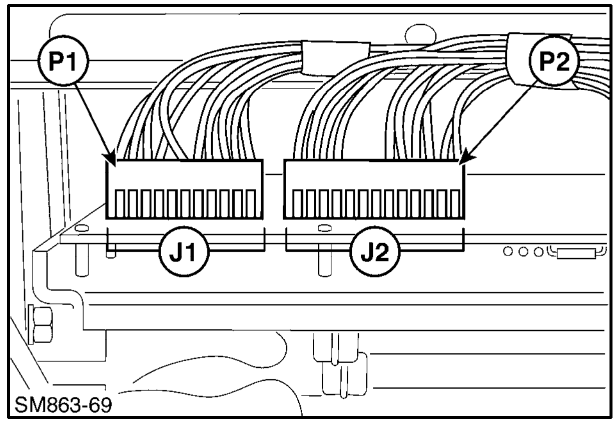
EIC (ELECTRONIC INSTRUMENT CLUSTER) BOARD INSTALLATION

1. Connect the wire harness connectors P1 to J1 and P2 to J2 on the EIC board, making sure the connectors are properly aligned and fully seated.

IMPORTANT: *If the connector is not connected correctly, damage to the EIC may occur:*
1. Board circuits burned out.
2. Display will not light up.
3. Board memory may be lost.



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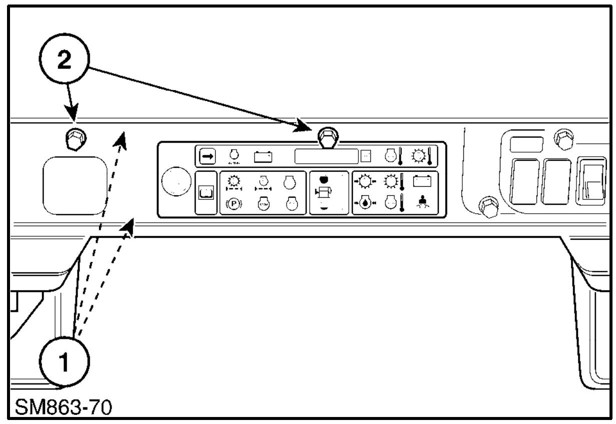
2. Position the EIC board into the overhead dash flat against the support at 1, and secure with the hardware previously removed at 2. Make sure that wires are not pinched between the EIC board and dash frame.

IMPORTANT: *Do not force the EIC board into the overhead dash area or damage to the EIC board may occur.*

3. Reconnect the negative (-) battery cable.



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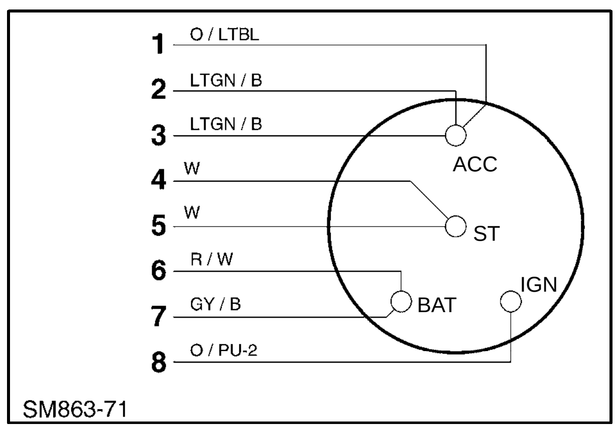
IGNITION (KEY) SWITCH WIRING

Ref	Color	Destination	Battery Voltage
1	O/LTBL	To Four-Way Flashing lights 10A Fuse (cab panel)- To Beacon Light 7.5A Fuse (cab panel)	Key “ON” position
2	LTGN/B	To EIC Board Pin #11 (small connector)	Key “ON” position
3	LTGN/B	To Accessory Relay (engine panel)	Key “ON” position
4	W	To Service/Run Switch	Key “START” position
5	W	To EIC Board Pin #10 (large connector)	Key “START” position
6	R/W	From 15A Fuse (engine panel)	All times
7	GY/B	Power to dome light (not available)	All times
8	O/PU-2	To Electronics 5A Fuse (cab panel)	Key “ON” position



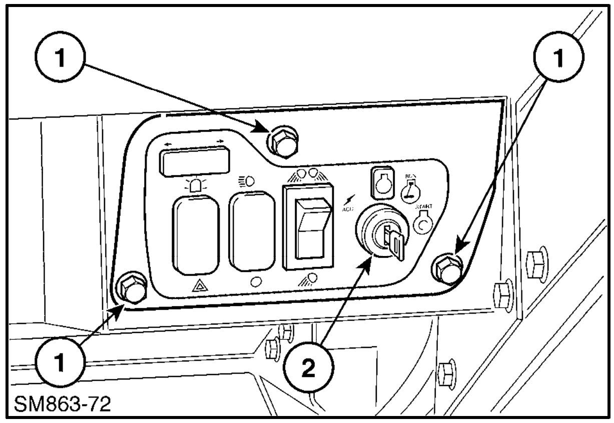
91

IGNITION (KEY) SWITCH

Op. 55 201 10

REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the retaining hardware, 1, and remove the switch panel, 2, from the overhead dash area.
3. Remove the wires from the switch terminals.



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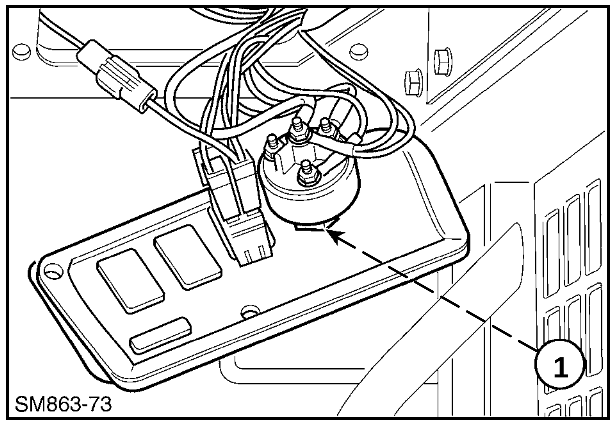
4. Remove the switch retaining nut, 1, from the switch and remove the switch from the dash panel.



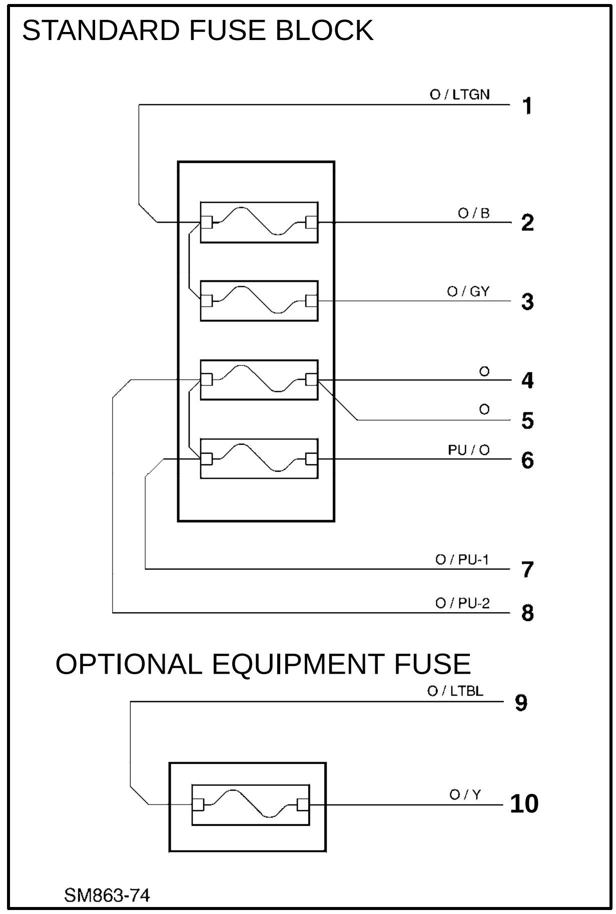
93

INSTALLATION

1. Attach the switch to the panel and secure with nut, 1, previously removed.
2. Reconnect the wires to the terminals as shown above.
3. Reinstall the switch panel to the overhead dash. Make sure wires are positioned to prevent wires from being pinched between the switch panel and the dash.
4. Reinstall the negative (-) battery cable.

CAB FUSE PANEL WIRING

Ref	Color	Destination	Battery Voltage
1	O/LTGN	(15A Fuse) From Accessory Relay (engine panel)	Key “ON” position (If equipped with lights or other accessories).
2	O/B	(15A Fuse) To Road/ Work Light Switch	Key “ON” position
3	O/GY	(7.5A Fuse) To Wiper Motor Switch	Key “ON” position
4	O	(5A Fuse) To EIC Board Pin #12 (P2 connector)	Key “ON” position
5	O	(5A Fuse) To Start Interlock Relay (engine panel)	Key “ON” position
6	PU/O	(5A Fuse) To Fuel Pump	Key “ON” position
7	O/PU-1	To Service/Run Switch	Key “ON” position
8	O/PU-2	From Key Switch (Ign. terminal)	Key “ON” position
9	O/LTBL	From Key Switch (Acc. terminal)	Key “ON” position
10	O/Y	(7.5A Fuse) To Beacon, Four-Way Warning Lights Switch	Key “ON” position



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CAB FUSE BLOCK AND PANEL REMOVAL

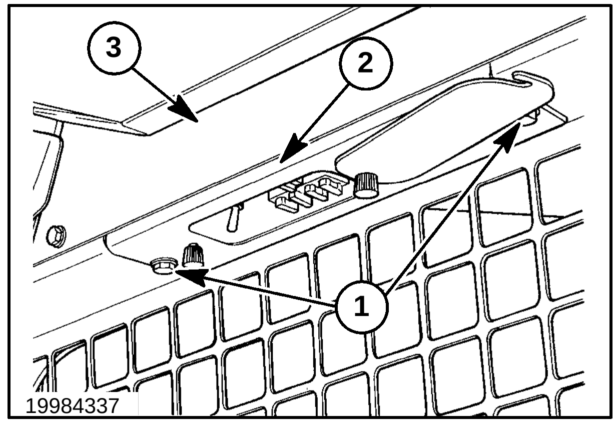
REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the panel retaining hardware, 1, and lower the panel, 2. Removal of the headline support panel, 3, will give more access.
3. Unplug the wires from the fuse block.
4. Remove the fuse block retaining hardware.

NOTE: *The standard fuse block is part of the main harness and cannot be completely removed.*

INSTALLATION

1. Attach the wires to the proper side of the fuses as shown at 1, and as shown in the “Cab Fuse Panel Wiring” figure. Check that the fuses, 2, are in their proper slots.
2. Reinstall the block retaining hardware.
3. Reinstall the panel to the support.
4. Reinstall headliner support if removed.
5. Reconnect the negative (-) battery cable.



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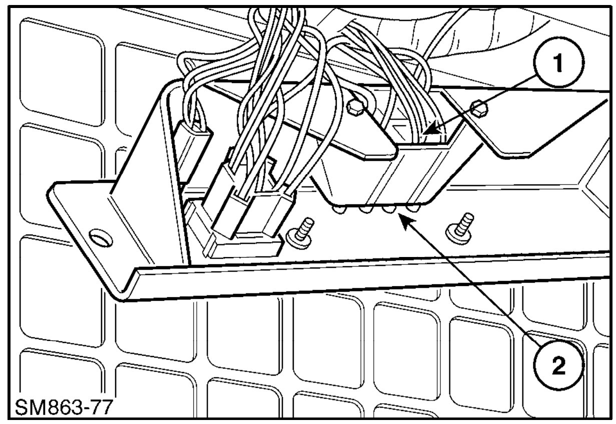

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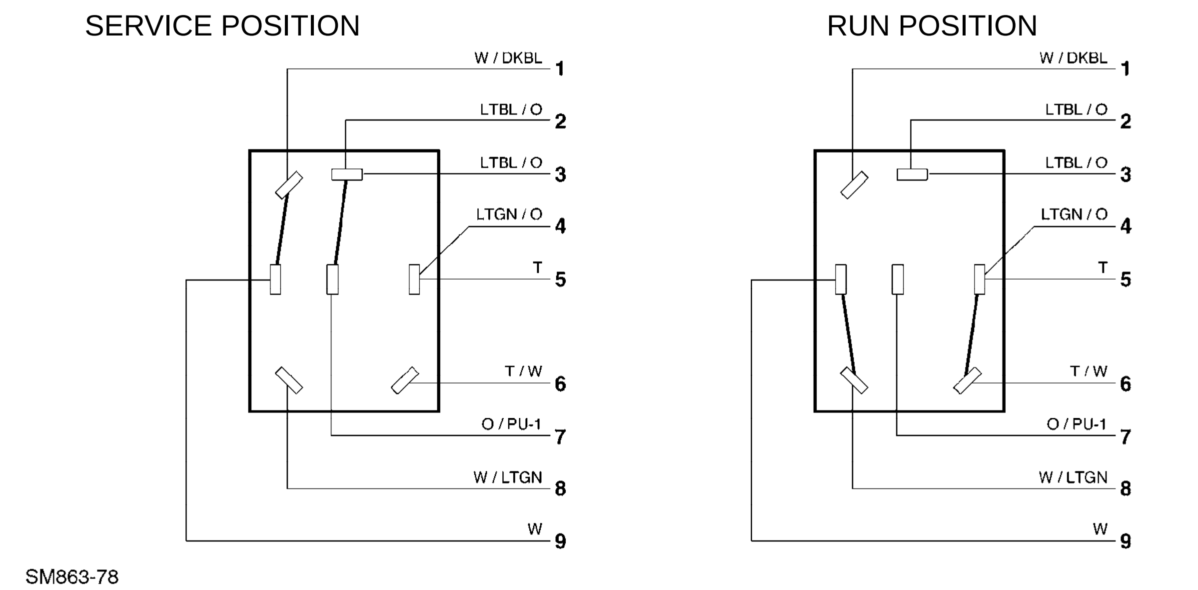
SERVICE/RUN SWITCH WIRING



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SERVICE/RUN SWITCH - SERVICE POSITION

Ref	Color	Destination	Battery Voltage
1	W/DKBL	To Start Relay (engine panel)	Key “START” position
2	LTBL/O	From EIC Board Pin #5 (large connector)	Key “ON” position
3	LTBL/O	To Start Interlock Relay (engine panel)	Key “ON” position
4	LTGN/O	To Manual Preheat Switch	Sitting in Seat
5	T	From Seat Switch(es)	Sitting in Seat
6	T/W	To EIC Board Pin #4 (large connector)	No Voltage Anytime
7	O/PU 1	From 5A Fuse (cab panel)	Key “ON” position
8	W/LTGN	To Start Interlock Relay (engine panel)	No Voltage Anytime
9	W	From Key Switch (ignition)	Key “START” position

SERVICE/RUN SWITCH - RUN POSITION

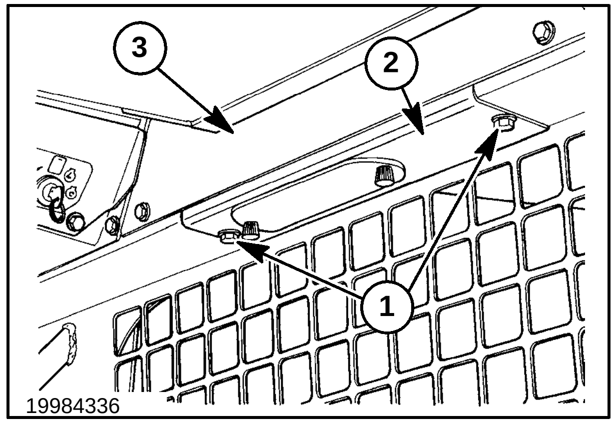
Ref	Color	Destination	Battery Voltage
1	W/DKBL	To Start Relay (engine panel)	Key “START” position (backfed from start interlock relay)
2	LTBL/O	From EIC Board Pin #5 (large connector)	Key “ON” position (will read 0.5 to 1.0 volt below battery voltage)
3	LTBL/O	To Start Interlock Relay (engine panel)	Key “ON” position (will read 0.5 to 1.0 volt below battery voltage)
4	LTGN/O	To Manual Preheat Switch	Sitting in Seat
5	T	From Seat Switch(es)	Sitting in Seat
6	T/W	To EIC Board Pin #4 (large connector)	Sitting in Seat
7	O/PU 1	From 5A Fuse (spare) (cab panel)	Key “ON” position
8	W/LTGN	To Start Interlock Relay (engine panel)	Key “START” position
9	W	From Key Switch (Ignition)	Key “START” position

SERVICE/RUN SWITCH

Op. 55 418 30

REMOVAL

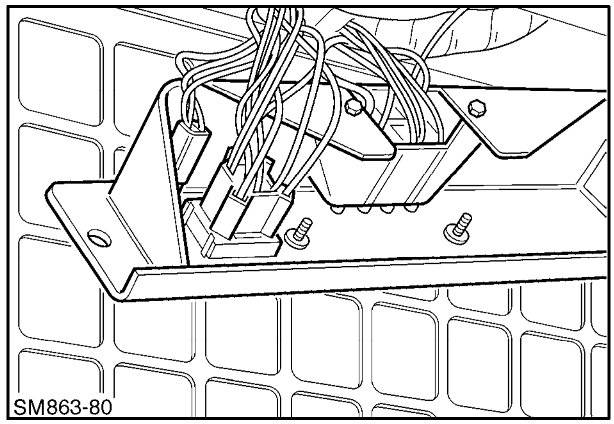
1. Disconnect the negative (-) battery cable.
2. Remove the panel, retaining hardware, 1; and lower the panel, 2, from the support. Removal of head line support panel, 3, may be required for easier access.
3. Remove the wires from the switch terminals.
4. Push the switch retaining tabs in and remove the switch from the panel.



98

INSTALLATION

1. Insert the switch into the panel and insure the locking tabs secure the switch.
2. Reconnect the wires to the proper terminals as shown in the “SERVICE/RUN SWITCH WIRING” figure above.
3. Reinstall the panel to the support.
4. Reconnect the negative (-) battery cable.



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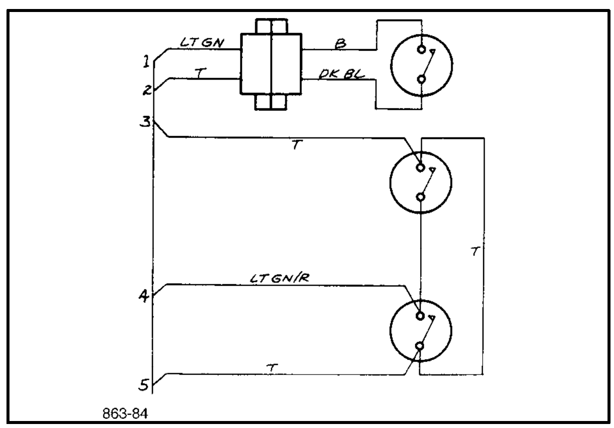
SEAT AND SEAT BELT SWITCH WIRING

Ref	Color	Destination	Battery Voltage
1	LTGN	To EIC Board Pin #11 (large connector)	Seat Belt Buckled
2	T	From Seat Switch(es)	Sit in Seat
3	T	To Seat Belt switch	Sit in Seat
4	LTGN/R	From Electronics 5A Fuse (engine panel)	All Times
5	T	To Service/Run Switch	Sit in Seat



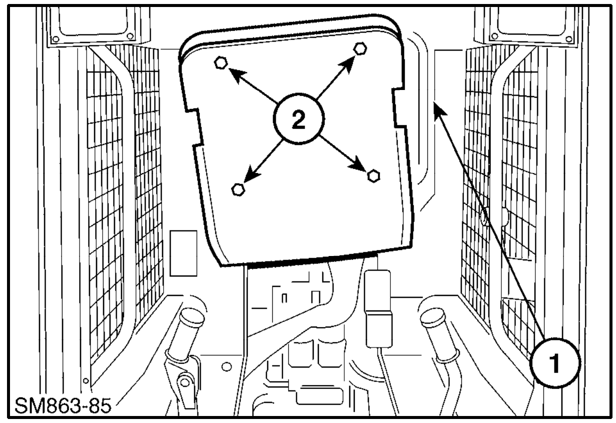
100

SEAT SWITCH

Op. 55 201 15

REMOVAL

1. Disconnect the negative (-) battery cable.
2. Slide the seat to the most rearward position. Raise the seat and securely latch in the raised latched position, 1.

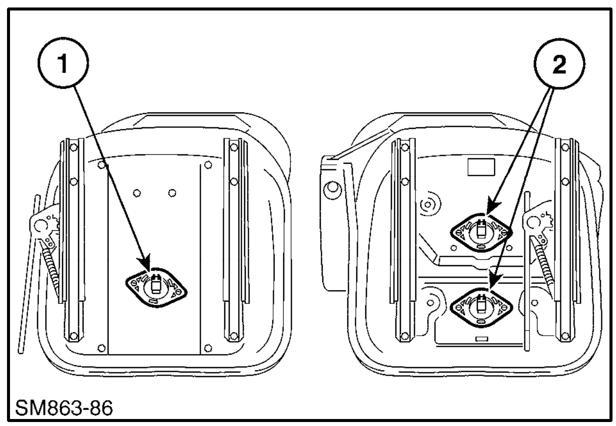


101

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

3. Remove the seat retaining hardware, 2.
4. Holding the seat in place, lower the seat pan and seat and unplug the seat switch(es).
5. Remove the seat from the loader.
6. Disconnect the wire harness from the switch(es) by releasing the latch away from the switch.
7. Remove the switch(es) from the seat pan. The standard seat uses one switch, 1, and the deluxe seat uses two switches, 2.



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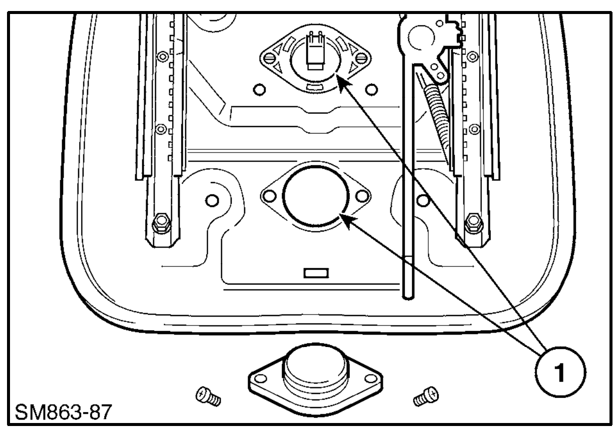
INSTALLATION

1. Install the switch(es) into the seat pan, making sure the switch is seated into the hole in the seat pan, 1.

IMPORTANT: *If the switch is not seated properly when the retaining hardware is tightened, the switch flange will be broken.*

2. Reconnect the wire harness to the switch(es) and reinstall the seat retaining hardware. Make sure the harness connector latches are engaged.
3. Reconnect the negative (-) battery cable.



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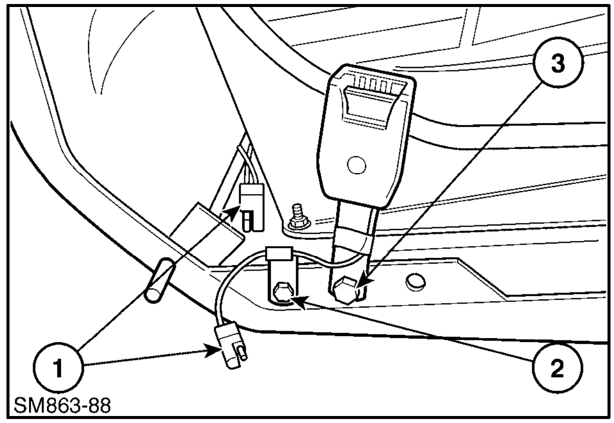
Op. 55 201 14

SEAT BELT BUCKLE AND SWITCH ASSEMBLY REMOVAL

1. Disconnect the negative (-) battery cable.
2. Unplug the seat belt wire harness, 1.
3. Remove the clamp hardware and clamp, 2, and save for reuse.
4. Remove the seat belt retaining hardware, 3.



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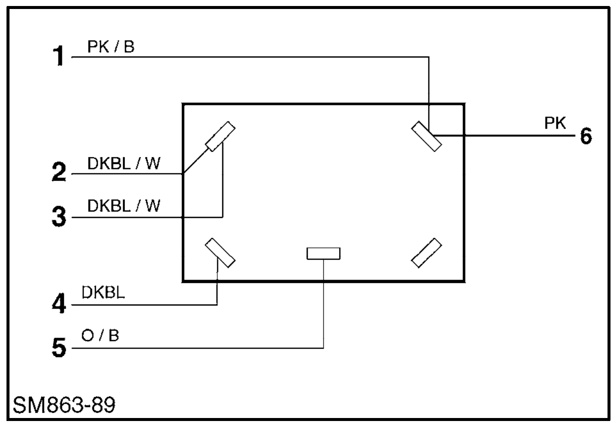
SEAT BELT BUCKLE INSTALLATION

1. Reinstall the seat belt buckle retaining hardware. Tighten the locknut to hold the belt in position that will allow the belt assembly to move front or rearward.
2. Reconnect the wire harness.
3. Reinstall clamp holding harness above seat track.
4. Reconnect the negative (-) battery cable.

ROAD LIGHT AND WORK LIGHT SWITCH WIRING



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Switch Pushed in at Top

Ref	Color	Destination	Battery Voltage
1	PK/B	To Taillights	YES
2	DKBL/W	To Front Road/Work Light	YES
3	DKBL/W	To Front Road/Work Light	YES
4	DKBL	To Rear Work Light	YES
5	O/B	From 15A Fuse (cab panel)	Key "ON" position
6	PK	To EIC Board Pin #9 P2 connector (to dim EIC board lights)	YES

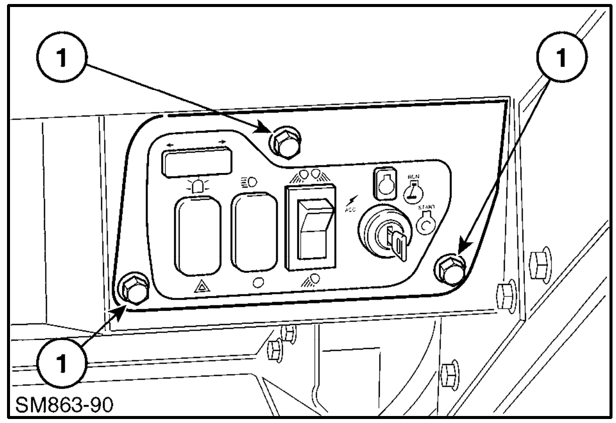
Switch Pushed in at Bottom

Ref	Color	Destination	Battery Voltage
1	PK/B	To Taillights	YES
2	DKBL/W	To Front Road/Work Light	YES
3	DKBL/W	To Front Road/Work Light	YES
4	DKBL	To Rear Work Light	NO
5	O/B	From 15A Fuse (cab panel)	Key "ON" position
6	PK	To EIC Board Pin #9 P2 connector (to dim EIC board lights)	YES

Op. 55 404 20

ROAD LIGHT AND WORK LIGHT SWITCH REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the switch panel retaining hardware, 1, and lower the panel.
3. Remove the wires and connector from the switch terminals.
4. Press in the switch retaining tabs and remove the switch from the panel.



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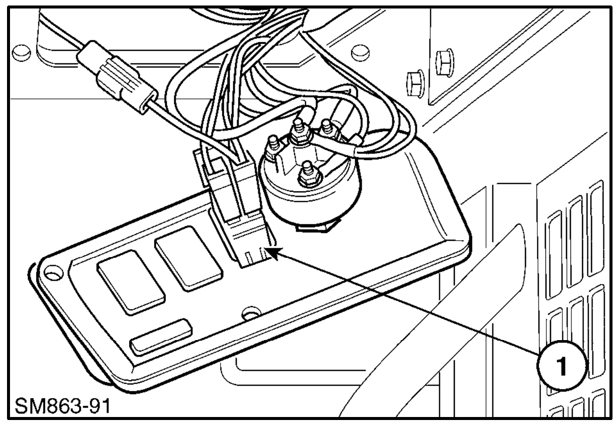
ROAD LIGHT AND WORK LIGHT SWITCH INSTALLATION

1. Insert the switch into the panel and insure the locking tabs secure the switch, 1.
2. Reconnect the wires and connector to the proper terminals with the PK/B and PK wires toward the top of the panel.
3. Reattach the switch panel to the overhead dash.
4. Reconnect the negative (-) battery cable.



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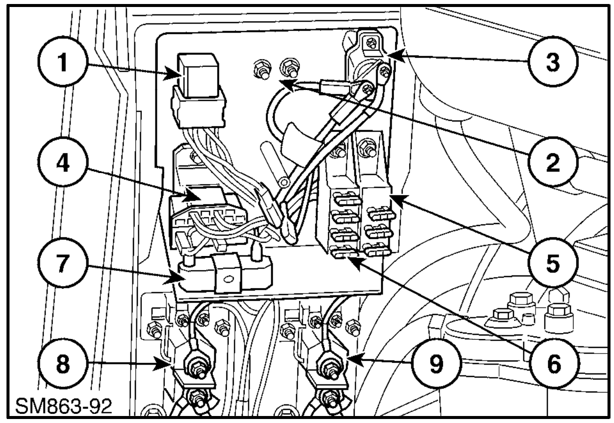
ENGINE FUSE AND RELAY PANEL

The engine panel electrical components are shown here:

1. Accessory relay
2. Heater power relay (if equipped, not shown)
3. Preheat circuit breaker
4. Start interlock relay
5. Standard fuse block
6. Optional equipment fuse block
7. Alternator excite resistor
8. Start relay
9. Preheat relay



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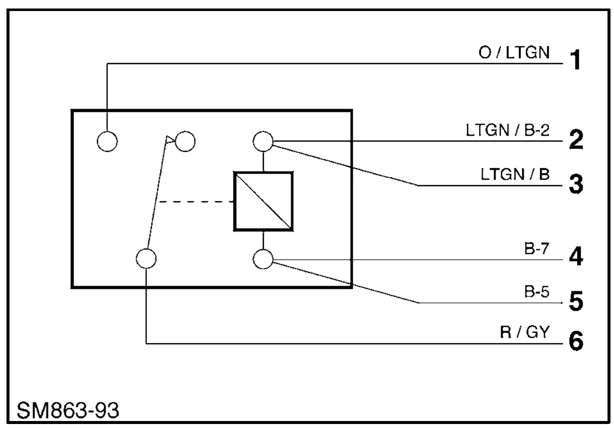
To access the electrical components in the engine compartment, raise the boom and rest it on the boom lock pins.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

ACCESSORY RELAY WIRING

Ref	Color	Destination	Battery Voltage
1	O/LTGN	To Attachment/Horn 15A Fuse	Key "ON" position
2	LTGN/ B-2	To Turn Signal Relay or Heater Power Relay	Key "ON" position
3	LTGN/B	From Key Switch (accessory terminal)	Key "ON" position
4	B-7	To Turn Signal Relay or Heater Power Relay	Ground Circuit
5	B-5	To Start Relay	Ground Circuit
6	R/GY	From Accessory 25A Fuse	All Times



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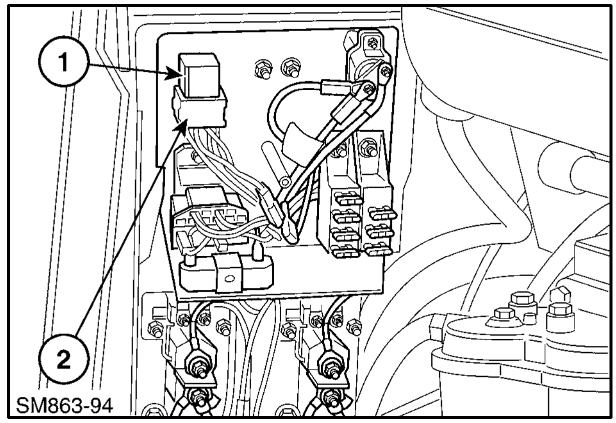
ACCESSORY RELAY WIRING

Op. 55 100 34

REMOVAL

1. Disconnect the negative (-) battery cable.
2. Unplug the relay, 1, from the socket, 2. The corners provide an area to insert screwdriver and twist to assist removal.
3. The relay socket is wired into the main wire harness.



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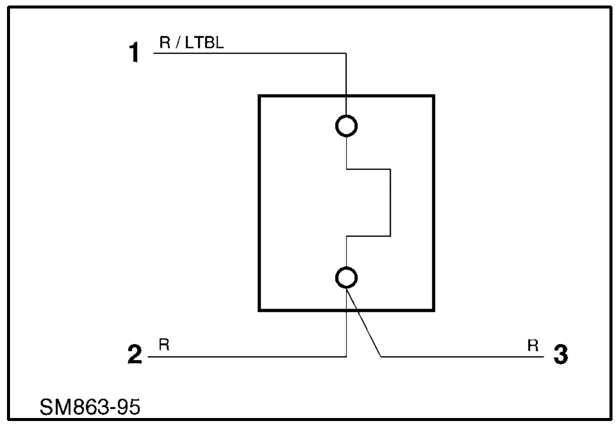
INSTALLATION

1. Insert new relay fully into socket.
2. Reconnect the negative (-) battery cable.

PREHEAT CIRCUIT BREAKER WIRING

Ref	Color	Destination	Battery Voltage
1	R/LTBL	To Preheat Relay	All Times
2	R	To Start Relay	All Times
3	R	From 15A Key Main Fuse Engine Fuse Block	All Times



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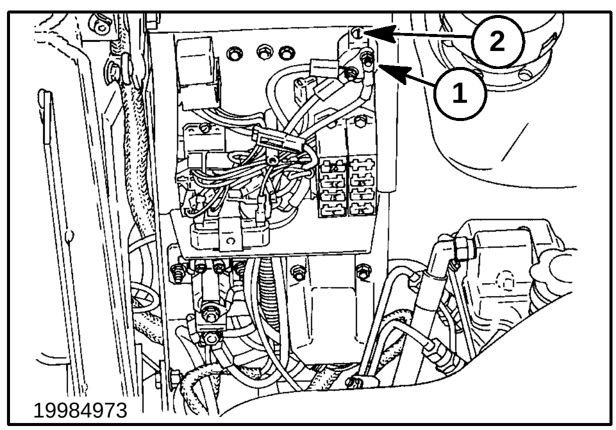
Op. 55 100 24

PREHEAT CIRCUIT BREAKER REMOVAL

1. Disconnect the negative (-) battery cable.
2. Disconnect wires from the terminals, 1.
3. Remove the circuit breaker retaining hardware, 2.



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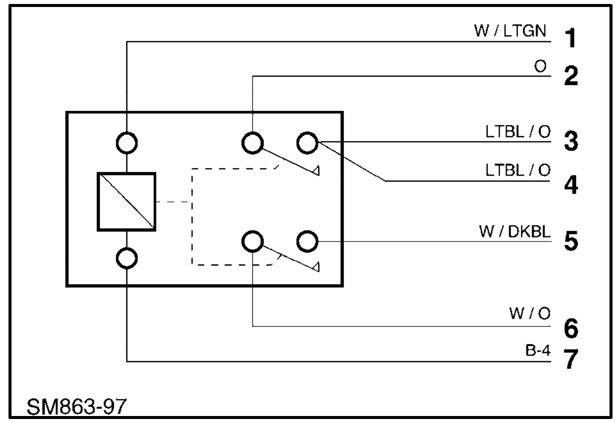
PREHEAT CIRCUIT BREAKER INSTALLATION

1. Reinstall the retaining hardware.
2. Reconnect the wires to the proper terminals.
3. Reconnect the negative (-) battery cable.

START INTERLOCK RELAY WIRING



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Service/Run Switch - Run Position

Ref	Color	Destination	Battery Voltage
1	W/LTGN	From Service/Run Switch	Key "START" position
2	O	From Cab fuse panel 5a electronic ignition fuse.	Key "ON" position
3	LTBL/O	To Fuel Solenoid	Key "ON" position *
4	LTBL/O	From EIC Board Pin #5, P2 connector	Key "ON" position *
5	W/DKBL	To Start Relay	Key "START" position Sitting in Seat with Seat Belt Buckled
6	W/O	From the Seat/Seat Belt Connector and Connector at Boom/ Bucket Control Valve	Key "START" position Sitting in Seat with Seat Belt Buckled
7	B-4	To start Relay	Ground Circuit

*Voltage will be 0.5 to 1.0 volt below battery voltage.

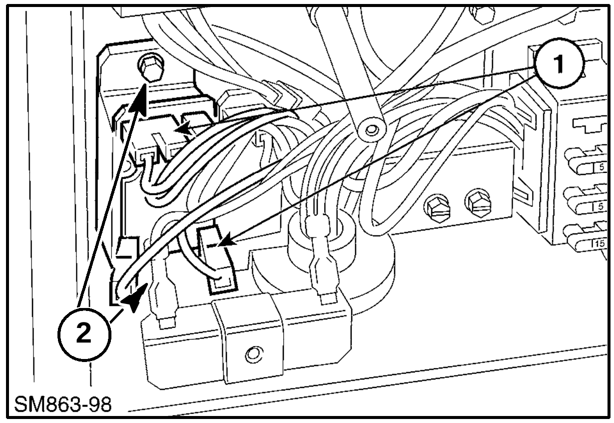
Service/Run Switch - Service Position

Ref	Color	Destination	Battery Voltage
1	W/LTGN	From Service/Run Switch	No Voltage Anytime
2	O	From Cab fuse panel 5a electronic ignition fuse.	Key "ON" position
3	LTBL/O	To Fuel Solenoid	Key "ON" position
4	LTBL/O	From EIC Board Pin #5	Key "ON" position
5	W/DKBL	To Start Relay	Key "START" position
6	W/O	From Connector at Boom/Bucket Control Valve	Sitting in Seat with Seat Belt Buckled
7	B-4	To start Relay	Ground Circuit

Op. 55 100 34

START INTERLOCK RELAY REMOVAL

1. Disconnect the negative (-) battery cable.
2. Disconnect the wires from the terminals, 1.
3. Remove the interlock relay retaining hardware, 2.



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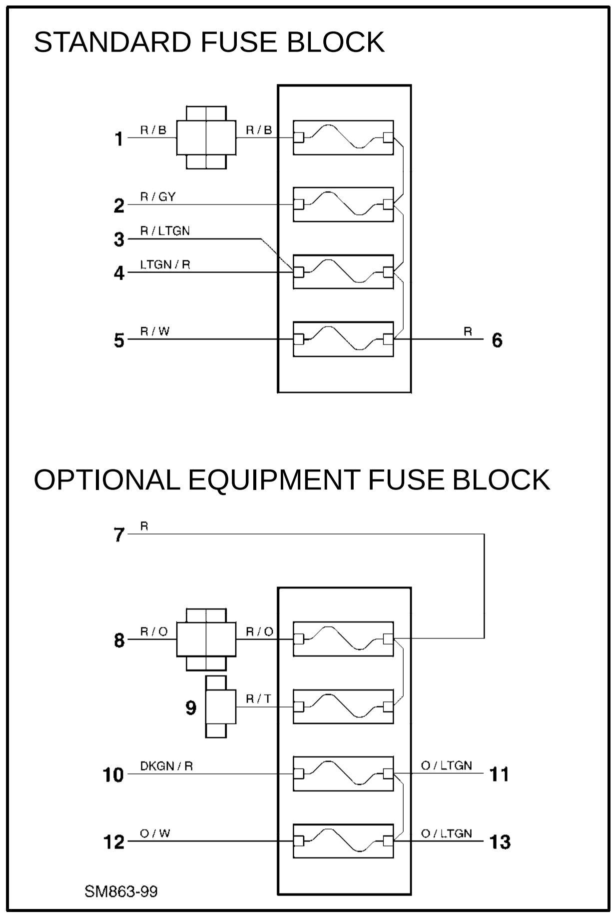
START INTERLOCK RELAY INSTALLATION

1. Reinstall the retaining hardware.
2. Reconnect the wires to the proper terminals as shown in the “START INTERLOCK RELAY WIRING” figure above.
3. Reconnect the negative (-) battery cable.

ENGINE FUSE PANEL WIRING

Ref	Color	Destination	Battery Voltage
1	R/B	(10A Fuse) To Turn Signal Relay	All Times
2	R/GY	(25A Fuse) To Accessory Relay	All Times
3	R/LTGN	(5A Fuse) To EIC board Pin #14 P2 connector.	All Times
4	LTGN/R	(5A Fuse) To Seat Switch(es)	All Times
5	R/W	(15A Fuse) To Key Switch (Battery Terminal)	All Times
6	R	From Preheat Circuit Breaker	All Times
7	R	From Start Relay	All Times
8	R/O	(20A Fuse) To Heater Power Relay	All Times
9	R/T	(7.5A Fuse) Spare	All Times
10	DKGN/R	(15A Fuse) To High Flow, Horn, Power Outlet	Key “ON” position
11	O/LTGN	From Accessary Relay	Key “ON” position
12	O/W	(5A Fuse) To Back Up Alarm Switch	Key “ON” position
13	O/LTGN	From Road/Work light fuse (cab panel)	Key “ON” position



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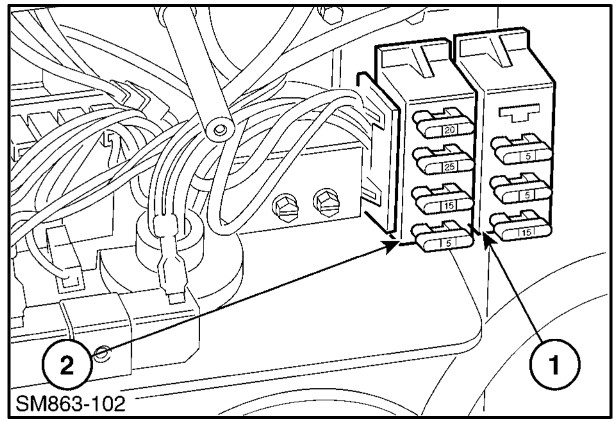
ENGINE FUSE BLOCK

REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the fuse block retaining hardware.

NOTE: *The standard fuse block, 1, is part of the main harness and cannot be completely removed from the main wire harness and replaced separately.*

3. The optional equipment fuse block, 2, locks into the standard fuse block. Insert a 1/4″ blade screwdriver at the center of the fuse block bases and twist to release the lock. Slide the optional block up past the fuses on the standard block to separate.
4. Unplug the wires from the fuse block assembly.



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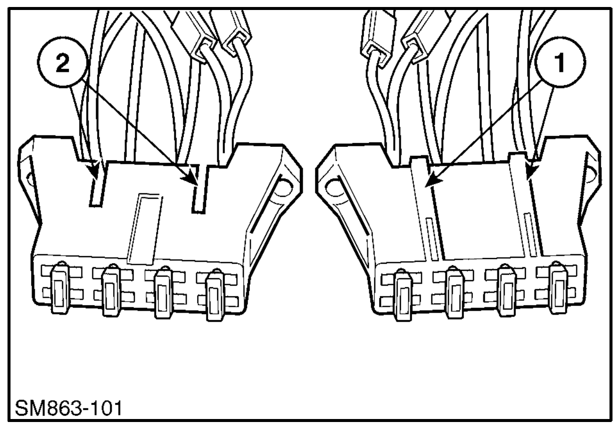
INSTALLATION

1. Insert the lock tabs, 1, into slots, 2, and slide the two blocks together to lock securely as shown.

NOTE: *The optional equipment fuse block slides down over the standard block guides and is positioned toward the center of the panel.*



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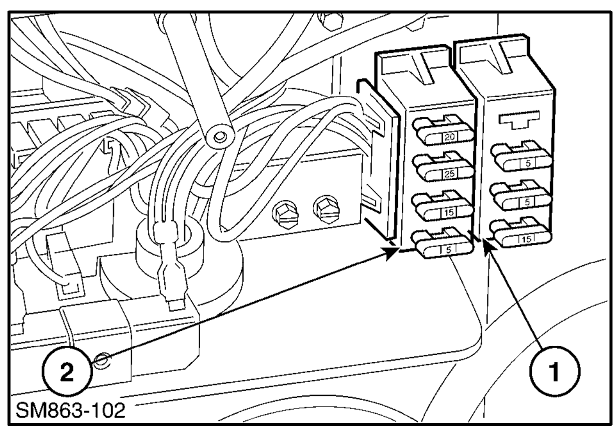
2. Attach the wires to the proper side of the fuses as shown in “ENGINE FUSE PANEL WIRING” figure above.
   1 Standard fuse block
   2 Optional fuse block
3. Reinstall the block retaining hardware.
4. Reconnect the negative (-) battery cable.



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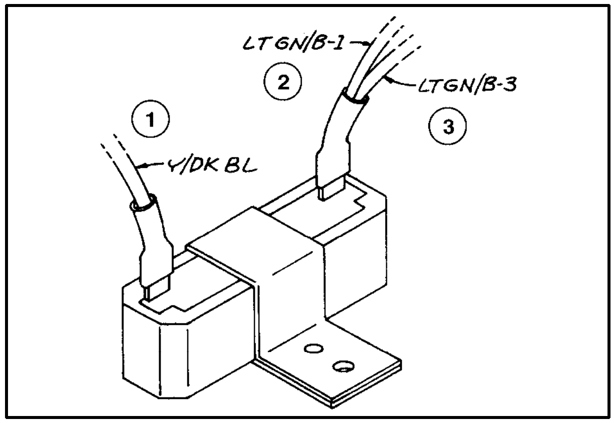
ALTERNATOR EXCITE RESISTOR WIRING

Ref	Color	Destination
1	Y/DKBL	To Alternator
2	LTGN/B-1	From Accessory Relay
3	LTGN/B-3	To Alternator



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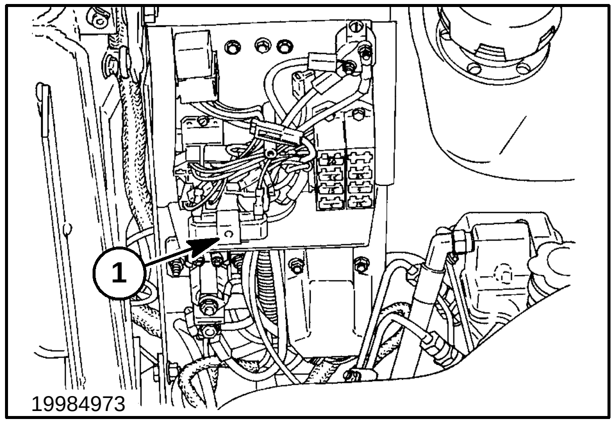
Op. 55 301 16

ALTERNATOR EXCITE RESISTOR REMOVAL

1. Disconnect the negative (-) battery cable.
2. Unplug the wires from the resistor terminals.
3. Remove the resistor, 1, retaining hardware.

Testing the resistor using an ohmmeter, the resistance should read approximately 50 ohms ± 5 ohms.



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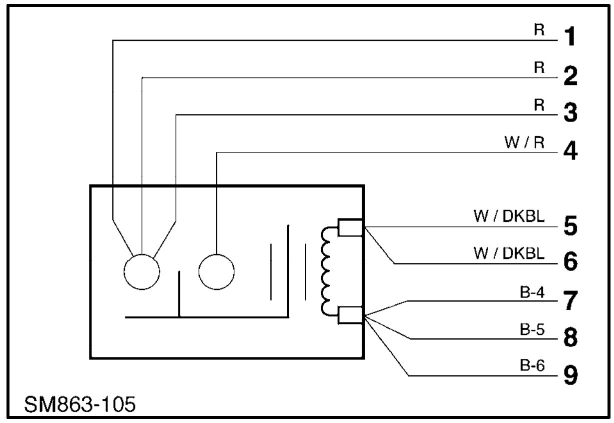
ALTERNATOR EXCITE RESISTOR INSTALLATION

1. Reinstall the resistor retaining hardware.
2. Reconnect the wires to the proper terminals.

START RELAY WIRING

Ref	Color	Destination	Battery Voltage
1	R	To 20A Heater Fuse (optional fuse block)	All Times
2	R	To Preheat Circuit Breaker	All Times
3	R	From Starter Solenoid	All Times
4	W/R	To Starter Solenoid	Key “START” position
5	W/DKBL	From Start Interlock Relay	Key “START” position
6	W-DKBL	From Service/Run Switch	Key “START” position
7	B-4	To Start Interlock Relay	Ground Circuit
8	B-5	To Accessory Relay	Ground Circuit
9	B-6	To Preheat Relay	Ground Circuit



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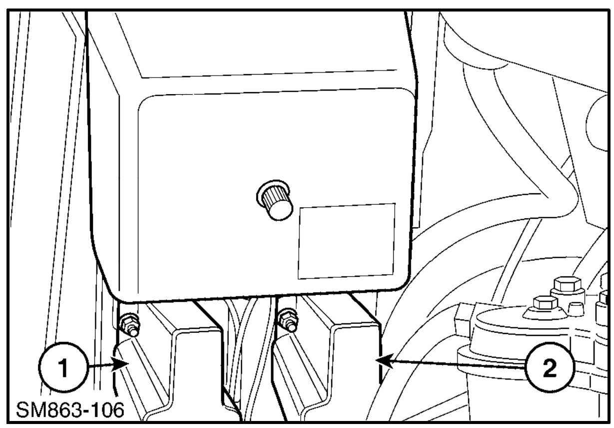
Op. 55 100 34

START RELAY REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the relay cover, 1, attaching hardware and cover.
3. Remove the wires from the relay terminals.
4. Remove the relay retaining hardware.
5. Remove the barrier from between the large terminals and install on new relay.

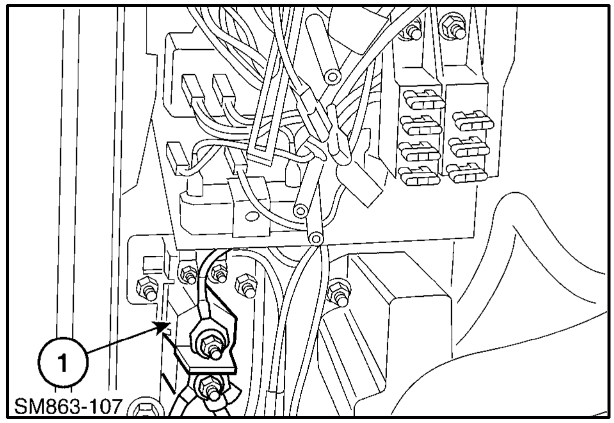
NOTE: *The start relay, 1, and the preheat relay, 2, may be wired in either position. Check wire colors for proper relay location.*



122

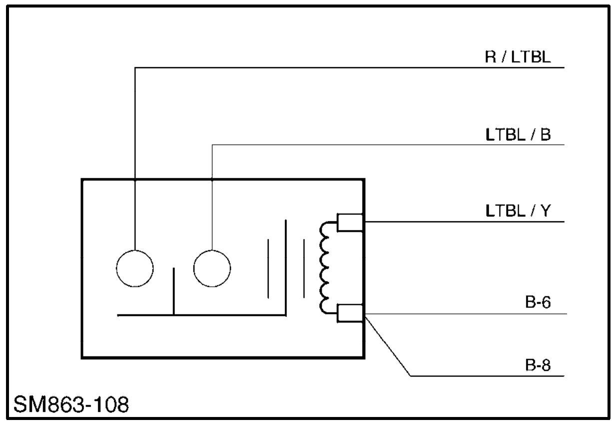
START RELAY INSTALLATION

1. Reattach the relay, 1, to the support.
2. Reconnect the wires to the proper relay terminals.
3. Reinstall the relay cover.
4. Reconnect the negative (-) battery cable.



123

PREHEAT RELAY WIRING



124

Service/Run Switch - Service Position

Ref	Color	Destination	Battery Voltage
1	R/LTBL	From Preheat Circuit Breaker	All Times
2	LTBL/B	To Glow Plugs	Push Button
3	LTBL/Y	From Manual Preheat Button	Push Button
4	B-6	To Start Relay	Ground Circuit
5	B-8	To Engine Bellhousing Ground	Ground Circuit

Service/Run Switch - Run Position

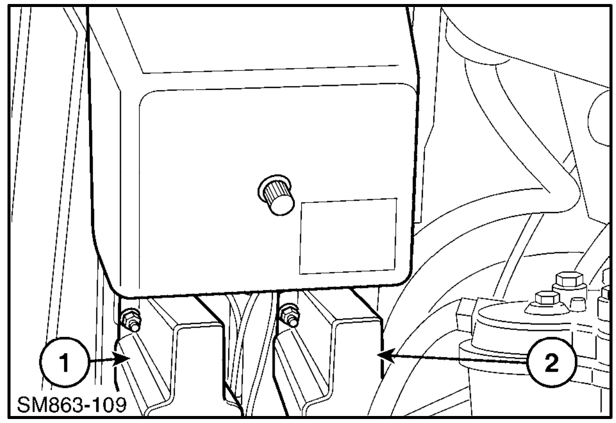
Ref	Color	Destination	Battery Voltage
1	R/LTBL	From Preheat Circuit Breaker	All Times
2	LTBL/B	To Glow Plugs	EIC Preheat Cycle
3	LTBL/Y	From Manual Preheat Button	EIC Preheat Cycle (Voltage will be 0.5 to 1.0 volt less than battery voltage).
4	B-6	To Start Relay	Ground Circuit
5	B-8	To Engine Bellhousing Ground	Ground Circuit

Op. 55 100 34

PREHEAT RELAY REMOVAL

1. Disconnect the negative (-) battery cable.
2. Remove the relay cover, 2, attaching hardware and cover.
3. Remove the wires from the relay terminals.
4. Remove the relay retaining hardware.
5. Remove the barrier from between the large terminals and install on new relay.

NOTE: *The start relay, 1, and the preheat relay, 2, may be wired in either position. Check wire colors for proper relay location.*



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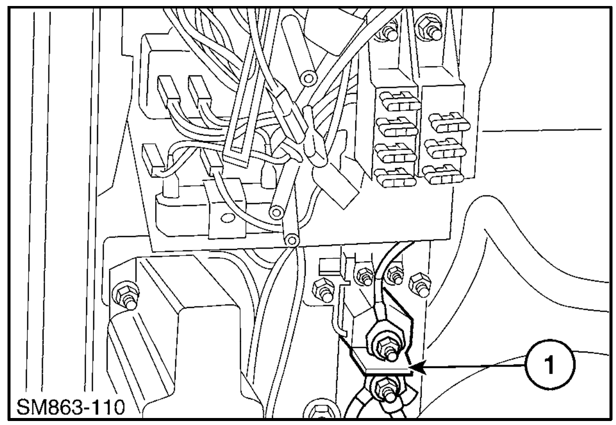
PREHEAT RELAY INSTALLATION

1. Reattach the relay, 1, to the support.
2. Reconnect the wires to the proper relay terminals.
3. Reinstall the relay cover.
4. Reconnect the negative (-) battery cable.

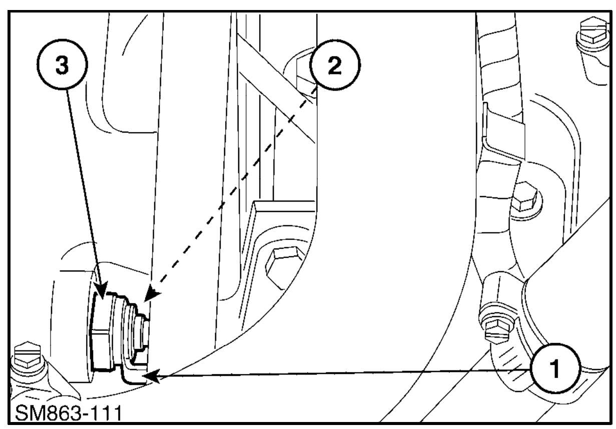


126

Op. 55 201 26

PREHEAT MANIFOLD HEATER REMOVAL

1. Disconnect the negative (-) battery cable.
2. Disconnect the LTBL/B wire, 1, from the manifold heater.
3. Remove the fuel supply line, 2, from the manifold heater.
4. Remove manifold heater, 3, from the intake manifold heater.



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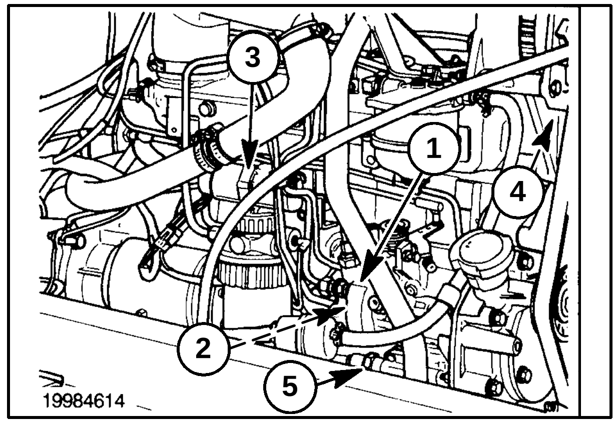
PREHEAT MANIFOLD HEATER INSTALLATION

1. Install the manifold heater into the intake manifold at 3.
2. Reconnect the fuel supply line, 2, to the manifold header.
3. Reconnect the LTBL/B wire to the manifold heater at 1.
4. Reconnect the negative (-) battery cable.

FUEL SYSTEM COMPONENTS

The fuel system consists of a fuel tank, fuel pickup and return lines, fuel tank sending unit, and injection pump, 1, and a fuel shutoff solenoid, 2.

The additional emissionized engine fuel system components are the fuel lift pump, 1, the two-wire cold advance switch sender, 2, and the cold advance unit, 3. The fuel lift pump sits on top of the fuel filter. The cold advance switch sender is on top of the engine next to the normal engine coolant temperature sensor. The cold advance unit attaches to the injector pump.



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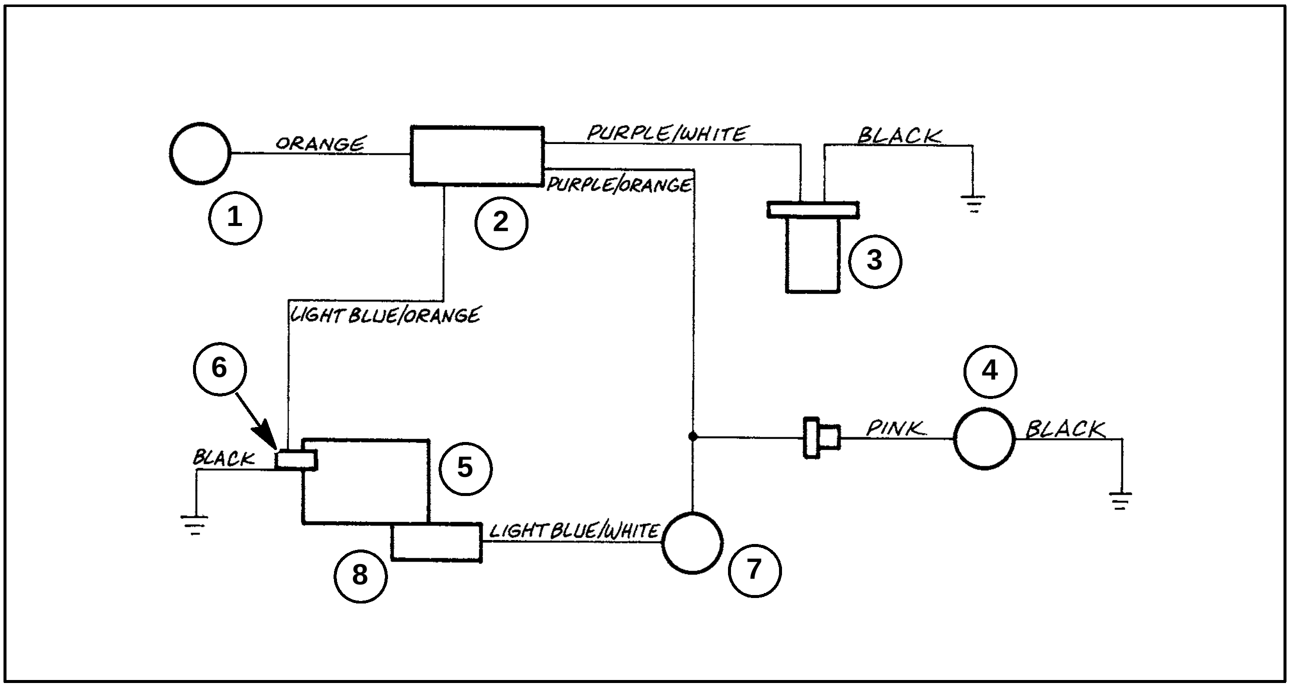
FUEL SYSTEM ELECTRICAL DIAGRAM



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1 - Key switch
2 - EIC board
3 - Fuel level sender
4 - Electric lift pump
5 - Injector pump
6 - Fuel shutoff solenoid
7 - Cold advance switch
8 - Cold advance unit

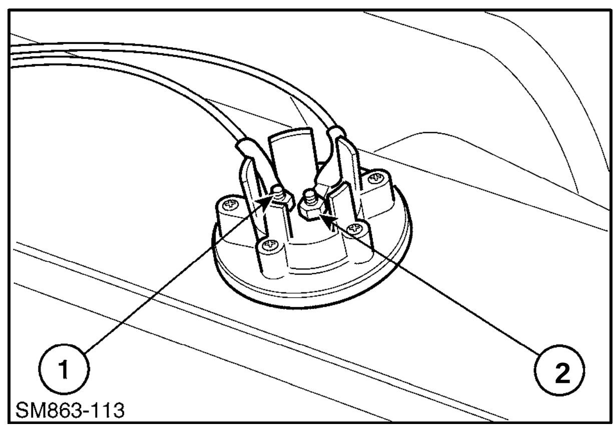
FUEL GAUGE

In the center of the EIC panel is the fuel gauge, implemented as a vertical 10-segment green LED bar graph. The lowest segments will flash when the fuel level is low. An audible alarm will accompany the flashing light for about 5 seconds.

FUEL TANK SENDING UNIT (Fuel level)

STEP	PRETEST INSTRUCTIONS	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Loader on level with parking brake engaged, key “ON” position	EIC gauge and sender operation	NO bars light up	Check wires from sender to EIC board. If OK, replace EIC board
	Symptom: No bars lit	Jumper wire from one terminal to other at sender	YES (bars light up)	Replace sender
2	Symptom: Fuel level does not read lower on gauge (too many bars lit)	Disconnect PU/W wire	Bars stay lit	Check for PU/W wire shorted to ground. If OK, replace EIC board.
			Bars go out	Replace sender

TESTING FUEL GAUGE IN DIAGNOSTIC MODE
Use a jumper wire and connect sender terminal, 1, to terminal, 2, and the EIC board will light and beep. If the EIC board lights and beeps, the EIC and circuit wires to the sender are OK. If the EIC board fails to light, check the wires to the EIC board.



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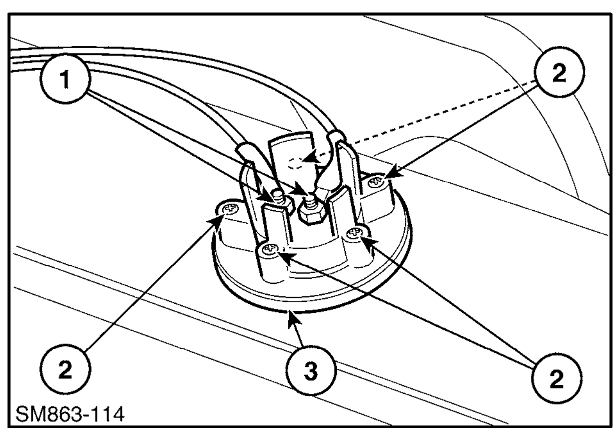
Op. 55 410 80

REMOVAL OF FUEL GAUGE
If the fuel gauge is found operative, the complete EIC board will require replacement.

REMOVAL OF FUEL LEVEL SENDER

1. Support the boom on the boom lock pins.
2. Open the rear door and remove the left engine side shield.
3. Disconnect the wires from the sender, 1.
4. Remove the sender retaining screws, 2, and remove the sender, 3, assembly from the tank.



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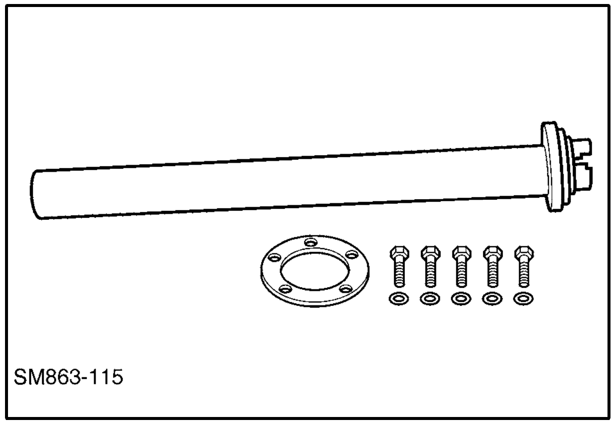
TESTING OF THE FUEL LEVEL SENDER

Using a volt/ohmmeter, put one lead on one terminal and the second lead on the other terminal. Rotate the sender from full tank to empty tank, and the ohms reading should be between 35 ohms full and 240 ohms empty.



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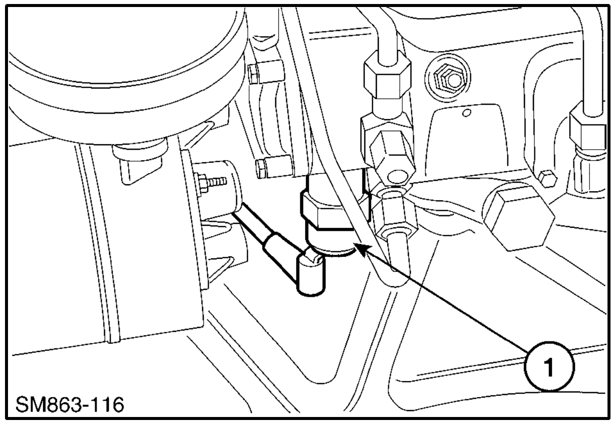
Op. 10 223

FUEL SHUTOFF SOLENOID

The fuel shutoff solenoid is located at the injection pump at 1. The solenoid is controlled through the starting circuit during cranking. After the engine is started, the EIC takes control of the solenoid for normal operation.

If a fault occurs in either the engine oil pressure or the hydrostatic charge pressure circuits, the EIC will remove power from the solenoid, stopping the engine within 30 seconds.



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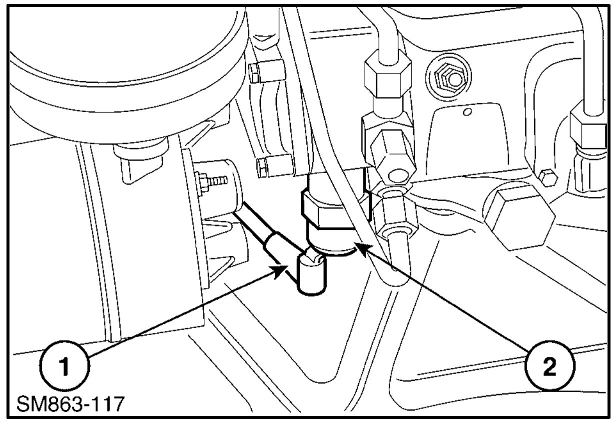
FUEL SHUTOFF SOLENOID TESTING

STEP	PRETEST INSTRUCTIONS	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Loader on level with parking brake engaged, key “ON” position, service “RUN” switch in “RUN” position	Battery voltage to solenoid	NO	Check power wire from EIC to solenoid for open; if OK, go to next step
			YES	Replace solenoid
2	Key “ON” position, service “RUN” switch in “SERVICE” position	Battery voltage to solenoid	NO	Check power wire from service/run switch to fuel solenoid; if OK, go to next step
			YES	Replace solenoid
3	Key “ON” position, “SERVICE/RUN” switch in “RUN” position	Check EIC board operation	NO	Check power to EIC board. Check 5-amp electronics Ign. fuse in cab fuse panel.
			YES	Replace EIC board

Op. 10 223 10

REPLACEMENT OF FUEL SHUTOFF SOLENOID

1. Support the boom on the boom lock pins.
2. Open the rear door and remove the left engine side shield.
3. Remove the power wire from the solenoid, 1.
4. Remove the solenoid, 2, from the injection pump.
5. Solenoid pull-in amperage 1.2 to 1.5 amps. Solenoid hold-in amperage 1.2 to 1.5 amps.
6. Reinstall the solenoid and tighten securely. Reinstall the power wire.



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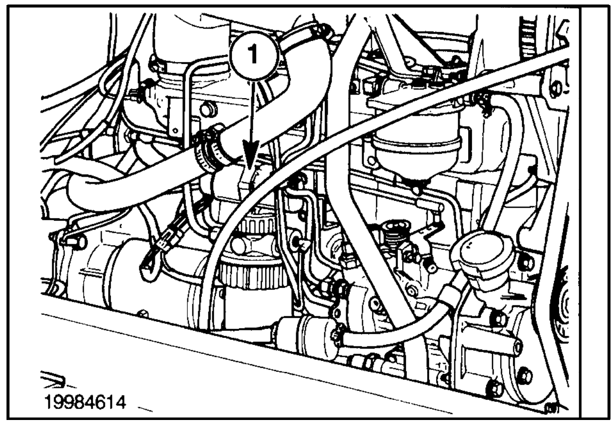
ELECTRIC LIFT PUMP

The electric lift pump, 1, is located in the left side of the engine compartment.



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ELECTRIC LIFT PUMP TESTING

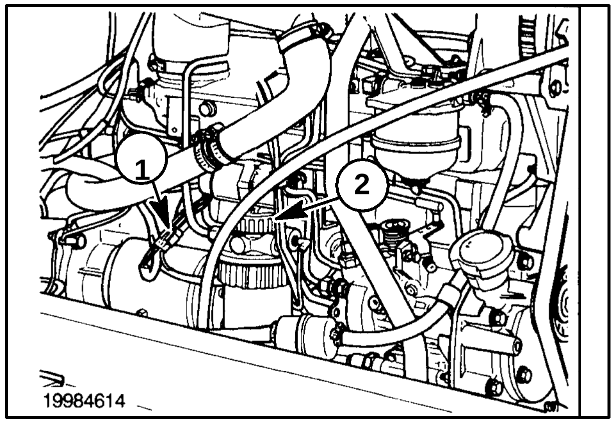
STEP	PRETEST INSTRUCTIONS	TEST	RESULT	PROBABLE CAUSE AND CORRECTION
1	Loader on level with parking brake engaged, key “OFF” position	Fuel level in tank	NO YES	Add fuel and bleed system Go to next step
2	Key “ON” position	Fuel pump operating	NO YES	Check power supply (5-amp fuse in cab panel). If not OK, check ground; if OK, replace pump Go to next step
3	Key “ON” position	Fuel pump operating but not pumping fuel	NO YES	Check line to tank, air leak, fuel level, tank pickup tube; if OK, replace pump Go to next step
4	Key “ON” position	Fuel pump operating and pumping fuel	NO YES	Replace pump Remove fuel line at injector pump and bleed system; if OK, go to next step
5	Key “ON” position	Fuel pump operating and pumping fuel	YES	Check fuel shutoff solenoid for operation

Note – Always check fuel level in tank. Always check fuel filters.

Op. 10 210 21

ELECTRIC LIFT PUMP REMOVAL

1. Support the boom on the boom lock pins.
2. Open the rear door and remove the left engine side shield.
3. Unplug the three-wire connector, 1.
4. Unscrew the filter head/pump assembly connection, 2, and lift away from filter assembly.
5. Upon reinstallation of the pump, make sure the pump wires are placed to prevent getting damaged. Make sure the ground wire is making good contact.



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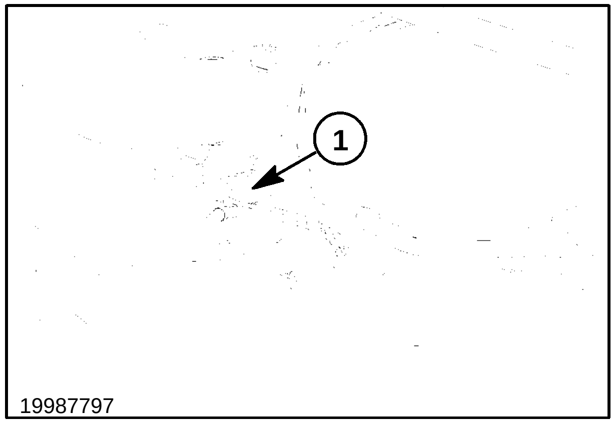
Op. 55 414 10

COLD ADVANCE SWITCH REMOVAL

1. Support the boom on the lock pins.
2. Open the rear door and raise and latch the top engine shield, in the raised position, to access the sender.
3. Remove the two-wire plug connector, 1.
4. Remove the switch from the engine block.

COLD ADVANCE SWITCH INSTALLATION

1. Clean the threads of the sender.
2. Apply pipe sealant to the threads of the sender.
3. Install the switch into the engine block.
4. Reinstall the two-wire connector.



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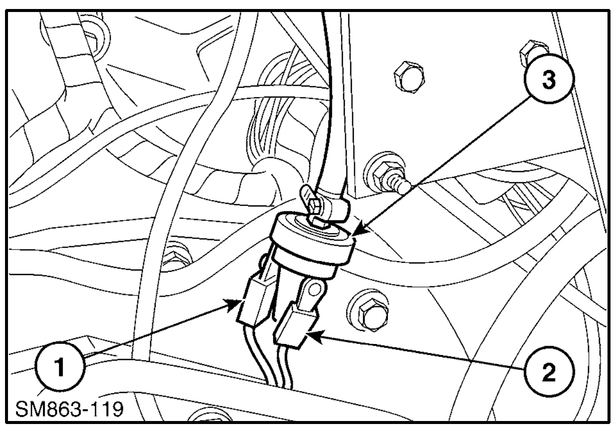
Op. 55 414 14

AIR FILTER RESTRICTION INDICATOR SWITCH REMOVAL

1. Support the boom on the boom lock pins.
2. Raise the seat and latch in the raised position.
3. Remove the B/Y, 1, and B, 2, wires from the sender.
4. Remove the sender, 3, from the air cleaner hose.

AIR FILTER RESTRICTION INDICATOR SWITCH INSTALLATION

Install the sender and reinstall the B/Y and B wires to the sender terminals.



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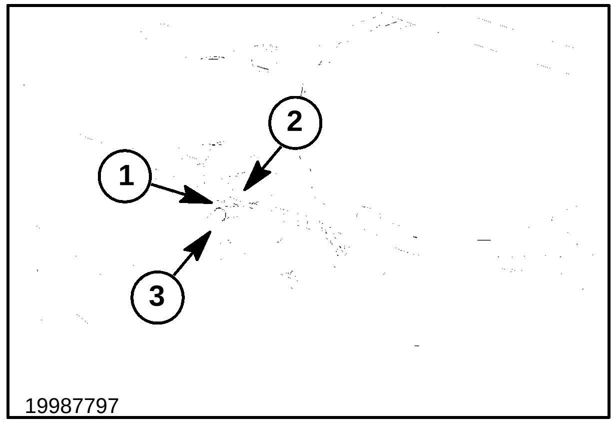
Op. 55 414 10

ENGINE COOLANT TEMPERATURE SENDER REMOVAL

The one-wire temperature sender, 1, is on the front of the engine block next to the two-wire cold advance switch, 2.

1. Support the boom on the boom lock pins.
2. Open the rear door and raise and latch the top engine shield, in the raised position, to access the sender.
3. Remove the PU/LTGN wire, 1, from the sender terminal.
4. Drain the cooling system down below the sender level to prevent loss of coolant.
5. Remove the sender, 2, from the engine block.

NOTE: *Later model loaders have two coolant temperature senders — the normal one-wire sender, 1, and a two-wire cold advance switch, 2.*



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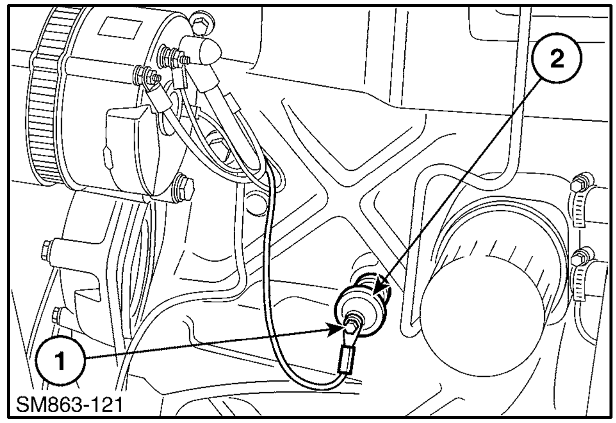
ENGINE COOLANT TEMPERATURE SENDER INSTALLATION

1. Remove and clean the engine block thread area.
2. Apply pipe sealant to the threads of the sender.
3. Install the sender into the engine block.
4. Reinstall the PU/LTGN wire to the sender terminal.
5. Refill the cooling system with coolant previously removed or a 50/50 mixture of a permanent-type antifreeze.
6. Operate the unit to remove air from the cooling system and recheck the coolant level.

Op. 55 414 12

ENGINE OIL PRESSURE SWITCH REMOVAL

1. Support the boom on the boom lock pins.
2. Open the rear door and raise the top engine shield to access the switch.
3. Remove the Y/B wire, 1, from the switch terminal.
4. Remove the switch, 2, from the engine head.



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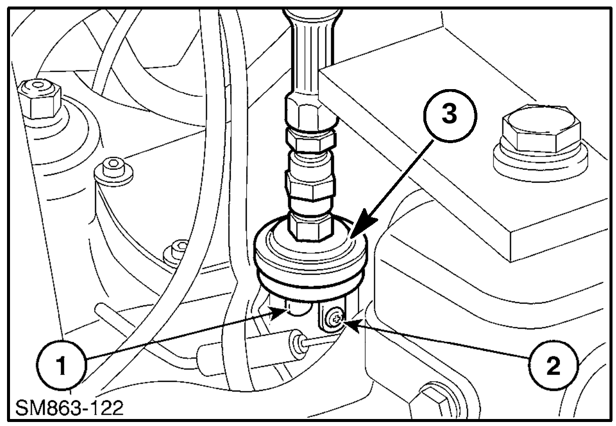
ENGINE OIL PRESSURE SWITCH INSTALLATION

1. Install the switch.
2. Attach the Y/B wire to the switch terminal.

Op. 55 414 28

HYDROSTATIC CHARGE PRESSURE SWITCH REMOVAL

1. Support the boom on the boom lock pins.
2. Remove the left fender or raise the seat and latch in the raised position to access the switch.
3. Remove the Y/GY wire, 1, and B wire, 2.
4. Remove the charge pressure switch, 3, from the hose.



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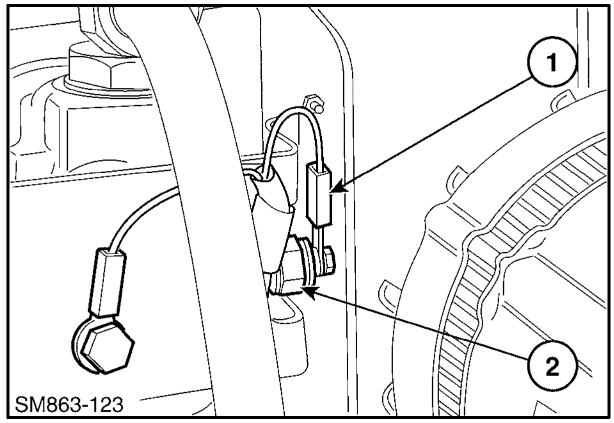
HYDROSTATIC CHARGE PRESSURE SWITCH INSTALLATION

1. Install the charge pressure switch into the hose.
2. Reinstall the Y/GY and B wires to the switch.
3. Reinstall the fender if removed for access.

Op. 55 414 24

HYDRAULIC OIL FILTER RESTRICTION SWITCH REMOVAL

1. Support the boom on the boom lock pins.
2. Open the rear door, raise the top engine shield and remove the right engine side shield to access the switch.
3. Remove the DKGN/O wire, 1.
4. Remove the restriction switch, 2, from the filter base.



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HYDRAULIC OIL FILTER RESTRICTION SWITCH INSTALLATION

1. Install the switch into the filter base.
2. Attach the DKGN/O wire to the switch terminal.

Op. 55 414 20

HYDRAULIC OIL TEMPERATURE SENDER REMOVAL

1. Remove any attachment from the boom face plate and support the boom on the boom lock pins.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

2. Raise the operator's seat and latch in the raised latched position.

CAUTION

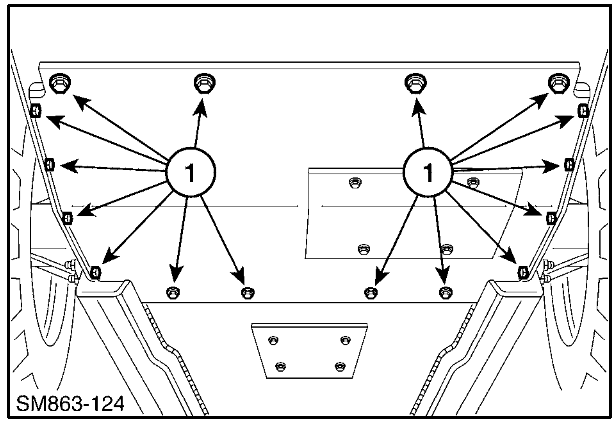
Never work under a raised seat unless it is securely latched in the raised position.

3. Drain the hydraulic reservoir.

   Remove the rear engine belly pan hardware, 1, and lower the pan from the loader.

CAUTION

Use a floor jack to support the belly pan and prevent serious injury.



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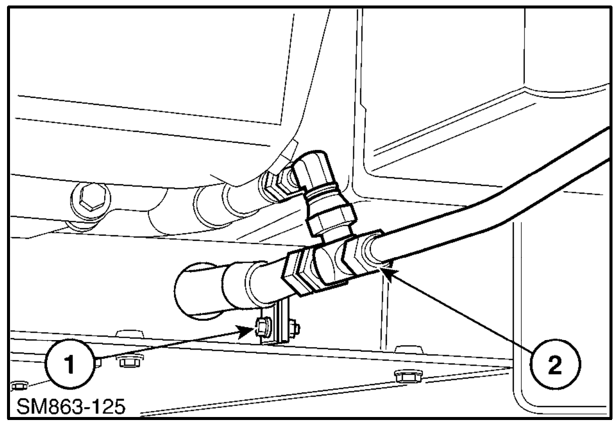
4. Loosen the return line clamp at 1.
5. Remove the return line at 2, and rotate the line so the oil drains into a clean suitable pan for reuse.
6. After the reservoir is drained, reconnect the return lines and tighten all fittings and connections.



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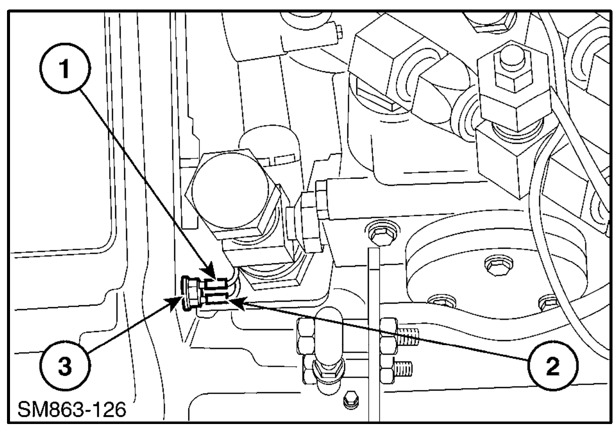
7. Remove the PU/LTBL wire, 1, and B wire, 2, from the sender, 3.
8. Remove the sender from the reservoir by rotating the sender counterclockwise.
9. Remove the grounding ring and washer from the old sender.



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HYDRAULIC OIL TEMPERATURE SENDER INSTALLATION

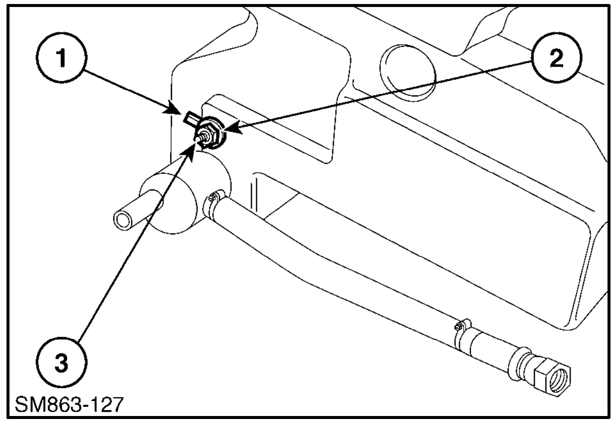
1. Install grounding ring, 1, and washer, 2, over threads of sender, 3.

IMPORTANT: *The grounding ring and washer must be threaded all the way onto the sender before installing the sender into the reservoir.*

2. Use hydraulic thread sealant on the sender threads and install the sender, 3, into the reservoir.

IMPORTANT: *Do not over tighten the sender or damage to the reservoir threads may occur resulting in oil leakage.*

3. Reconnect the sender wires, B wire on the ground blade, and the PU/LTBL wire to the center sender terminal.
4. Refill the hydraulic reservoir with the oil previously removed or new SAE 10W/30 API Service SG-CEF motor oil.
5. Reinstall the engine belly pan, and tighten the retaining hardware.
6. Operate the unit and check for leaks. Repair if required.



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BOOM/BUCKET CONTROL VALVE SPOOL LOCK SOLENOIDS

Op. 35 724 90

REMOVAL

1. Remove any attachment from the loader attaching plate.
2. Raise the boom and support on the boom lock pins.
3. Stop the engine, turn the ignition key to the “RUN” position and operate the boom and bucket controls to relieve pressure in the boom and bucket circuits. Turn “OFF” the key.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

Never work under a raised boom with an attachment. Always remove the attachment from the loader.

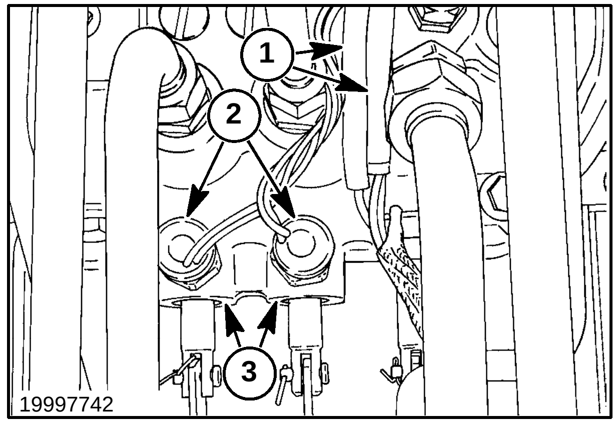
4. Raise the operator's seat and latch in the raised latched position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

5. Remove the step shield to access the control valve area.

6. Unplug the solenoid coil wires, 1, and remove the coils, 2, from the control valve, 3.



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INSTALLATION

1. Thoroughly clean the control valve block.
2. Install the solenoid coil, 2, into block, 3, and torque the coils to 15 N·m (11 ft. lbs.).
3. Reconnect the coil wires to the main wire harness.
4. Reinstall the step shield.
5. Lower the seat to the operate position and securely latch.

CAUTION

Do not operate the loader unless the seat/seat support is properly latched in the latched position.

WIRE HARNESS

Op. 55 100 74

MAIN WIRE HARNESS REMOVAL

1. Remove any attachment from the loader attaching plate.
2. Raise the boom and support on the boom lock pins.
3. Stop the engine, turn the ignition key to the “RUN” position and operate the boom and bucket controls to relieve pressure in the boom and bucket circuits. Turn “OFF” the key.

CAUTION

Never work under a raised boom unless it is properly supported by the boom lock pins.

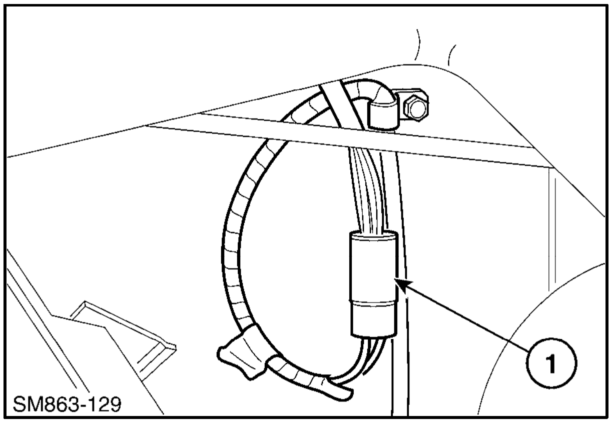
Never work under a raised boom with an attachment. Always remove the attachment from the loader.

4. Raise the operator’s seat and latch in the raised latched position.

CAUTION

Never work under a raised seat unless it is securely latched in the raised position.

5. Remove the step shield to access the control valve area.
6. Disconnect the negative (-) battery cable.
7. Unplug the seat and seat belt wire harness at connector, 1, behind the seat assembly.



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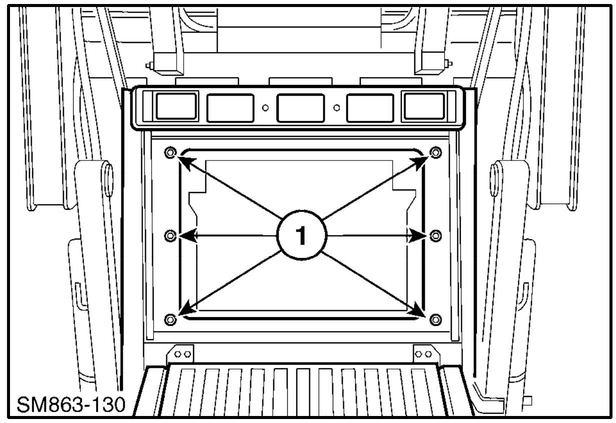
8. Remove the rear window and frame assembly retaining hardware, 1.



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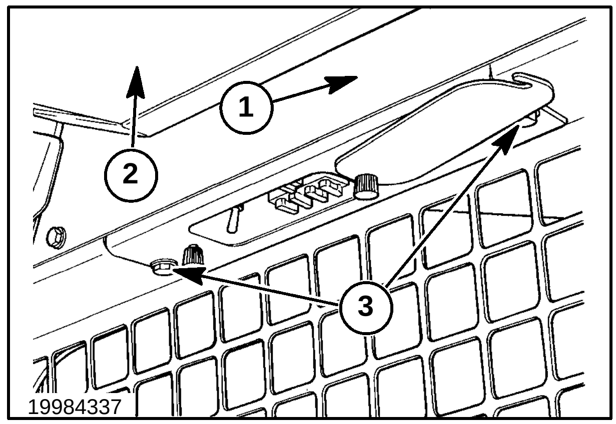
9. Remove the right side plate, 1, and headliner, 2, if equipped. Unhook all wire connections at the service/run switch, and fuse block at this time. Removal of fuse block/switch panel, 3, may be required for easier switch access.



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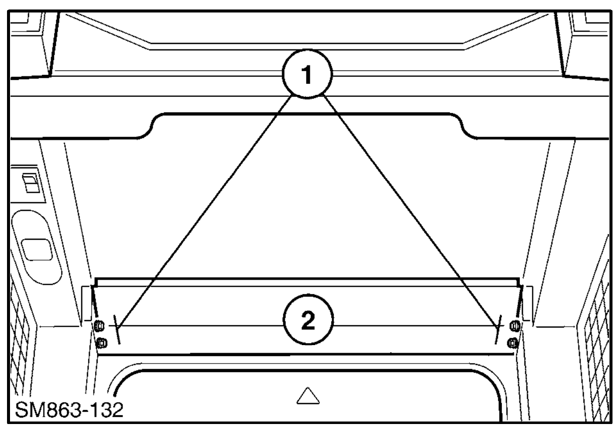
10. Remove the upper rear support retaining hardware, 1, right and left side and remove support, 2.



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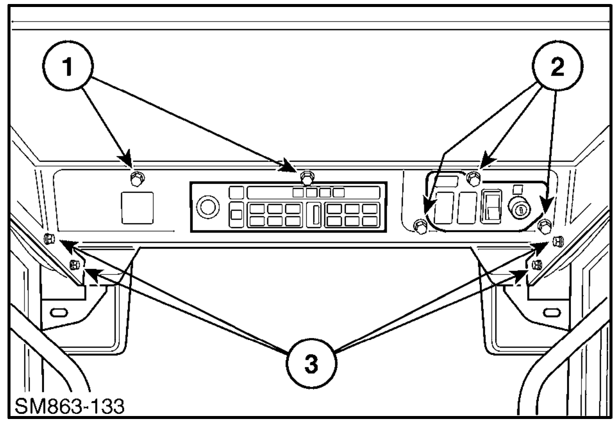
11. Remove the EIC board retaining hardware, 1, unplug the EIC board and remove from the dash. Remove the ignition key switch panel, 2, and remove wires from the switches. Remove the panel. Loosen the front support (dash) retaining hardware, 3, and remove the hardware from the right side.



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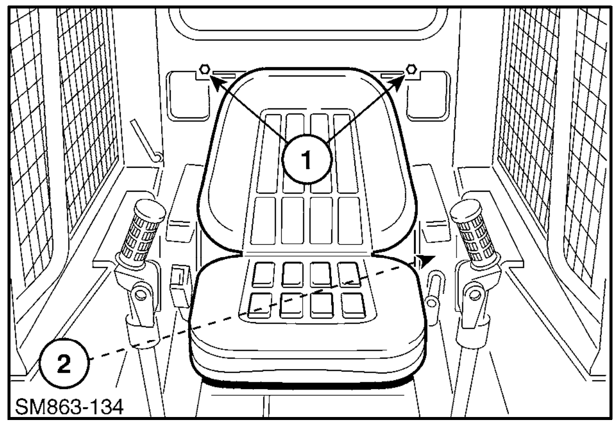
12. Unplug the seat wire harness from the main harness, if not previously unplugged.
13. Remove the seat and seat pan assembly retaining hardware, 1, unlatch the seat assembly at 2, and remove the assembly from the loader.



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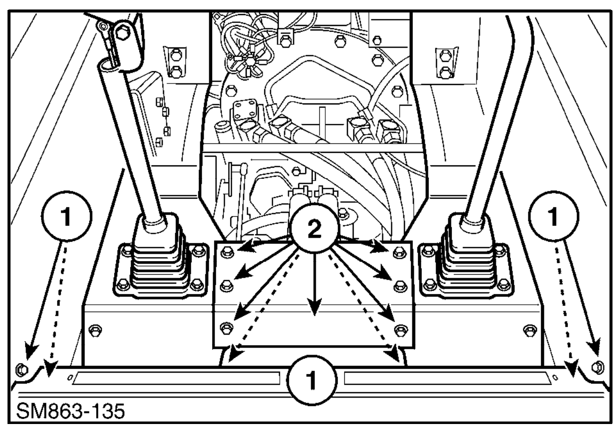
14. Remove the four retaining screws from the front shield, 1, and the eight retaining bolts from the step shield, 2. Remove both shields from the loader.



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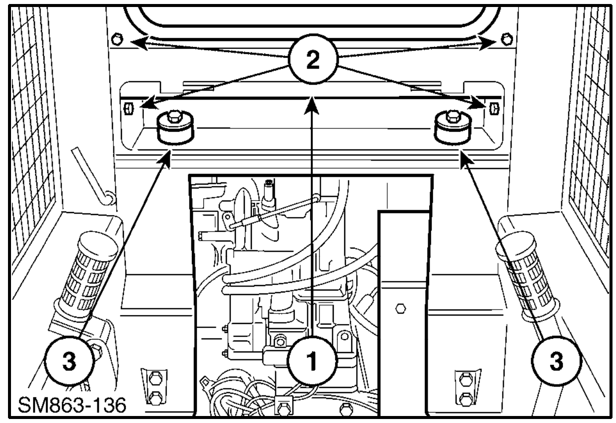
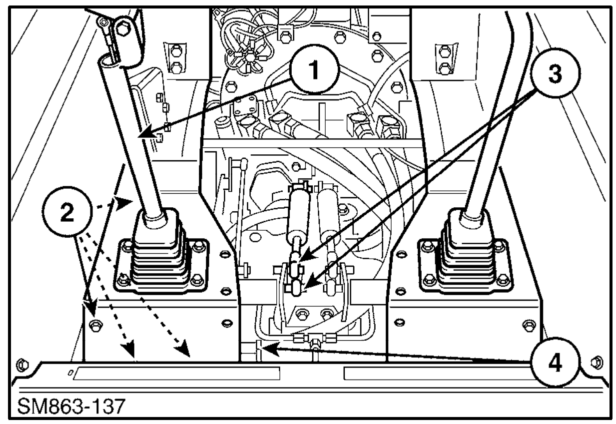
15. Remove the rear seat support, 1, hardware at 2, and the isolator mount hardware, 3.



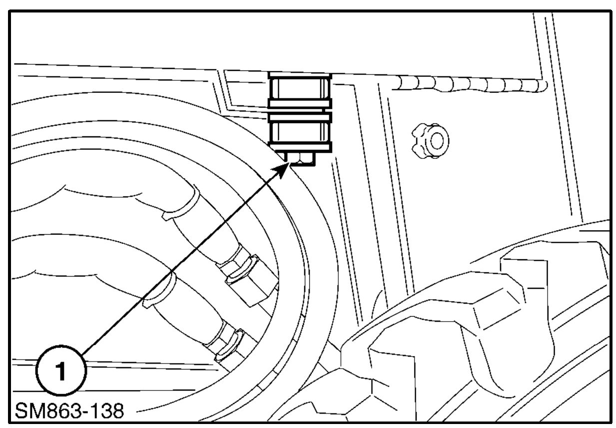
155

16. Remove the right hydrostatic control handle assembly, 1, retaining hardware, 2. Unhook the hydrostatic control linkage, 3, and auxiliary boom hydraulic linkage, 4, (if equipped). Lift the control assembly from the loader.



156

17. Remove the right fender to access and loosen the right front isolator mount bolt, 1.

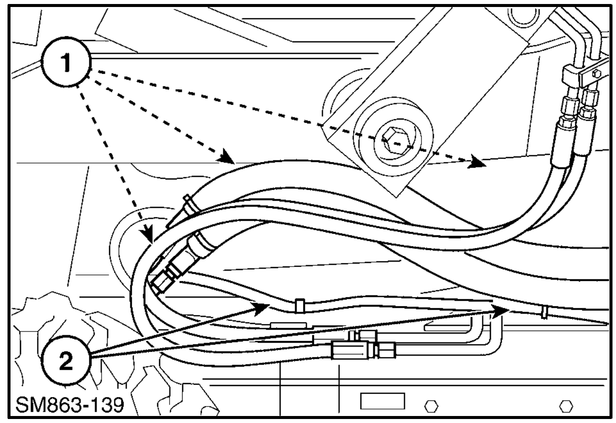


157

18. Remove the left fender.

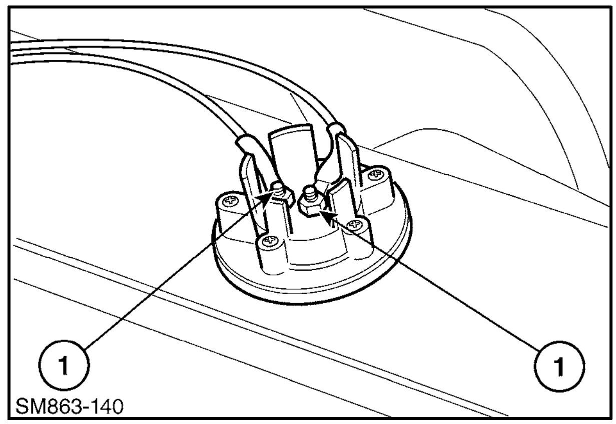
19. Remove all wire harness retaining clamps from the main wire harness, 1 and 2, at the rear and left side of the loader frame.

    (Cut wire ties along the right side of the rear window if so equipped and any ties retaining the optional harness to the main harness. Cut the wire tie at the keeper bar at the left front to rear of cab pivot).



158

20. Remove harness from left rear of engine area after disconnecting wires from fuel sender, 1.

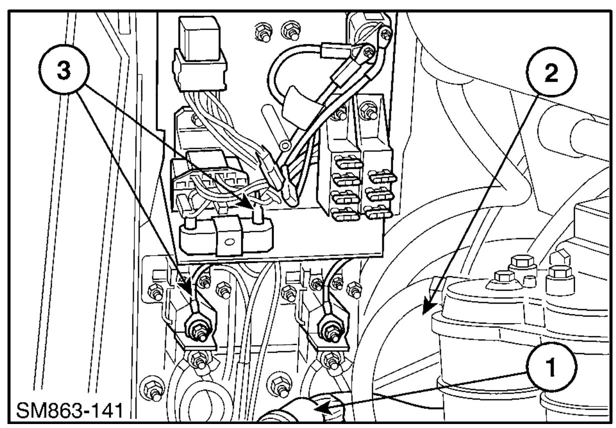


159

21. Thoroughly clean the connector between the main and engine harness. Make sure the connector is dry.

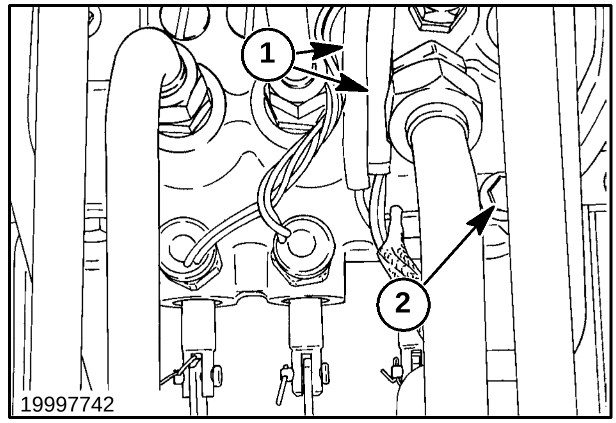
22. Unplug the main wire harness from the engine wire harness, 1, and remove the ground wires from the engine bellhousing ground stud, 2. Remove wires from the engine fuse and relay panel, 3.

23. Remove the hydraulic oil temperature sender wires and remove the harness from the clamp on the face of bellhousing. Remove the remaining bellhousing clamps.



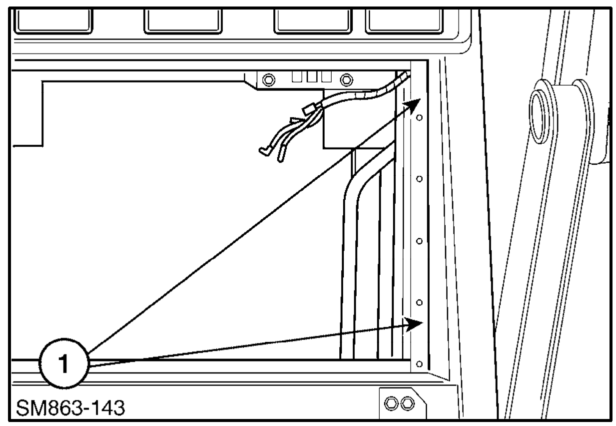
160

24. Disconnect the control valve connectors, 1, remove the J clamp bolt, 2, on the valve and pull the harness out through the left fender area.



161

25. Now the right side panel, 1, can be pivoted into the center of the cab area at the rear and the wire harness can be removed from the corner of the side panel.



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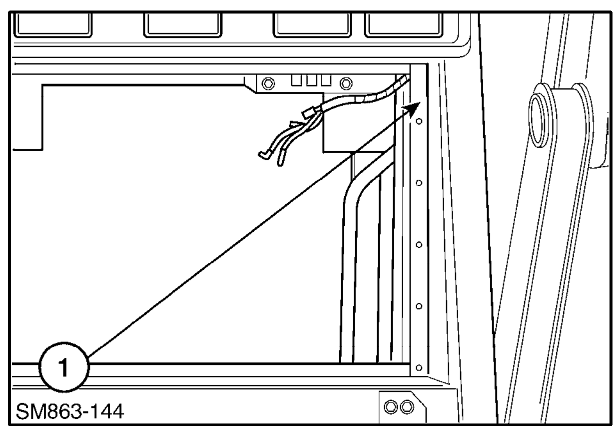
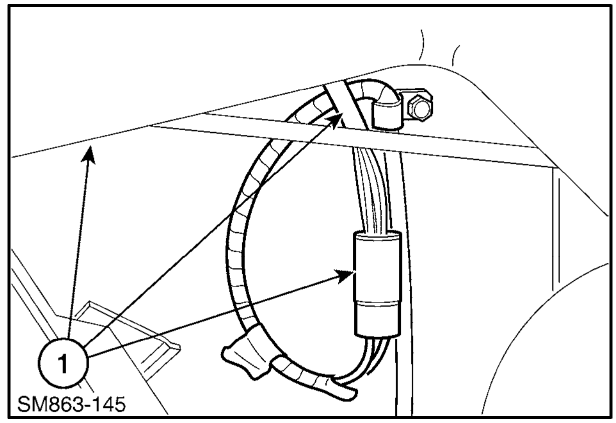
MAIN WIRE HARNESS INSTALLATION

1. Install the wire harness up the right rear corner of the side panel with the EIC board connector toward the front of the loader cab. Position the service/run and fuse block connectors at their location. Place the wire in the upper rear corner of the cab side panel at 1, to prevent the wire harness from contacting the cab panel retaining hardware. Install two wire ties or clamp at the upper right side of the rear window and one tie at the bottom to hold the harness up and maintain clearance from the cab panel hardware and headliner support.



163

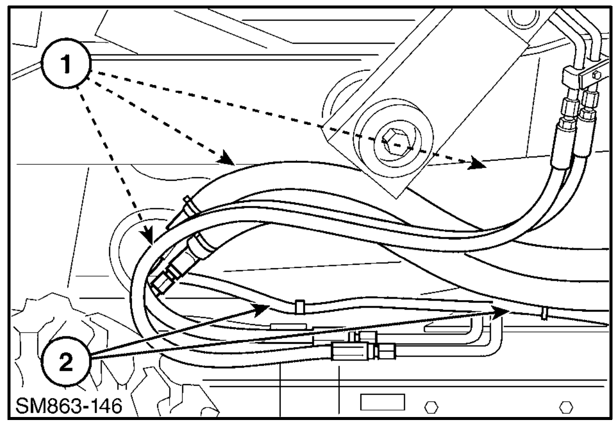
2. Place the main wire harness to the front side of the boom lock linkage at 1, and reinstall the wire clamps. Route the harness across the loader to the left side of the loader.



164

3. Route the wire harness to the front of the loader on the left side, 1 and 2, and install wire clamps where previously installed. Place the harness into the loop (keeper) and secure with a wire tie at 1, and then along the top of the lower frame to the rear of the loader to the engine fuse/relay panel area.

4. Route the harness branch to the inside of the frame with the hydraulic lines and down to the floor and front of the control valve. Refasten in the J clamp and route the connectors between valve bosses and plug in solenoids. Tuck the connectors between valve bosses to protect the harness.



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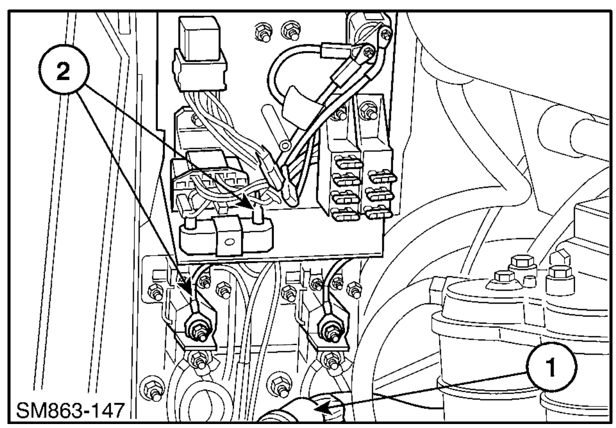
5. Connect the main wire harness connector to the engine wire harness, 1. Reconnect the wires to the engine fuse and relay panel, 2.

6. Reconnect the wires to the fuel tank sender.

NOTE: *Refer to “Removal, Installation and Wiring of Electrical Components” earlier in this section for more details of proper wire connections.*



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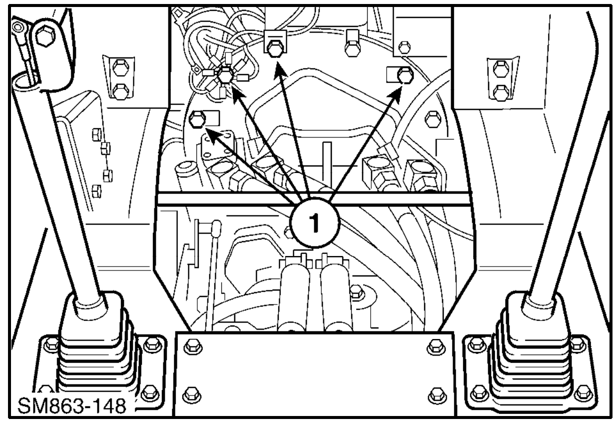
7. Attach the ground wires and clamps at the engine bellhousing ground studs, 1.

NOTE: *When attaching ground wires, always place the heaviest ground wire (battery ground cable) next to the ground surface (bellhousing). Then stack the remaining ground wires according to wire size; largest on bottom, smallest on top of the heaviest wire.*

8. Continue harness routing to the hydraulic temperature switch and secure in the bell housing clamp. Clamp harnesses to the bellhousing.



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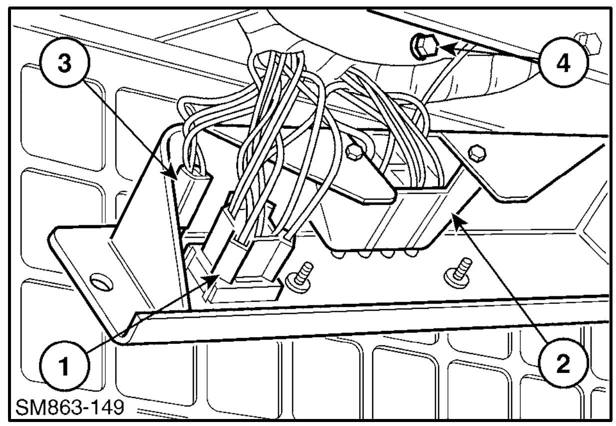
9. Reattach the wires to the service/run switch, 1; fuse block(s), 2; preheat switch, 3; and any ground wires if removed at 4.

NOTE: *When attaching ground wires, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to wire size on top of the heaviest wire.*



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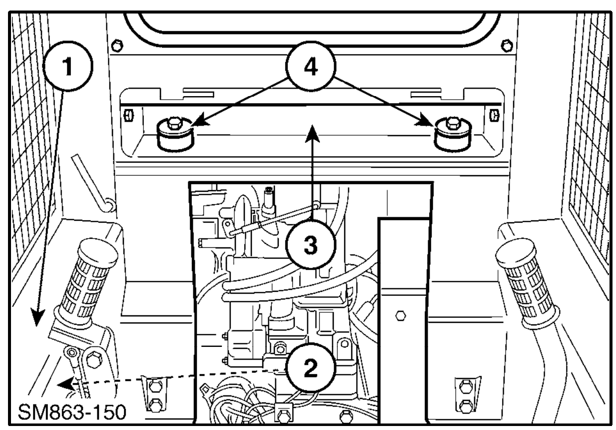
10. Reposition the right side panel, 1, and reinstall the front dash support hardware.
11. Reinstall the right front isolator, 2, if removed.
12. Reinstall the upper rear support.
13. Reinstall the lower rear support, 3, and the isolators, 4. Tighten all cab support and side shield hardware at this time.



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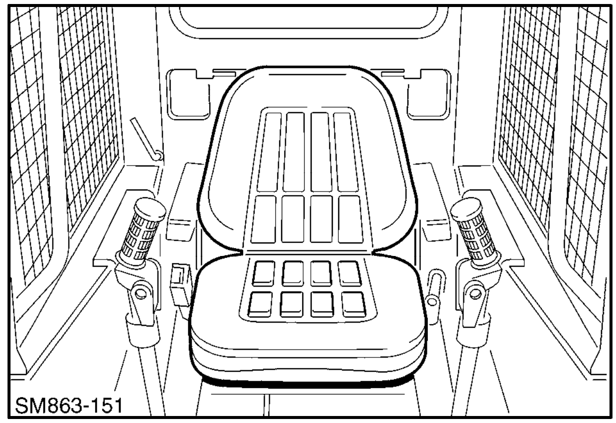
14. Reinstall all wire harness clamps previously removed, position the wire harness to prevent damage, and tighten the clamp hardware at this time.
15. Reinstall the seat and seat pan assembly and tighten the hardware. Reconnect the seat harness to the main harness. Check the loop for clearance when the seat is raised and lowered.



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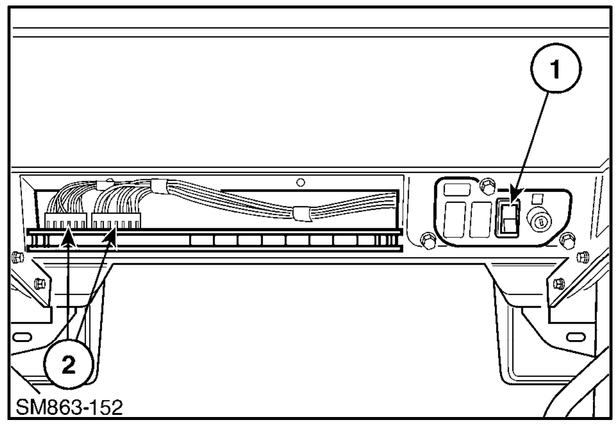
16. Route the wire harness to the front of the cab to the ignition switch and EIC board area. Attach the wires to the ignition switch and position the wire harness to prevent damage. Reinstall the switch panel, 1.
17. Attach the wire harness connectors, 2, to the proper EIC board connector and position the wire harness across the front of the dash area to prevent damage. Reinstall the EIC board.
18. Reconnect the negative (-) battery cable.
19. Check the electrical system for proper operation.



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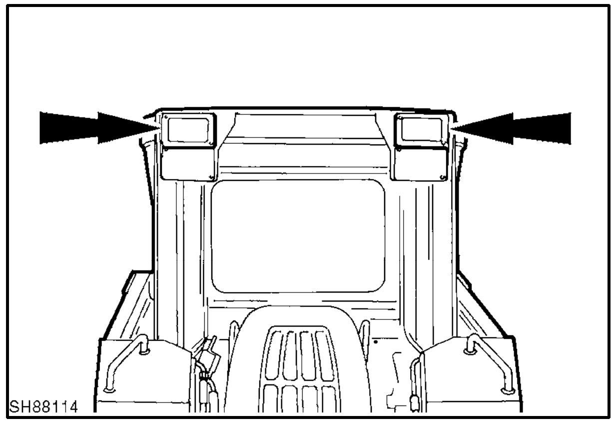
Op. 55 404

ROAD/WORK LIGHTS

The road and work lights provide illumination for road travel and work operations. The rear work lights are not recommended for road travel.



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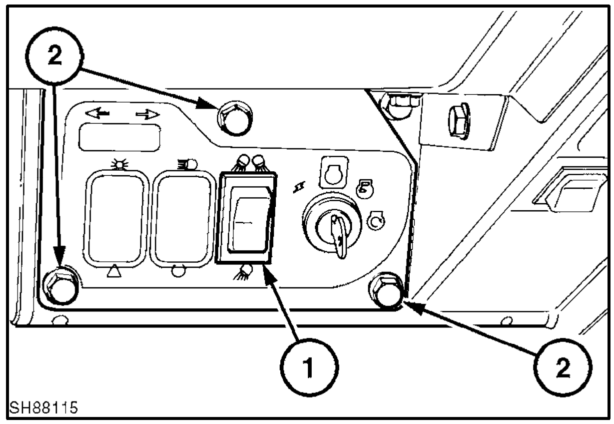
Road/work light switch, 1, is located in the ignition key switch panel in the upper right corner of the overhead dash. To remove the switch, disconnect the negative (-) ground battery cable. Remove the key switch panel hardware, 2, and tilt the panel down.



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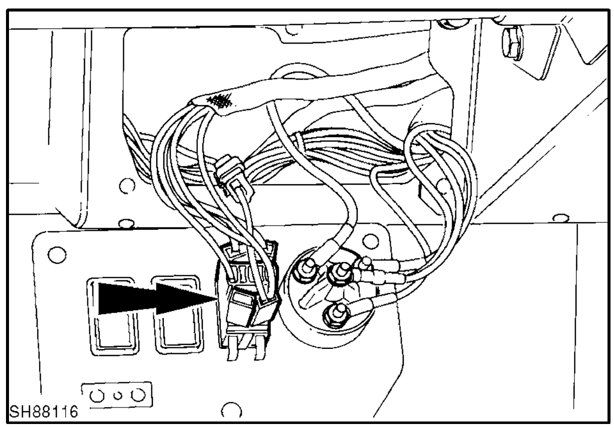
Disconnect wires from the switch, squeeze the switch retaining tabs in, and remove the switch from the panel.



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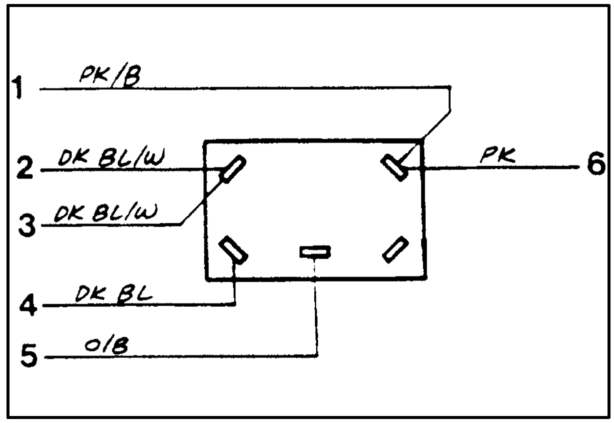
Road/Work Light Switch Wiring



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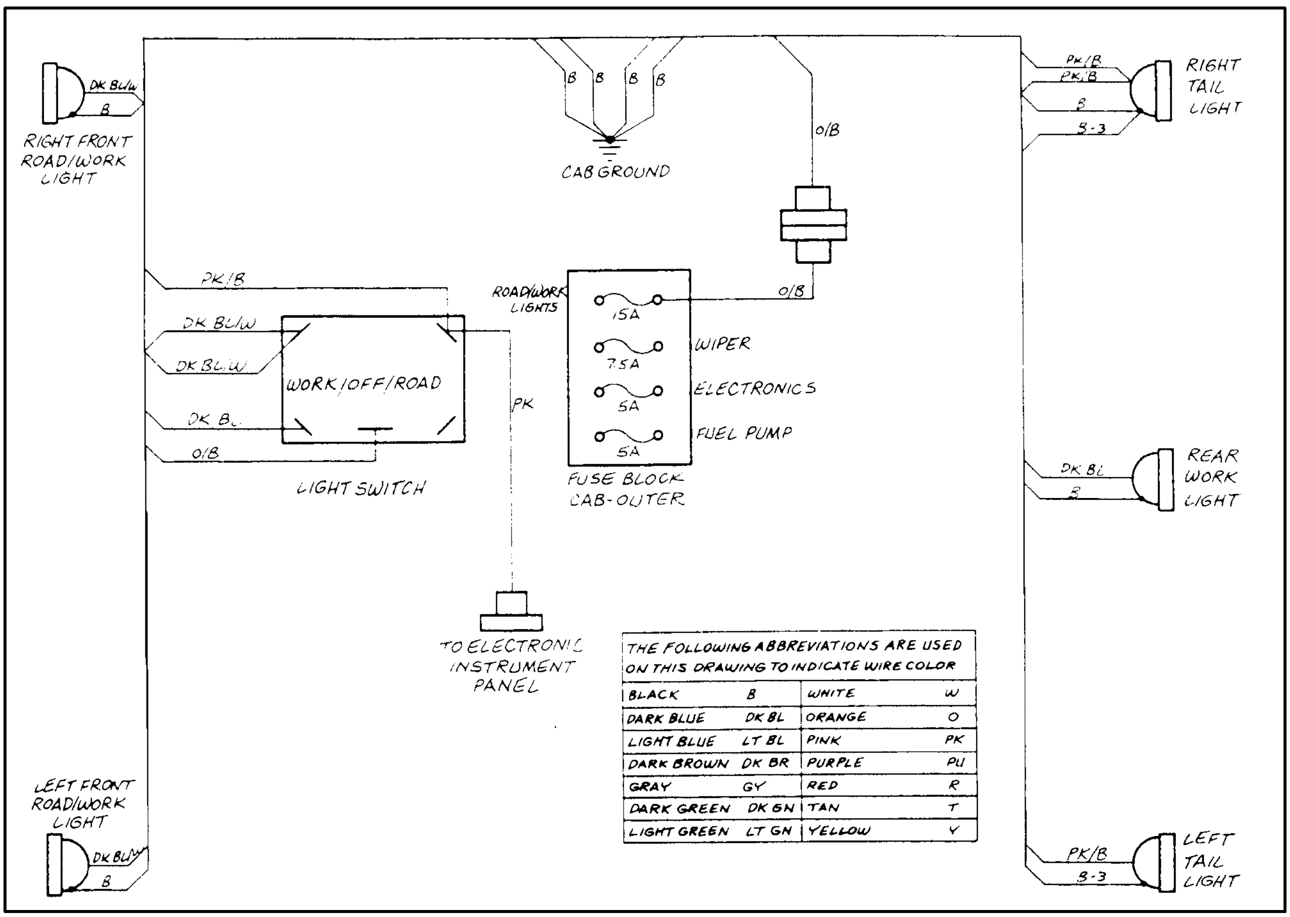
Road/Work Light Wiring Diagram

NOTE: *When attaching ground wires, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to size on top of the heaviest wire.*



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Bulb Replacement
Clear lens with bulb #86533429

Bulb only (clear) #86533428

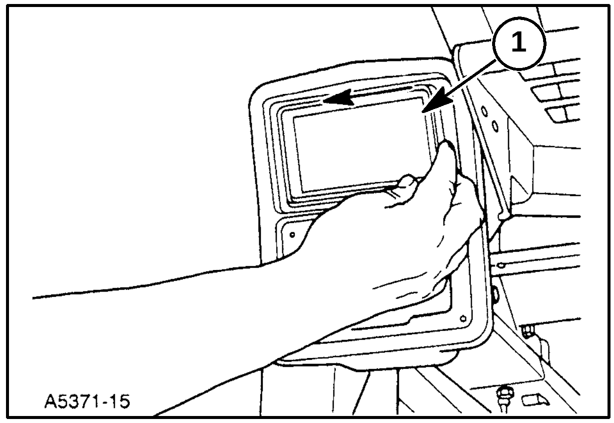
Red lens with bulb #9829515

Bulb only (red) #C6AB13465A

Op. 55 404 10

Front Road/Work Light

1. Facing the lens of the light assembly, push the lens assembly, 1, to the left and lift the right side of the assembly from the support.



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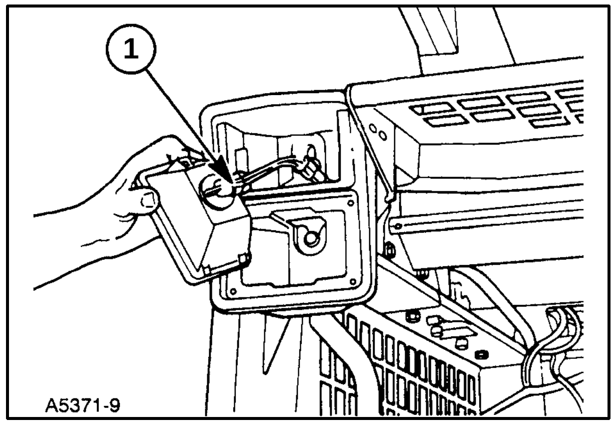
2. Unplug the wire harness from the bulb, unlatching the connector at 1, and sliding the harness from the bulb.



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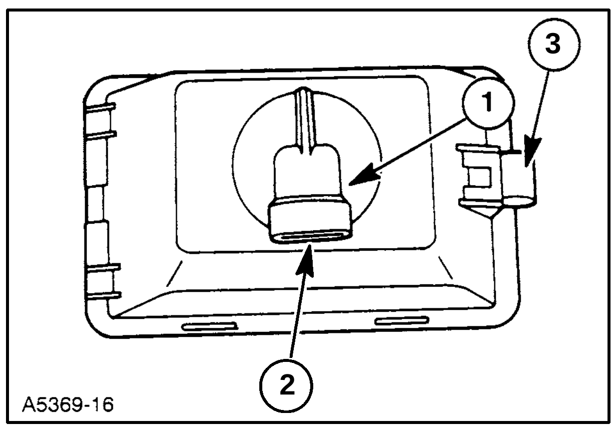
3. Facing the back of the assembly, rotate the bulb holder, 1, counterclockwise and remove the bulb from the support.
4. Position the bulb so when it is locked in position the connector, 2, is pointed down with the clip, 3, to the right.



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***IMPORTANT**: DO NOT touch the bulb during removal and installation. The bulb may become damaged or a premature failure may occur.*

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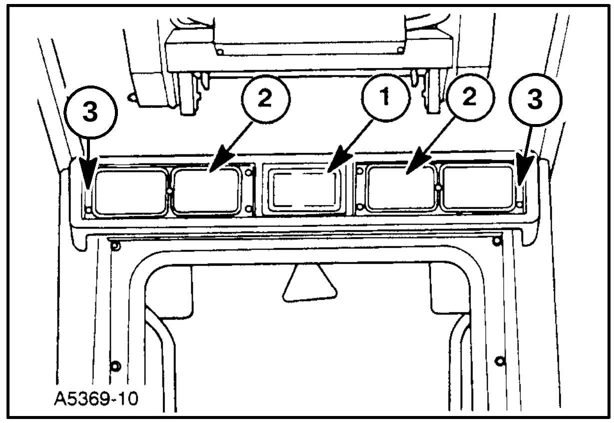
Rear Work and Taillight

1. Remove the center work light, 1, by pushing the lens assembly to the left and lift the right side of the assembly from the support.

2. Remove the red taillight lamps, 2, by unscrewing the bezel self-tapping screws and removing the bezels, 3.

3. Unplug the wire harness from the bulb, unlatching the connector, and sliding the harness from the bulb.



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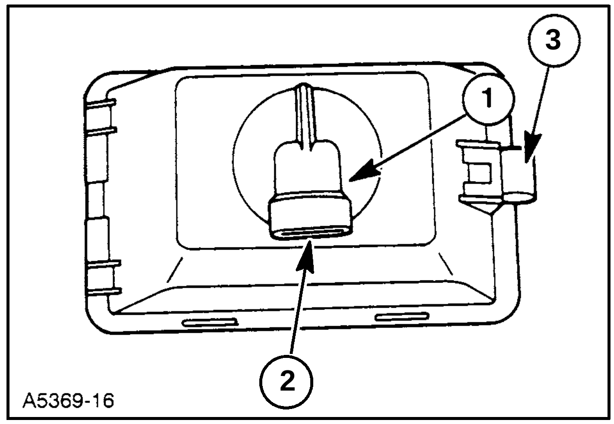
4. Facing the back of the assembly, rotate the bulb holder, 1, counterclockwise and remove the bulb from the support. Replace the bulb.

5. For the clear rear work lamp, position the bulb so when it is locked in position the connector, 2, is pointed down with the clip, 3, to the right.

IMPORTANT: *DO NOT touch the bulb during removal and installation. The bulb may become damaged or a premature failure may occur.*



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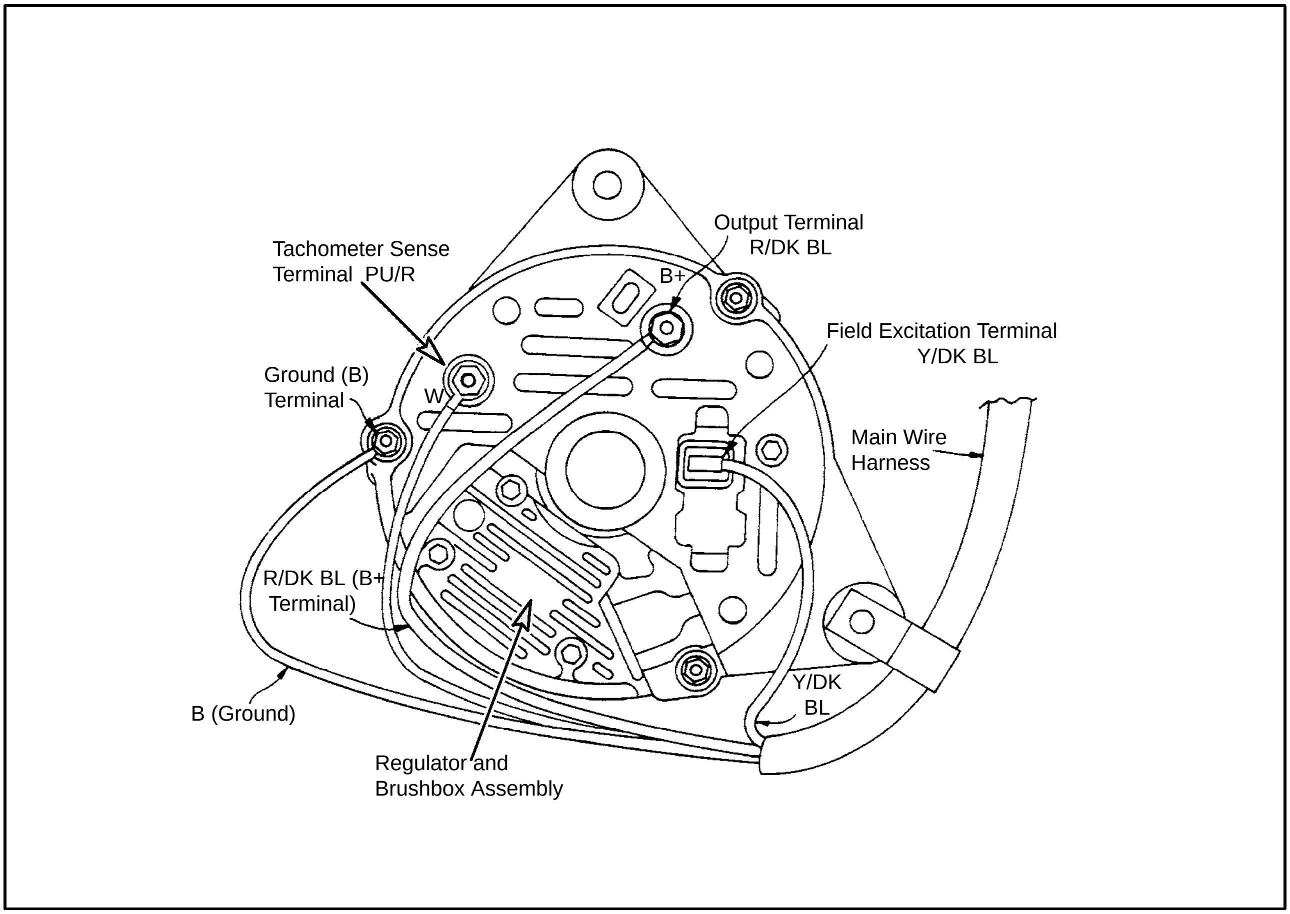

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Op. 55 301

ALTERNATOR

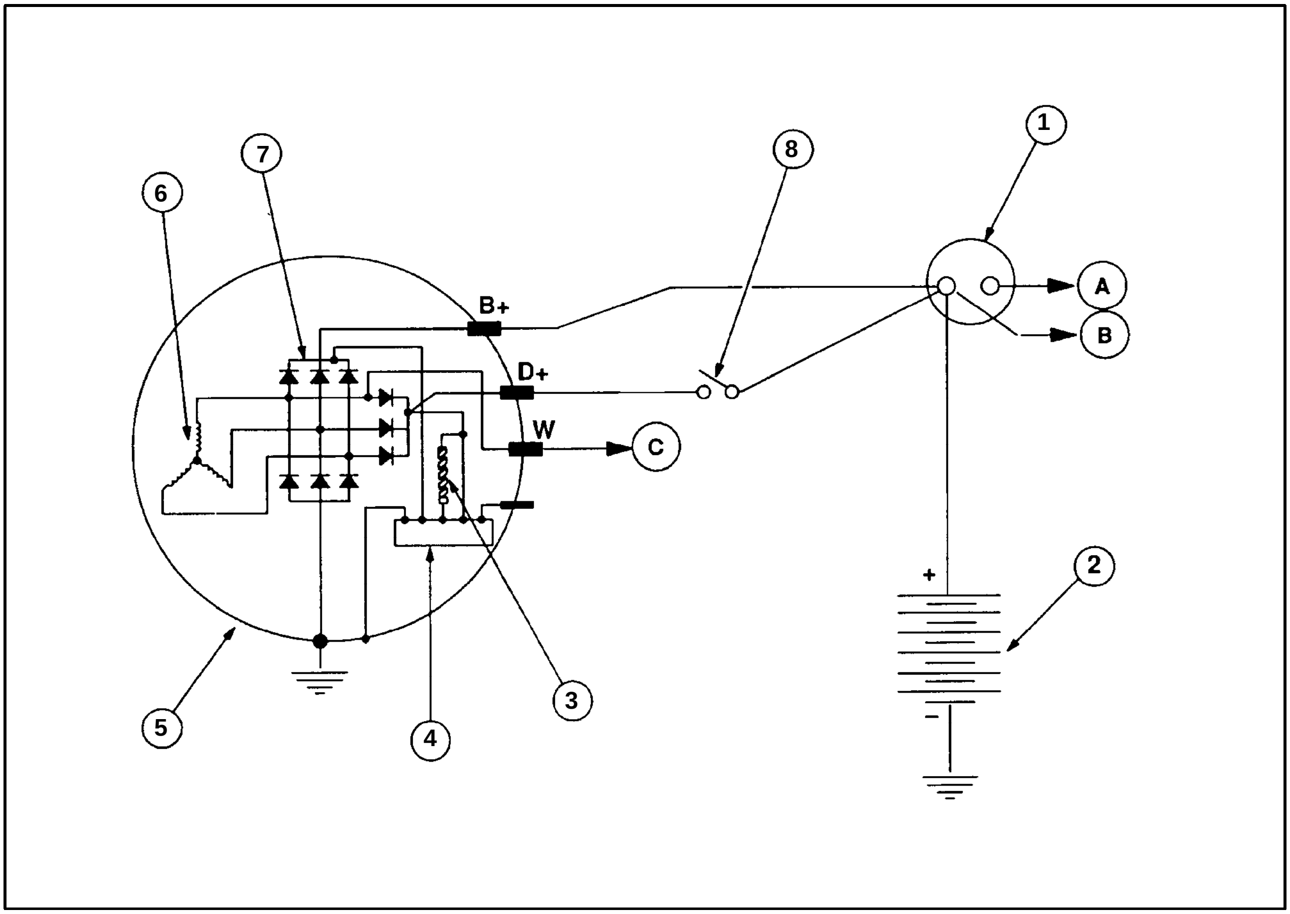
CHARGING SYSTEM

Introduction

The LS180 and LS190 skid steers are equipped with Magnetti Marelli (Lucas) A127-type alternators. This alternator is rated at 45 amps, has an integral regulator, and is driven by a single V-belt from the engine crankshaft.

Four cables from the wire harness connect with the alternator:

1. A heavy-gauge wire, red with a dark blue tracer, is the main power cable from the alternator. It connects to the “B+” (output) terminal.
2. A light-gauge wire, yellow with dark blue tracer, connects to the field excitation terminal. This circuit provides initial voltage to energize the field at startup.
3. A wire, purple with red tracer, connects to the “W” terminal. This circuit provides an engine speed signal to the Electronic Instrument Cluster.
4. The fourth wire, black, connects to one of the alternator housing bolts and functions as the ground circuit.



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Alternator Charging Circuit

A To Starter Motor
B To Starter Relay
C To Electronic Instrument Panel

1. Starter Solenoid
2. Battery
3. Rotor Field Winding
4. Regulator
5. Alternator Frame
6. Stator Output Windings (45/70 Amp Alternators)
7. Rectifier Pack
8. Key Start Switch

B+ Output (R/DB)
D+ Field Excitation (Y/DKBL)

When the key start switch, 8, is turned on, a small current flows from the battery, 2, through the rotor field winding, 3. The circuit is made through the key start switch, the “D+” terminal, the rotor field winding, and the integral regulator, 4, to ground.

At this stage, the rotor is partially magnetized.

When the engine is started and the partially-magnetized rotor revolves within the stator windings, a 3-phase alternating current is generated. This AC current is converted to direct current by the three field diodes in the rectifier pack, 7.

A portion of this current is fed back to the rotor field winding, through the regulator, supplementing the initial current. This produces an increasing magnetic field in the rotor, resulting in a rapid rise in generated output current and voltage.

The voltage continues to rise until the regulated voltage level is reached. The voltage regulator controls alternator output voltage by controlling the strength of the field current.

In a properly operating alternator, voltage at the output terminal (B+) will always equal voltage at the field excitation terminal (D+).

ALTERNATOR

General Specifications

Model	A127-45
Polarity	Negative ground
Nominal voltage	12.0 volts
Maximum RPM	15,000

Service Specifications

Maximum output	45 amps
Regulator controlled voltage	13.6 - 14.4 volts
Rotor field winding resistance	2.9 ± 0.5 ohms
Stator field winding resistance	0.2 ohms
New brush length	20 mm (0.80″)
Minimum brush length	5 mm (0.20″)
Brush spring pressure	1.3 - 2.7 N (5 - 10 oz.)

Torque Specifications

	ft. lbs.	N·m
Alternator through bolts	4.0	5.5
Pulley retaining nut	52.0	70.0
Rectifier retaining screws	3.0	4.0
Regulator and brushbox screws	2.0	2.7
Terminal nuts	2.0	2.7

ALTERNATOR SYSTEM TESTING AND TROUBLESHOOTING

Service Precautions

Observe the following service precautions to avoid damage to the charging system:

1. NEVER make or break any of the charging system connections, including the battery, when the engine is running.
2. NEVER short any of the charging system components to ground.
3. ALWAYS disconnect the battery negative cable when charging the battery in the machine with a battery charger.
4. ALWAYS observe correct polarity when installing the battery or when using a booster battery to start the engine.

   CONNECT POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE.

Preliminary Checks

Prior to electrical testing, thoroughly inspect the charging and electrical system.

Check all leads for continuity and tightness.

1. Check the battery.

   Using a voltmeter on a sealed battery, or a hydrometer on an unsealed battery, check that the battery is at least 75% charged before further testing. The voltmeter reading should be 12.4 volts minimum. The hydrometer reading should be 1.240 minimum.

2. Check the drive belt.

   Inspect the alternator drive belt and pulley, ensuring that both are clean, free from oil and grease, and in good condition.

   The drive belt should be tightened such that a force of 1 kg (2 lbs.), applied at the center of the longest span, will not deflect the belt more than 3 mm (1/8″).

Initial Tests

Certain initial tests may be performed without removing any of the charging components from the loader. These allow the following items to be checked:

1. Alternator wire connections.
2. Alternator charging current and controlled voltage.
3. Alternator charging circuit voltage drops.
4. Alternator maximum output performance.

Test equipment required:

Voltmeter (0-1 and 0-20 volt scales).

Ammeter (0-60 amp minimum scale).

Carbon pile variable load resistor.

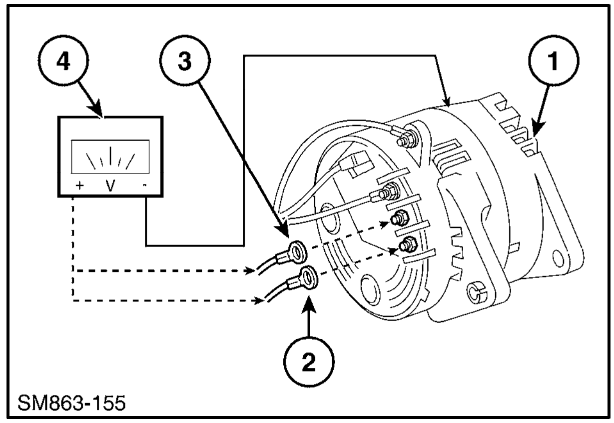
NOTE: *Most commercial test equipment incorporates several test functions in a single unit. Follow the manufacturer's instructions when using such a tester.*

Alternator Wiring Connections Test

1. Disconnect the battery negative cable.
2. Disconnect the B+, 2, and field excitation lead, 3, from the alternator, 1.
3. Reconnect the battery and turn the key start switch on. Do not start the engine. Connect a voltmeter, 4, between each of the disconnected leads and ground. Battery voltage should be indicated at both of the leads.

If battery voltage is not indicated at both leads, a continuity fault exists which must be traced and corrected.

4. Disconnect the battery and reconnect the removed leads to the alternator. Reconnect the battery.



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Charging Current and Controlled Voltage Tests

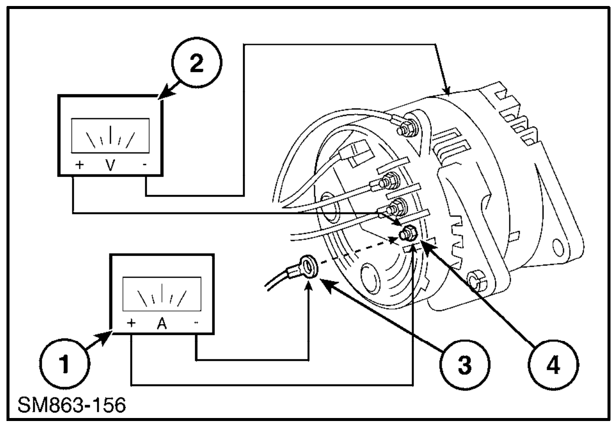
1. Switch off all electrical components. Disconnect the battery negative cable.
2. Disconnect the B+ terminal, 4, at the alternator. Connect an ammeter, 1, between the removed (Red/Dark Blue) wire, 3, and the B+ terminal of the alternator.
3. Connect a voltmeter, 2, between the alternator B+ terminal and ground.
4. Reconnect the battery. Start and run the engine at 2000 RPM and observe the voltmeter and ammeter readings.

   The voltmeter should register in excess of battery voltage and when the ammeter reading falls below 10 amps, the voltmeter reading should stabilize at 13.6-14.4 volts.

   If the voltmeter reading exceeds 14.4 volts, the regulator is faulty and must be replaced. After replacement, conduct the charging current and controlled voltage tests.

   If the voltmeter reading is below 13.6 volts, a faulty alternator or a high resistance fault in the external portion of the charging system is indicated.

   If the ammeter registers zero amperes, a faulty alternator is indicated. Turn off the engine and conduct the “alternator component tests” as detailed in this chapter.



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Charging Circuit Voltage Drop Tests

Insulated Side Voltage Drop Tests

1. With the key start switch in the “off” position, disconnect the battery negative cable and the B+, 5, cable from the alternator.

2. Connect a voltmeter, 4, with a low-voltage scale between the battery positive terminal and the free end of the B+ cable. The voltmeter positive lead connects to the B+ cable while the negative lead connects to the battery positive terminal.

3. Connect an ammeter, 2, of 60-amp minimum capacity between the B+ post of the alternator, 1, and the B+ cable, 5, (ammeter positive lead to alternator).

4. Reconnect the battery negative cable. Connect a variable discharge rate (carbon pile) load tester, 3, across the battery terminals. Adjust the tester for minimum draw (maximum resistance) before connection.

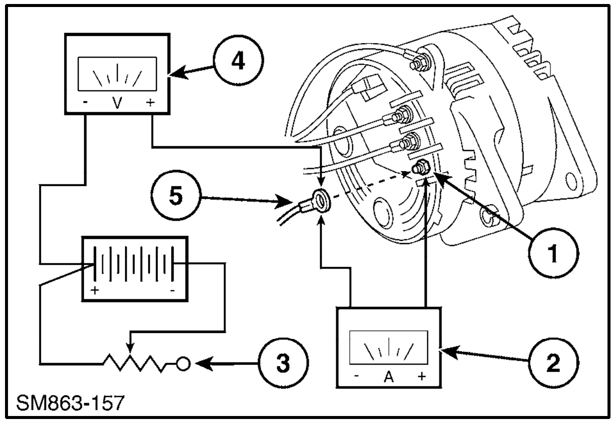
5. Start the engine and increase speed to 2000 RPM. Slowly increase the current draw until the ammeter reads 45 amps.

6. At that point, the voltmeter should not read more than 0.4 volts.

   If the ammeter reading exceeds 0.4 volts, there is a high resistance fault in the insulated side of the circuit.

   If maximum output is less than 45 amps and the voltmeter reading is less than 0.4 volts, proceed to the Ground Side Voltage Drop Test.

7. Stop the engine.



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Ground Side Voltage Drop Test

1. Ensure the key start switch is in the OFF position.
2. Test connections are the same as the previous test except that the voltmeter, 4, is now connected between the negative post of the battery and the alternator frame. Voltmeter negative lead connects to the alternator frame.

NOTE: *Ensure the variable rate load tester, 3, is set to the minimum current draw position.*

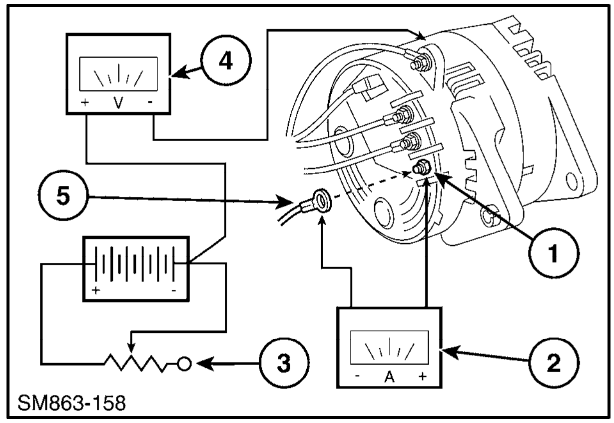
3. Start the engine and increase the speed to 2000 RPM.
4. Slowly increase current draw until the ammeter, 2, reads 45 amps.
5. At that point the voltmeter should not read more than 0.2 volts.

   If the reading is in excess of 0.2 volts, there is a high resistance fault in the ground side of the circuit.

   If the maximum output reading obtained is less than 45 amps and voltage drop is within specifications, the alternator is faulty. Conduct the alternator component tests outlined in this section.

   If the voltage reading is less than 13.6 volts, a fault in the alternator is indicated. Conduct the alternator component tests outlined in this section.

6. At that point, the voltmeter reading should be 13.6 volts minimum.



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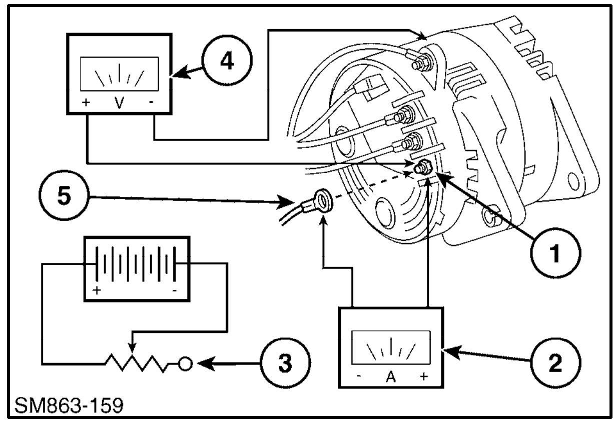
Alternator Maximum Output Performance Test

1. With the key start switch in the OFF position, disconnect the battery negative cable and the B+ cable, 5, from the alternator.
2. Connect an ammeter, 2, of 60-amp minimum capacity between the B+ post of the alternator, 1, and the B+ cable (ammeter positive lead to alternator).
3. Connect a voltmeter, 4, between the alternator B+ terminal and ground.
4. Reconnect the battery, start the engine, and increase the engine speed to 2000 RPM.
5. Slowly increase current draw until the ammeter reads 45 amps.
6. At that point, the voltmeter reading should be 13.6 volts minimum.

If the voltage reading is less than 13.6 volts, a fault in the alternator is indicated. Conduct the alternator component tests outlined in this section.



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ALTERNATOR COMPONENT TESTS

The following tests should only be conducted if the INITIAL TESTS have indicated a fault in the alternator. These tests will check the following components:

Regulator
Rotor Field Winding Continuity
Brushes and Springs and Rotor Slip Rings

NOTE: *These tests may be performed with the alternator installed in the loader. Further testing of the alternator will require removal from the machine.*

IMPORTANT: *Prior to removing any cables from the alternator, ensure that the key start switch is in the OFF position and the battery negative cable is disconnected.*

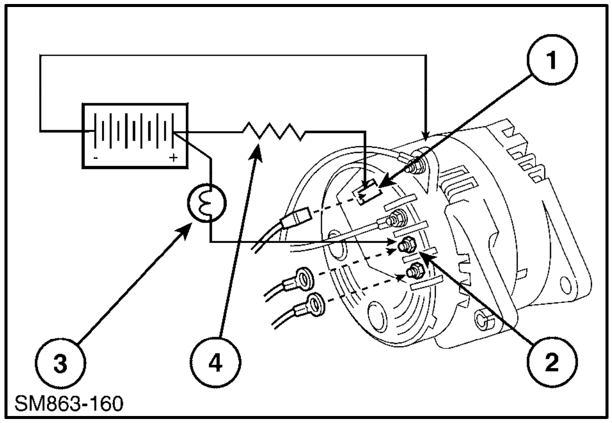
Test equipment required:

12 volt battery
Ohmmeter
2.2-watt test lamp

Regulator and Rotor Field Circuit Test

1. Disconnect all of the alternator cables.
2. Connect a 12-volt battery and a 2.2-watt test lamp in series between the D+, 1, terminal and the alternator frame (positive lead to D+ terminal).
3. The test lamp should illuminate.

   If the test lamp does not illuminate, there is a fault in the rotor circuit. Proceed with the following two tests of rotor continuity, slip rings, and brush condition. If no fault is found in these components, suspect a faulty regulator.



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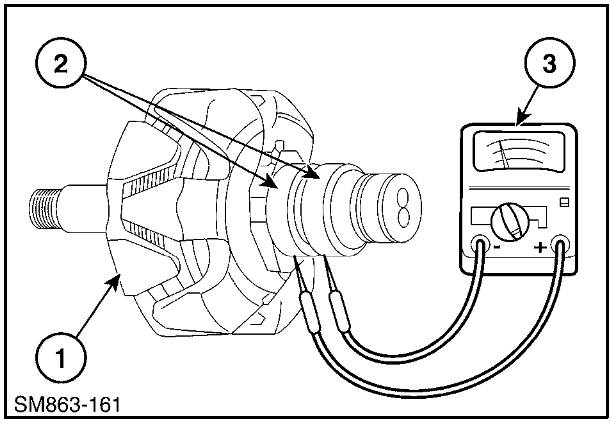
Rotor Field Winding Continuity Test

1. Remove the regulator and brushbox assembly from the alternator by withdrawing three screws and one slip on connector.
2. Using an ohmmeter, 3, check resistance between the two slip rings, 2. The slip rings are accessible through the brushbox opening.
3. Resistance should be 2.9 ± 0.5 ohms at room temperature.

If resistance is outside of specification, replace the rotor.



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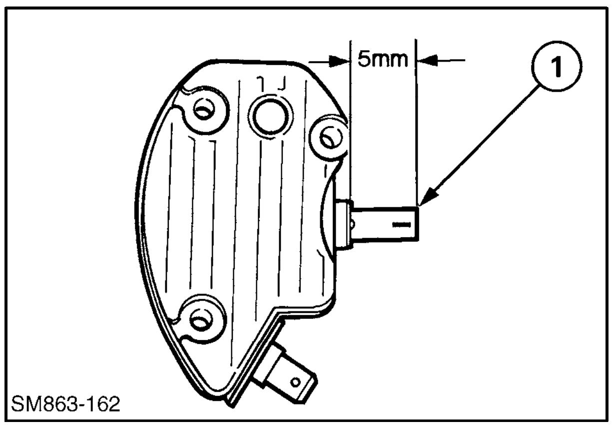
Brushes and Springs and Rotor Slip Rings

1. Remove the regulator and brushbox assembly from the alternator by withdrawing three screws and one slip on connector.
2. Examine the brushes, ensuring they are clean and free in the housing. The visible-free length of the brushes should be 5 mm (0.25″) minimum.
3. Check the brush spring pressure which should be 1.3 - 2.7 N (5 - 10 oz.) with the brush face flush with the housing.

If the brush-free length or spring pressure are below specification, replace the brushbox and regulator assembly. The brushes are an integral part of the assembly and cannot be replaced as individual items.



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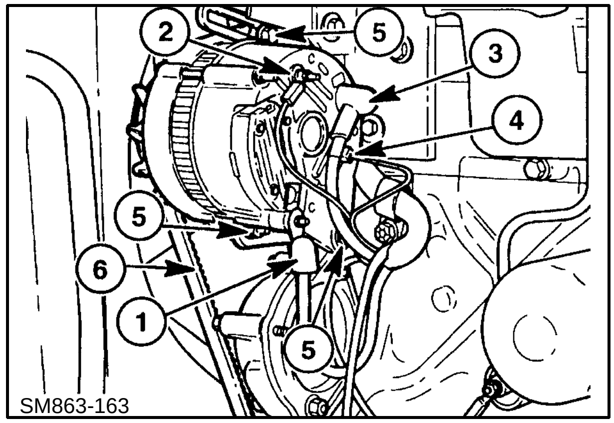
Op. 55 301 04

ALTERNATOR OVERHAUL AND COMPONENT TESTING

Op. 55 301 10

ALTERNATOR REMOVAL

1. Disconnect the negative battery cable.
2. Disconnect the RED/DK BL wiring lead, 3, from terminal B+ and PUR/RED wiring lead, 2, from terminal W.
3. Disconnect BLK wiring lead, 1, and YEL/DK BL electrical connector, 4.
4. Remove the mounting bolts, nuts and lock washers, 5. Remove belt, 6. Remove the alternator from the machine.



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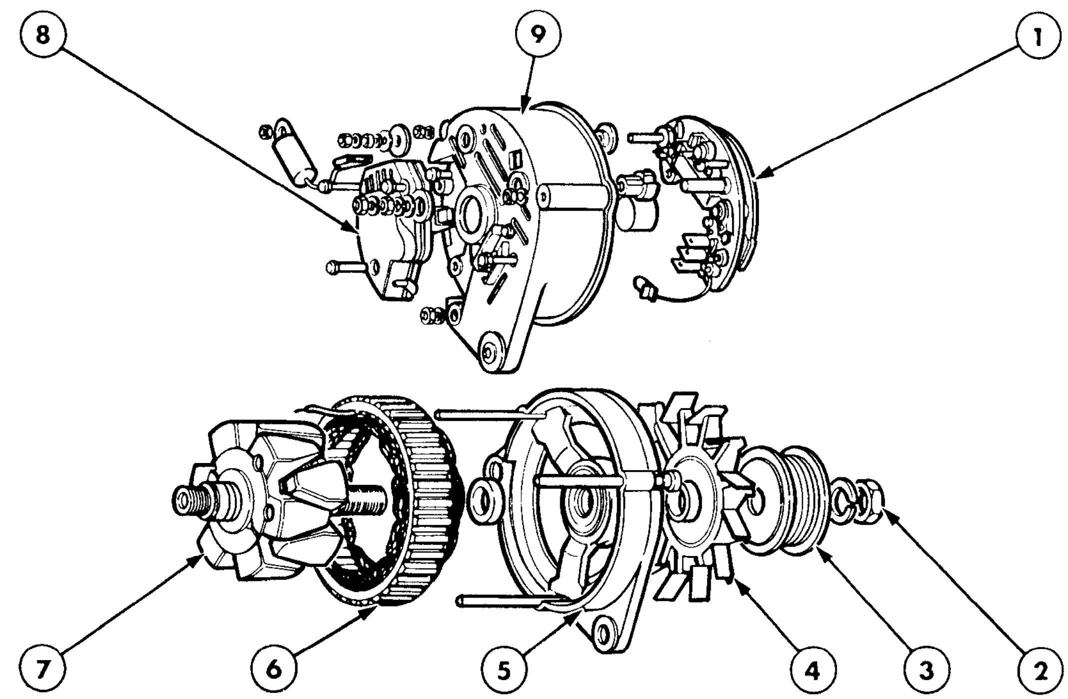

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45 Amp Alternator Components

1.	Rectifier Assembly	5. Front End Housing	8. Regulator and Brushbox Assembly
2.	Pulley Retaining Nut	6. Stator	9. Rear End Housing
3.	Pulley	7. Rotor	
4.	Cooling Fan		

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DISASSEMBLY

1. Remove the nut, insulator and washers from terminal “W”.
2. Remove the nut, insulator, and washers from terminal “B+”.
3. Remove the three securing bolts and withdraw the regulator and brushbox assembly, 8. Disconnect the slip on connector.
4. Remove the three nuts from the alternator through bolts.
5. Mark the alternator front end housing, 5, stator, 6, and rear end housing, 9, to ensure correct alignment on reassembly.
6. Separate the front end housing from the stator and rear end housing.
7. Remove the two screws securing the rectifier assembly, 1, to the rear end housing. Separate the stator and the rectifier assembly from the rear end housing.
8. Unsolder the stator leads from the tabs on the rectifier using pliers as a heat sink to protect the diodes from overheating.
9. Remove the nut, 2, washer, pulley, 3, fan, 4, and spacer from the rotor shaft, 7.
10. Press the rotor shaft out of the front-end bracket bearing.

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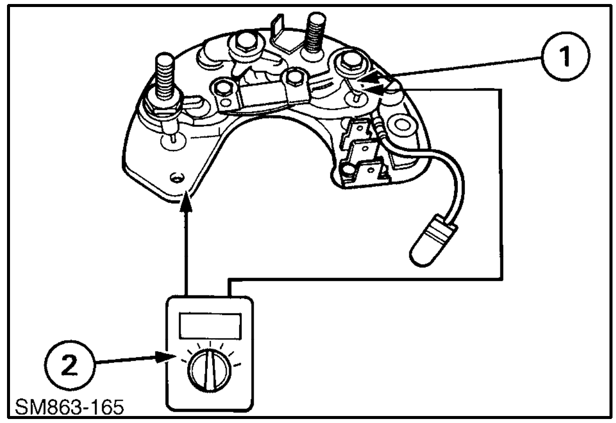
ALTERNATOR COMPONENT TEST

Rectifier Assembly - Positive and Negative Diode Test

Test each of the six diodes separately as described:

1. Connect one lead from an ohmmeter, 2, to a diode connecting pin, 1, and the other ohmmeter lead to the plate into which the diode is mounted.
2. Note the resistance reading shown. Reverse the ohmmeter leads and note the reading.
3. The ohmmeter should indicate continuity in one-half of the test and an open circuit in the other. If any one diode fails this test, the entire rectifier assembly must be replaced.



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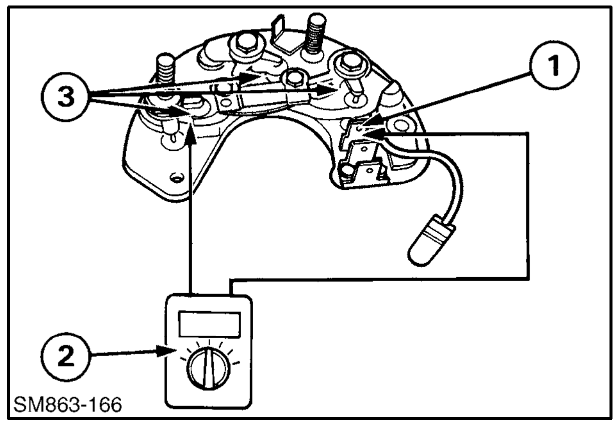
Rectifier Assembly - Field Diode Test

Test each of the three field diodes separately as described:

1. Connect one lead from an ohmmeter, 2, to the D+ terminal, 1, (brush assembly lead) and the other lead, in turn, to each of the field diode connections, 3.
2. Note the resistance reading shown. Reverse the ohmmeter leads and note the reading.
3. The ohmmeter should indicate continuity in one-half of the test and an open circuit in the other. If any one diode fails this test, the entire rectifier assembly must be replaced.



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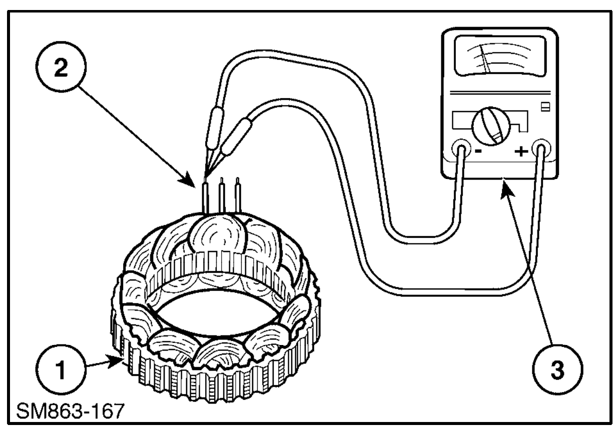
Stator Test - Winding Continuity

1. Connect ohmmeter, 3, leads between each of the three stator leads, 2, in turn. There should be a small resistance of approximately 0.2 ohms between each of the wires. A higher reading indicates a possible break in the winding. A reading of 0.0 ohms indicates a short circuit. If the readings are outside of specification, a new stator assembly, 1, will be required.



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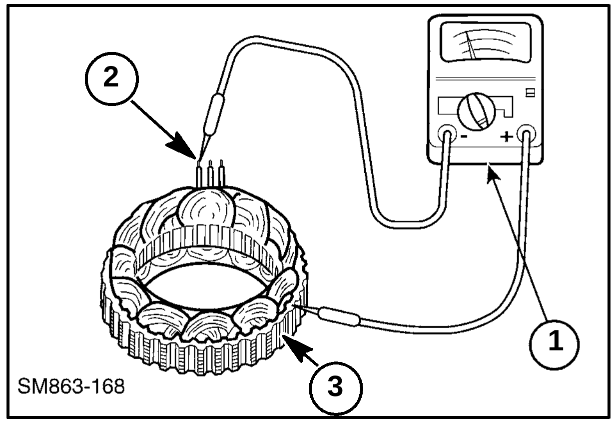
Stator Test - Insulation

1. Check the insulation of each winding to the stator casing by connecting ohmmeter, 1, leads between each of the stator wires, 2, and the stator casing, 3. There should be no continuity between the winding and the casing. If any ohmmeter reading other than open circuit is obtained, the stator assembly must be replaced.



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Rotor Tests

Prior to performing component tests on the rotor, inspect the slip rings. The slip rings should be clean and smooth. If dirty, they may be cleaned with a solvent-moistened cloth. If the slip rings are burned, they may be polished with a fine crocus cloth, then wiped clean.

The refinishing cloth must be fine enough to leave a highly-polished slip ring surface, otherwise excessive brush wear will occur.

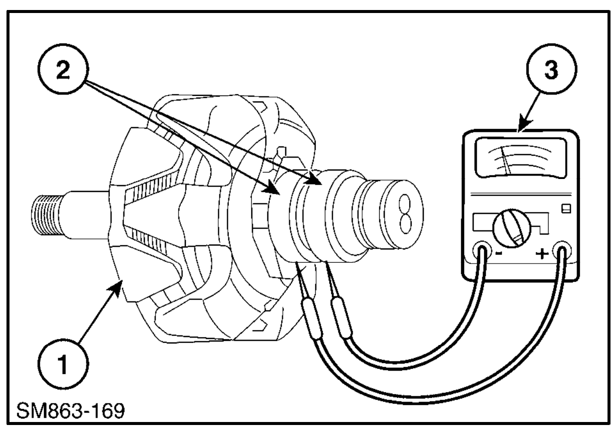
Do not use an emery cloth, as it will leave an abrasive residue, leading to premature brush failure.

If the slip rings are excessively worn, a new rotor must be installed.

Rotor Field Winding Continuity Test

1. Connect an ohmmeter, 3, between the slip rings, 2. The resistance should be 2.9 ± 0.5 ohms.

   If the resistance is outside of specification, replace rotor, 1.



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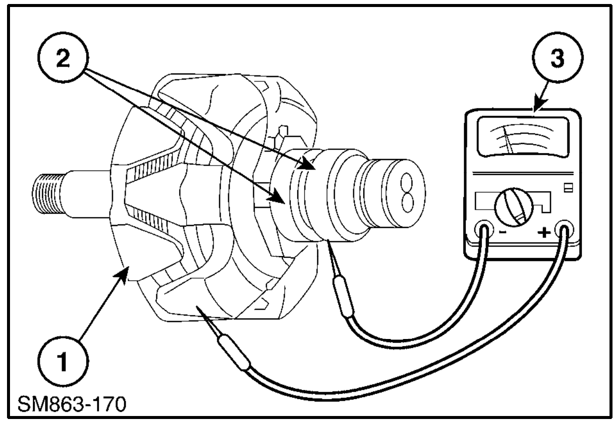
Rotor Field Winding Insulation Test

1. Using an ohmmeter, 3, test for continuity between each of the slip rings, 2, and the rotor poles, 1. Any reading other than open circuit indicates a short circuit within the rotor and it must be replaced.



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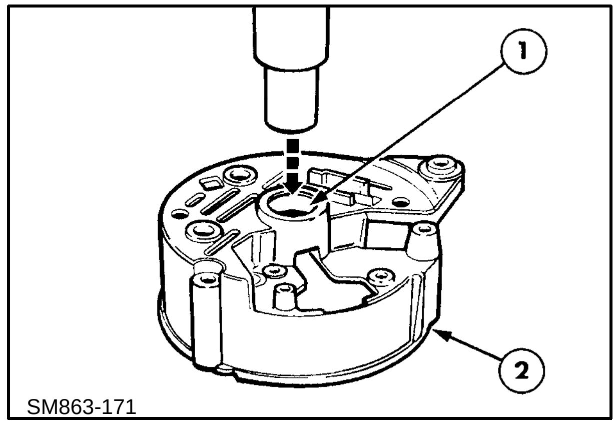
INSPECTION AND REPAIR

1. Inspect the rotor poles and stator for signs of rubbing. Areas of rubbing indicates possible worn bearings, misaligned housings or a bent rotor assembly shaft.

NOTE: *The front-end bearing is not serviced separately. It will be necessary to replace the front-end housing assembly if the bearing has failed.*

2. Inspect the roller bearing, 1, located in the rear end housing, 2.
3. If bearing replacement is necessary, support the housing and carefully drive out the bearing using a properly-sized mandrel.
4. Clean and examine all components.
5. Press the new bearing into the housing, 1. The bearing, 2, should be positioned 0.50 - 0.70 mm (0.020″ - 0.028″) above the inner face of the bearing boss, 3.



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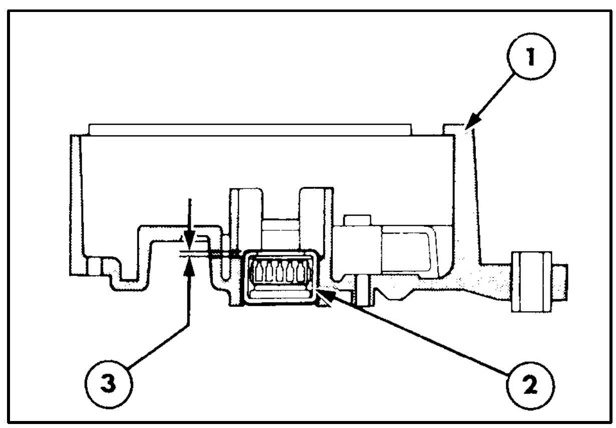

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REASSEMBLY

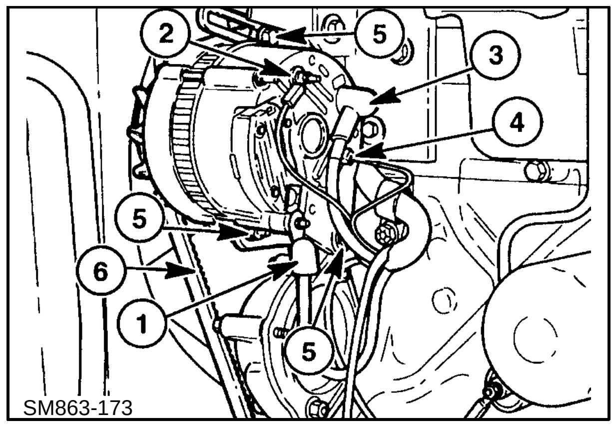
1. Reassembly of the alternator follows the disassembly process in reverse.

   On reassembly, observe the following precautions:

   - Use a low-wattage soldering iron and a heat sink when connecting the stator leads to the rectifier assembly to avoid damaging the diodes.
   - To avoid misalignment of the end brackets, install the stator assembly in the front-end bracket and then assemble the rear-end bracket to the stator assembly.

REINSTALLATION

1. Installation of the alternator is the reverse of the removal procedure.
2. Install the mounting bolts, nuts, and lock washers, 5. Install belt, 6.
3. Connect the RED/DKBL wiring lead, 3, to terminal B+ and PUR/RED wiring lead, 2, to terminal, W.
4. Reconnect BLK wiring lead, 1, and YEL/DKBL electrical connector to 4.
5. Reconnect the negative battery cable.



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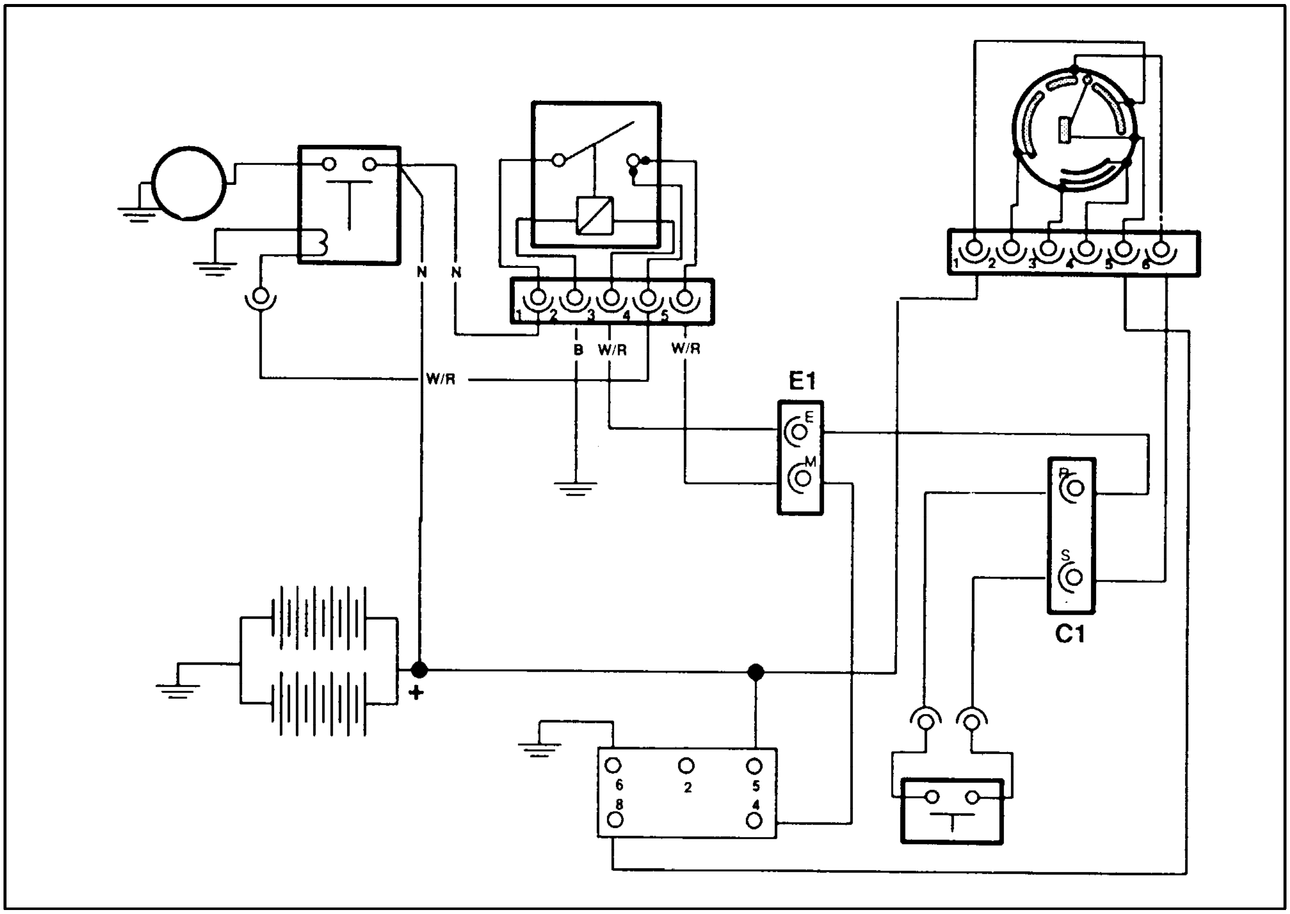

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Op. 55 201

STARTER

INTRODUCTION

The starting system consists of a starter motor and solenoid assembly, a starter relay, seat belt interlock system, battery, key start switch, and heavy-duty wiring.

The starter motor, rated at 3.1 Kw, is a four-pole, four-brush-type with integral solenoid and positive engagement drive assembly.

The integral solenoid incorporates two windings connected in parallel. One winding is the low resistance “pull-in” coil grounded through the motor, while the other is the high resistance “hold-in” coil grounded via the solenoid body.

When the key start switch is closed with the operator in the seat and the seat belt fastened, or with the “Service/Run” switch in the “Service” position, the solenoid coils are energized, pulling the solenoid plunger into the solenoid core. This action forces the drive pinion via pivoted linkage into mesh with the starter ring gear. On full engagement, the solenoid plunger closes a set of contacts to give a direct feed from the battery to all four field coils, providing full power to the starter motor.

The starter incorporates a single set of contacts and a two-piece solenoid plunger which completely closes the contacts, even if the pinion and ring gear teeth are misaligned. When this happens, an engagement spring is compressed, which forces the pinion into full engagement as soon as the starter begins to turn.

When the key start switch is released, power to the solenoid and motor is removed. The solenoid return spring, acting through the pivoted linkage, pulls the drive pinion out of mesh and opens the solenoid contacts.

Incorporated in the drive pinion assembly is an overrunning clutch, 8. This clutch prevents the armature from over-speeding if the pinion remains in mesh with the ring gear after the engine has started.

STARTER

General Specifications

Rated voltage	12 volts
Output	3.1 kw
Motor-type	Four-pole series wound
Engaging system	Solenoid engaged pinion
Rotation	Clockwise (when viewed from pinion)

Service Specifications

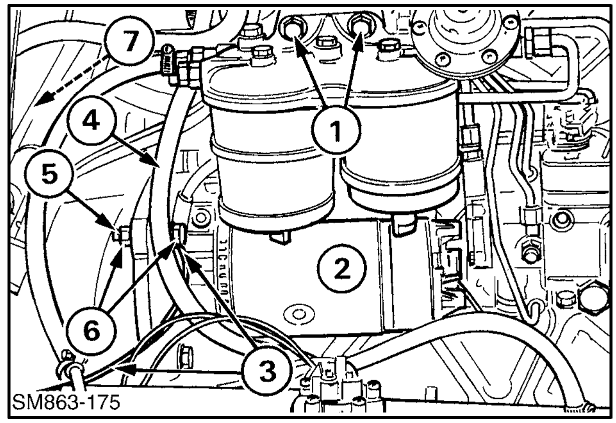
No load test	11.5 volts 170 amps 8000 RPM
Locked rotor test	6.8 volts 1200 - 1400 amps 35 N·m (26 ft. lbs.) torque
Solenoid holding voltage, min.	8.0 volts
Commutator dia.	45 mm (1.77 in.) - new 42.5 mm (1.67 in.) - min.
Commutator brush,	8.5 mm (0.33 in.) min. length

Armature end play	0.1 - 0.3 mm (0.004 - 0.012″)
Pinion tooth backlash	0.4 - 0.7 mm (0.016 - 0.028″)

STARTER MOTOR TROUBLESHOOTING

SYMPTOM	CAUSE	CORRECTION
Solenoid moves pinion to engage ring gear but starter fails to crank engine.	Battery is discharged.	Charge battery to minimum 1.225 specific gravity, or 12.5 open circuit volts.
	Poor connection at terminals.	Inspect, clean and tighten as necessary. Must have no more than 0.2 voltage drop between positive battery post and starter solenoid and between negative battery post and ground stud on starter.
	Defective starter.	Perform starter draw test. Replace or repair starter.
	Engine is seized.	Repair engine.
Solenoid does not move pinion into engagement with flywheel. Worklights remain bright.	Open in starter activation circuit:	Disconnect W/R wire at starter solenoid. Check for 12 volts with key switch in start position.
	Operator not in seat with seat belt buckled.	Sit in seat. Buckle seat belt. Retest.
	Blown 15 amp main key switch fuse or 5 amp ignition fuse.	Determine cause and replace fuse.
	Loose connection at key switch or defective key switch.	Correct or replace.
	Fault in seat belt interlock system.	Place “Service/Run” switch in Service position. Retest. If 12 volts, repair interlock system.
Pinion engages ring gear, starter motor turns but engine does not.	Defective overrunning clutch in starter drive.	Replace starter drive assembly.

STARTER MOTOR



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REMOVAL

1. Raise the boom, extend the boom lock pins, and rest the boom on the pins.
2. Open the engine compartment and remove the left side shield.
3. Disconnect the negative battery cable.
4. Remove the fuel filter/sedimenter assembly, 1, to provide access to the starter, 2.
5. Disconnect the throttle cable from the fuel injection pump and lay it, with the mounting bracket, out of the way.
6. Disconnect the heavy electrical cables from the upper post of the starter solenoid. Remove the solenoid signal wire (white/red) from the solenoid.
7. Remove the cap screw and nut, which serve as a main ground location, as well as retain the starter in place. Retain all of the ground wires on the cap screw and replace the nut. This will ensure all grounds are connected at reassembly.
8. Remove the remaining two cap screws holding the starter and rotate the starter to remove from the flywheel housing.

INSTALLATION

Starter installation is the reverse of the removal procedure, observing the following precautions:

1. Ensure the starter fits properly on the mounting flange before tightening any of the mounting cap screws.
2. Ensure all of the grounding wires removed in step 7 above are properly replaced with the heaviest gauge wires placed closest to the flywheel housing.
3. Check fuel lines for leaks after engine startup.

NOTE: *The ground strap, 3, ground strap to main frame, battery (-) negative ground cable, 4, and ground wire, 5, must all be connected to the engine bell housing at 6. Ground wire, 5, connects this ground connection to the main electrical ground stud at 7, at the front of the engine bell housing. If the ground wires are not properly connected, engine crankshaft and bearing damage may occur.*

STARTER MAINTENANCE

Little maintenance of the starter is required. No periodic lubrication of the sealed bearings or starter drive are required.

If the starter drive becomes sluggish or hangs up, due to dirt, it should be washed with diesel fuel. The fuel will not wash away the lubricant in the bushings and will lubricate the starter drive.

The starter brushes should be inspected whenever the starter is removed, after extended use and whenever a problem with the starter is suspected.

Ensure the brushes are free to slide freely in their holder. If dirty, wash with a suitable solvent, drying with a clean, lint-free cloth and dry compressed air. If binding, smooth with a fine abrasive or fine file. Clean all residue before installation.

Replace a brush if it is broken, if the soldered pigtail has loosened, or if it is worn below 8.5 mm (11/32″). Ensure new brushes do not bind in the holder. The commutator should be turned whenever new brushes are installed.

SYSTEM TESTING

For easier and rapid diagnosis, and for most conclusive test results, it is recommended that a battery/starter tester (high rate discharge tester) incorporating a 0-20 volt voltmeter and a 0-500 amp ammeter be used to diagnose starting system problems.

When using test equipment, follow the manufacturer's recommended test procedures. If the recommended test equipment is not available, the following test procedure (using a standard 0-20 volt voltmeter and a 0-500 amp ammeter) can be used to determine if the starter is operating correctly without removing it from the engine.

Before testing:

1. Ensure that the battery is fully charged.
2. Check the complete starting system wiring circuit for frayed or broken wires. Also check for loose or corroded terminal connections.
3. Ensure the engine is not seized.

NOTE: *Starter motor draw is directly dependent on the load placed on it. The above specifications are based on moderate ambient temperatures and a cold motor. Extremely high or low temperatures will affect the load placed on the starter motor, thus the amperage draw reading. Likewise, cold temperatures particularly will affect battery voltage readings.*

NOTE: *Before performing these tests ensure the hydrostats are in neutral. If the starter motor is required to pump oil in the hydrostat system, the amperage draw will be excessively high, even with a good starter motor.*

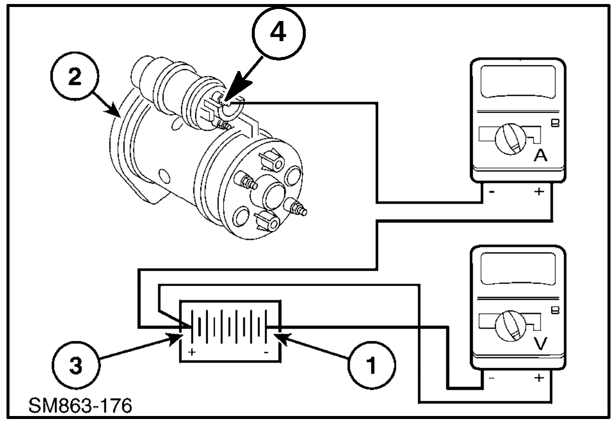
STARTER MOTOR CURRENT DRAW

1. Disconnect the ground (negative) cable, 1, from the battery.
2. Disconnect the battery positive cable from the starter solenoid, 2. Connect the ammeter positive lead to the battery positive terminal, 3, and the negative lead to the solenoid input terminal, 4.
3. Reconnect the battery negative cable to the battery negative terminal.
4. Connect the voltmeter positive lead to the battery positive terminal, 3, and the voltmeter negative lead to the battery negative terminal, 1.
5. Disconnect the wire from the fuel injection pump shut-off solenoid.
6. Crank the engine while observing the voltmeter and ammeter readings. The voltage should remain above 10 volts with 325-375 amps draw.

   If the voltage and current draw are within specification, the starter motor is functioning correctly. If the voltage drops below 10 volts during the test, proceed to "Starting Circuit Resistance Test."

   If the current draw is greater than specified, perform the starting circuit resistance test. If the starting circuit passes the tests, the starter motor is defective and must be repaired or replaced.

   If the current draw is less than specified, the starter motor is defective and must repaired or replaced.



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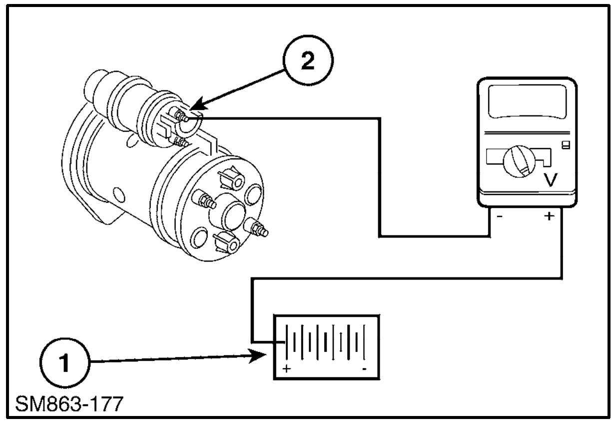
Starting System Circuit Resistance (Voltage Drop) Test

If there is an excessive current draw, the circuit should be checked by determining voltage drop across the individual components in the circuit.

IMPORTANT: *Disconnect the fuel injection pump fuel shut-off solenoid wire.*

Battery Positive Cable Test

1. Connect the voltmeter positive lead to the battery positive terminal, 1, (not the cable clamp).
2. Connect the voltmeter negative lead to the starter solenoid battery terminal, 2, (not the cable end).
3. Crank the engine while observing the voltmeter reading. If the reading exceeds 0.2 volts, check, clean and tighten the cable connections. Retest. If voltage drop is still excessive, install a new cable.



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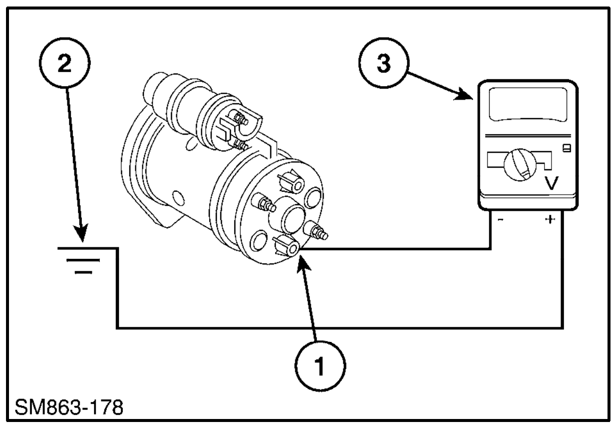
Starter Motor Ground Connection Test

1. Connect the voltmeter to the starter motor frame, 1.
2. Connect the voltmeter negative lead to the engine block, 2. Ensure that the meter lead is not insulated from the block by paint.
3. Crank the engine while observing the voltmeter reading. If the reading exceeds 0.2 volts, check the ground connections between the starter motor flange and the rear engine plate.



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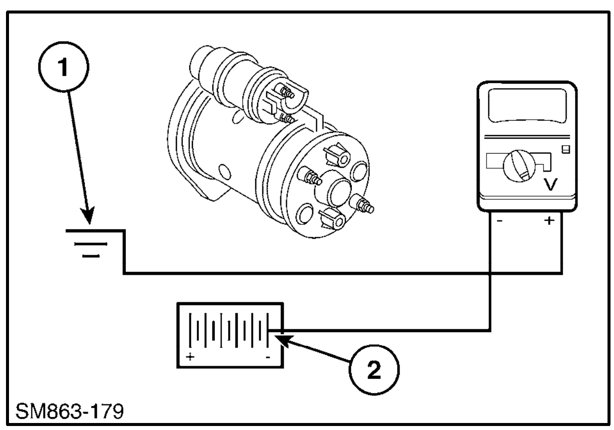
Battery Ground Cable Test

1. Connect the voltmeter positive lead to the engine block, 1.
2. Connect the voltmeter negative lead to the battery negative terminal, 2.
3. Crank the engine while observing the voltmeter reading. If the reading exceeds 0.2 volts, check, clean and tighten the ground cable connections. Retest. If voltage drop is still excessive, install a new ground cable.



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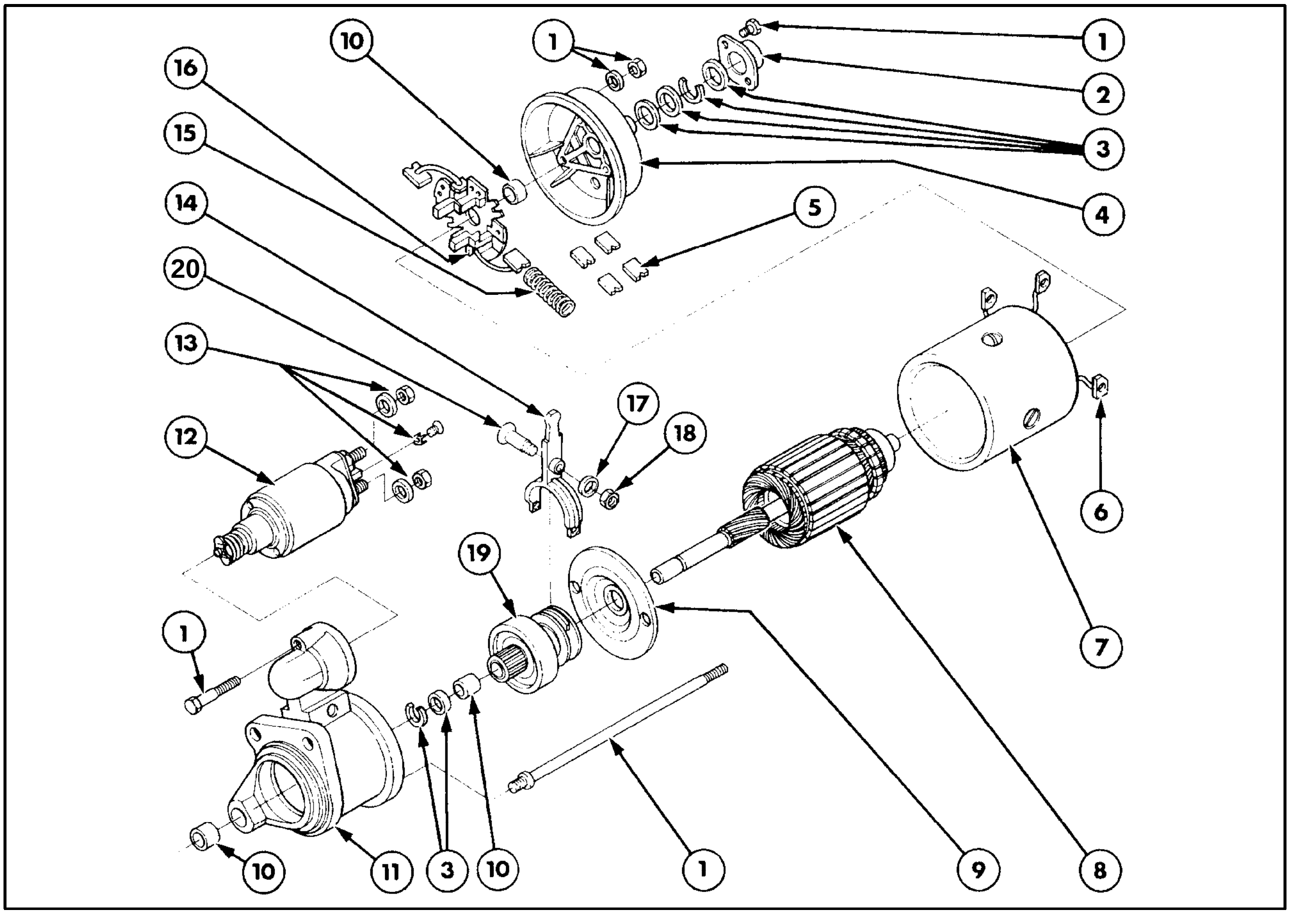

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Starter Motor - Exploded View

1. Stud and Bolt Kit
2. End Cap
3. Collar and Ring Assembly, Drive Thrust
4. Brush End Plate Assembly
5. Brush Assembly
6. Brush Assembly
7. Field Coils and Housing Assembly
8. Armature
9. Center Bearing Plate
10. Bushing
11. Housing Assembly
12. Solenoid Assembly
13. Solenoid Hardware Kit
14. Lever Assembly
15. Brush Spring
16. Brush Holder Assembly
17. Washer
18. Nut
19. Drive Assembly
20. Pivot Pin

DISASSEMBLY

1. Support the starter motor in a soft jaw vise.
2. Disconnect the thick braided wire from the field coil housing to the solenoid assembly.
3. Remove the three screws from the front housing assembly, 11, and withdraw the solenoid assembly, 12. The plunger will remain in the drive engagement lever, 14.
4. Remove the solenoid plunger from the drive engagement lever by gripping the plunger and lifting up the front end and releasing it from the drive engagement lever.
5. Remove the two end housing nuts and the two screws retaining the end cap, 2, and brush plate to the end housing, 4. Remove the “C” clip and armature shaft end play shims, 3, and withdraw the end housing, leaving the brush gear, 16, on the commutator. Remove the thin metal washer from the commutator end of the armature.

NOTE: *At this point, inspect the brushes and commutator as detailed under “Inspection and Repair Bench Test” and determine if these are the cause of failure.*

6. To remove the brush carrier and brushes, compress the brush springs by inserting a small screwdriver through the spring coil and bend back the spring retaining tabs. Gently release the spring and remove the brush from the holder. With the four brushes removed, remove the carrier.

7. Remove the armature and drive end bracket from the motor housing assembly.

8. Remove the drive engagement lever pivot pin, 20, from the drive end housing.

9. Remove the drive assembly, 19, and inner plate retaining snap ring, 3, from the armature shaft by driving the securing thrust collar squarely off the snap ring with a suitable diameter tube and then levering the snap ring from the groove.

10. Remove the armature and drive assembly.

REASSEMBLY

Reassembly of the starter follows the disassembly procedure in reverse.

After completing reassembly and prior to installation in the engine, check the armature end play to specification and test the starter no load operation.

Checking Armature End Play

1. Support the starter motor in a soft jaw vise. Attach a dial indicator to the drive end housing flange. Place the dial indicator pointer on the end of the armature shaft.

2. Lever the armature fully forward and zero the dial indicator. Lever the armature fully rearward and record the indicator reading.

3. The indicator reading should not exceed 0.3 mm (0.012″). If the reading is greater, inspect the armature assembly for wear. Replace worn components as required and recheck the end play.

INSPECTION AND REPAIR - BENCH TEST

Brush Assembly

1. Check for sticking brushes. If necessary, clean brushes and brush guides with a solvent-moistened cloth. Remove any burrs on the brushes with a fine abrasive or a fine file.

2. Check brushes for wear. If worn below the minimum length specified of 8.5 mm (0.33″), they should be replaced. The commutator should be turned whenever new brushes are installed.

Brush Removal and Installation

1. Unsolder the field brush leads from the field coils.

2. Unsolder the ground brush leads from the brush holders.

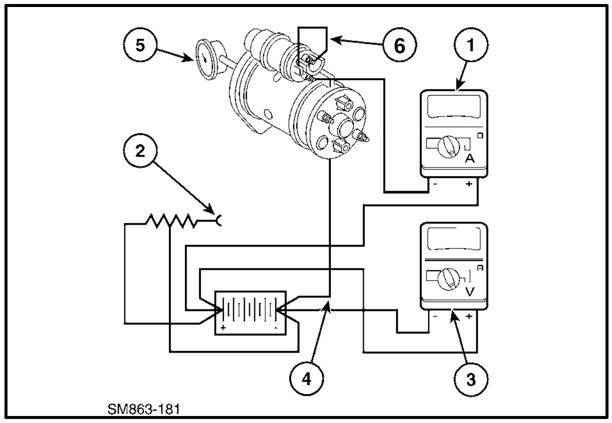
3. Install the new brushes, soldering the leads using a 300-watt soldering iron and resin core solder.

4. Ensure the new brushes move freely in the holders. If necessary, smooth the sides of the brushes with a fine abrasive or fine file.

Starter Motor No-Load Test

NOTE: *A fully-charged battery and a battery/starter tester (high rate discharge tester) with a carbon pile (variable load resistor) should be used to perform this test.*

1. Support the starter motor in a soft jaw vise.
2. Connect the battery negative cable to the starter motor mounting flange, 4.
3. Connect a short jumper wire between the solenoid battery and solenoid switch terminals, 6.
4. Connect a voltmeter positive lead to the battery positive terminal and the voltmeter negative lead to the battery negative terminal, 3. Connect the ammeter positive lead to the battery positive terminal and the ammeter negative lead to the solenoid battery terminal, 1.
5. Hold a hand tachometer, 5, on the end of the armature shaft. Adjust the carbon pile, 2, to actuate the starter motor until a reading of 11.5 volts is obtained. The armature speed should be between 7500 and 8500 RPM. Maximum current draw should not exceed 170 amps.
6. If the starter motor does not perform to specification, check for grounded field coils, a rubbing armature, or a distorted armature shaft.



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Armature Tests

1. The commutator should be clean and free from burned spots. If necessary, remove any burned spots using fine glass paper, not emery cloth. Finally, clean the commutator with a solvent-moistened cloth.
2. If it is necessary to skim the commutator, ensure the diameter is not reduced below the minimum specified diameter of 42.5 mm (1.67″). Following skimming, the commutator should be polished with a fine glass paper and then wiped clean with a solvent-moistened cloth.

NOTE: *Do not cut into the commutator metal when recutting insulation slots.*

3. Armature insulation can be checked by connecting an ohmmeter between the commutator segments and the armature shaft, 1. There should be an infinity reading, i.e. no continuity.

4. To test the armature for short circuits, it is necessary to use a “growler” test instrument. Alternatively, it may be tested by substitution.

5. If there is evidence that armature core segments have contacted the field pole shoes, then the armature bearings are worn or the armature is warped. First, check to see the pole shoes are tight and that the armature runs true in a lathe. If necessary, replace the armature bearings.

LABOR GUIDE

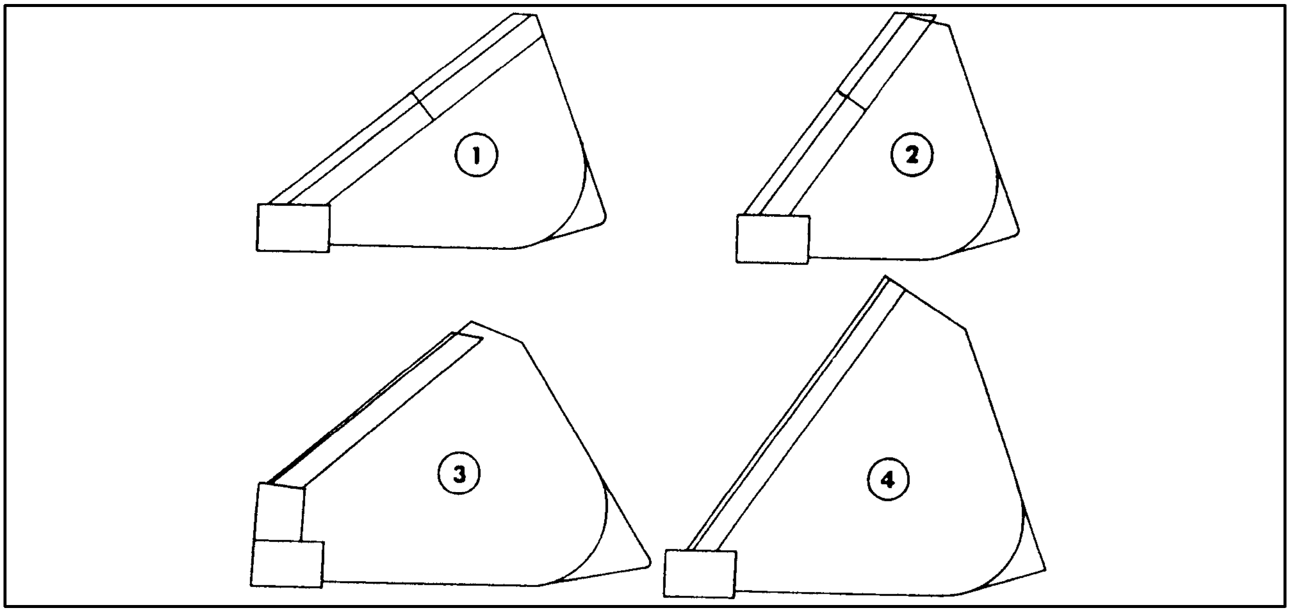
The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
Air filter sensor, remove and replace	0.5 hr.
Alternator, remove and replace	0.5 hr.
Battery, remove and replace	0.25 hr.
Cold advance switch, remove and replace	0.25 hr.
Electronic instrument cluster	0.25 hr.
Engine coolant sensor, remove and replace	0.25 hr.
Engine oil pressure sender, remove and replace	0.25 hr.
Fuel level sender, remove and replace	0.5 hr.
Fuel shutoff solenoid, remove and replace	0.25 hr.
Hydraulic oil temperature sensor, remove and replace	2.0 hrs.
Hydraulic oil filter sensor, remove and replace	0.5 hr.
Hydrostatic charge pressure sensor, remove and replace	0.5 hr.
Ignition (key) switch, remove and replace	0.25 hr.
Light (road/work) switch, remove and replace	0.25 hr.
Preheat manual switch, remove and replace	0.5 hr.
Preheat circuit breaker, remove and replace	0.5 hr.
Preheat relay, remove and replace	0.5 hr.
Resistor, alternator charge circuit, remove and replace	0.5 hr.
Road/work/taillight bulb, remove and replace	0.25 hr.
Road/work lights, remove and replace switch	0.5 hr.
Road/work lights, remove and replace lamp bulb or lamp assembly (1)	0.25 hr.
Road/work lights, remove and replace front lamp pod	0.5 hr.
Road/work lights, remove and replace rear lamp bar	1.0 hr.
Road/work lights, remove and replace wire harness	2.0 hr.
Seat belt (buckle) switch, remove and replace	0.25 hr.
Seat switch(es), remove and replace	0.5 hr.
Service/run switch, remove and replace	0.5 hr.
Solenoid, control valve spool locks, remove and replace	0.5 hr.
Start interlock relay, remove and replace	0.5 hr.
Starter, remove and replace	1.0 hr.
Starter relay, remove and replace	0.5 hr.
Wire harness (main), remove and replace	6.0 hrs.
Wire harness (engine), remove and replace	1.5 hrs.
Wire harness (seat/seat belt), remove and replace	1.0 hr.

SECTION 82 – FRONT LOADER (BOOM AND MOUNTING PLATE)

Chapter 1 – Buckets

CONTENTS



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Op. 82 100

GENERAL INFORMATION

BUCKETS

Bucket Types
1 - LP - Low profile

The low-profile bucket has a shorter back and is longer from bucket heel to cutting edge for optimum cutting edge visibility. This is important for finish grading and accurate cut and fill jobs.

2 - D & F - Dirt and foundry

The dirt and foundry bucket is shorter from bucket heel to cutting edge to provide maximum breakout force for tough digging conditions.

3 - M & F - Manure and fertilizer (slurry)

The manure and slurry bucket is for handling loose or fluid materials with more rollback to minimize spillage.

4 - LM - Light material

The light-material bucket is for light, high- volume materials for more productivity handling light material.

Select bucket styles and sizes to provide both adequate breakout force and reasonable carrying capacity. Handle dense materials with a relatively small bucket. Handle lighter materials with higher capacity buckets. Refer to the following bucket capacity chart and the material weight chart in the operator’s manual when choosing the bucket for a job.

Bucket Capacity Cubic Feet

Bucket Width	Bucket	Capacity Heaped (cu ft)	Capacity Struck (cu ft)
66″	Utility fork	N/A	N/A
66″	Low profile	15.5	11.2
66″	Dirt and foundry	15.2	11.6
72″	Low profile	17.1	12.2
72″	Dirt and foundry	16.7	12.7
72″	Manure and fertilizer	19.1	15.5
72″	Light material	23.7	19.0
84″	Low profile	20.2	14.3
84″	Manure and fertilizer	22.5	18.2
84″	Light material	27.9	22.3

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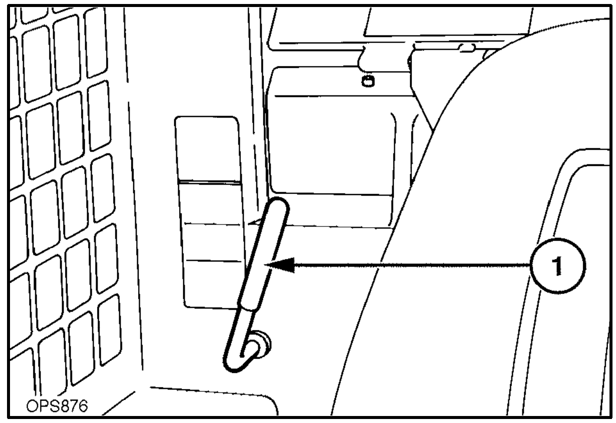
BOOM LOCK PINS AND LINKAGE

The operator can engage the boom lock pins from the operator's seat. The control is located to the right rear of the operator's seat at 1. Pivoting the handle towards the outside of the cab extends and engages the lock pins. Pivoting the handle in will retract the lock pins.



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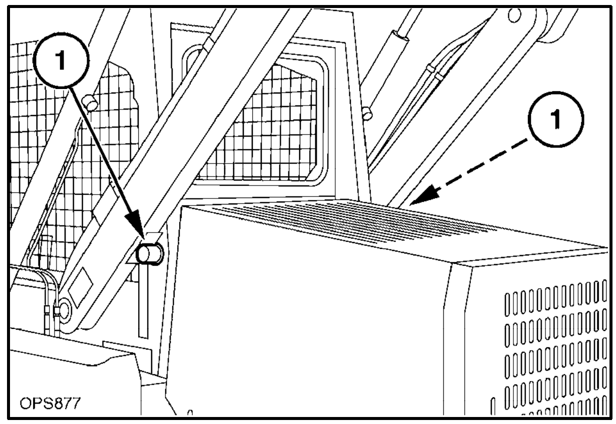
To engage the boom lock pins:

1. Raise the boom above the boom lock pins and engage the pins, 1.
2. Turn the ignition key to the "**OFF**" position to stop the engine.
3. Turn the ignition key to the "**ON**" position and operate the boom and bucket pedals to lower the boom onto the lock pins and to relieve the pressure in the boom and bucket circuits. Turn the ignition key to the "**OFF**" position.



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CAUTION

Never work under a raised boom unless the boom is resting on the boom lock pins, 1.

Never work under a raised boom with an attachment, always remove any attachment from the loader mounting plate.

BOOM

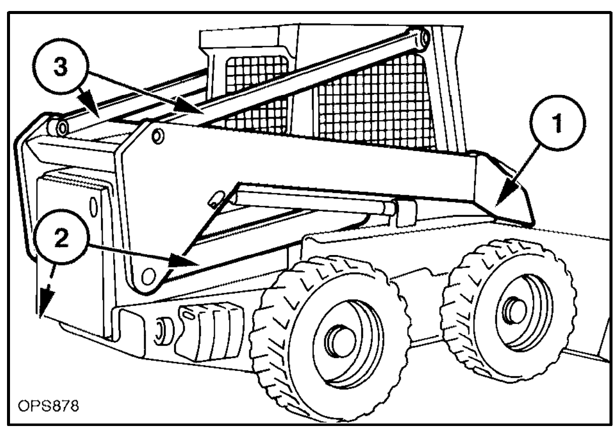
The boom assembly consists of:

Op. 82 100 50
1 - Main boom frame

Op. 82 100 52
2 - Lower link, right and left

Op. 82 100 53
3 - Upper link, right and left

The boom and links are supported on the ROPS main frame with tapered pivot pins at all pivot locations.



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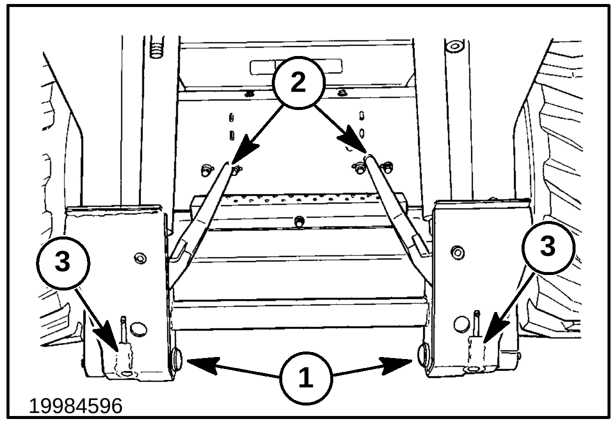
Op. 82 100 70

ATTACHMENT MOUNTING PLATE

The mounting plate is attached to the main boom frame with two tapered pivot pins at 1. The attachments used on the skid steer can be easily attached or removed from the loader with the over center levers, 2, and pins, 3. The control levers and pins are spring loaded to hold the levers over center when unlatched to assist in changing attachments. When the control levers are in the latched position the spring-loaded pins are forced into the latch points on the attachment. The control levers and pins are shown in the unlatched position.



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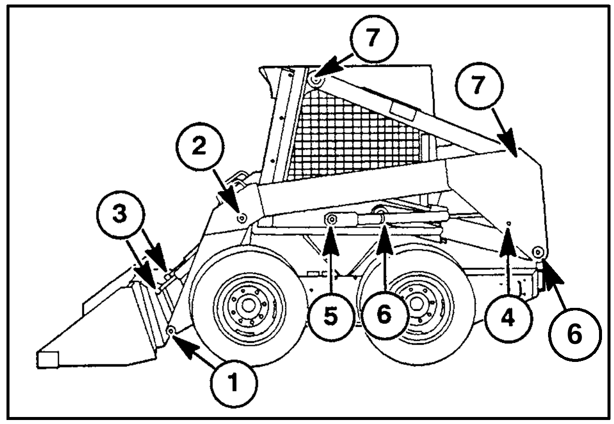
BOOM AND CYLINDER PIVOT PINS

When the boom, upper and lower boom links and cylinders are removed, the following figures and charts may be use for proper pin placement. The following charts and figures list the pivot pin, part number, location, and size for identification and locations.



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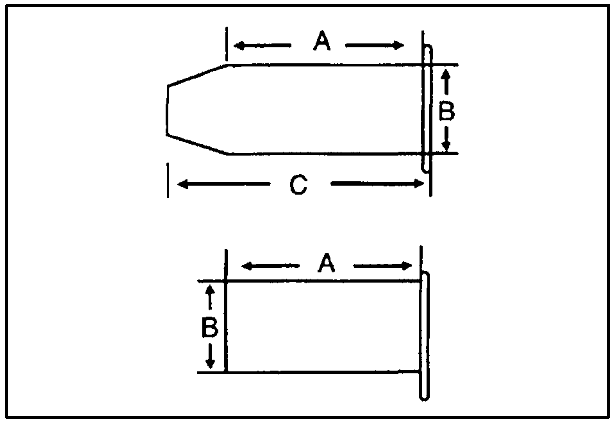
BOOM AND CYLINDER PIVOT PIN LOCATION AND MACHINE USAGE

Ref.	Description	Part Number	Qty.	Torque
1	Mounting Plate Pivot	86501434	2	80 ft. lbs. (108 N·m)
2	Upper Bucket Cyl. Pivot	86501432	2	80 ft. lbs. (108 N·m)
3	Lower Bucket Cyl. Pivot	9614349	2	28 ft. lbs. (38 N·m)
4	Upper Boom Cyl. Pivot	86521982	2	28 ft. lbs. (38 N·m)
5	Lower Boom Cyl. Pivot	86501428	2	250 ft. lbs. (338 N·m)
6	Boom Lower Link Pivot	86501424	4	250 ft. lbs. (338 N·m)
7	Boom Upper Link Pivot	86501426	4	250 ft. lbs. (338 N·m)

BOOM/CYLINDER PIVOT PINS SIZE



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Part Number	A	B	C
9614349	(95mm) 3-3/4″	(38mm)-1-1/2″	
86501424	(92mm)-3-5/8″	(60.3mm)-2-3/8″	(156mm)-6-9/64″
86501426	(62.5mm)-2-15/32″	(60.3mm)-2-3/8″	(126.5mm)-5″
86501428	(59mm)-2-21/64″	(60.3mm)-2-3/8″	(126.5mm)-5″
86501432	(78.3mm)-3-5/64″	(38.10mm)-1-1/2″	(118.5mm)-4-43/64″
86501434	(57.8mm)-2-9/32″	(38.10mm)-1-1/2″	(92mm)-3-5/8″
86521982	(117mm)-4-39/64″	(38.1mm)-1-1/2″	

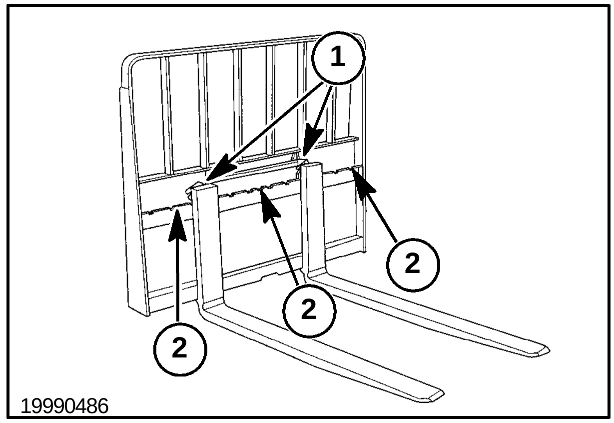
NOTE: *After the tapered pivot pin retaining hardware is torqued, the pins must be properly seated. Using a hammer, strike the head of the bolt and pin several times to seat the tapered pin the taper of the boom and/or ROPS. Retorque the hardware to the specified torque. Repeat this process until the torque is maintained.*

Op. 82 100 30

PALLET FORK

Pallet fork frame/guard, 36″ - 42″ - 48″ fork sets are available. A block fork set is also available.

To adjust fork spacing, raise the lock pin, 1, and slide the fork to the required spacing and relatch lock pins into notches, 2.



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Pallet Fork Capacity - LS180

WITH WEIGHT KIT	
Max. Reach Height	**SAE Rating**
2794 mm (110″)	804 kg (1773 lbs.)
WITHOUT WEIGHT KIT	
Max. Reach Height	**SAE Rating**
2794 mm (110 ″)	757 kg (1670 lbs.)

Pallet Fork Capacity - LS190

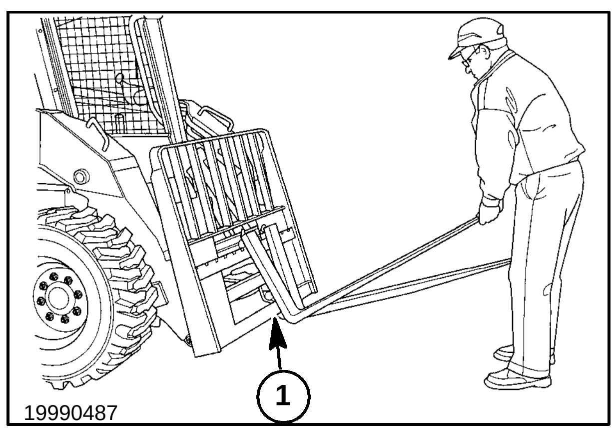
WITH WEIGHT KIT	
Max. Reach Height	**SAE Rating**
2794 mm (110″)	899 kg (1980 lbs.)
WITHOUT WEIGHT KIT	
Max. Reach Height	**SAE Rating**
2794 mm (110 ″)	830 kg (1830 lbs.)

Capacities rated, full fluids, 79 kg (175 lbs.) operator, 1219 mm (48″) pallet forks w/back guard, per SAE rating specification J1197.

To install or remove the forks from the frame, slide the forks to the center of frame at, 1, and pick the end of fork up to remove fork from frame.

CAUTION

Do not use a pallet fork attachment unless the back guard is in good condition and properly installed on the attachment frame.



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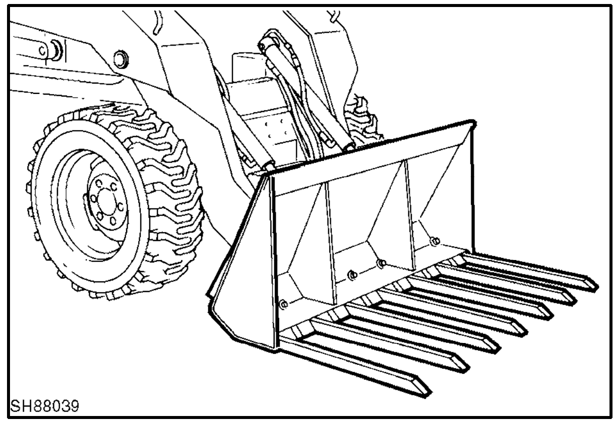
Op. 82 100 20

UTILITY FORK

The utility fork is for handling matted, stringy material which is difficult to load into a standard bucket.



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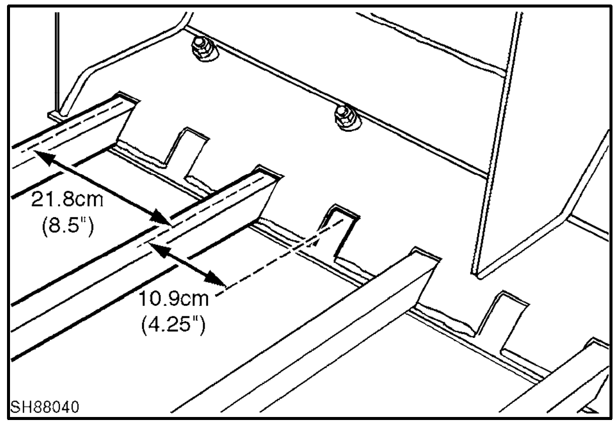
The standard tine spacing, center to center, is 21.8 cm (8-1/2″). The fork frame is equipped with additional holes for additional tines, reducing the tine spacing to 10.9 cm (4-1/4″).



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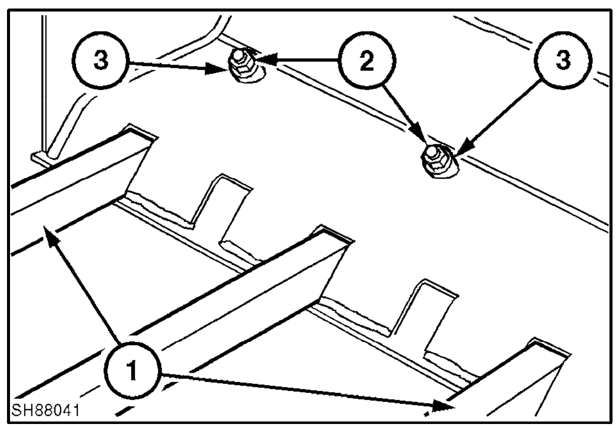
Op. 82 100 11

Tine Installation

1. Slide each tine, 1, into the fork backplate for the desired tine spacing, until the 1/2″ x 2-3/4″ bolt, 2, can be inserted through the fork backplate and tine with the nut to the inside of the fork backplate.
2. Position the spacer, 3, as shown with the angle end of the spacer next to the floor of the backplate. Secure the assembly with 1/2″ lock washer and nut. Tighten securely.



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BUCKETS

Op. 82 100 12

CUTTING EDGE (REPLACEMENT)

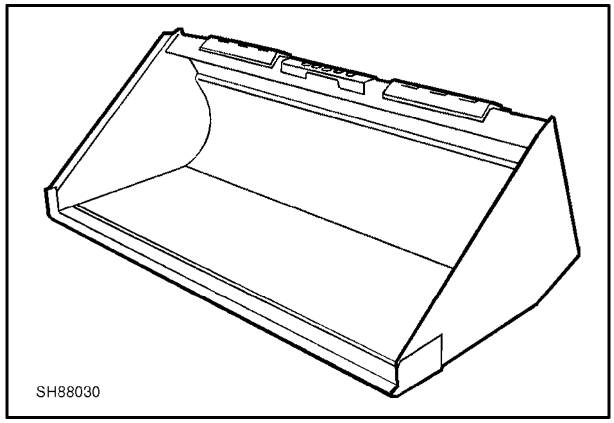
Cut or grind the old cutting edge from the bucket floor and sides. Remove all old weld and foreign material from the welding area.

1. Straighten the bucket floor and sides if required.
2. Thoroughly clean the area where the new cutting edge will be welded.
3. Use dry AWS-E7018 low hydrogen electrodes or either of the following equivalent low hydrogen wire feed electrodes: Gas metal arc welding (CO_2 or argon CO_2) AWS-E70S6 or flux cored arc welding AWS-E70T1.
4. Preheat the parts to be welded (both tack and final welds) to a minimum of 400°F (204°C). **The preheat temperature must be throughout the entire thickness of the parts joined, and at least 51 mm (2″) back from the joint.** Maintain preheat throughout the entire welding operation.

NOTE: *This is a hardened steel edge. If not preheated, the cutting edge may later crack during use.*

5. Tack weld the preheated parts starting at the center of the bucket and working toward the outside ends.
6. Finish welding the preheated parts starting at the center of the front edge of the bucket floor and working toward the outside ends. Repeat this operation at the back side of the cutting edge to bucket floor.
7. Do not remove the bucket from the welding environment until the weld and metal temperature drops to the ambient temperature. **Do not force the cooling rate of the welds and material.**

Follow the same welding procedure for welding the side cutting edges and bottom wear plates to the bucket.



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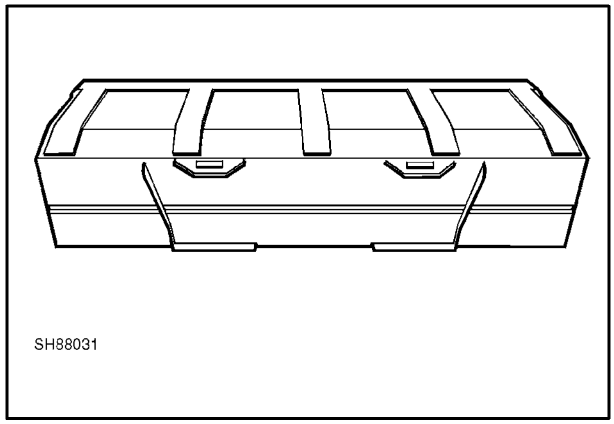

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Op. 82 100

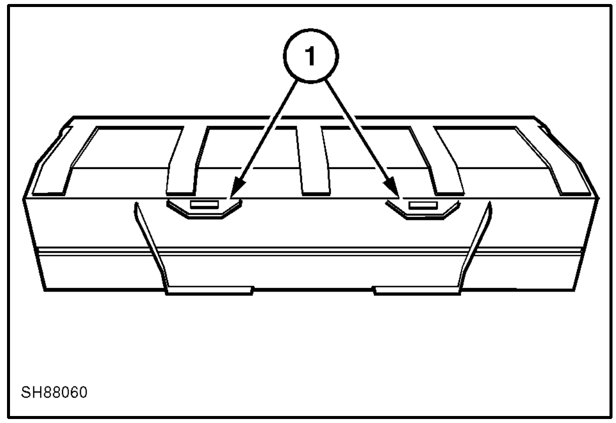
BUCKET LATCH PLATE INSTALLATION PROCEDURE

1. Remove the bucket from the loader before welding to prevent damage to the loader electrical system.

Material to be welded is low carbon, grade 50 steel; use welding rods marked 6011 or comparable.

CAUTION

Good quality welds are necessary for new plates to be properly retained. Use a professional welder if required.



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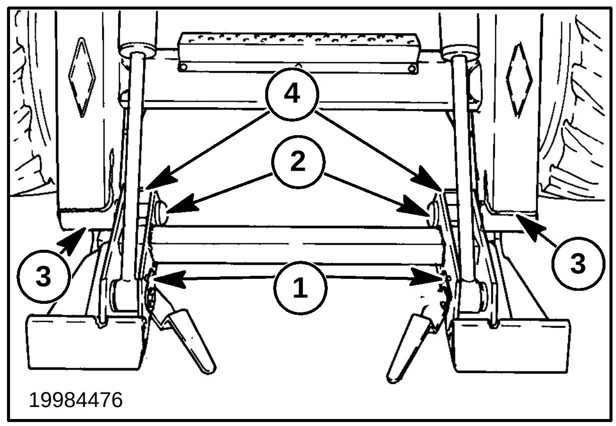
2. Turn the bucket over and support it about 305 mm (12″) off the floor.
3. Cut the old lower retaining plates, 1, off the bucket and grind the area flat.
4. For locating the new lower attaching plates, remove the quick-attach plate from the loader boom:
   - Remove the cylinder pivot pin retaining hardware, 1, and remove the pins.
   - Remove the hub caps, 2, from the plate pivots.
   - Loosen the quick-attach plate pivot pin hardware, 3.
   - With a soft-faced sledge hammer strike the mounting plate pivot area at 4. This will free up the tapered pivot pin in the boom link.
   - Remove the pivot pin hardware and pins.



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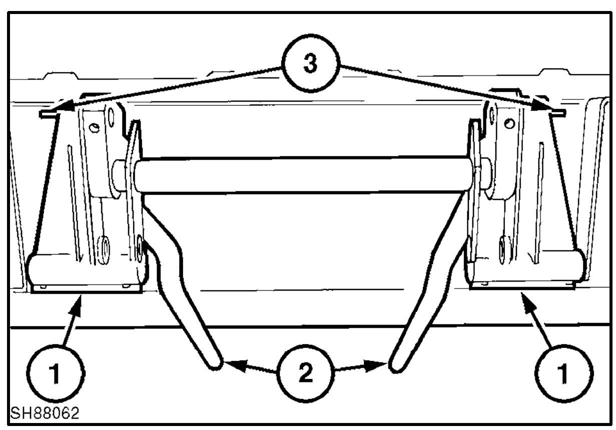
5. Rest the attaching plate in the saddle area, 1, of the bucket with the latch handles in the unlatched position as shown at 2. Put two 152 mm (6″) long pieces of 4.8 mm (3/16″) square key stock at 3, to position the attaching plate properly against the back of the bucket.



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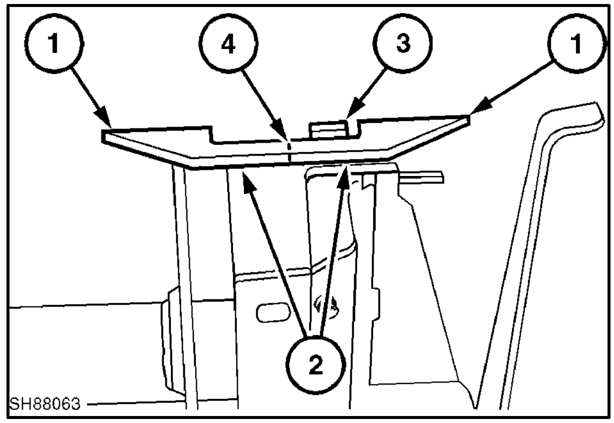
6. Position the first plates against the back of the bucket at 1, and rest on the quick-attach plate, 2. Locate the center of the latch plate notches, 4, and center the outer half of the notch over the latch pin, 3. Spot weld the plate to the bucket at 1 to hold the plate in position.

NOTE: *The material to be welded is low carbon, grade 50 steel; use welding rods marked 6011 or comparable.*



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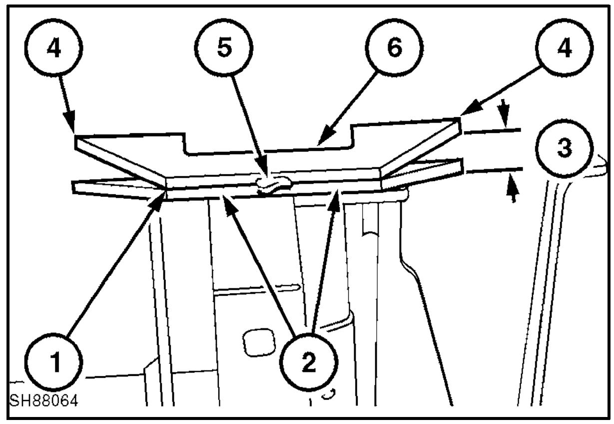
7. Position the second plates as shown at 1, with the plates contacting each other at 2, and about 28.6 mm (1-1/8″) spacing at 3. On low-profile buckets, the second plate will be at the rear corner of the bucket at 4. Spot weld the second plate to the bucket at 4 and the two plates together at 5.
8. Remove the 4.8 mm (3/16″) square key stock and push the latch handles to the latched position making sure the latch pins engage the bucket latch plates. The latch handles must fully latch. The latch pin will only contact the top latch plate, 6.



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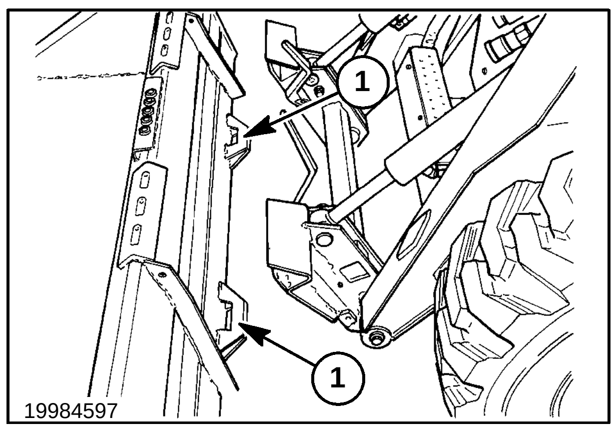
9. If the latch handles will not fully latch, the top plate may require some grinding in the pin area at 1, or the plates are not located properly.



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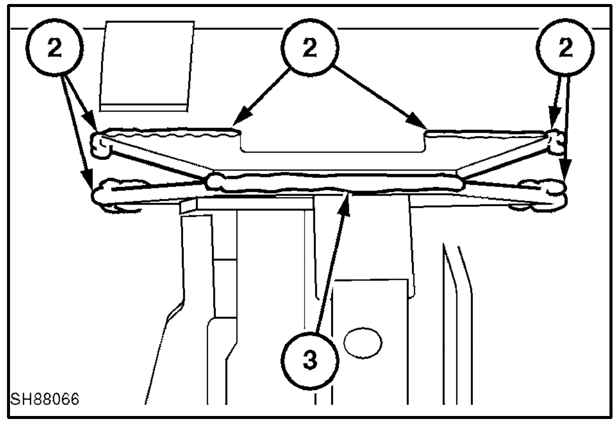
10. Weld the plates to the bucket at 2; also weld the two plates at 3.
11. Reinstall the bucket quick-attach plate to the loader boom with the pins previously removed.



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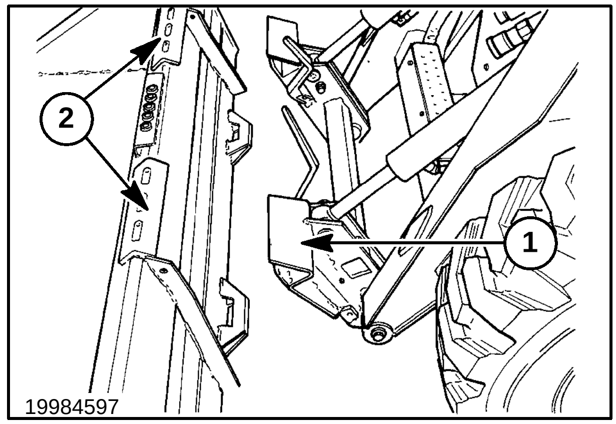
12. Attach the bucket to the loader by engaging the top of the plate, 1, under the lip of the bucket at 2. Curl the bucket back to allow the bucket to contact the loader quick-attach plate and engage the latch handles and pins, making sure the latch pins engage the bucket plates properly.



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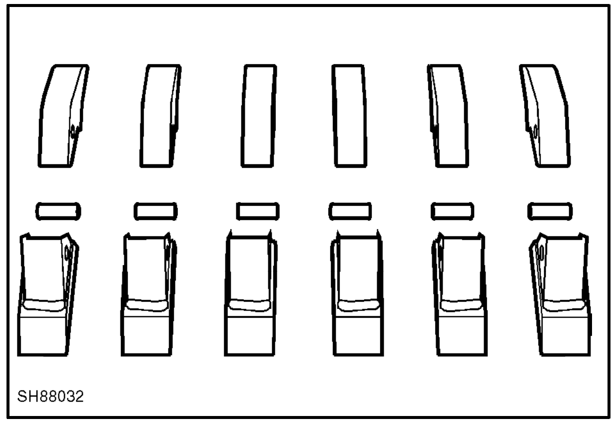
Op. 82 100

DIRT TOOTH KIT INSTALLATION

Bucket Dirt Tooth Kit

The dirt tooth kit consists of six teeth that are welded to the bucket cutting edge as indicated at 1. The teeth are used to break up the material when rough digging conditions are experienced. This will make it easier to fill the bucket. The teeth are intended to be used only on dirt and foundry or low-profile buckets.



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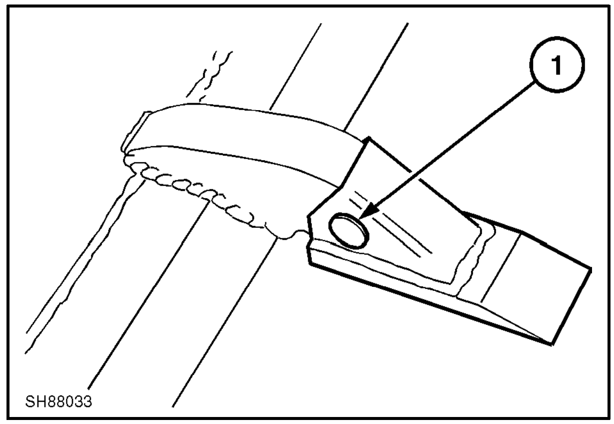
Op. 82 100 10

Tooth Point Replacement

The points of the teeth are a replaceable “pin-on” design and can be obtained from Parts.

To replace the “pin-on” points, use a punch that just fits into the pin hole, 1, and drive the old retaining pin from the shank.

Place the new point over the shank and insert the retaining pin into pin hole, 1. With a punch that contacts both sides of the metal part of the retaining pin, drive the pin until it is centered in the shank.



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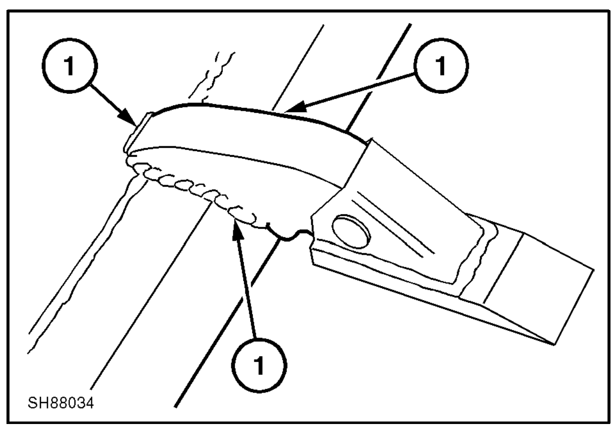
NOTE: *If the punch or driver is too small and just contacts the rubber center of the retaining pin, the pin will be damaged and will not retain the point.*

Tooth Location and Installation

1. The bucket should be flat on the floor when placing and welding the teeth to maintain good weld points, 1.

IMPORTANT: *Remove the bucket from the loader while welding teeth to prevent damage to the loader electrical system.*

Slide the replaceable points in place but do not attach with the steel/rubber pins as the rubber may be damaged during the welding process.



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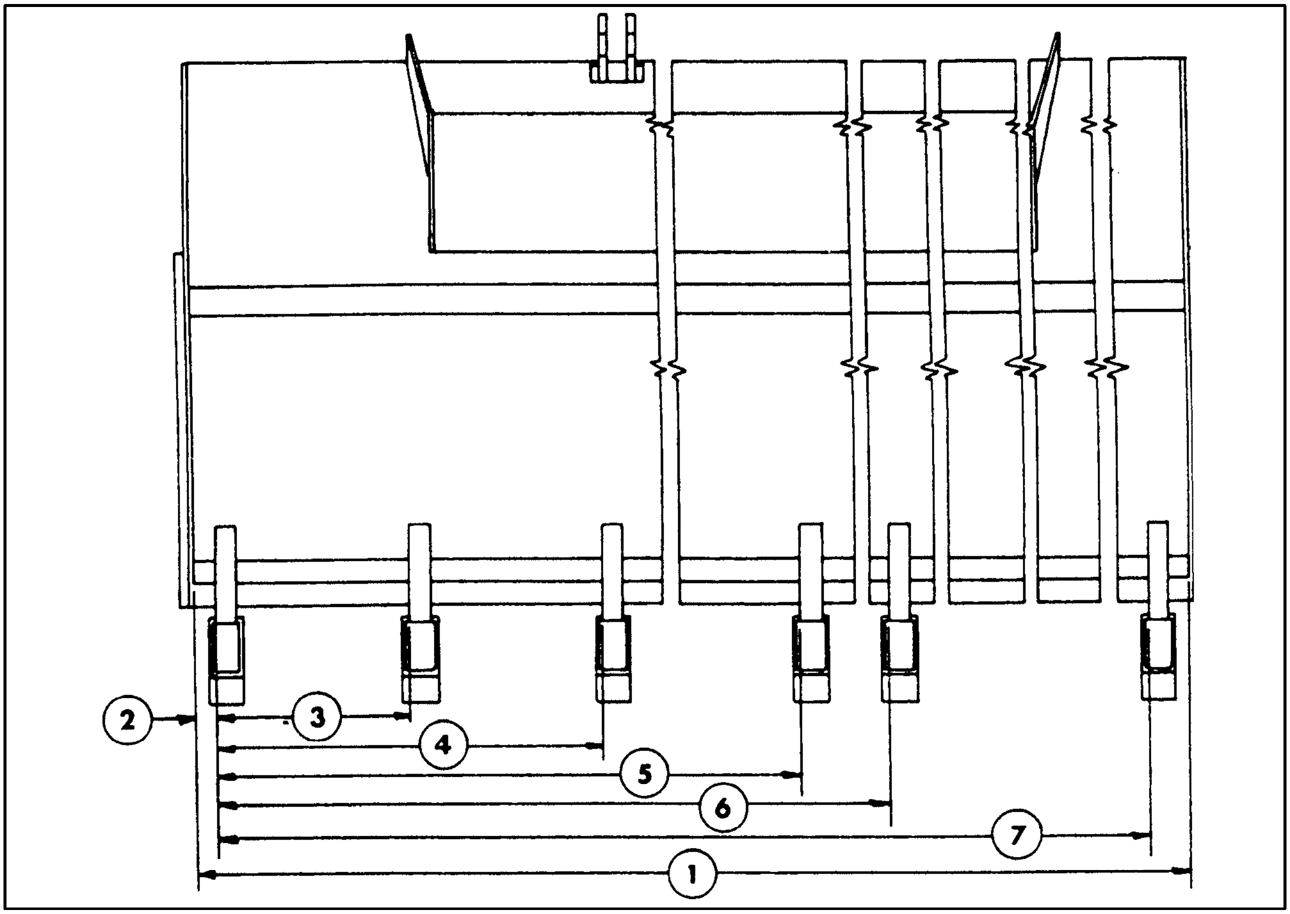

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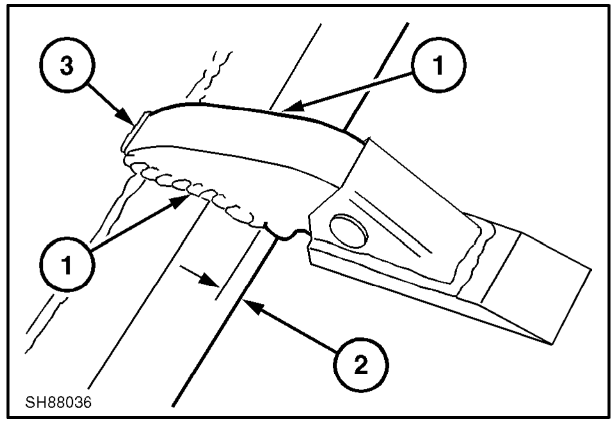
2. Locate the teeth on the bucket edge as indicated.

BUCKET TOOTH SPACING

Bucket Width	From End	2nd Tooth	3rd Tooth	4th Tooth	5th Tooth	6th Tooth
1	**2**	**3**	**4**	**5**	**6**	**7**
60″	1-13/16″	10-15/16″	21-5/16″	32″	42-5/8″	53-5/16″
66″	1-13/16″	13-27/32″	25-27/32″	37-29/32″	50-7/32″	62-1/4″
72″	1-13/16″	13″	26″	38-15/16″	51-7/8″	64-7/8″
78″	1-13/16″	14-3/16″	28-5/16″	42-1/2″	56-11/16″	70-7/8″
84″	1-13/16″	15-3/8″	30-3/4″	46-1/8″	61-1/2″	76-13/16″

***NOTE:** Position the teeth at these spacings, then re-center if necessary for equal spacing.*

3. Welds are high carbon steel (tooth) to high carbon steel (bucket). Use welding rods marked 7018 or some comparable rod. Weld on both sides of the tooth from the back of the tooth towards the replaceable point at 1. Stop welding 13 mm (1/2″) from the cutting edge as noted at 2. Weld along the back of the tooth at 3. A minimum 5 mm (3/16″) fillet weld is required for this application.



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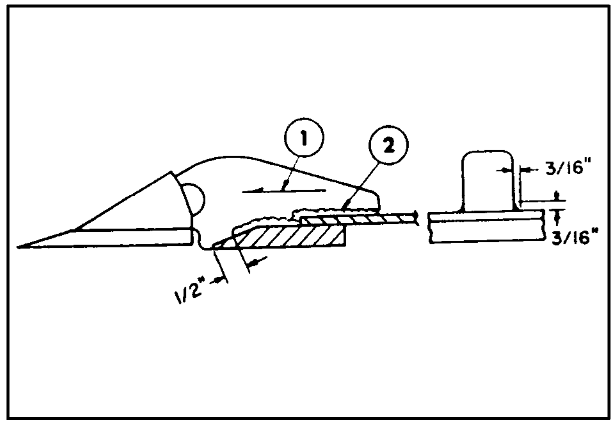
4. Weld in the direction shown at 1.

5. Weld a 5 mm (3/16″) fillet weld along both sides and rear of the tooth at 2, high carbon steel to high carbon steel.



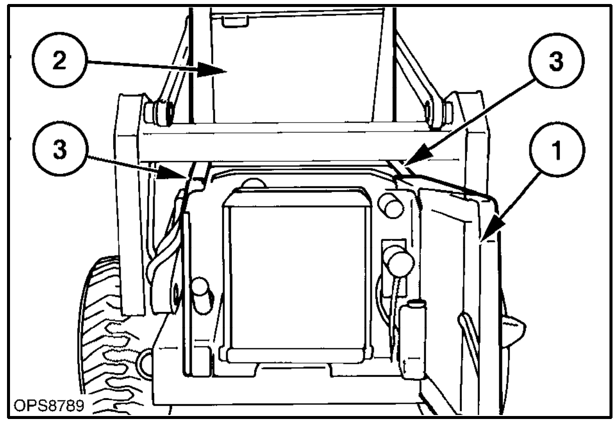
28

BOOM LOCK PIN LINKAGE

Op. 82 100 77

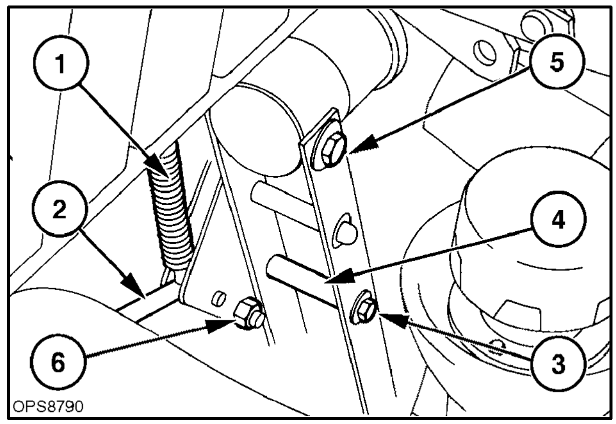
REMOVAL

1. Lower the boom to the lowered position.
2. Open the rear door, 1, and the top engine access cover, 2.
3. Remove the right and left engine side covers, 3.



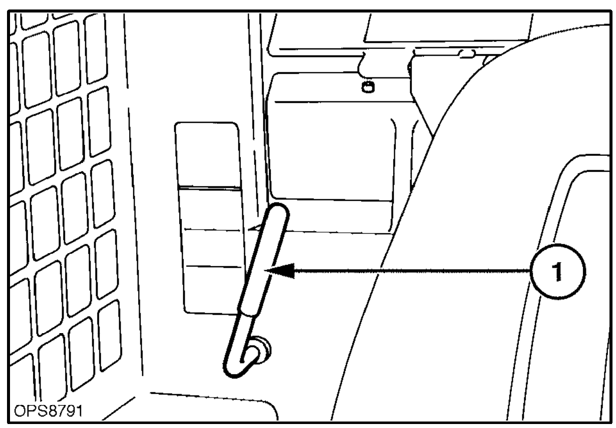
29

4. Unhook spring, 1, from the control rod, by sliding the spring to the side and removing spring at bottom hook, 2.
5. Remove the push nuts, 3, from the control rod, 4.
6. Detach the linkage from the lock pin by removing bolt, 5.
7. Remove the linkage support retaining hardware, 6.



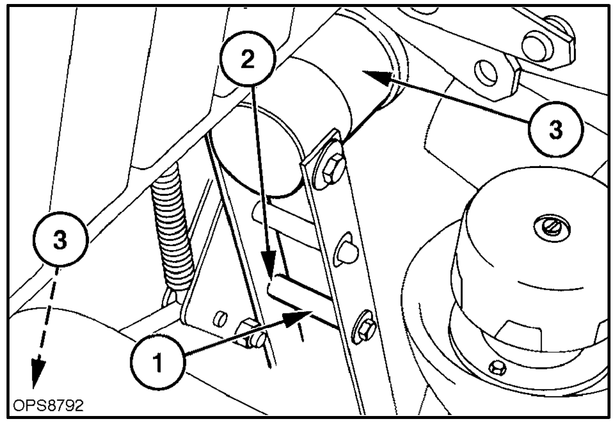
30

8. Remove the plastic handle grip, 1, from the control lever.



31

9. Remove the control rod, 1, from the lever at 2, and slide the handle from the rear of the cab.
10. Slide the boom pins, 3, right and left, from the loader ROPS post.



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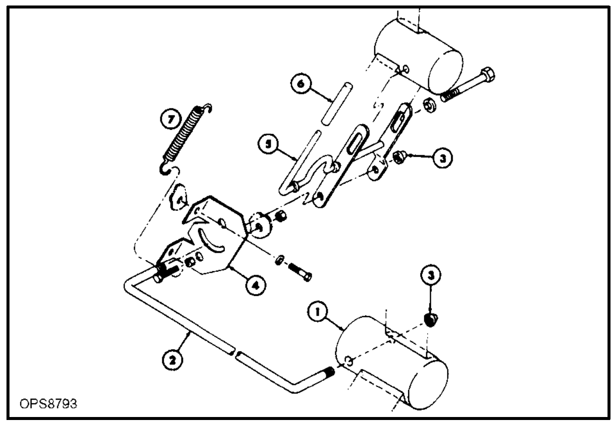
11. Shown are the boom lock pins and linkage.
    1. Boom Lock Pins (2)
    2. Control Rod (1)
    3. Push Nuts (2)
    4. Support Angle (1)
    5. Control Lever Assembly (1)
    6. Plastic Handle Grip (1)
    7. Spring



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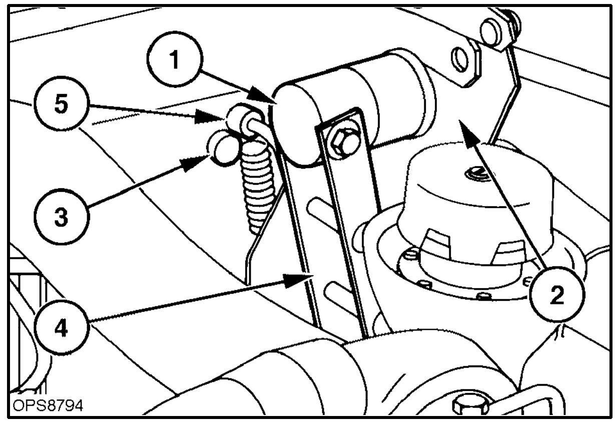
REINSTALLATION

1. Install the boom lock pins, 1, right and left, into the ROPS posts at 2.
2. Install a rubber grommet at 3. Insert the control handle assembly, 4, through the right cab side shield at 5.



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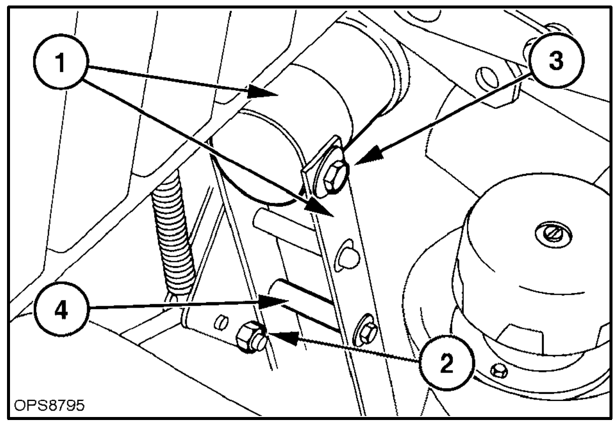
3. Position the control handle over the lock pin, 1, and install the support hardware at 2.
4. Install the handle and lock pin through bolt at 3.
5. With the handle properly positioned tighten the support hardware at 2, and the through bolt lock nut, 3.

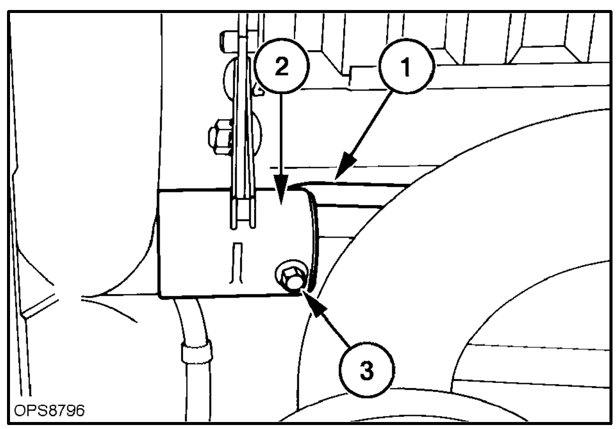
NOTE: *Do not over tighten the through bolt because the handle must pivot at the lock pin.*

6. Install the control rod, 4, in the handle assembly, positioning the seat and seat belt wire harness to the seat side of the control rod.



35

7. Install the control rod, 1, in the left boom lock pin, 2. Slide new push retaining nuts onto the control rod on both sides at 3.



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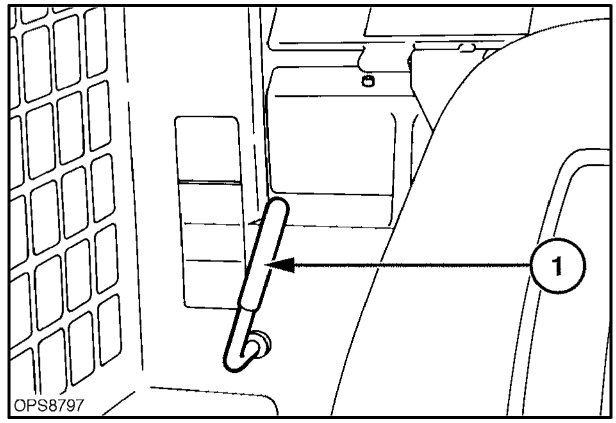
8. Slide the plastic handle grip, 1, onto the handle.
9. Operate the control handle to insure proper operation.
   - Pivot the handle towards the outside of the operator's cab. The lock pins should extend from the cab post.
   - Pivot the handle towards the inside of the operator's cab. The lock pins should retract into the cab post far enough to allow boom movement without contacting the lock pins.
10. Reinstall the engine side shields. Close the top engine cover and rear door.



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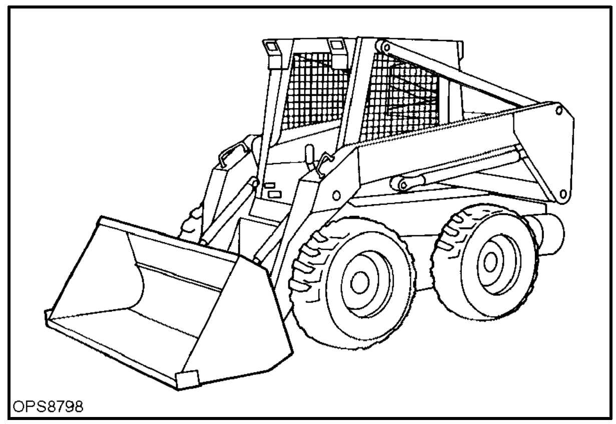
BOOM, UPPER AND LOWER LINK

REMOVAL

1. Remove any attachment (bucket, fork, etc.) from the boom mounting plate and lower the boom to the lowered position.



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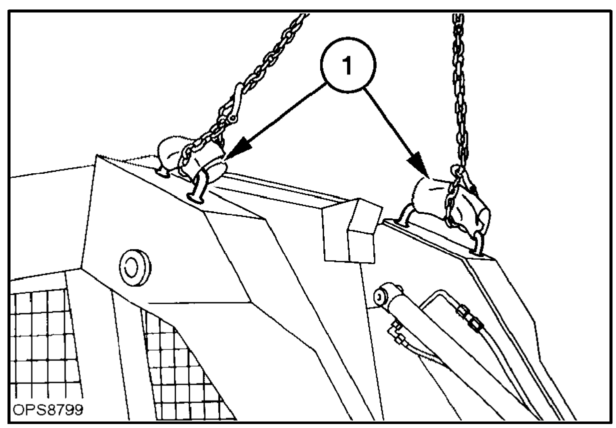
2. Attach a chain or strap suitable for handling the weight of the boom, approximately 360 kg (800 lbs.), to the boom grab handles as shown at 1, and support about level with the top of the loader ROPS.

CAUTION

Always use suitable lifting device and chains or straps to support and remove the boom.



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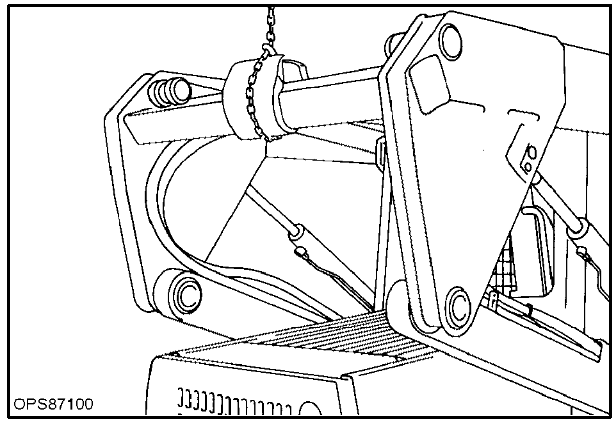
3. Support the rear of the boom with the rear lower link pivot above the top of the engine shielding as shown.

NOTE: *This will enable the removal of the link pivot hardware.*



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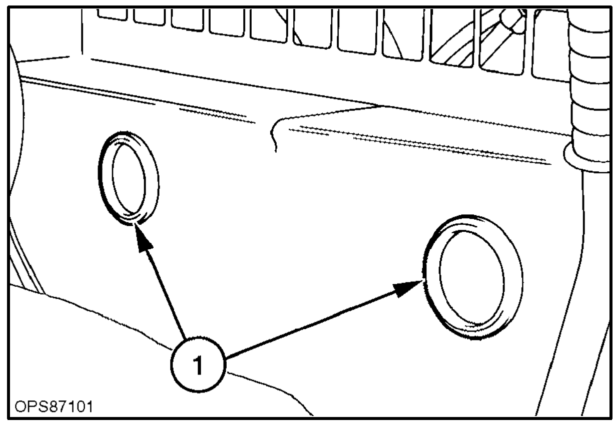
Op. 82 100 52

Lower Link Removal

1. Remove the plastic plugs, 1, from the cab inner shell to access the boom lower link and cylinder pivot hardware.
2. Remove the fenders to gain access to the boom and bucket hydraulic tube and hose connections.



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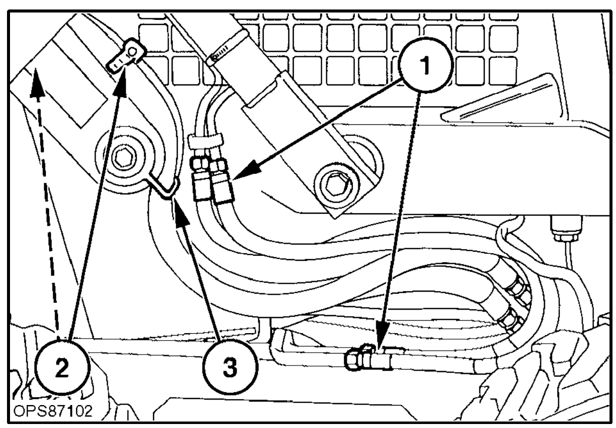
3. With the boom properly supported and all hydraulic oil pressure removed from the boom and bucket circuits, disconnect the hydraulic lines at 1. Cap open ends of lines and hoses. Remove the boom hose clamps, 2, retaining the hoses to the lower boom links. Remove the hoses from the lower hose retainer, 3.



42

CAUTION

Always use suitable lifting device and chains or straps to support and remove the boom.

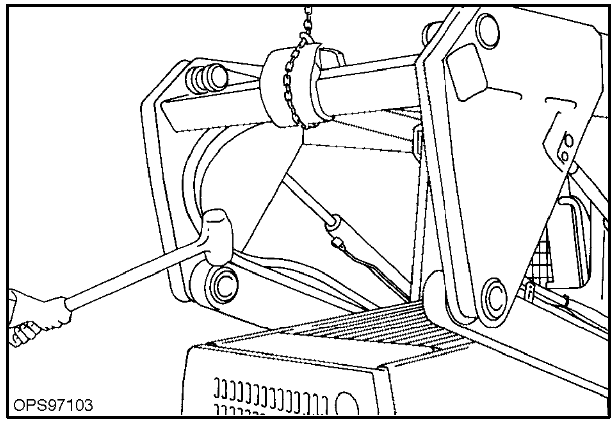
Do not disconnect any hydraulic lines until all hydraulic pressure is removed from the boom and bucket hydraulic circuits.

NOTE: *Mark all boom and boom link tapered pins with their proper location prior to removal. This will ensure that all pins are installed in their correct position during reassembly.*

4. Loosen the right and left lower link, rear pivot pin retaining hardware.

CAUTION

Do not remove the pin retaining hardware until the tapered pivot pin is broken loose at the tapered end of pin or the link and pin may fall.



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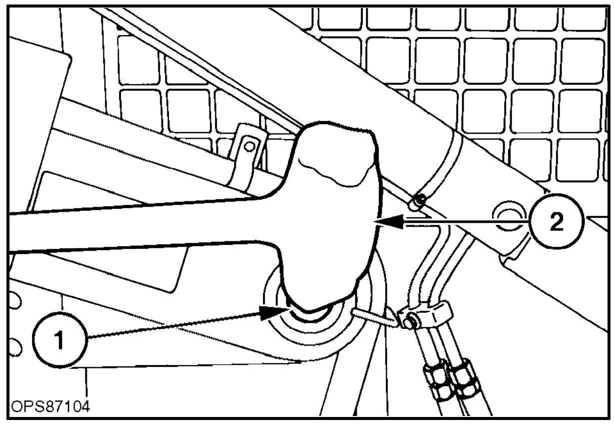
5. With a soft-faced sledge hammer, strike the lower link as shown to break the tapered pivot pin loose in the main boom link.

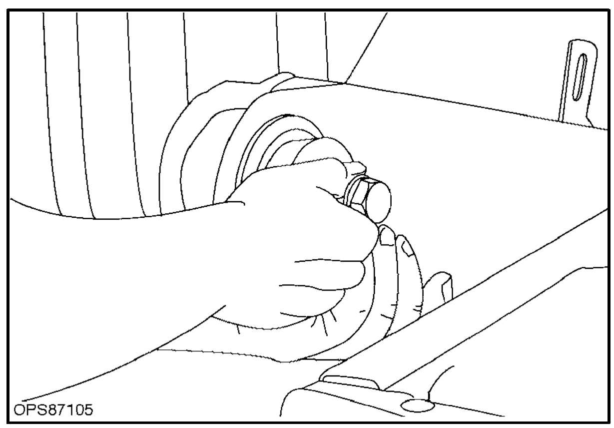
6. Loosen the front lower link pivot pin retaining hardware, 1, and strike the link at 2, to break the tapered pivot pin loose in the ROPS frame.



44

7. Remove the retaining pin hardware from the front and rear pins. Lift the lower link and pins from the loader.

NOTE: *Both the right and left lower links can be removed as described.*



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Op. 82 100 53

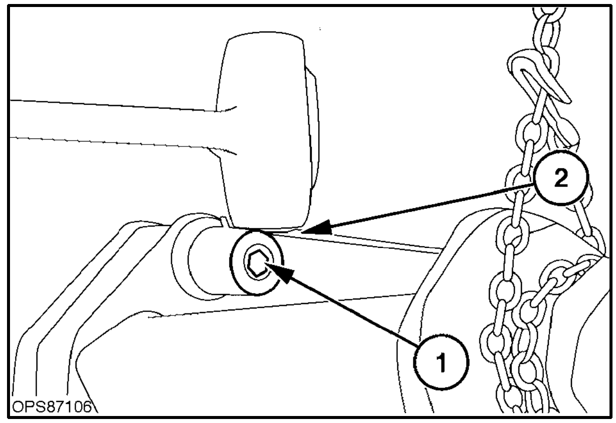
Upper Link Removal

1. The boom must be properly supported at the front and rear with the boom in the lowered position or raise and support the boom above the front upper link pivot. Remove all hydraulic oil pressure from the boom and bucket hydraulic circuits.

NOTE: *Supporting of the boom will keep the boom positioned during removal of the upper links.*

CAUTION

Always use suitable lifting device and chains or straps to support and remove the boom.



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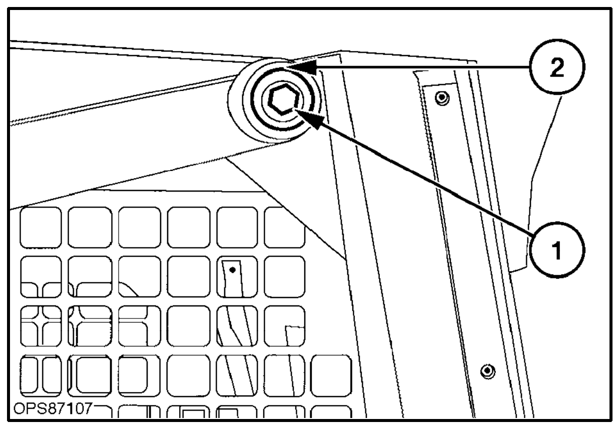
2. Loosen the rear link retaining bolt, 1; do not remove. With a soft-faced sledge hammer, strike the link at 2, to break the tapered pivot pin loose in the main boom.
3. Loosen the front upper link pivot hardware, 1, and with a soft-faced sledge hammer, strike the link at 2, to loosen the tapered pin in the ROPS post.
4. Remove the front and rear pivot pin retaining bolts and tapered pins and lift the link from the loader.



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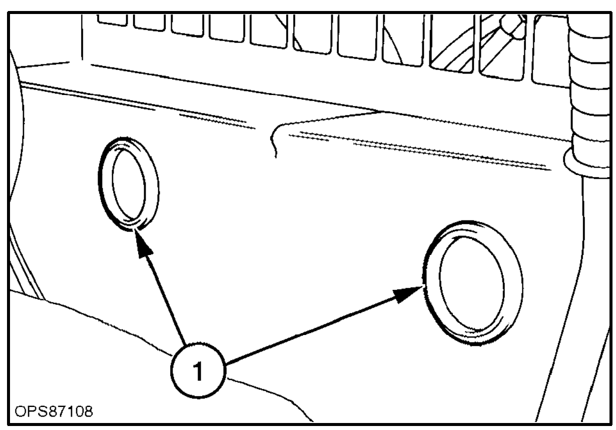
Op. 82 100 50

Main Boom Removal

1. Remove the plastic plugs, 1, from the cab inner shell to access the boom lower link and cylinder pivot hardware.
2. Remove the fenders to gain access to the boom and bucket hydraulic tube and hose connections.



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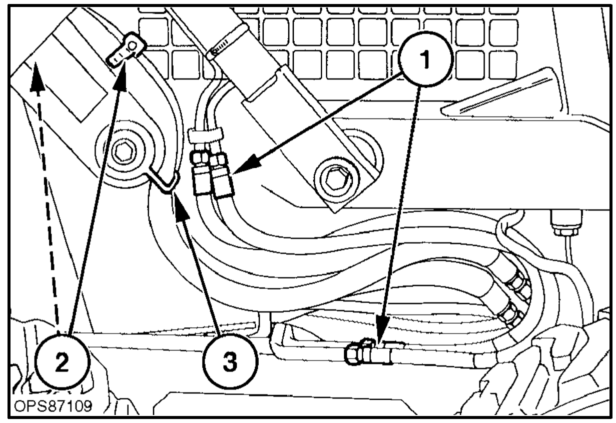
3. With the boom properly supported and all hydraulic oil pressure removed from the boom and bucket circuits, disconnect the hydraulic lines at 1. Cap open ends of lines and hoses. Remove the boom hose clamps, 2, retaining the hoses to the lower boom links. Remove the hoses from the lower hose retainer, 3.



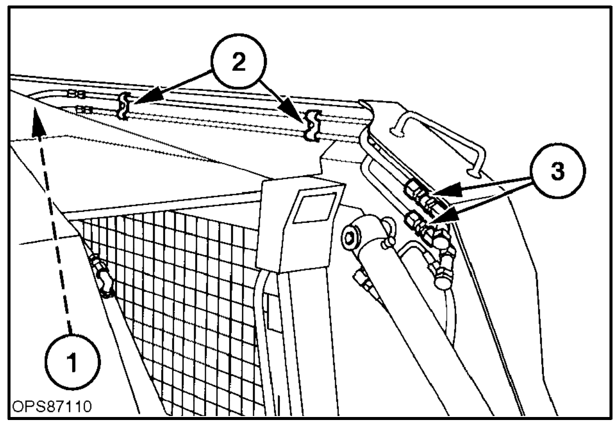
49

CAUTION

Always use suitable lifting device and chains or straps to support and remove the boom.

Do not disconnect any hydraulic lines until all hydraulic pressure is removed from the boom and bucket hydraulic circuits.

4. Remove the hoses from the rear hose support, 1, remove the tube clamps, 2, and disconnect the tubes at the Z-bracket and quick couplers, 3.



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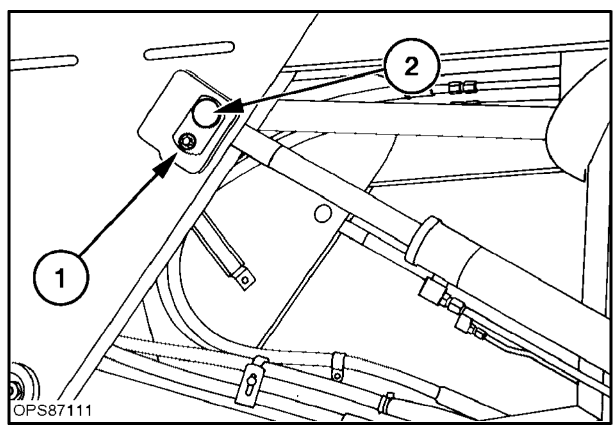
5. Remove the right and left upper boom cylinder pivot pin retaining hardware, 1, and pin, 2, from cylinders and boom.

NOTE: *If only the main boom is being removed the cylinders can remain attached at the bottom pivot.*

NOTE: *Mark all boom and boom link tapered pins with their proper location prior to removal. This will ensure that all pins are installed in their correct position during reassembly.*



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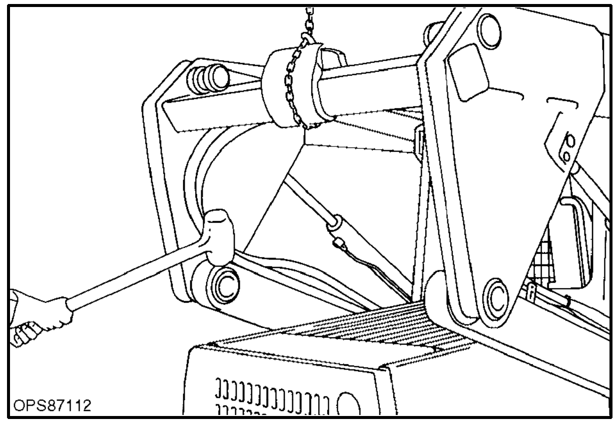
6. Loosen the right and left lower link, rear pivot pin retaining hardware.

CAUTION

Do not remove the pin retaining hardware until the tapered pivot pin is broken loose at the tapered end of pin or the link and pin may fall.



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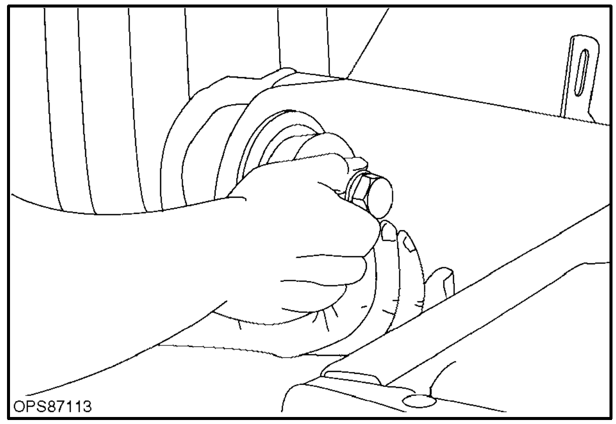
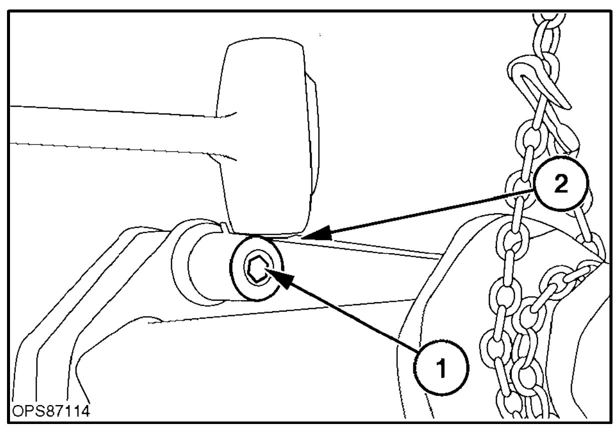
7. With a soft-faced sledge hammer, strike the lower link as shown to brake the tapered pivot pin loose in the main boom link.



53

8. Remove the pin retaining hardware and pin from the link and main boom. Lower the link and rest it on the loader frame.



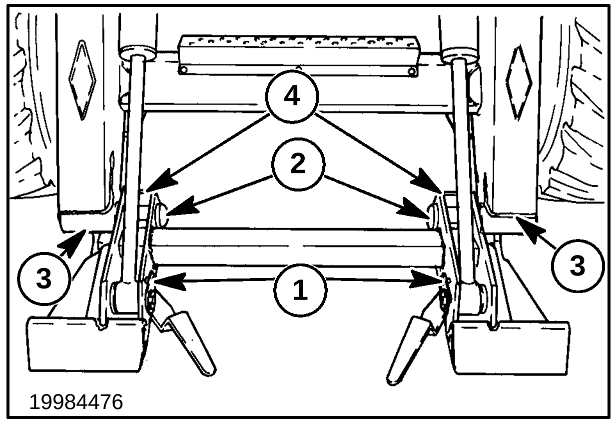
54

9. Loosen the right and left upper link rear retaining bolts, 1; do not remove. With a soft-faced sledge hammer, strike the link at 2, to break the tapered pivot pin loose in the main boom.
10. Remove the hardware and pins from the ROPS and link, resting the link on the lower link.
11. Lift the boom assembly from the loader.

Op. 82 100 70

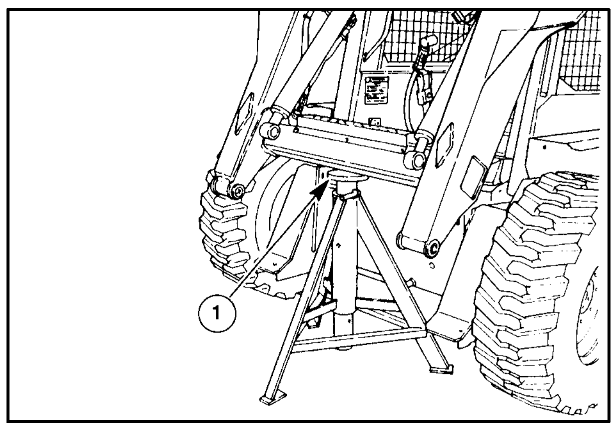
FRONT BOOM MOUNTING PLATE PIVOT HUB REPLACEMENT

1. Remove any attachment, bucket, etc., from the boom mounting plate.
2. Pivot the mounting plate out flat and remove all hydraulic pressure from the bucket circuit.
3. Remove the cylinder rod pivot pin retaining hardware, 1, and remove the pins from the mounting plate and cylinder.
4. Remove the mounting plate from the main boom.
   - Remove the hub caps, 2, from the pivots.
   - Loosen the mounting plate pivot hardware, 3. DO NOT remove the hardware.
   - With a sledge hammer (8 lbs.) or larger, strike the mounting plate at 4, to loosen the tapered pivot pin.
   - Remove the retaining hardware, pins, and mounting plate from the boom.



55

5. Raise the boom and support the boom 609.6 mm (24″) off the ground on jack stands or suitable blocking at 1.
6. Remove the negative (-) battery cable.



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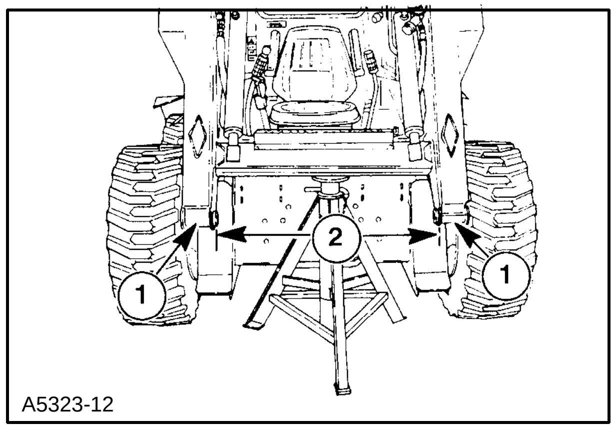
7. Using a cutting torch, cut the weld around the hub to separate the hub from the main boom. DO NOT cut any material from the main boom. Grind to remove any remaining weld and hub from the boom



57

8. Position the hubs on the boom straight, from side to side, with center spacing, 2, as follows, and tack weld the hubs to the boom.

   Hub Center Spacing - 822 mm (32.36″)

9. Reinstall the mounting plate and tapered pivot pins and hardware. Pivot the mounting plate up and down to ensure there is no binding between the mounting plate and pivot pins. Weld the hubs to the boom.

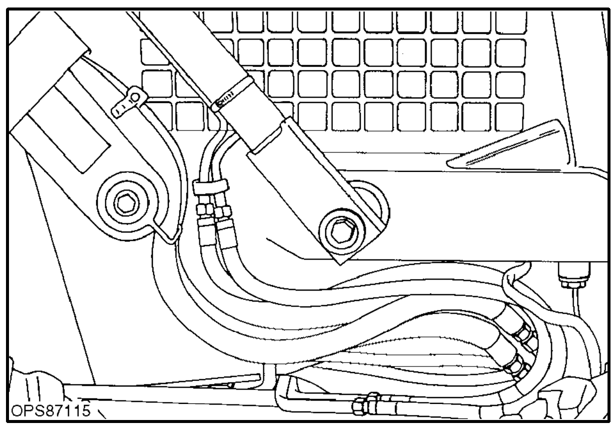
10. Install the hub reinforcement gussets described earlier in these instructions.

11. Lubricate the pivots and torque and hammer seat the tapered pins and hardware. Refer to “MOUNTING PLATE REPAIR,” in this section.

BOOM, UPPER AND LOWER LINK REINSTALLATION

1. If the upper and lower boom links and boom cylinders were removed, attach the upper and lower links to the ROPS before installing the main boom assembly.

2. Install the lower link pivot pins through the links and insert the tapered end of the pin into the ROPS frame. Install the pin retaining hardware and tighten, making sure the tapered pin is inserted into the ROPS straight.



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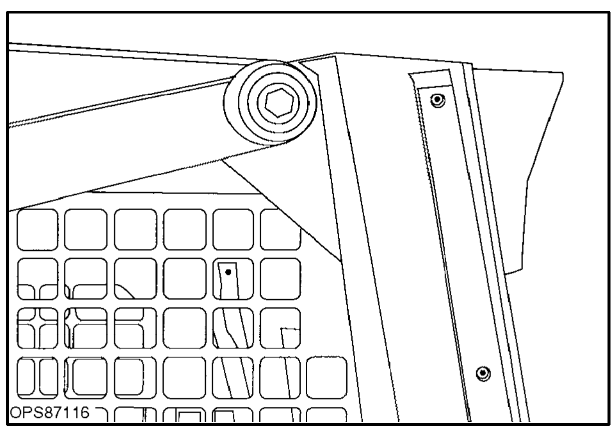
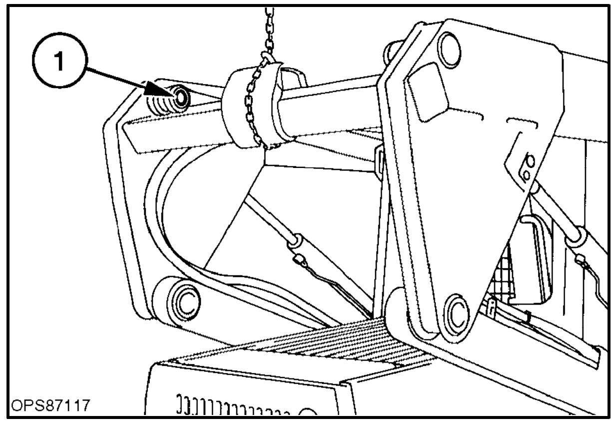
3. Install the upper link pivot pins through the links and insert the tapered end of the pin into the ROPS post. Install the pin retaining hardware and tighten, making sure the tapered pin is inserted into the ROPS post straight.

4. Position the main boom assembly over the loader positioning the boom against the front boom stops (front of the final drive case).



59

5. Attach the rear of the upper link at 1, using the tapered pivot pins and retaining hardware. Tighten the hardware, making sure the pin is straight in the main boom.



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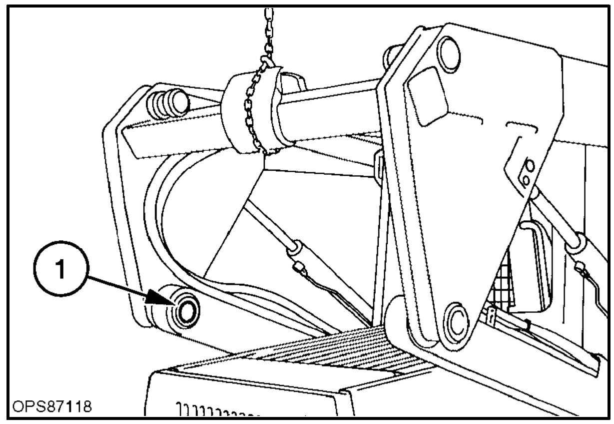
6. Attach the rear of the lower link at 1, using the tapered pivot pins and retaining hardware. Tighten the hardware, making sure the pin is straight in the main boom.



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7. With the main boom, upper and lower links attached, the pivot pins and hardware must be properly seated.

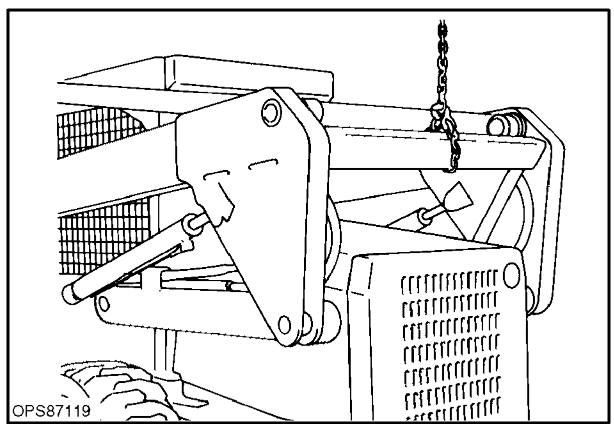
   Torque the pin retaining hardware to the following torques:

   Lower link - 250 ft. lbs. (338 N·m)

   Upper link - 250 ft. lbs. (338 N·m)

   Cylinder pivot (lower) - 125 ft. lbs. (169 N·m)

   Cylinder pivot (upper) - 28 ft. lbs. (38 N·m)



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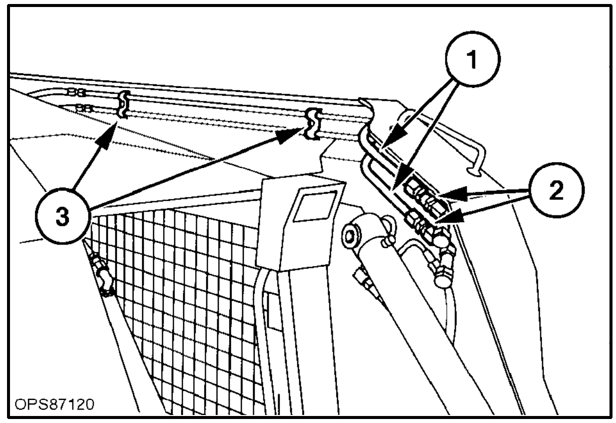
8. After the pivot pin retaining hardware is torqued the pins must be properly seated. Using a hammer, strike the head of the bolt and pin several times to seat the tapered pin in the taper in the ROPS. Retorque the hardware to specified torque. Repeat this process until the torque is maintained.

9. Reinstall the cylinders at the boom upper pivot.
10. 1Reinstall the boom hydraulic tubes and hoses if removed. Position tubes, 1, at the front of the boom, to maintain clearance between boom and tubes. The tubes must be properly positioned or when the boom is raised and lowered the tubes will contact the corner of the ROPS (cab).
11. Reattach the tubes to the Z-bracket, 2, and install the quick couplers. Install the tube clamps, 3.



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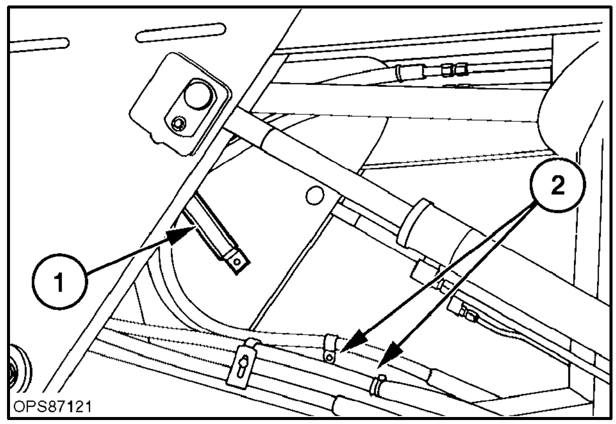
12. Route the tubes and hoses to the rear of the boom through the rear hose supports, 1, and on the top side of the lower link at 2.



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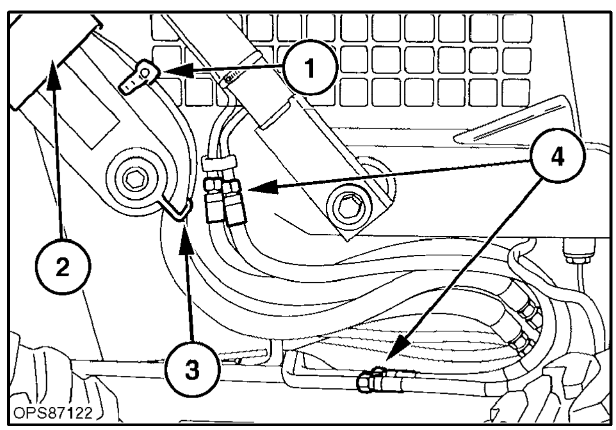
13. Position the hoses with one on each side of the lower link retaining clips, 1, and through the hose retainer at 2. Do not tighten clamps at this time, further adjustment will be required later.
14. Insert the hoses through the hose support on the end of link at 3.
15. Reconnect the hoses to the tubes at 4, positioning the hoses and tubes for clearance to the fender, when the boom is raised and lowered.



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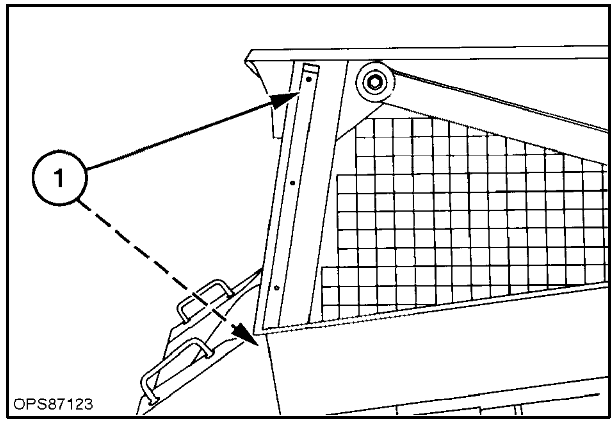
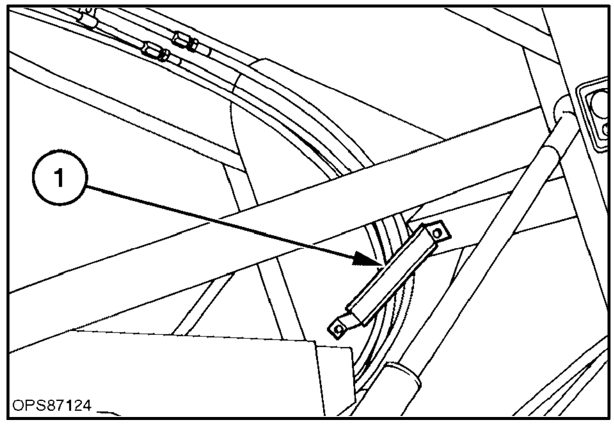
16. When all boom links and pivot pins are properly seated and torqued and all hydraulic connections are tightened, operate the boom up and down. Check the tube to ROPS (cab) at 1, for clearance.



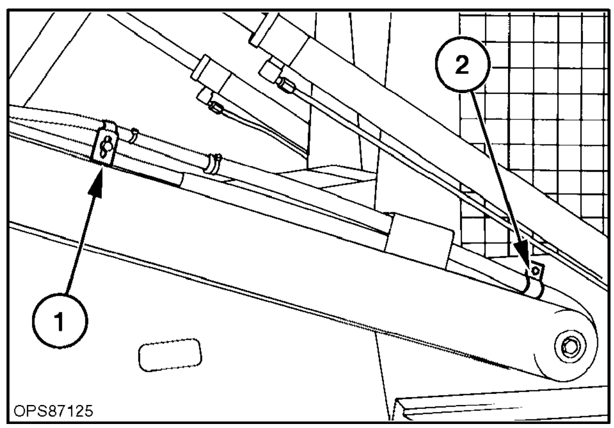
66

17. Check the hoses through the rear supports, 1. When the boom is fully raised, position the hoses in the support as shown, and remove any slack from the hoses to the boom tubes.



67

18. Pull all slack from hoses and tighten the top clamp, 1. Remove any slack between the clamps and then tighten the second clamp, 2.



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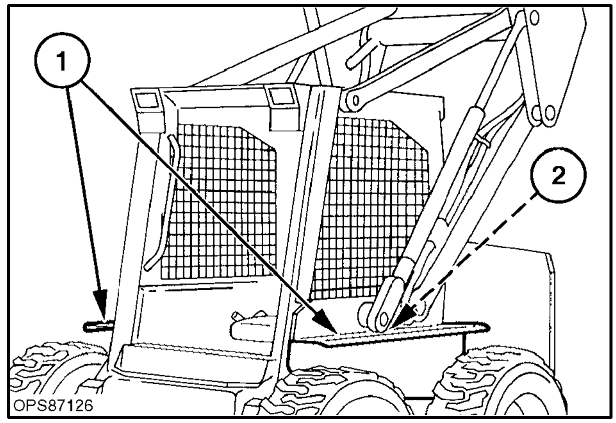
19. Install the fenders, 1, then raise and lower the boom checking the hose/tube clearance behind the fenders at 2, and readjust if required. Check for any oil leaks and repair if required.

NOTE: *The boom may require several cycles up and down to remove the air from the boom hydraulic circuit.*



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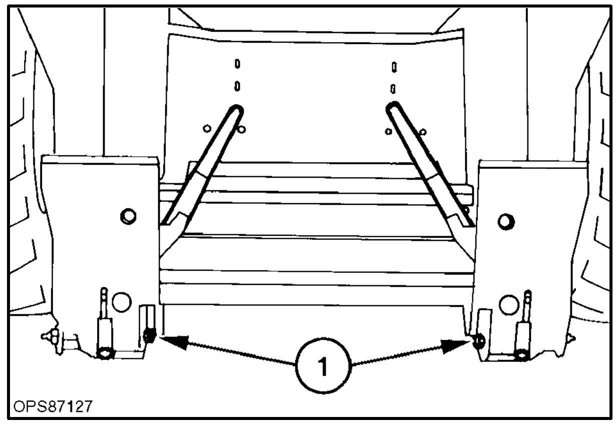
20. Reinstall the boom mounting plate if removed. Torque the pivot bolts, 1, to 80 ft. lbs. (108 N·m). The tapered pivot pins and retaining hardware must be hammer seated by striking the head of the bolt and pin and retorquing the bolt. This step must be repeated until the torque is maintained.

21. Reinstall any shields removed for the repair.



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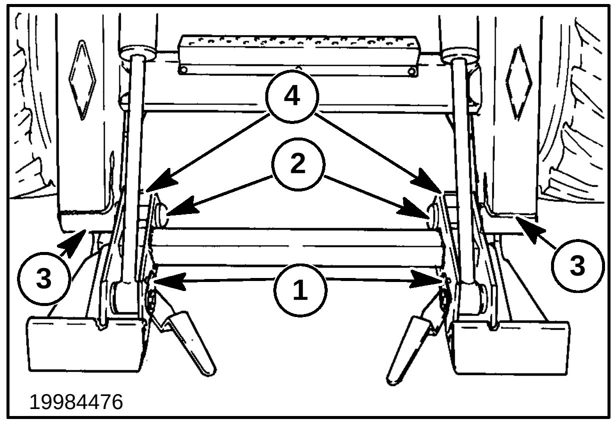
ATTACHMENT MOUNTING PLATE

Op. 82 100 70

REMOVAL

1. Remove any attachment from the loader attachment mounting plate.
2. Lower the boom to the fully lowered position.
3. Tilt the attachment mounting plate forward until the face is level with the ground.
4. Remove the cylinder attachment mounting plate pivot pins by removing the pin retaining bolts, 1, and sliding the pins from the mounting plate and cylinders.



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CAUTION

Support the mounting plate during removal to prevent dropping the plate when pins are removed.

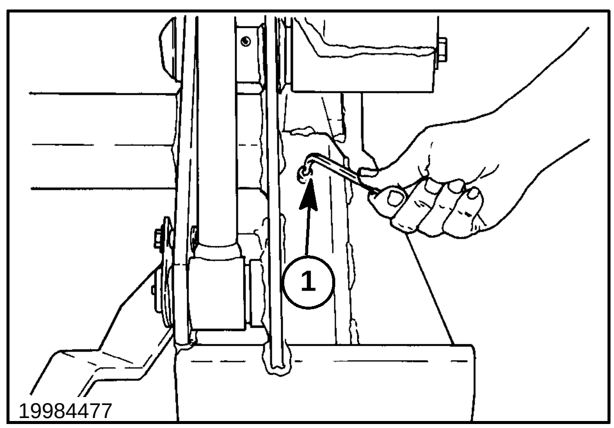
5. Remove hub caps, 2, from the plate pivots.
6. Loosen the attachment mounting plate to boom pivot pin hardware, 3. DO NOT remove the bolts at this time.
7. With a soft-faced sledgehammer, strike the mounting plate pivot area, 4. This will free the tapered pivot pin in the boom link.
8. Remove the pivot pin retaining hardware and remove the tapered pins.

REPAIR/REBUILD MOUNTING PLATE

Op. 82 100 74

LATCH LEVER AND PIN REMOVAL/REPAIR

1. Remove any attachment from the loader attachment mounting plate.
2. Lower the boom to the lowered position.
3. Tilt the attachment mounting plate forward until the face is level with the ground.
4. With an allen wrench, remove the setscrew, 1, from the backside of the mounting plate for both the left and right sides.



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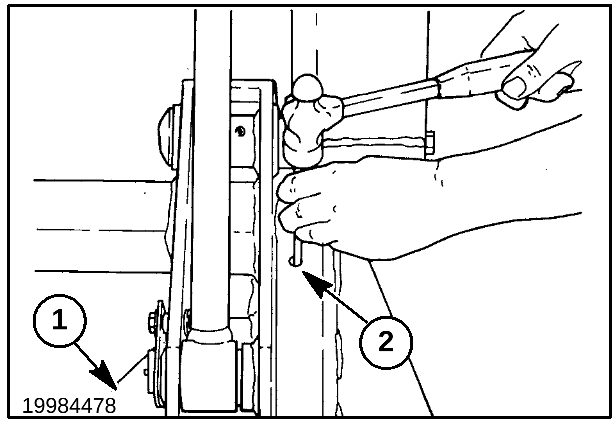
5. Move the latch handle, 1, to align the groove pin in the setscrew hole, 2. Drive out the groove pin with a hammer and punch. Repeat this procedure on other side.
6. Remove the latch pin from each side from the bottom of the mounting plate.



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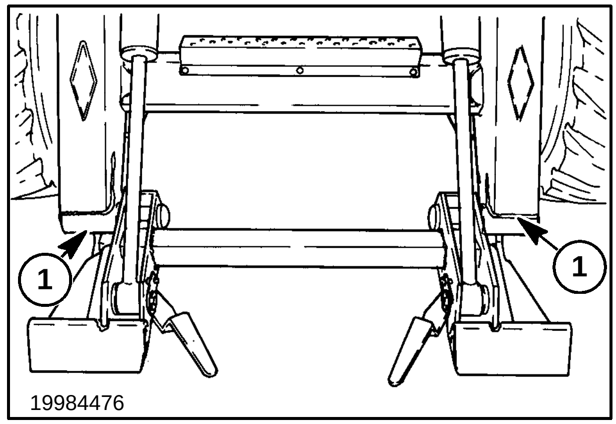
7. Remove the cylinder attachment mounting plate pivot pins to allow access to the latch handle pivot pin snap ring clips.

CAUTION

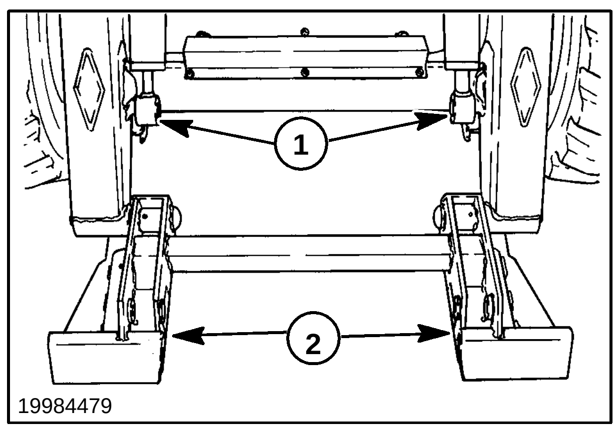
Support the mounting plate during removal of the mounting plate pivot pins to prevent dropping the plate down when pins are removed.

8. Remove the pin retaining bolts, 1, and slide the pins from the mounting plate and cylinders.



74

9. Enter the skid steer. Sitting in the operator's seat with the seat belt buckled, start the loader and retract the attachment mounting plate actuating cylinders, 1, fully to clear the attachment mounting plate, 2.



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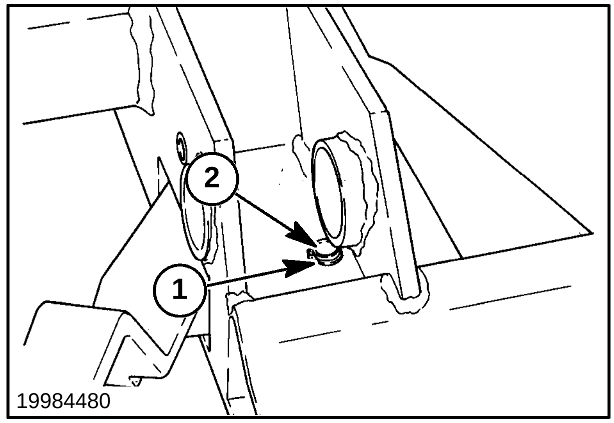
10. Remove the retaining ring, 1, from the latch handle pivot pin, 2, from the rear of the mounting plate on the LEFT and RIGHT sides.

11. Using a punch and hammer drive the latch handle retaining pin, 2, downward and out through the front of the attachment mounting plate on both sides. If there is insufficient ground clearance to fully remove the latch handle pivot pins, lift the attachment mounting plate up as necessary to clear the pins.



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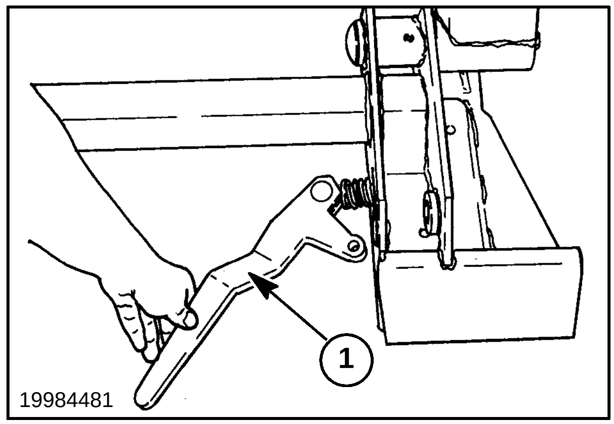
12. Remove the handle/spring assembly, 1, from the attachment mounting plate on the LEFT and RIGHT sides of the attachment mounting plate.



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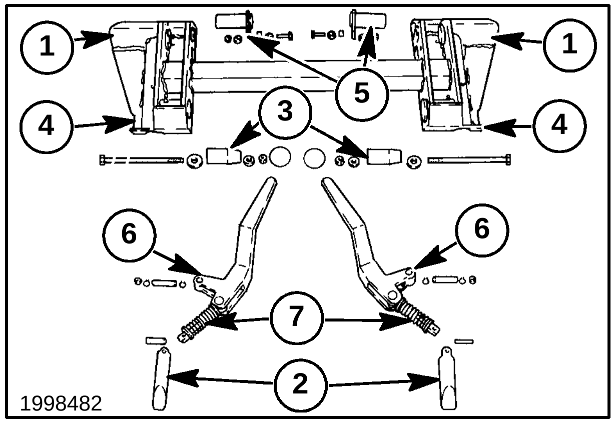
PARTS INSPECTION



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Mounting Plate Assembly

1. Inspect the plate, 1, for straightness. If the mounting plate pods are not straight with each other it may be difficult to hook up to attachments. Refer to the “Checking Procedure for Buckets and Attachments” in Section 88 - Optional Equipment for further details. If the mounting plate is not within specifications, replace the assembly.

2. Inspect the latch pin area for excessive wear, which can result in loose attachments. If the pins, 2, do not slide freely, remove the pins, clean and lubricate.

3. Inspect the mounting plate pivot pins, 3, and bushings, 4, for wear, which can result in loose attachment to the mounting plate boom cylinders.

4. Inspect the cylinder pivot pins, 5, for wear. Inspect the pivot pin holes for wear that could cause a sloppy fit. Replace the bushings in the mounting plate or pivot pins, if necessary.

Latch Handle/Spring Assemblies

1. Inspect the latch handle pivot holes, 6, for excessive wear and binding in the mounting plate.

2. Check that the spring, 7, is not bent, damaged, or has broken coils. Replace if necessary.

Latch Pins

1. Examine the latch pins, 2, for excessive wear and binding in the mounting plate.

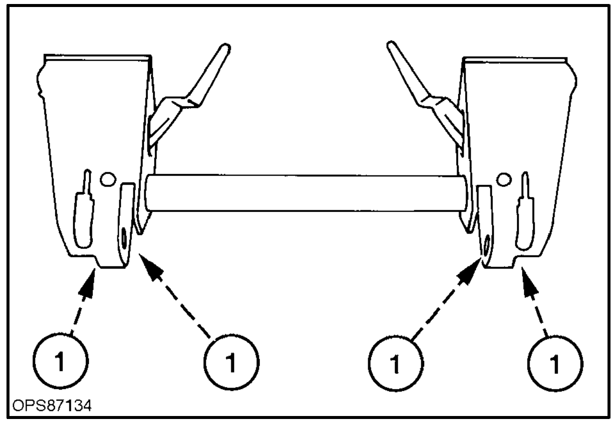
2. Check the tapered area of the pins for wear or chips. Replace if necessary.

Op. 82 100 57

Pivot Bushings Replacement

1. Use a suitable bushing driver and remove the old bushings.
2. Clean the bushing area to remove any dirt, debris and burrs.
3. Using a bushing driver, install the new pivot bushings from each end of hole, 1. Drive bushings flush with the outer edge of the hub.

NOTE: *There will be a space in the center between the two bushings.*



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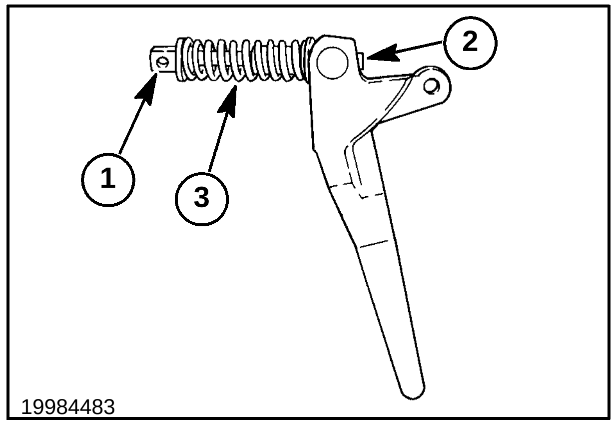
Op. 82 100 74

Latch Lever and Spring Repair/Rebuild

1. Clamp the lower spring guide, 1, in a vise. Turn the step bolt, 2, to remove the lower spring guide from the step bolt and remove spring, 3.

CAUTION

When removing the step bolt, the spring will have some compression pressure. Remove the bolt while applying downward pressure on the bolt.



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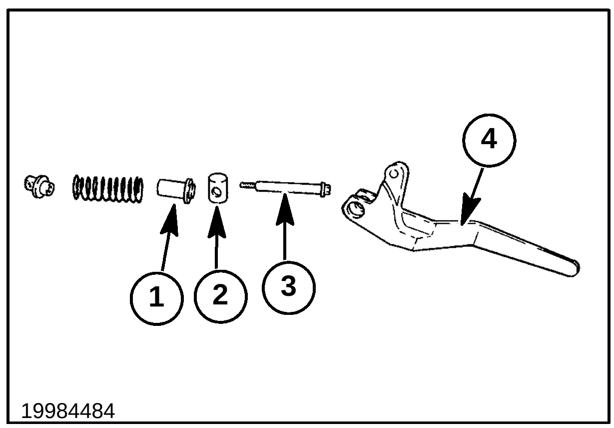
2. Remove the upper spring guide, 1, pivot block, 2, and step bolt, 3, from handle, 4.



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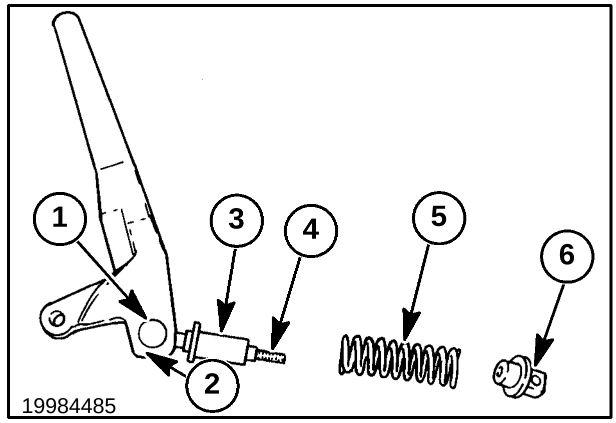
Reassembly

1. Insert the pivot block, 1, and step bolt, 4, into the handle, 2. Install the upper spring guide, 3, onto step bolt, 4.
2. Install spring, 5, over the upper spring guide, 3. Install the lower spring guide, 6, onto step bolt, 4, and tighten.

NOTE: *Apply slight pressure to the lower spring guide to compress the spring slightly and start threading the lower guide onto the step bolt.*



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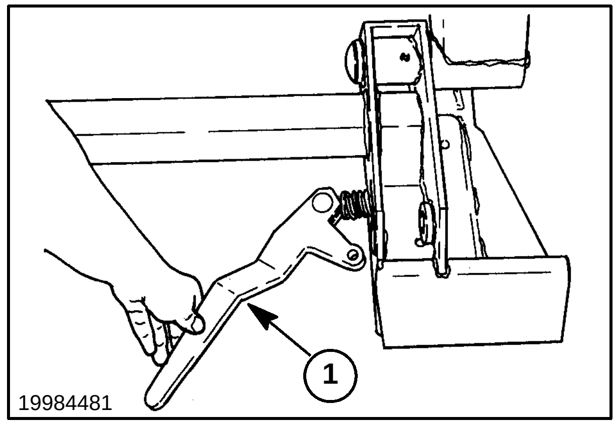
3. Slide the latch handle/spring assembly, 1, into the mounting plate, pointing the spring down.



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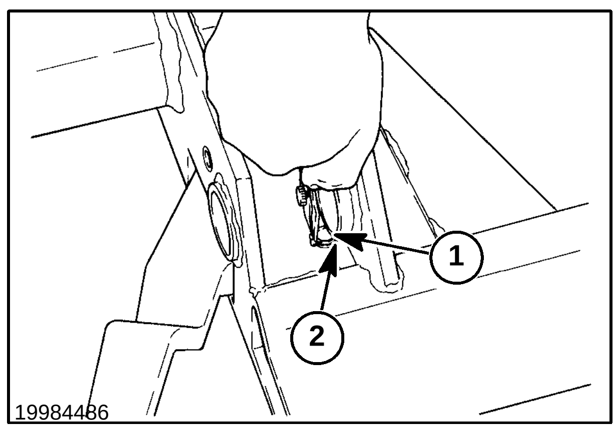
4. Install the handle pivot pin, 1, from the front of the plate and install the snap ring retaining clip, 2. The pivot pins will have a snap ring on both ends of the pins.

NOTE: *The handle pivot pin should have one snap ring retaining clip already installed prior to reinstallation in the attachment plate. If the snap ring retaining clip is not present, install the clip prior to pin installation.*



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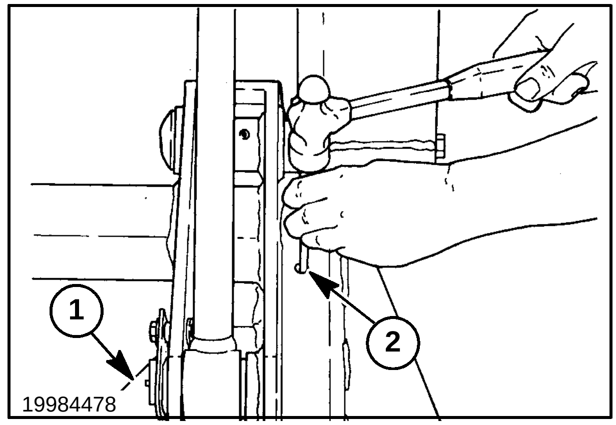
5. Move the latch handle, 1, to align hole with the groove and insert the latch pin with the tapered side towards the loader boom, away from the attachment.
6. With a hammer and punch, drive the grooved pin, 2, through the lower spring guide and latch pin.



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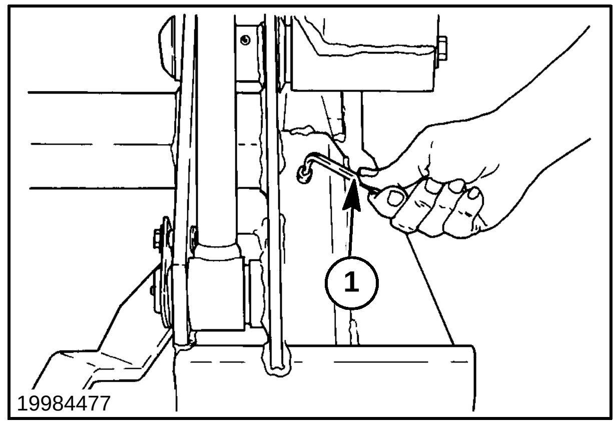
7. Reinstall the setscrew, 1.



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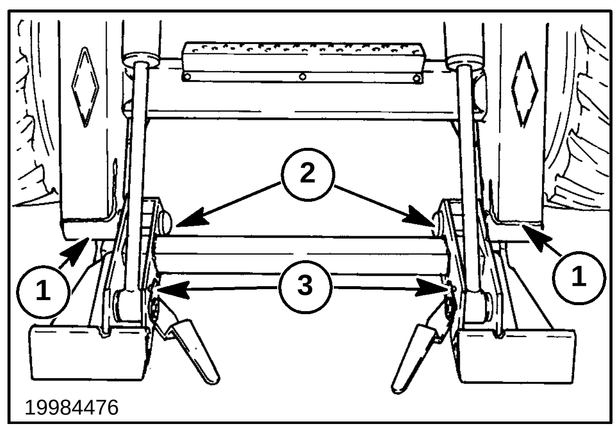
8. Reinstall the boom mounting plate, if removed, by installing the plate pivot taper pins and retaining hardware, 1.
9. Torque the pivot bolts, 1, to 108 N·m (80 ft. lbs.).

NOTE: *The tapered pivot pins and retaining hardware must be hammer seated by striking the head of the bolt and pin, and then re-tightening. This step must be repeated until the torque remains constant.*

10. Reinstall hub caps, 2, into the plate pivots.
11. Extend the attachment mounting plate cylinders until they align with their mounting holes on the attachment mounting plate.
12. Install the cylinder attachment mounting plate pins through the mounting plate and into the cylinder rod ends. Install the pin retaining hardware, 3, and tighten.
13. Grease the two boom mounting plate pivot pins and the two cylinder mounting plate pivot pins prior to moving the attachment mounting plate to prevent any damage to the pivot points.



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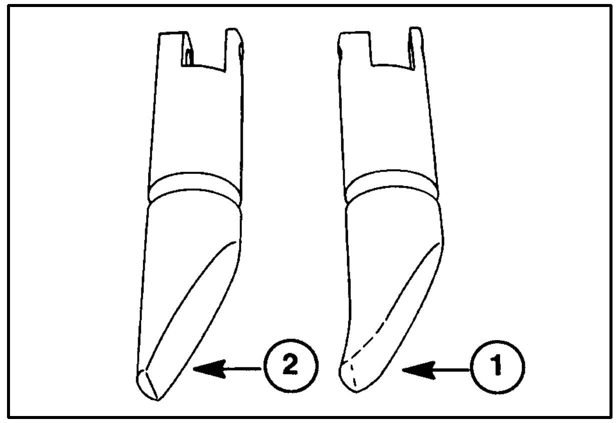
Attachment Plate Over-Center Latch Pins Wear/ Bend

The loader attachment may become loose at the mounting plate. Inspection of the over-center latch pins part #9822358, shows the pin ends worn and bent, 1.

The over-center pins are NOT heat-treated. Thus, if an attachment does not fit correctly and hammers against the pins, the pins will wear and bend. New pins and ones used with properly fitted attachments should be straight, as shown at 2.

If worn pins are encountered, the pins must be replaced. Additionally, an inspection of all the customer's attachments must be made to determine the improperly fitted attachment which is causing the pin problem. Usually, an old attachment used on a previous loader can be worn and can be the problem.



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CHECKING PROCEDURE FOR BUCKETS AND ATTACHMENTS

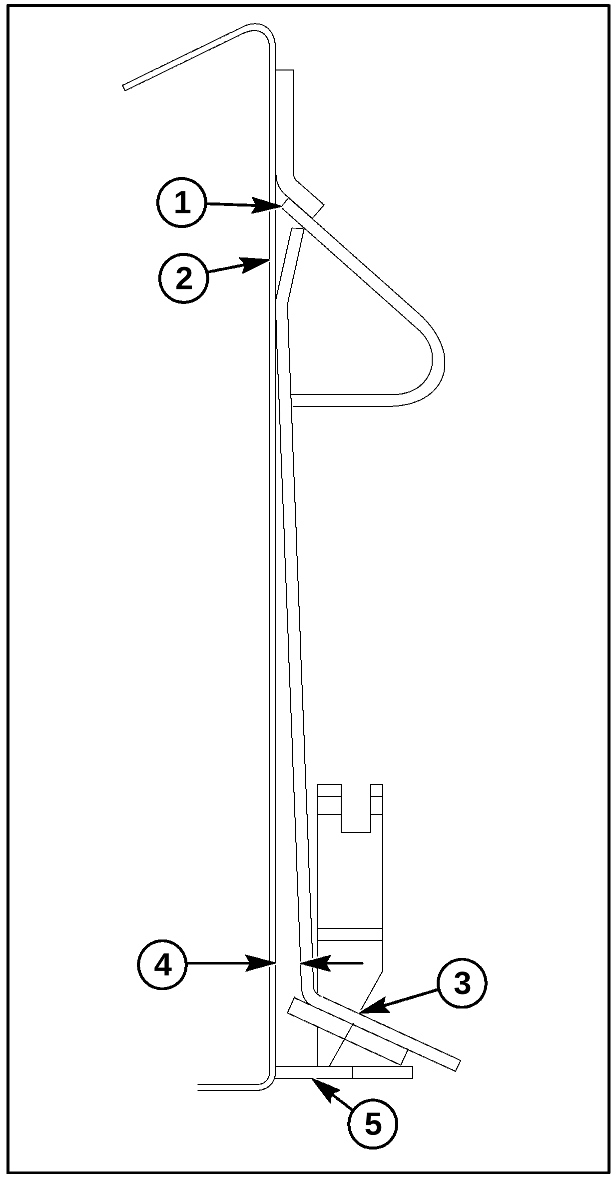
The bucket/attachment does not fit or appears to come loose on the boom faceplate.

The loader boom faceplate is worn or out of height dimensions and/or the bucket latch points are worn or out of dimensions.

Inspection

The Ls180 and Ls190 loader latching system requires that the faceplate wedge into the attachment. The faceplate must contact the attachment at 1, 2, and 3, and must have clearance between the attachment and faceplate at 4, when the attachment is latched properly.

The latch pins should not extend below the lower plate at 5.



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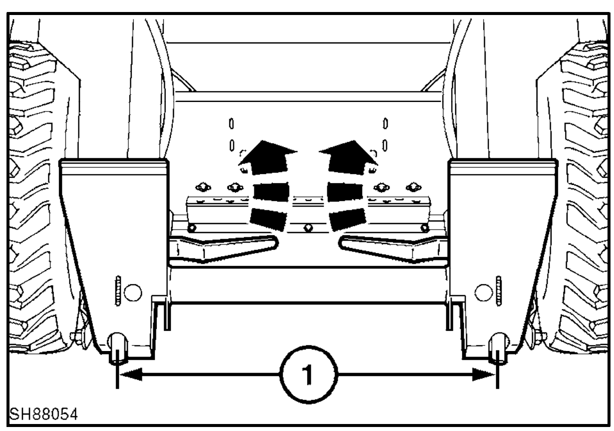
The following are some quick visual checks of the loader faceplate and attachment.



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1. The attachment must have an 850 mm ± 0.8 mm (33-15/32″ ± 1/32″) center to center latch point, 1, to be compatible with the latch system.
2. Check the latch pins and levers for proper operation and lubrication. If the latch pins do not move freely, the system will not function properly.
   - Control levers pivot over center into the lowered latched position.
   - Latch pins fully extend from the faceplate.
   - Control levers pivot over center into the raised unlatched position and hold in this position.

Loader faceplate, 5, and attachment, 6, engagement.

3. Check the saddle area of the attachment at 1, for interference, weld, debris, etc. to prevent the attaching plate and attachment from seating properly.

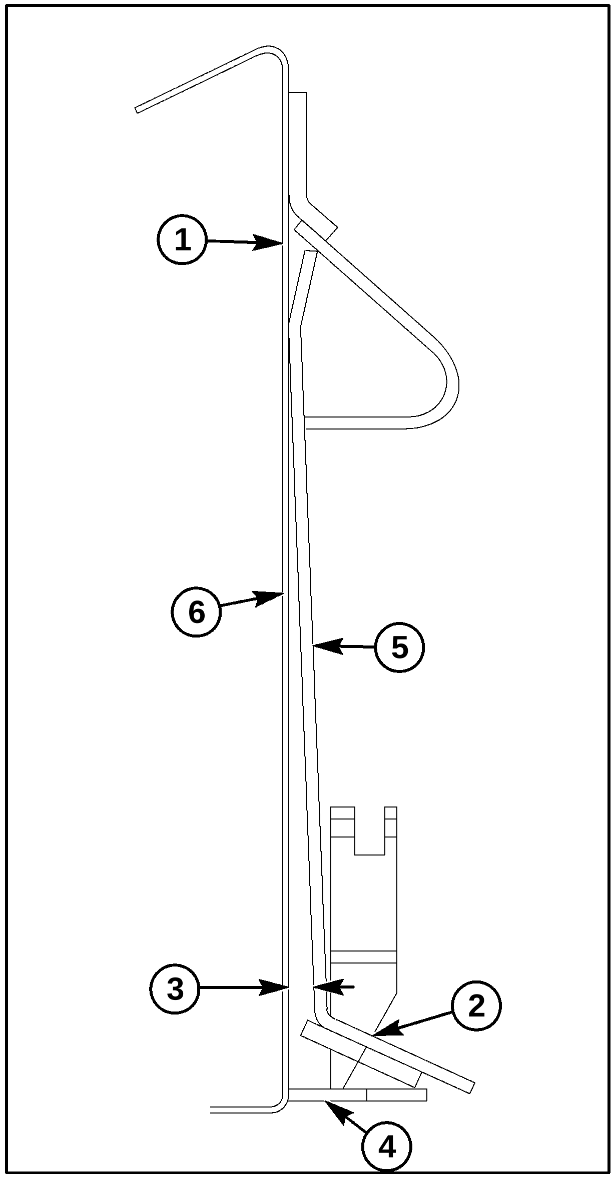
4. The loader latch pin should engage the lower latch plates as shown at 2.

5. Check for clearance between the faceplate and attachment at 3, minimum 0.8 mm (1/32″) and maximum 9.5 mm (3/8″), with the latch pins fully engaged.

   - If there is no clearance at 3, the loader faceplate is too short or the distance between the top saddle area and lower latch plates is too great, 2, Figure 92.
   - If the clearance is too great or the latch pins will not engage into the latch plates on the attachment, the loader faceplate is too long or the distance between the top saddle area and lower latch plates is too short, 2, Figure 92 or the latch plates are located incorrectly, 1, Figure 92.

6. When the latch pins are fully engaged, New Holland buckets only, the end of the pin should not extend beyond the lower plate at 4.

   - If the latch handles do not fully engage, the dimension from the back of the attachment to the rear of the slot in the latch plates is too short at 1, Figure 92.
   - If the latch pins extend below the lower plate at 4, the dimension from the back of the attachment to the rear of the slot in the latch plate is too long at 1, Figure 92.



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CHECKING PROCEDURE

The following are the procedures used to measure the skid steer faceplate and how to measure the attachment.

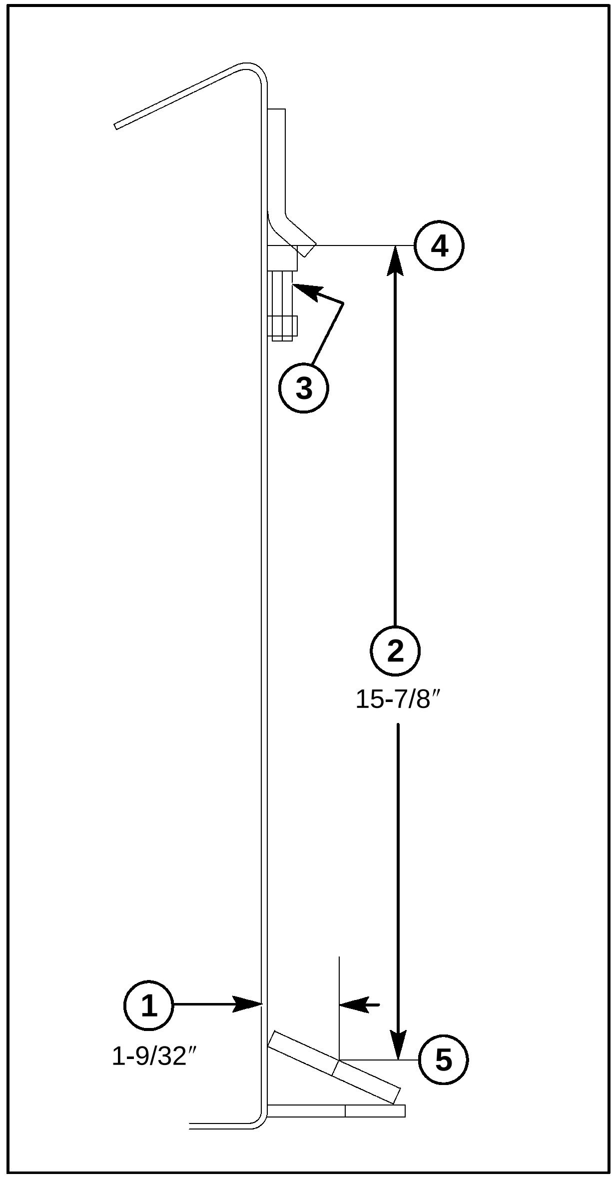
Checking the Attachment

1. Check the placement of the lower latch plates at 1. Measure from the back surface of the attachment to the rear of the latch plate slot at 1: 235.8 mm ± 0.8 mm (1-9/32″ ± 1/32″).
   - If this dimension is too short, the slot can be widened by grinding out the slot 1/16″ maximum or replace the latch plates.

     If grinding is required, the rear of the slot must be ground square with the top surface of the plate to ensure proper pin engagement, 2, Figure 91.
   - If the dimension is too long, replace the latch plates.
2. Check the height of the attachment at 2. Insert a 1/2″ x 2″ hex head cap screw with 1/2″ standard nut as shown at 3. Measure from the top of the bolt, 4, to the rear of the latch plate slot at 5: 403.2 mm ± 0.8 mm (15-7/8″ ± 1/32″).

   If this dimension is incorrect, the lower latch plates will require replacement.

NOTE: *If new latch plates are required, order four plates #86506587 (102 mm, 4″ slot) through Parts and follow the latch plate installation procedure.*



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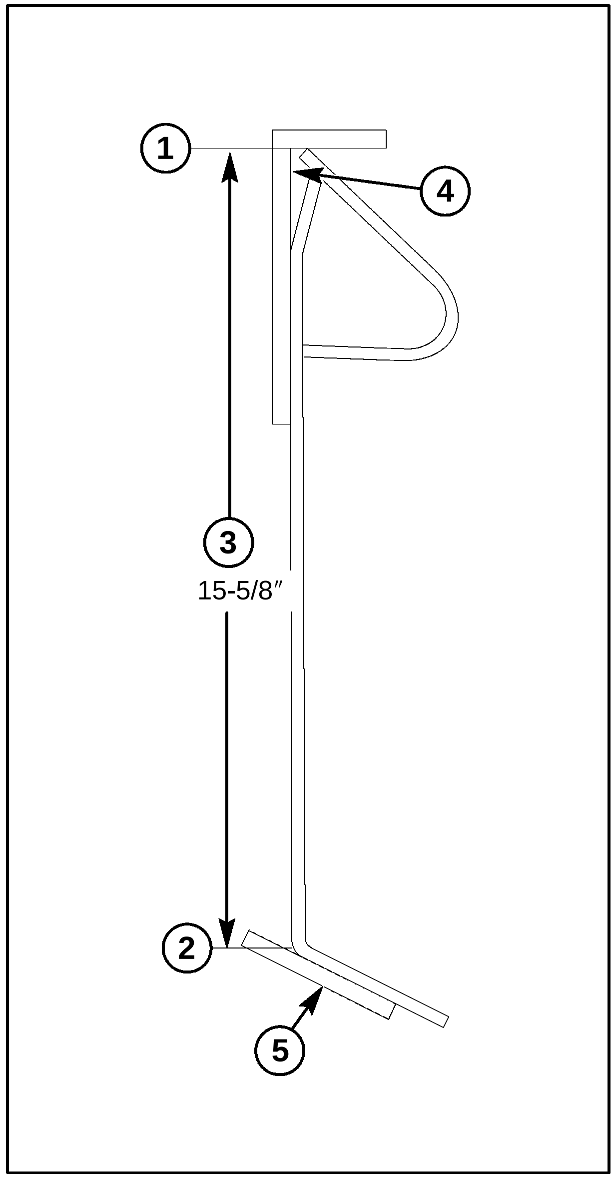
CHECKING THE LOADER FACEPLATE

1. Check the height, 3, of the loader faceplate from the top of the plate at 1, to the bottom of the plate at 2: 396.9 mm ± 0.8 mm (15-5/8″ ± 1/32″). To check the faceplate, place a 24″ square over the top of the plate as shown at 4, and a straightedge at 5.

   If the faceplate is not within specifications, the plate will require replacement.



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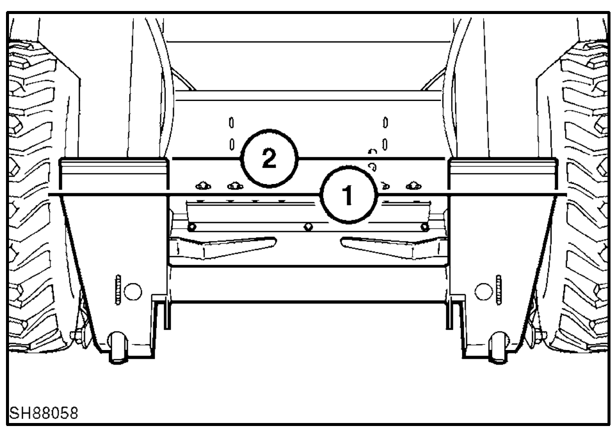
2. Check the faceplate pods to ensure they are straight with each other and not twisted. Place a straightedge across both pods as shown at 1, across the front flat surface and at 2, the top of the pods.

   If the pods are not straight, the faceplate will require straightening or replacement.



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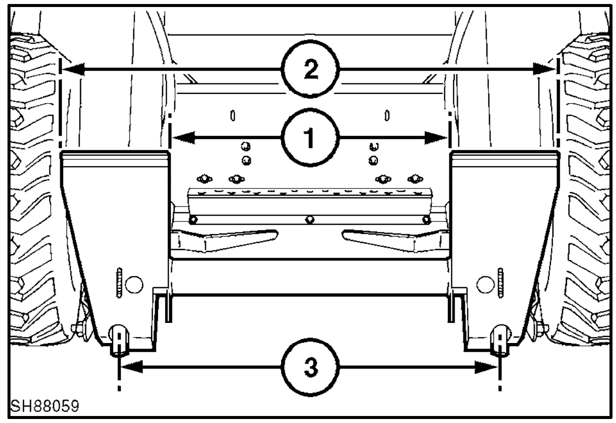
3. Check the center dimension between the faceplate pods and the overall outside dimension including the removable plates in the extended position for new buckets on the L865, Lx865, Lx885, and Lx985 faceplates.

   Inside Dimension, 1: 647.7 mm (25-1/2″)

   Outside Dimension, 2: 1122.4 mm (44-3/16″)

   Latch Pin Dimension, 3: 850.1 mm ± 0.8 mm (33-15/32″ ± 1/32″) center



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CAUTION

Do not cut or grind the loader faceplate to adapt any buckets or other attachments.

Do not cut or grind the loader faceplate latch pins.

When **attaching unapproved attachments**, the latch points on the attachment must meet the correct dimensions and be strong enough to maintain the correct dimensions during operation.

LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
Remove and replace boom lock pins and linkage	2.5 hrs.
Remove and replace main boom	4.5 hrs.
Remove and replace one upper link	1.0 hr.
Remove and replace one lower link	2.0 hrs.
Remove and replace attachment mounting plate	1.0 hr.
Remove attachment mounting plate	1.5 hr.

SECTION 88 – ACCESSORIES

Chapter 1 – Dealer Installed Options

CONTENTS

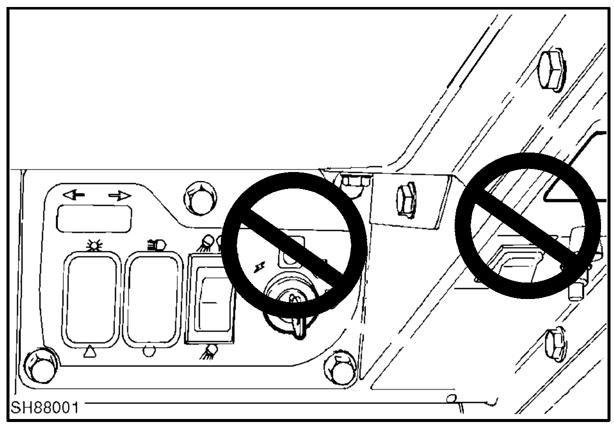
Op. 88 100

GENERAL INFORMATION

ADAPTING ATTACHMENTS REQUIRING 12V ELECTRICAL POWER

There are important rules that must be followed when adapting attachments that require 12 volt electrical power. Proper wiring of electrical devices and power and ground connections is very important to prevent other electrical component damage. Attaching electrical connections to locations other than recommended may allow electric current to feed back through the EIC board, creating false EIC board readings and warnings, or causing EIC board damage or failure.

1. ALWAYS FOLLOW the instructions for New Holland kit installation to ensure proper function and operation.
2. NEVER CONNECT an electrical device to any wires, fuses, switches or grounds inside the cab area. This includes any terminals of the ignition switch, fuse panel, or ground terminal.
3. NEVER INSTALL an electrical device, music radio, two-way radio, or unapproved New Holland attachment into the cab area.
4. ONLY USE the 12-volt accessory power outlet for attachments requiring less than 10 amps. The accessory outlet is connected to the engine fuse/relay panel and protected with a 15 amp fuse.



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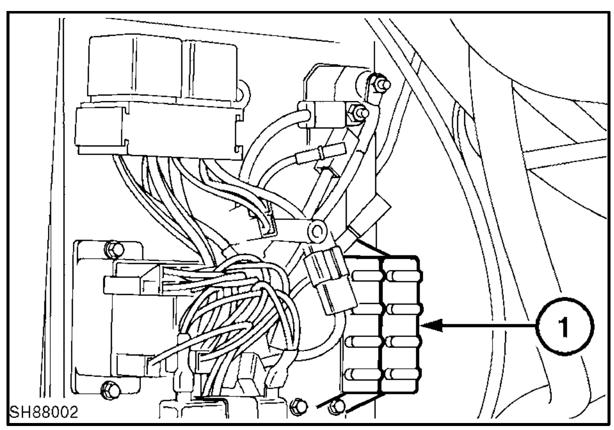
5. ALWAYS CONNECT new electrical attachments to the engine fuse/relay panel, 1, and connect the grounds to the engine bell housing. USE ONLY vacant connections and fuses not in use for specified attachments.
6. PLEASE REFER to Service Bulletin 11/95-I4 for more detailed information about higher amperage requirements and making electrical connections.



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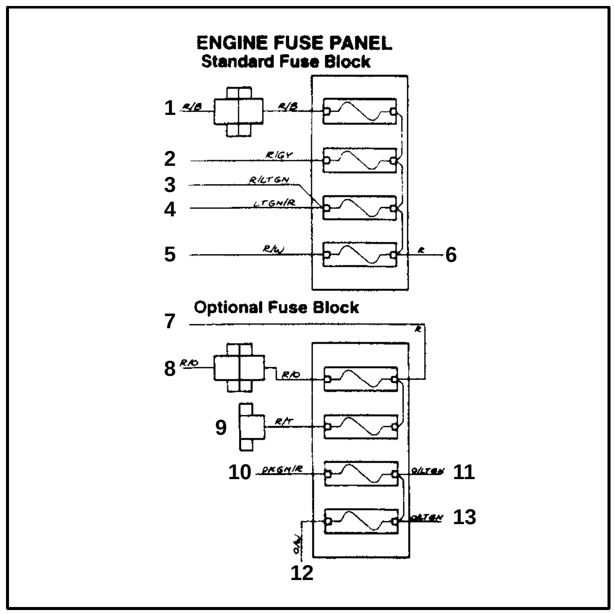
Wire connections available if electrical attachments were not previously installed.

Engine Fuse Panel

Ref.	Color	Destination	Fuse	Battery Voltage	Status
1	R/B	To turn signal relay	10-amp	All times	Available
2	R/GY	To accessory relay	25-amp	All times	Available
3	R/LTGN	To EIC board pin #14 P2 connector	5-amp	All times	Occupied
4	LTGN/R	To seat switch(es)	5-amp	All times	Occupied
5	R/W	To key switch (battery terminal)	15-amp	All times	Occupied
6	R	From preheat circuit breaker	20-amp	All times	Occupied
7	R	From start relay		All times	Occupied
8	R/O	To heater power relay	20-amp	All times	Available
9	R/T	Spare	7.5-amp	All times	Available
10	DKGN/R	To high flow, horn, power outlet	15-amp	Key “ON” position	Available
11	O/LTGN	From accessory relay		Key “ON” position	Occupied
12	O/W	To Back-up alarm switch	5-amp	Key “ON” position	Available
13	O/LTGN	From road/work light fuse (cab panel)		Key “ON” position	Occupied



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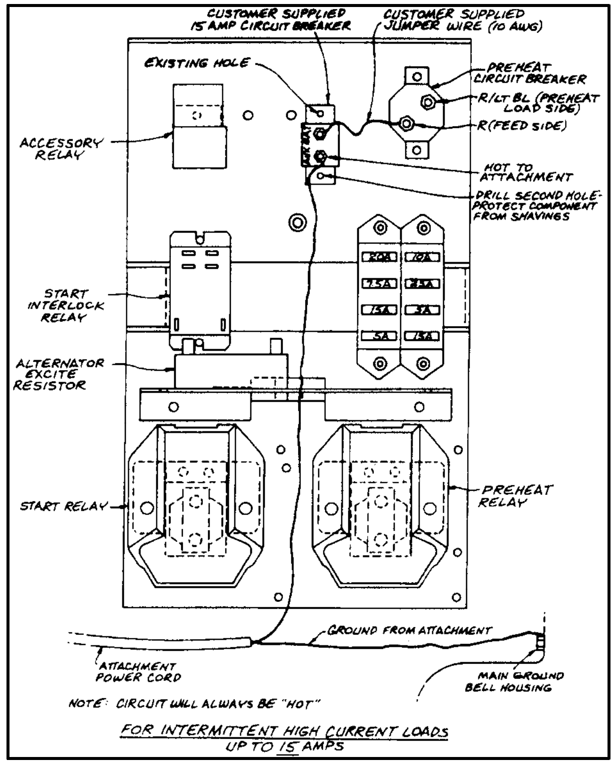
A completely new auxiliary wiring circuit can be installed as shown in Figures 4 and 5, depending on electrical requirements. Mounting holes for the added circuit breakers must be drilled in the panel. Disconnect the battery before drilling and installing new wiring. Protect the panel's electrical components from drilling shavings that could cause electrical shorting of components. Circuits for intermittent high current loads up to 15 amps are shown.



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This figure shows the circuit for intermittent high current loads up to 30 amps.

New Holland sealed circuit breakers that can be purchased from parts.

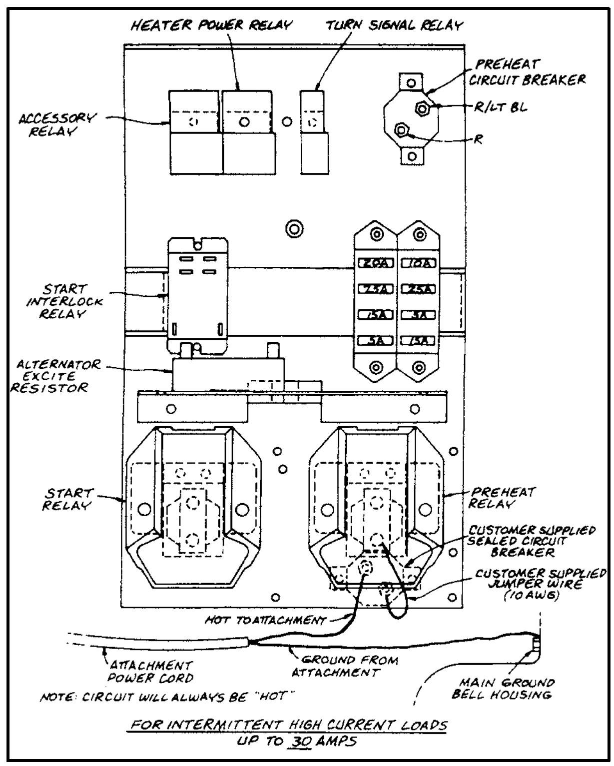
Part Number	Capacity
9827329	15 amp
9828493	20 amp
9840279	25 amp
9840280	30 amp

NOTE: *When attaching ground wires, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to size on top of the heaviest wire.*

IMPORTANT*: Additional electrical attachments must have circuits properly connected to prevent damage to the Advanced Warning System (EIC board) and other electrical components.*

CAUTION

Always disconnect the battery before installing any electrical attachment to prevent accidental shorting of system.



5

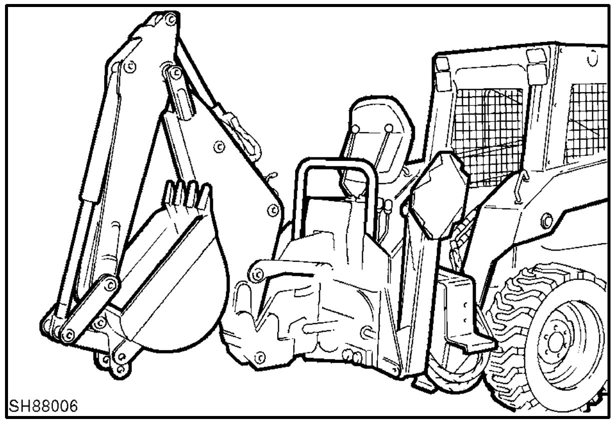
HYDRAULIC SYSTEM COMPATIBILITY

There are important questions that must be answered before adapting attachments that require hydraulic oil power.

1. What is the hydraulic pressure requirement, minimum and maximum? Are they higher than the maximum pressure of the model?

Model	Maximum Pressure
LS180	2500 to 2600 PSI (170-176 bar)
LS190	2500 to 2600 PSI (170-176 bar)

2. What is the hydraulic oil flow requirement? Is it more than the highest total flow rate of the skid-steer loader model?



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Model	Standard Hydraulics	High Flow Hydraulics
LS180	18.5 GPM (70.0 l/min.) @2350 RPM @1000 PSI (68 bar)	32.0 GPM (22 l/min.) @2250 RPM @1000 PSI (68 bar)
LS190	20.0 GPM (75.7 l/min.) @2350 RPM @1000 PSI (68 bar)	33.8 GPM (128 l/min.) @2350 RPM @1000 PSI (68 bar)

NOTE: *When using the High-Flow system, 3/4″ quick couplers must be used or high system backpressure may result.*

3. Will the attachment accept oil flow in both directions?

   If “YES”, nothing is required.

   If “NO”, install a check valve or cross into the attachment return line to prevent reverse oil flow to the attachment.

   Examples: Backhoes and trees spades with a separate control valve do not accept oil flow in both directions.

4. Must the attachment “Free Wheel” to a STOP?

   If “YES”, a crossover relief connection must be installed on the attachment side to allow the attachment to free wheel to a stop after the skid-steer loader hydraulics is turned off.

   If “NO”, nothing is required.
   Example: Snow blowers must free wheel to a stop.

5. Will the attachment accept hydraulic system backpressure?

   If “YES”, nothing is required.

   If “NO”, the attachment will not function properly on a New Holland skid-steer loader. Normal backpressure for New Holland skid-steer loaders is between 13.8 to 17.3 bar (200 to 250 PSI).

   Examples: Post drivers, some breakers, and some hand held hydraulic tools do not accept system backpressure.

   If all the skid-steer loader oil flow is not required to operate an attachment (e.g., shaver post driver), a flow divider can be installed into the hydraulic oil circuit on the attachment. The flow divider sends the required oil flow to the attachment and the remainder back to the normal skid-steer loader hydraulic circuits.

6. Does the attachment have a separate case drain oil line?

   If “NO”, nothing is required.

   If “YES”, install a separate case drain line to return the attachment case drain oil directly to the hydraulic oil reservoir.

   Example: Cold planners have a separate case drain oil line.

NOTE: *Most attachment case drains will not accept backpressure and must drain directly into the reservoir.*

NOTE: *Skid-steer loaders equipped with High Flow Hydraulics have a separate case drain coupler and return line attached to the right boom arm.*

7. Does the attachment require a circuit relief in the bucket circuit?

   If “NO”, nothing is required.

   If “YES”, install a bucket circuit relief valve on front of the control valve in the bucket circuit.

   Example: Some mini-backhoes attach like a bucket, and require a bucket circuit relief.

Op. 90 000

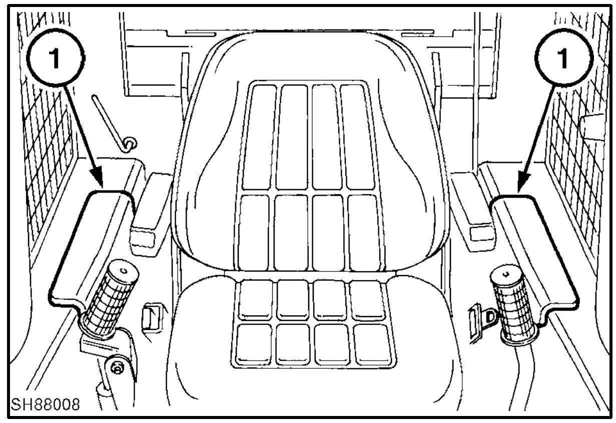
ARM PADS FOR CAB SIDE PANELS

The cab arm pads provide additional operator comfort and may be used separately or in combination with the seat armrest.

The arm pads, 1, require gluing in place to the cab side panels with Loctite® 454 gel adhesive.

The area where the arm pads are to be located must be cleaned thoroughly to ensure a secure bond to the cab side panel. If the area is not cleaned, the adhesive will not adhere to the metal side panels. Clean with methyl ethyl ketone, isopropyl alcohol, or equivalent cleaning solvent that will not leave a residue.

NOTE: *Position arm pads quickly because the adhesive begins to bond in a few seconds.*



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CAUTION

Read the adhesive label warnings. loctite 454 gel is a superglue-type material and can bond skin, eyes, etc. Use with adequate ventilation.

Op. 90 000

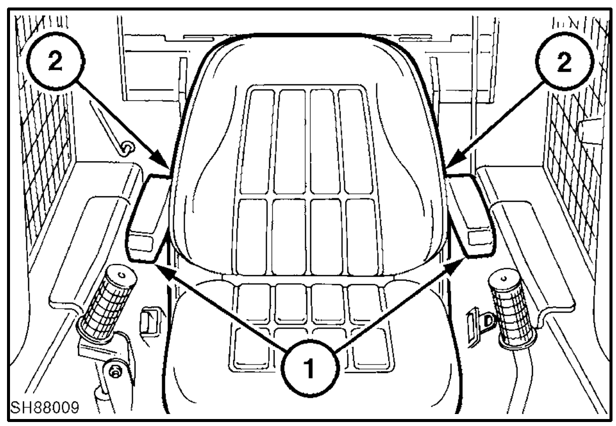
ARMRESTS FOR DELUXE SEAT

Right and left side armrests, 1, can be installed to the back of the **deluxe seat only**, at 2, for operator comfort.

NOTE: *The standard seat mounting holes are not provided to attach the armrests.*

There are two styles of armrest:

- Bolts attach armrests to the back of the steel back seat support.
- Bolts attach armrests to the sides of the plastic back seat supports.



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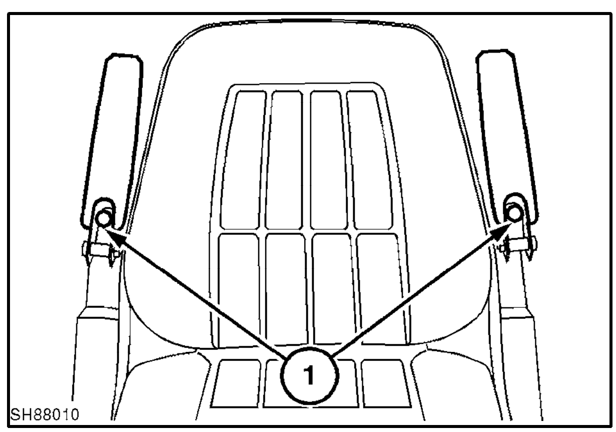
Armrest Adjustment

The armrest can be adjusted up or down for operator comfort by turning adjusting screws, 1.



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Op. 90 000

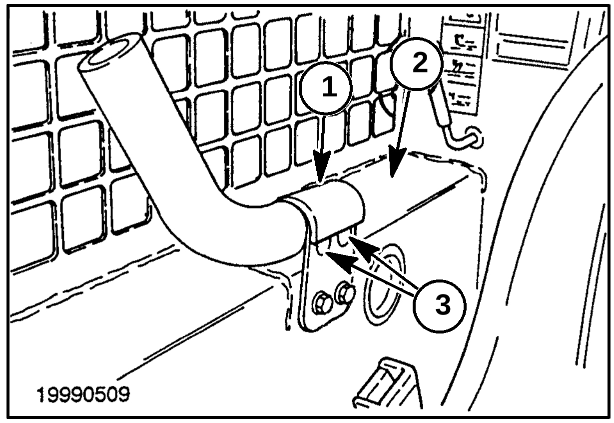
FOREARM RESTS

The forearm rests are attached to the side of the operator's cab (one each side) to be used to support the operator's arms while operating the skid steer. The armrest may be pivoted up when not being used or for ooerator entry and exit of the operator's area. The armrest may be used in any combination of controls, boom/bucket hand controls or boom/bucket foot controls. Using the armrest in combination with the boom and bucket hand controls provides the operator with arm support during boom and bucket operations.

NOTE: *The cab armrest pad kit cannot be installed in combination with the forearm rest kit. The armrest pads are glued to the same area of the operator's cab that the forearm rests are attached.*

The LS180 and LS190 armrests mount with the bracket, 1, over the cab side panel, 2.

Pivot the armrest up and down, and adjust the two clamp bolts, 3, if binding occurs, or to retain the armrest in the raised position.



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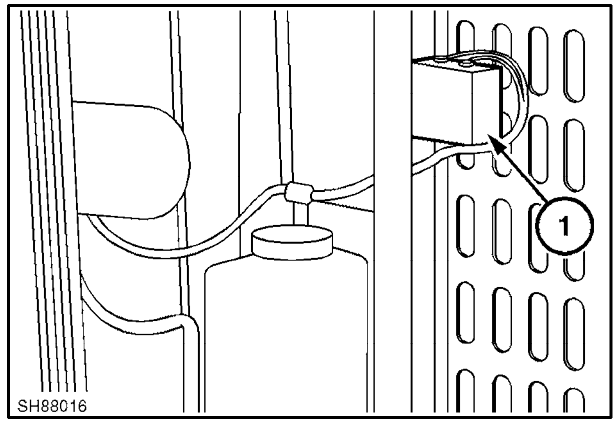
Op. 55 000

BACK-UP ALARM

The back-up alarm sound device should be located to the inside and in the upper right rear corner of the engine rear door at 1.



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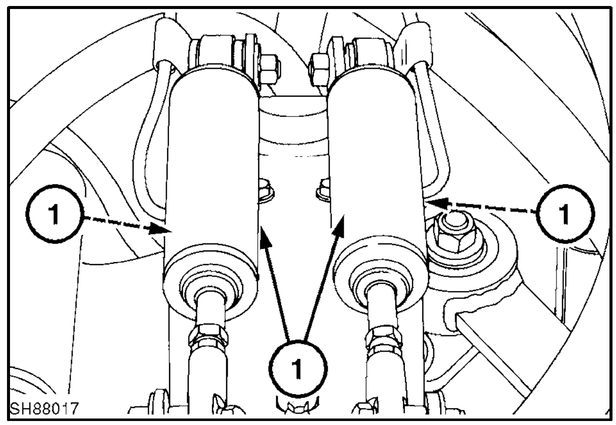
The back-up alarm serves as an audible warning device to alert bystanders and other machine operators of machine movements. The alarm will only sound when both hydrostatic control levers are stroked into reverse. Refer to local codes for requirements.

IMPORTANT: *Before servicing any switches or alarm, disconnect the negative (-) battery ground cable to avoid accidental shorts in the wiring system when removing or installing components.*

Adjustment

With the battery connected, and both hydrostatic control levers in the neutral position, loosen and slide both strikers, 1, rearward until the alarm sounds. Move the strikers forward until the alarm stops (approximately 1.5 mm [1/16″]) and tighten the hardware.

NOTE: *There are two different switch designs. Later model units will have round collars secured with set screws. The adjustment procedure is the same.*



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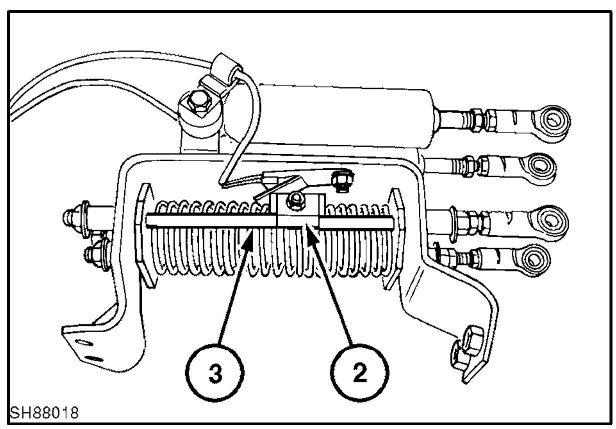
IMPORTANT: *Make sure the striker clamp, 2, is positioned around rod, 3, properly so the clamp will retain the striker.*

NOTE: *Both switches must be activated simultaneously for the alarm to sound.*



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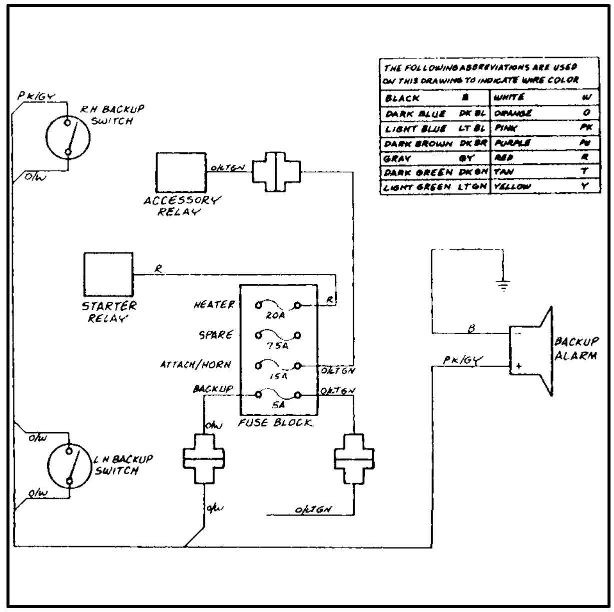
Back-up Alarm Wiring

The alarm is a negative (-) ground system.



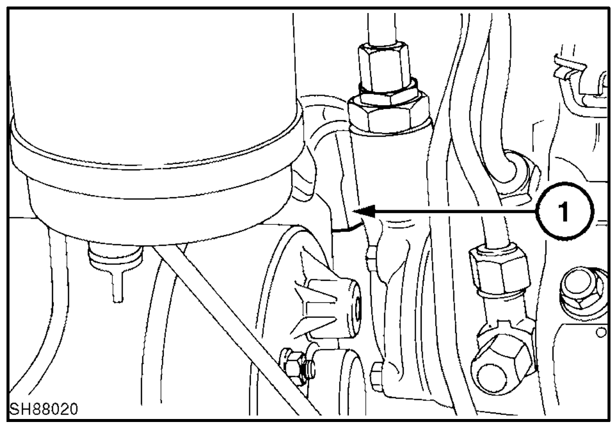
14

Op. 10 300

BLOCK HEATER (ENGINE)

The engine block heater, 1, may be required in colder climate areas to assist in starting of the diesel engine.

The block heater is a 115-volt, 400-watt immersion type.



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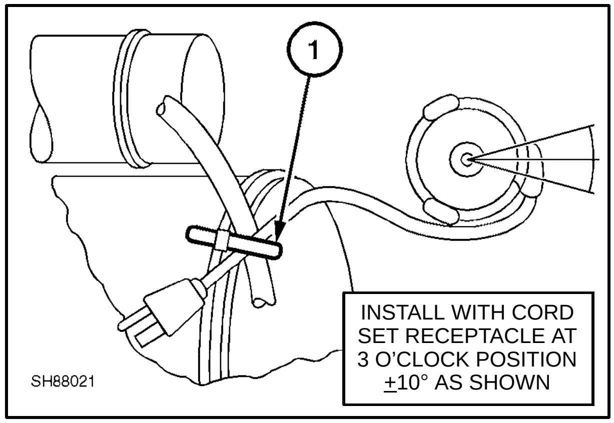
WARNING

The block heater must be installed and operated per the instructions provided with the kit or damage to the engine, heater element, and/or personal injury could occur.

Position the heater into the engine block so the cord set receptacle is at the 3 o'clock position ±10° as shown for proper heater operation. Install a wire tie, 1, to hold cord in place.



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WARNING

Before connecting the heater to the power source, be sure that the element is immersed in coolant. Never energize the heater in air. If so energized, the element sheath could burst and cause personal injury.

Do not operate the heater until the engine cooling system is filled with a 50/50 mixture of a permanent-type antifreeze and water.

Operate the engine and check for any coolant leaks and purge the air from the cooling system; repair accordingly.

IMPORTANT: *Failure to fill the cooling system and purging the air will cause premature failure of the block heater.*

CAUTION

This is a 115-volt heater. Use caution when installing and using the heater. Properly grounded electrical outlets and properly sized extension cords are essential for the use of the heater.

To insure continued protection against shock hazard, connect to properly grounded electrical outlets only.

First connect a grounded extension cord of the proper rating for the length used to the heater plug. Then connect the extension cord to the grounded electrical outlet.

CAUTION

Disconnect the extension cord from the grounded electrical outlet first and then from the heater before starting the loader. Inspect the heater wires periodically for broken or frayed wires and/or wire coverings. If wires and/or coverings are broken or frayed, do not use the heater.

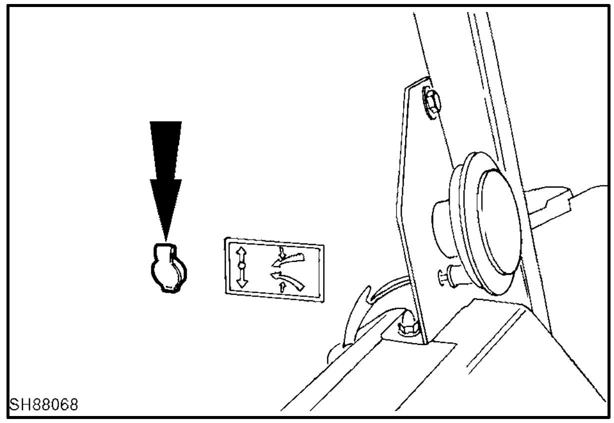
Op. 55 000

ELECTRIC POWER SUPPLY (12 VOLT, 15 AMP)

The electric power outlet can be installed on the loader to provide an auxiliary 12-volt power outlet rated at 15 amp. The power outlet is located to the left front of the operator's cab area.

If the horn kit is installed, the power kit wire harness is incorporated in the horn wire harness.

If the horn kit is not installed, the power kit receives its power from the 15-amp attachment/horn fuse in the engine fuse panel.



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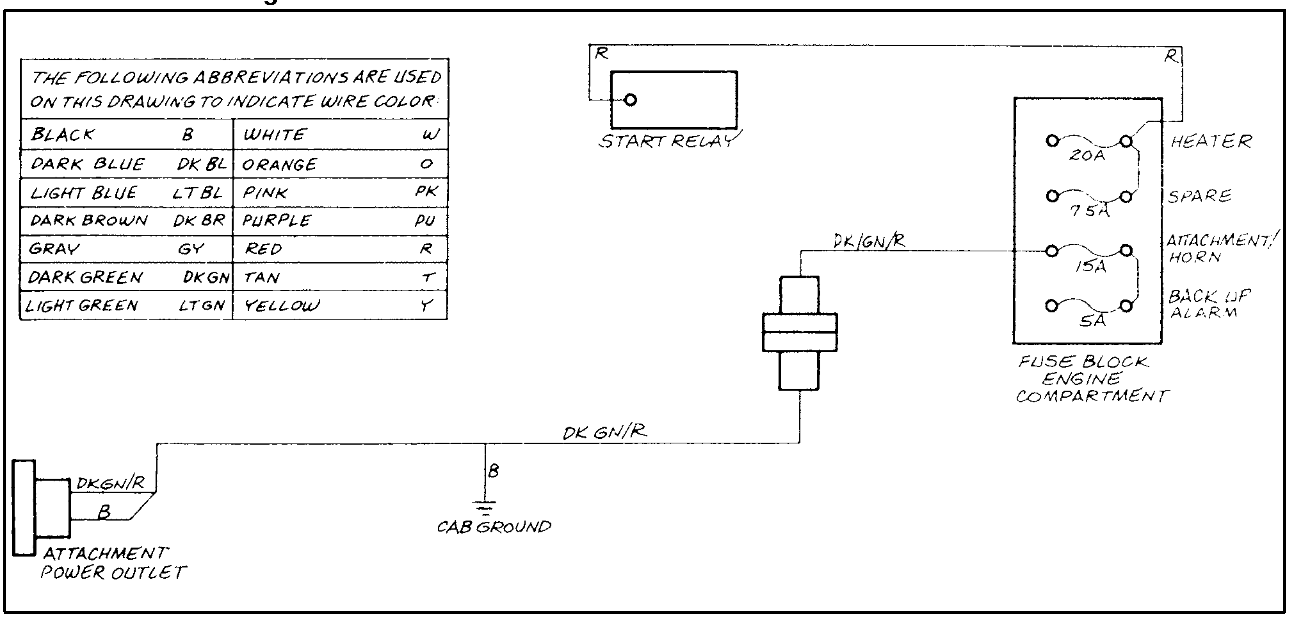
Electric Power Wiring



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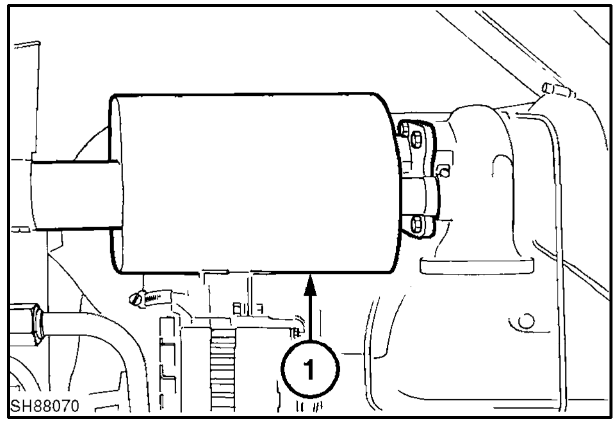
Op. 10 254

EXHAUST (ENGINE)

CATALYTIC MUFFLER LS180

The catalytic muffler kit is a combination catalytic and aspirated precleaner muffler and can be installed on diesel engines being operated in applications where cleaner exhaust emissions are required. The catalytic muffler, 1, is a direct replacement for the standard muffler.



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When operating a skid-steer loader equipped with the catalytic muffler, the unit must be operated at full engine speed.

The engine exhaust system must be operated at operating temperature for the catalytic purifier muffler to function properly. If the temperature is not high enough, the catalytic purifier muffler will not function properly and not reduce the carbon monoxide level. The operating life of the purifier muffler will also be reduced.

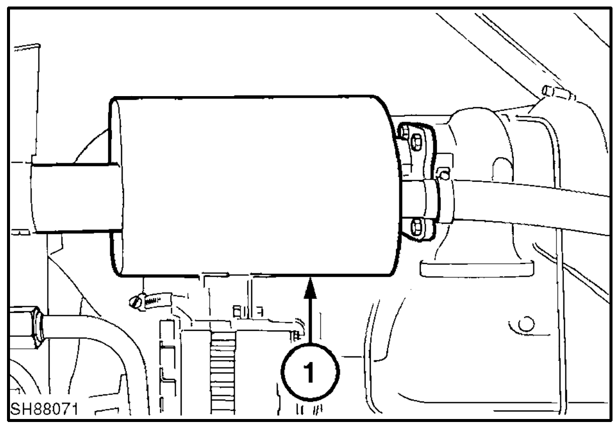
Op. 10 254

ASPIRATOR PRECLEANER MUFFLER

The precleaner aspirator muffler kit can be installed on diesel engines being operated in dusty applications to prolong air cleaner element life.

NOTE: *The precleaner aspirator muffler system is standard equipment from the factory on the model LS190.*

The aspirator muffler, 1, is a direct replacement for the standard muffler and standard air cleaner.



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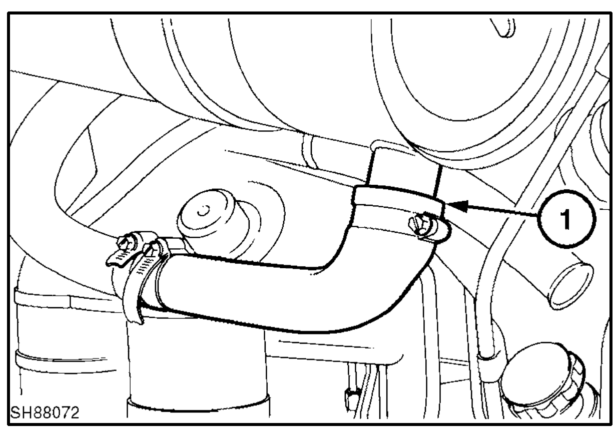
The aspirator muffler hose connects to the air cleaner at 1.

NOTE: *When the aspirator muffler is installed, the engine must be operated at or near full engine speed to reduce the recirculating of exhaust gases through the air cleaner. If an air cleaner element is sooted with diesel smoke, the engine is being operated at reduced speeds.*



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Op. 35 000

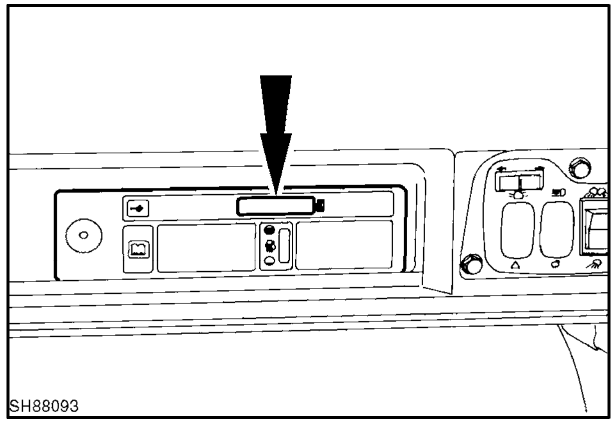
HIGH-FLOW HYDRAULICS

When the high-flow hydraulics circuit is used, it will allow the operator to utilize more available engine horsepower through the auxiliary hydraulic circuit.

The high-flow increases the hydraulic flow:

LS180
From 18.5 GPM (70 LPM) at 1000 PSI (68 bar) at 2225 RPM to 32.3 GPM (122 LPM) at 1000 PSI (68 bar), (at 2500 PSI [170 bar] = 47.1 hydraulic horsepower).

LS190
From 20.0 GPM (75.7 LPM) at 1000 PSI (68 bar) at 2325 RPM to 33.8 GPM (128 LPM) at 1000 PSI (68 bar), (at 2500 PSI [170 bar] = 49.3 hydraulic horsepower).



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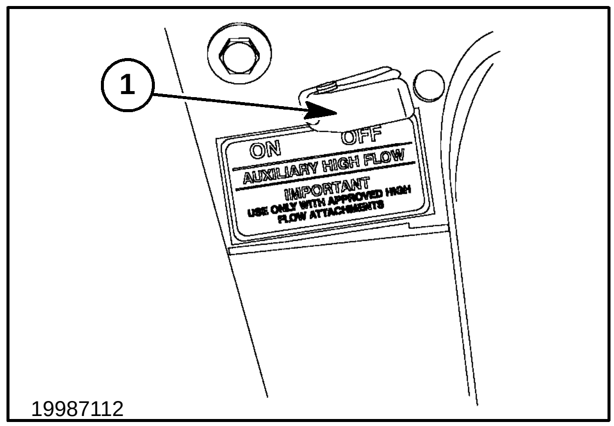
During warm climate operation, be conscious of the EIC (Electronic Instrument Cluster) temperature monitoring system. Adjust the attachment load (rate of feed) and length of continuous operation (duty cycle times) accordingly.

This high-flow is not intended to replace a fully dedicated, specialized machine.

When the attachment is not in use, be sure the high-low switch, 1, is in the “OFF” position to prevent overheating of the hydraulic oil.



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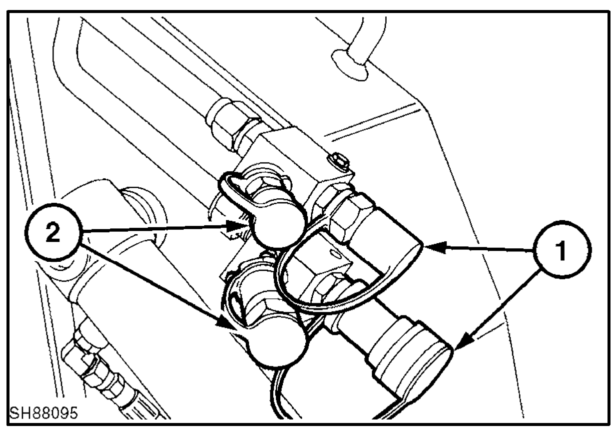
When the high-flow is being used, 3/4″ quick couplers, 1, must be used on the loader and attachment or overheating of the hydraulic oil may occur. The 1/2″ quick couplers, 2, can be used for other attachments that do not require the added oil flow.



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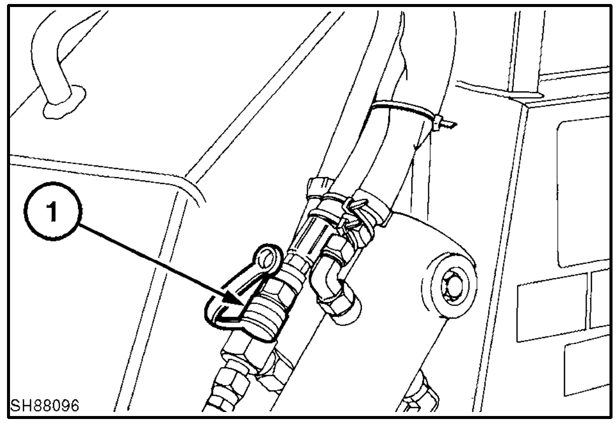
Attachment Case Drain

When the high-flow kit is installed, there is a separate case drain return line, 1, for the attachment case (housing) to drain oil.



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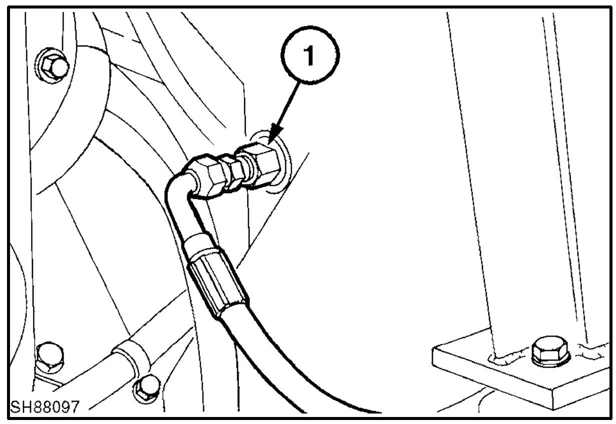
The case drain line drains into the hydraulic reservoir, 1. Most auxiliary hydraulic drive attachments equipped with a separate case drain line require no system back pressure for the drain line.



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HIGH-FLOW HYDRAULICS TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSES	CORRECTION
No switch operation	No battery voltage to switch	Check power supply at 15-amp fuse (attachment) engine fuse panel
		Check DKGN/R (Dark Green/Red) wire from fuse to switch
	Inoperative switch	Replace switch
No selector valve operation	No battery voltage to selector valve	Check switch for proper operation
		Check W/T (White/Tan) wire from switch to selector valve
	No circuit ground	Check B (Black) ground wire for proper grounding
	No selector valve spool movement	Check valve spool for binding and sticking
Hydraulic oil overheats	Using 1/2″ quick couplers	Must use 3/4″ quick couplers
	Control valve and boom steel lines and hoses were not changed from 5/8″ to 3/4″	Change lines and hoses to 3/4″
	Operating high-flow when not required	Turn high-flow switch to the “OFF” position
	Operating high-flow at relief pressure continuously	Operate attachment at lesser load
	Operating attachment when not applying a load to the attachment	Stop attachment when not loaded (moving from one work area to another)
	Operating attachment when high oil flows are not required	Turn high-flow switch to the “OFF” position
	Restriction in pressure or return lines	Check and repair
	All lift check parts not removed during assembly.	Remove all lift check parts (spring, poppet, and cap)
	Oil cooler restricted not allowing cooling air to flow properly	Clean oil cooler and radiator

PROBLEM	POSSIBLE CAUSES	CORRECTION
No increase in hydraulic oil flow when switch is in the “ON” position	No switch operation	Check power supply circuit
	No selector valve operation	Check power supply from switch
	Selector valve spool binding	Check for spool binding and repair
Low hydraulic power	Low main system relief valve setting	Check and replace relief valve
	Leaking control valve plugs, leaking oil to return	Check O ring and backup washer on plugs
	Inefficient gear pump (main)	Check pump efficiency, repair or replace
	Inefficient gear pump (high-flow)	Check pump efficiency, repair or replace

HIGH-FLOW HYDRAULICS COMPONENT REPLACEMENT

Op. 35 724

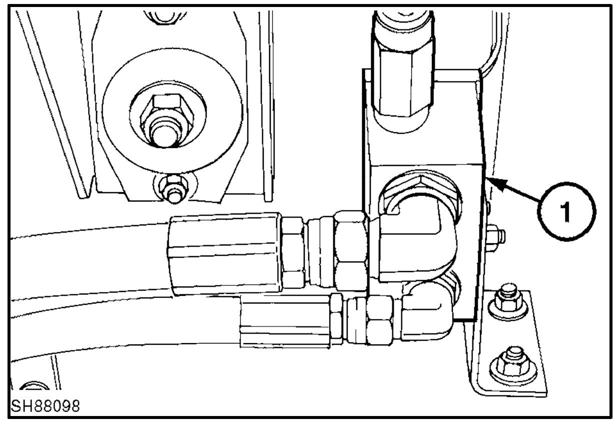
High-Flow Selector Valve Replacement
To access the selector valve:

1. Raise the boom and rest on the boom lock pins.
2. Open the rear engine access door and remove the right engine side shield.
3. The engine belly pan can also be removed for more access as shown.
4. Mark and remove the lines from the selector valve, 1.
5. Remove selector valve mounting hardware.

Rebuild the selector valve with new O rings on the spool and fittings at 1, and on both ends of the coil at 2.

To check the coil, use an ohmmeter and put one lead on one wire and the other on the other wire; the ohms reading should be between 7.5 and 11.5. If the coil is not within specification, replace it.

***NOTE:** The LS180 selector valve is located to the rear of the battery box (radiator end). The LS190 selector valve is located to the side of the battery box (engine side).*



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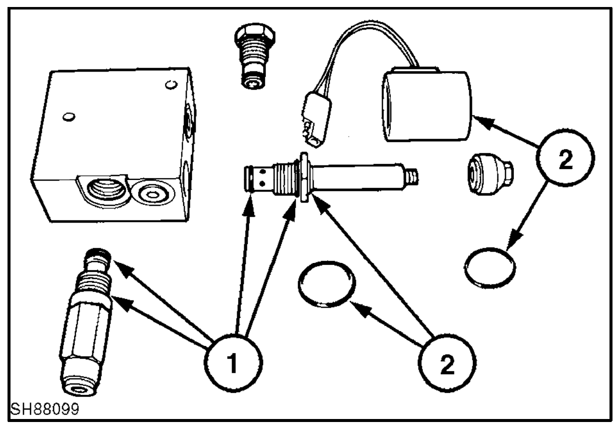

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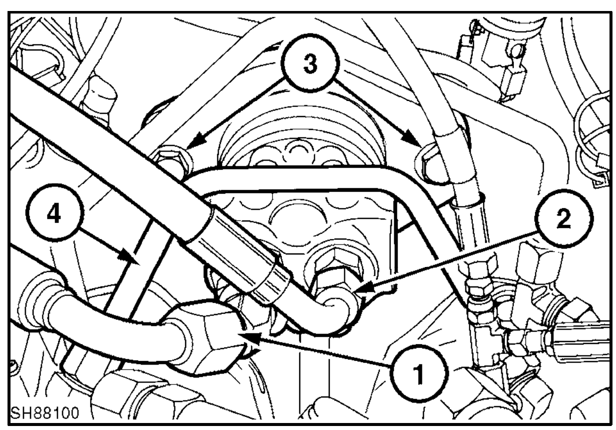
Op. 35 710

High-Flow Gear Pump Removal

1. Raise the boom and rest on the boom lock pins.
2. Raise the operator’s seat and latch in the raised latched position.
3. Remove suction line, 1, from the pump and cap the line. If the lines are not capped, the hydraulic oil reservoir must be drained to prevent loss of oil.
4. Remove the pressure line, 2, from the pump.
5. Loosen the gear pump mounting bolts, 3, and remove.
6. Remove the pump from gearbox. The charge line, 4, may need to be removed to remove pump.

***NOTE:** The gearbox oil level is below the pump drive level, the gearbox does not require draining.*



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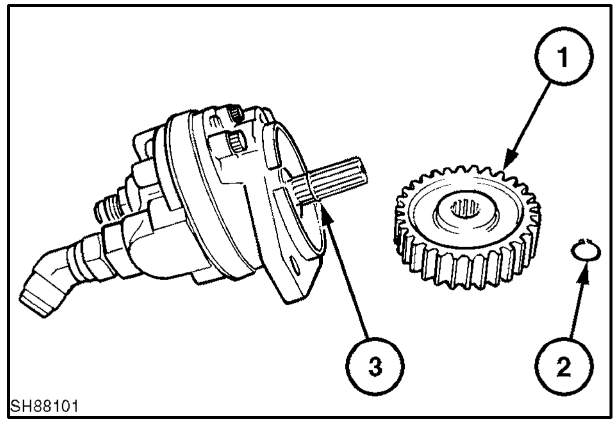
7. Remove the drive gear, 1, from the pump shaft by removing the retaining ring, 2.

8. Remove the inside retaining ring, 3, from the shaft.



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Op. 35 710 20

Gear Pump Repair

1. Remove the pump hardware, 1.

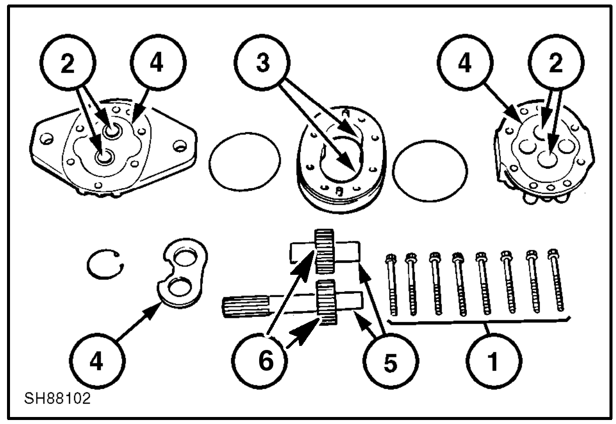
2. Using a soft hammer, tap the gear pump section to separate the pump sections.

3. Inspect the pump bearings, 2, for damage and wear.

4. Inspect the pump center section, 3, for scoring damage.

5. Inspect the pump end caps and bearing plate at 4 for scoring damage.

6. Inspect the drive shaft, 5, and gears, 6, for wear and scoring. Inspect the shaft in seal and bearing areas for scoring.



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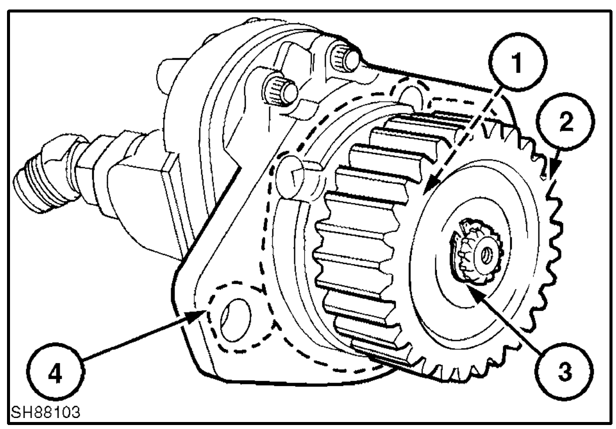
Gear Pump Reinstallation

1. Reinstall the inside retaining ring, 1, gear, 2, and outside retaining ring, 3, on pump shaft.

2. Apply a 1/4″ bead of silicone sealant around the pump flange at 4, and around the retaining hardware to seal pump top gearbox.



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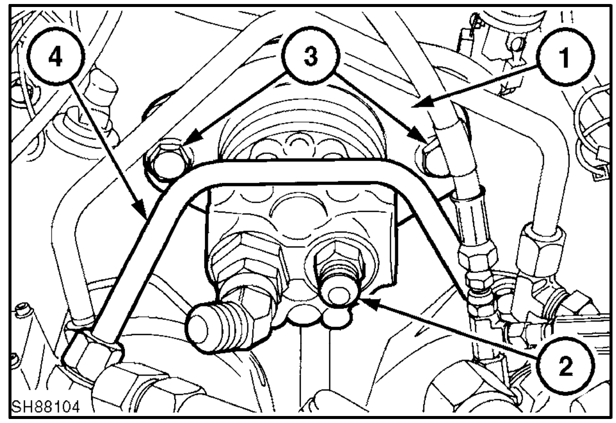
3. Insert the pump and drive gear assembly into the gearbox as shown at 1, with the 5/8″ straight flare fitting to the left of the loader as shown at 2.

   Attach the pump to the gearbox with two 1/2″ x 1-1/2″ G5 cap screws, 3, and two 1/2″ flat washers previously removed. Reconnect the hydrostatic charge line, 4, if previously removed.



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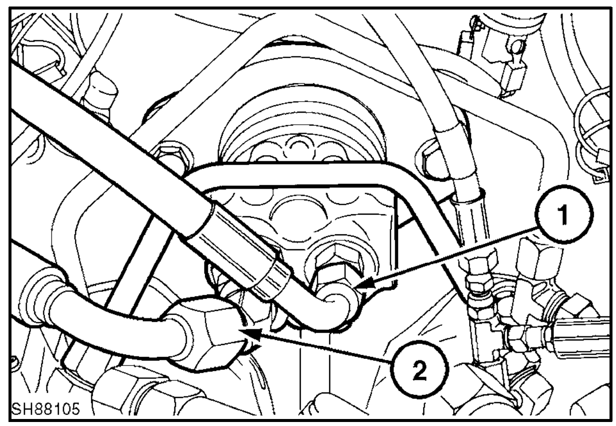
4. Reattach the 1/2″ hose to the pump fitting, 1.

5. Reattach the 3/4″ hose to the pump fitting, 2.



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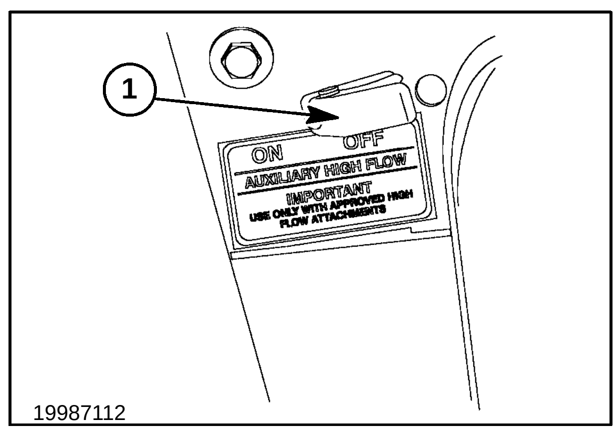
Start-Up After Repair

1. Engage the parking brake. Check that the high flow control switch, 1, is in the “OFF” position. (The switch is located to the left of the operator’s seat.)

2. Start the loader with the high-flow control switch in the “OFF” position and operate at idle, no more than 1500 RPM for about 10 minutes to allow air to be removed from the hydraulic system. Check for oil leaks and repair if required.

3. After operating the unit for a few minutes and with the control valve spool in the neutral position, turn the high-flow control switch to “ON” position and operate for a few minutes. Turn the switch to the “OFF” position. Check for oil leaks and repair if required.



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4. Connect a flow meter into the 3/4″ quick couplers, noting the flow of oil through the meter.

5. With the flow meter attached, start the loader and operate the auxiliary hydraulics with the high-flow control switch in the “OFF” position, and note the oil flow. Turn the high-flow control switch to the “ON” position and note the oil flow - the flow should increase. If the flow does not increase, check the operation of the electrical system and/or the operation of the control valve spool.

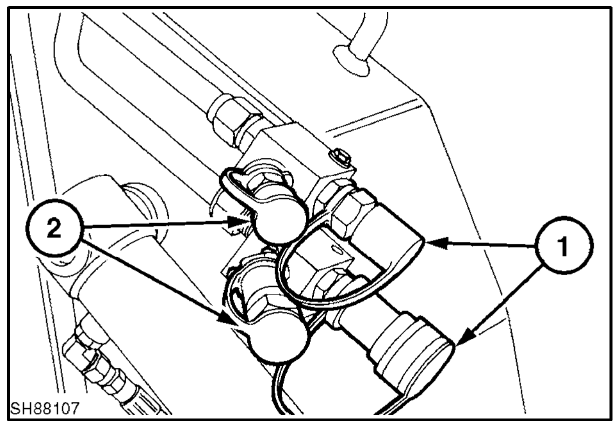
6. After operating the high-flow system, recheck the hydraulic reservoir oil level and add SAE 10W/30 APE Service SG-CF oil as required.

7. Reinstall all shields removed for kit installation.

HIGH-FLOW HYDRAULICS OPERATION

To operate the high-flow hydraulics, first have the attachment to be operated attached to the loader boom face plate and properly latched.

Connect the hydraulic hoses from the attachment to the boom quick couplers. If the manifold blocks were installed, the 1/2″ couplers, 2, or the 3/4″ couplers, 1, can be used, but not both at the same time. When operating the high-flow system, the 3/4″ couplers must be used to prevent high system backpressure, and to ensure proper operation of the attachments.



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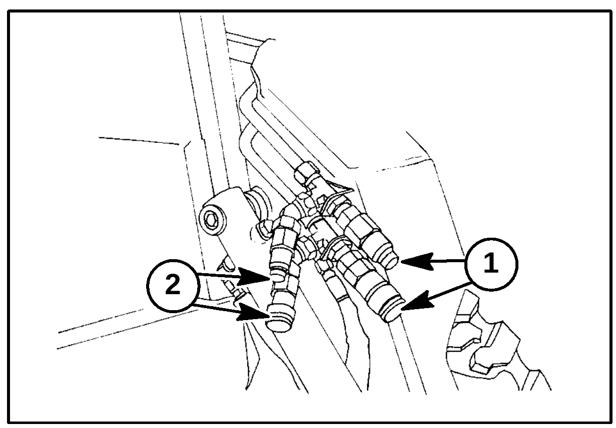
NOTE: *When the high-flow hydraulics are in operation, the 3/4″ couplers must be used.*

NOTE: *Flat-faced quide couplers have become standard equipment for Boom Hydraulic kits, High-Flow Hydraulic kits, and production models equipped with these options.*



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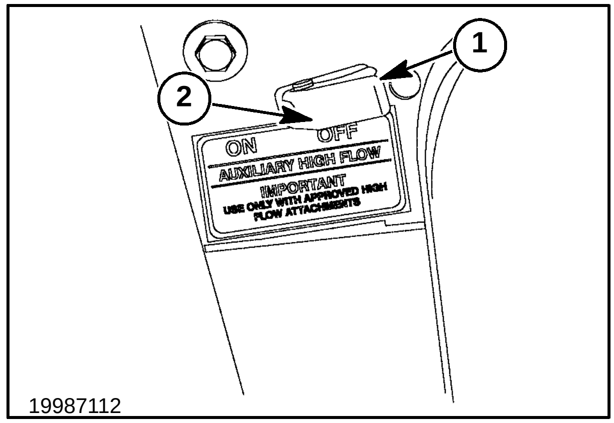
Start the Loader Engine

NOTE: *Before starting the skid-steer loader engine, make sure the high-flow control switch is in the "OFF" position and the auxiliary controls are in the neutral position. If this procedure is not followed, difficult starting may occur.*

The high-flow electronic selector valve switch is located to the left of the operator at 1. When the switch is in the "OFF" position, the skid-steer loader standard oil flow will be provided at the boom quick couplers and either the 1/2″ or 3/4″ quick couplers may be used.

To start the added oil flow, raise the switch cover, 2, and turn the switch to the "ON" position. The standard oil flow and the added high flow will be combined at the main control valve in the auxiliary spool circuit. The 3/4″ quick couplers must be used.



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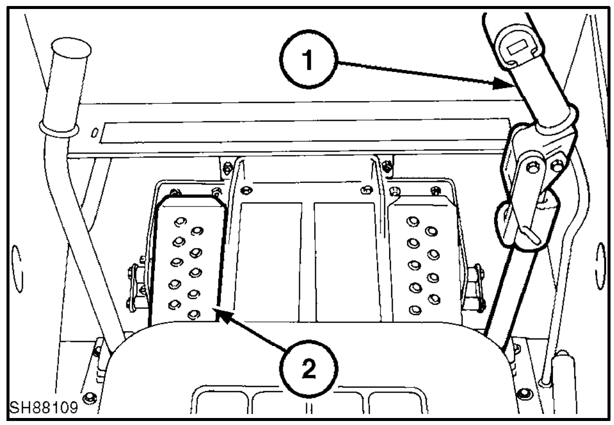
Operate the right-hand control lever, 1, with boom and bucket foot controls or the left foot pedal, 2, with boom and bucket hand controls to supply the oil flow to the boom quick couplers.

Pivoting the handle down supplies pressure oil to the male quick coupler.

Pivoting the handle up supplies pressure oil to the female quick coupler.

When the handle is released, it will return the control valve spool to the center (neutral) position.

Moving the handle down all the way will put the control valve spool in the detent position, supplying continuous oil flow to an attachment. The handle will stay in this position until the operator moves the handle.



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NOTE: *If the operator will be using the auxiliary spool detent position, the loader quick couplers and attachment must match properly to ensure proper oil flow and attachment operation.*

Some attachments may require oil flow in one direction ONLY and must be assembled accordingly. If the attachment will not accept oil flow in both directions, a check valve must be installed in the return line from the attachment to prevent damage to the attachment.

To stop the attachment operation, return the control to the neutral position. When the additional hydraulic oil flow is not required, turn the electronic control switch to the “OFF” position.

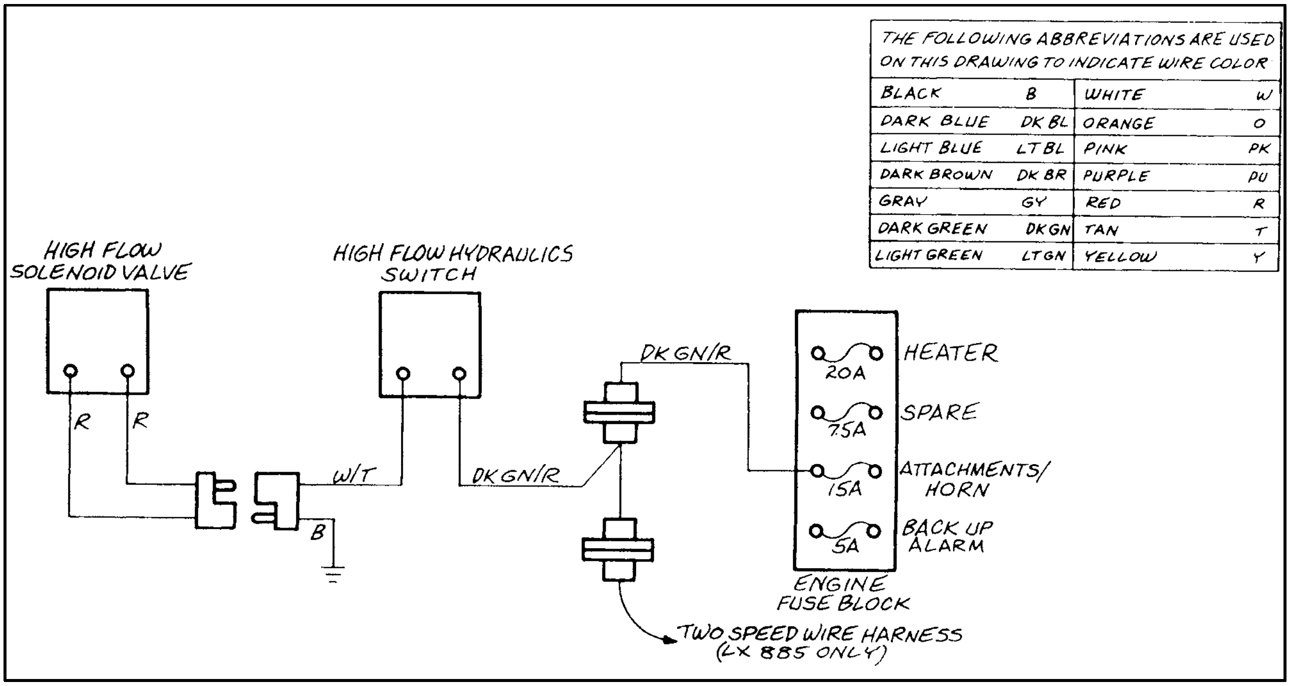
During operation of the hydraulic high flow, use the skid-steer loader Advanced Warning System to monitor the engine coolant or hydraulic oil temperature.

IMPORTANT*: When operating the high-flow for extended periods of time, monitor the system temperatures. If temperatures reach 210°F (99°C), for engine coolant, or 200°F (93°C), for hydraulic oil, back off operation to allow the systems to cool down.*

IMPORTANT: *Operating hydraulic attachments at maximum HP relief valve pressure will cause excessive heat. Relief valves operated at relief pressures will cause hydraulic oil to overheat quickly.*

The high-flow switch MUST BE IN THE “OFF” position when the added oil flow is not required or the attachment is not in use to prevent unnecessary hydraulic oil heating and engine loads.

High Flow Electrical Wiring Diagram



THE FOLLOWING ABBREVIATIONS ARE USED ON THIS DRAWING TO INDICATE WIRE COLOR

BLACK	B	WHITE	W
DARK BLUE	DK BL	ORANGE	O
LIGHT BLUE	LT BL	PINK	PK
DARK BROWN	DK BR	PURPLE	PU
GRAY	GY	RED	R
DARK GREEN	DK GN	TAN	T
LIGHT GREEN	LT GN	YELLOW	Y

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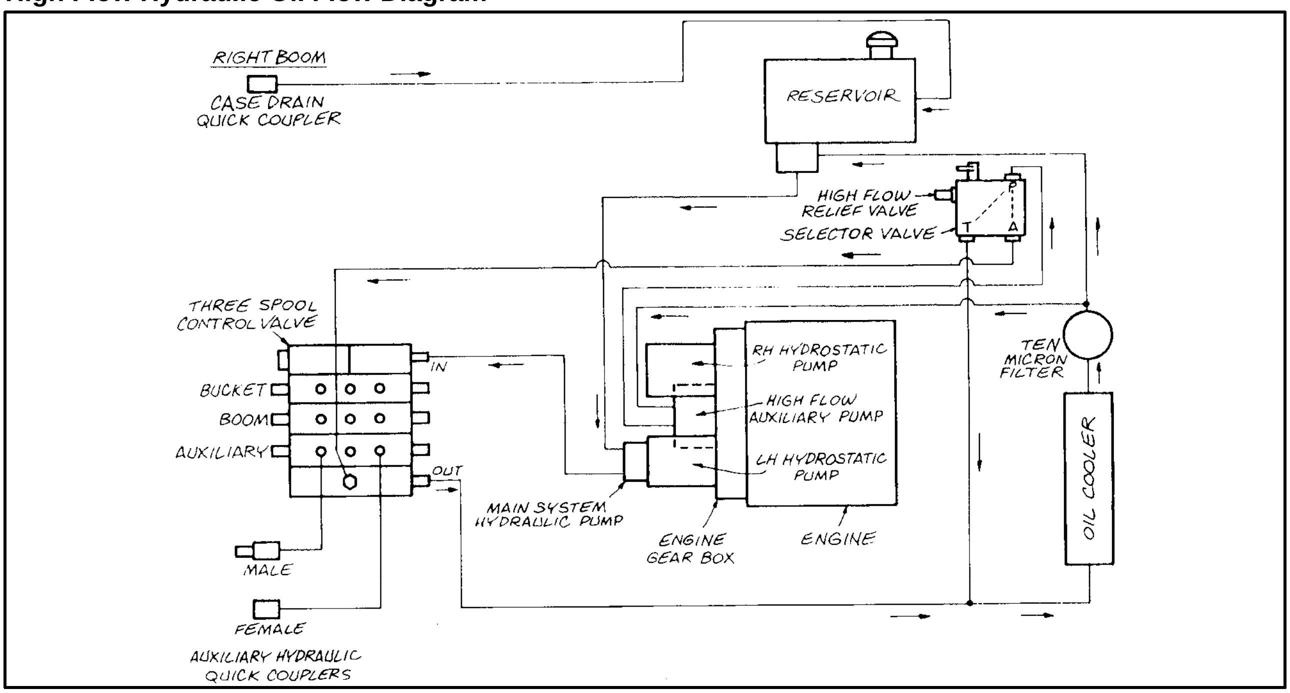
High Flow Hydraulic Oil Flow Diagram



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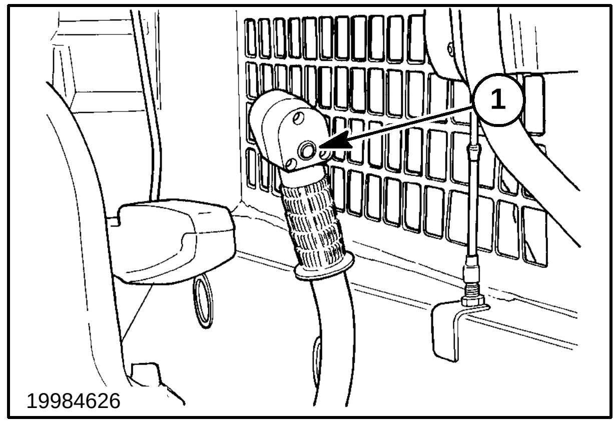
HORN

The horn kit provides an operator-controlled device to alert bystanders and other machine operators. The horn button is located in the top of the left hydrostatic control lever as shown at 1.



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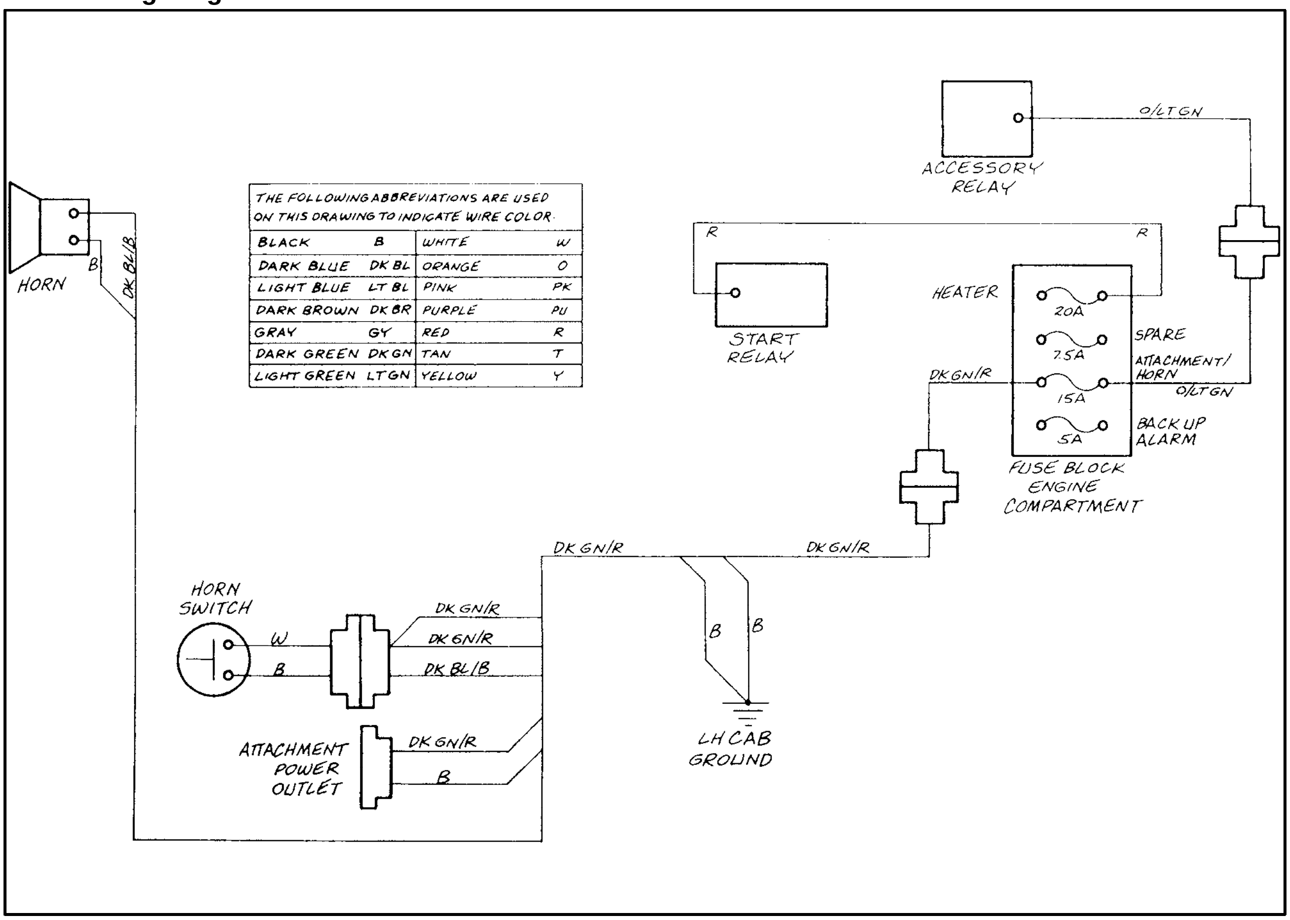
Horn Wiring Diagram



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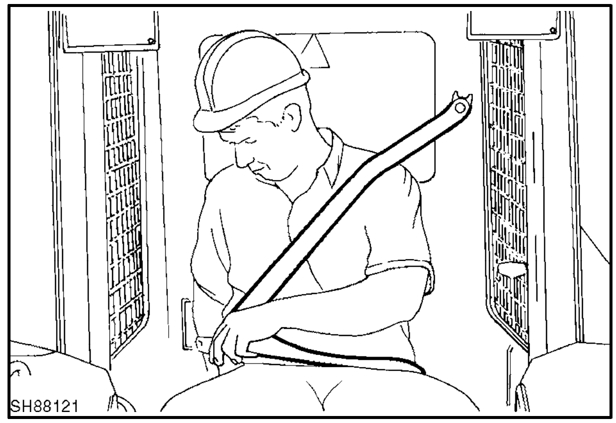
Op. 90 000

SHOULDER BELT (SEAT)

The shoulder belt can be installed with the lap seat belt.

The shoulder belt is recommended anytime a front cab door is installed.



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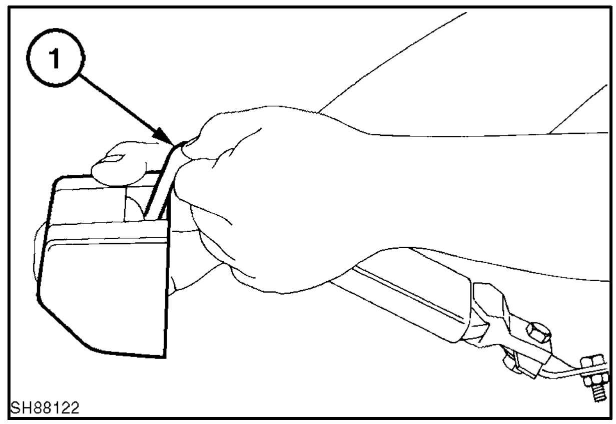
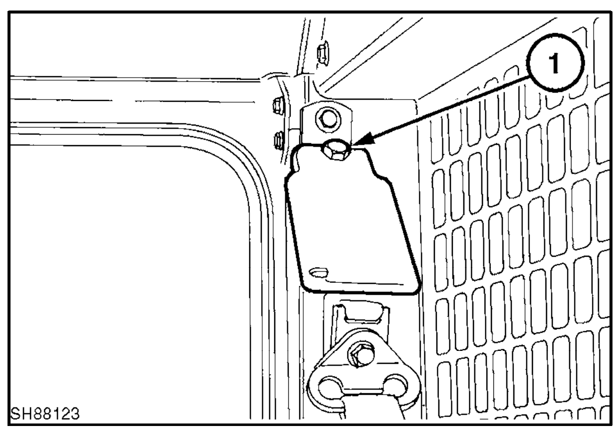
If the shoulder belt becomes completely retracted or the belt becomes locked, the web must move back into the retractor approximately 1/2″ with the retractor in 90/90 degree or proper mounting position. When the belt is retracted 1/2″, hold the belt straight up and pull the belt up slowly, 1. The belt will not unlock and pull out in any other position.



45

The shoulder belt support pivot bolt, 1, must be loose enough to allow the belt to pivot. If the belt will not pivot properly, it will not adjust to fit the operator.



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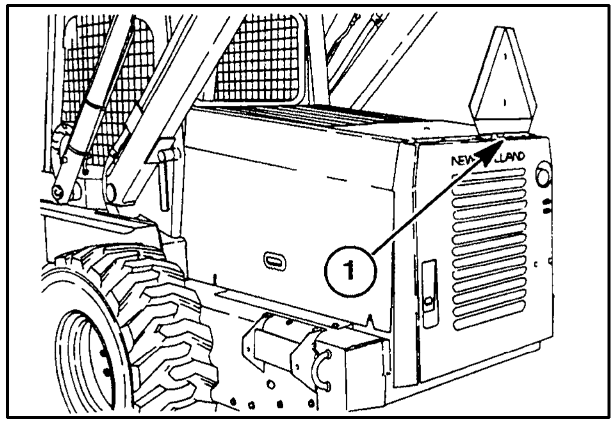
Op. 88 000

SLOW-MOVING VEHICLE (SMV) SIGN KIT

The Slow-Moving Vehicle (SMV) kit mounts to the rear door of the skid-steer loader to alert other vehicles when the loader is operated on roadways.

The bracket, 1, must be installed correctly to hold the SMV sign in place on top of the door.



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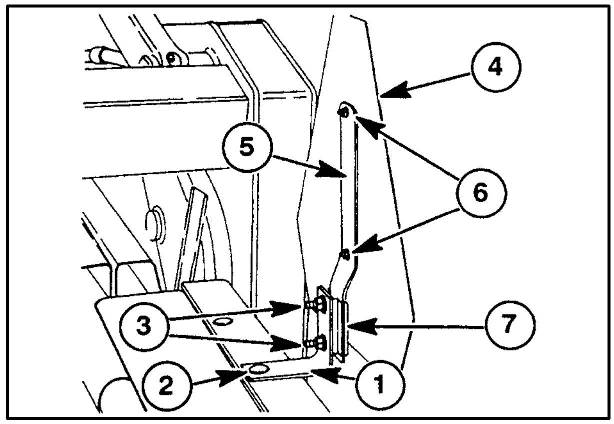
1. Attach the angle, 1, with one 5/16″ x 1-1/4″ carriage bolt from the kit and nut and M8 lock washer previously removed at 2.
2. Attach the spade socket to the angle at 3 using two 5/16″ x 1″ carriage bolts, M8 lock washers, and nuts.
3. Assemble the SMV sign, 4, to the support, 5, using two #10 x 1/2″ machine screws and flange nuts at 6.
4. Mount the SMV sign assembly in the spade socket as shown at 7.



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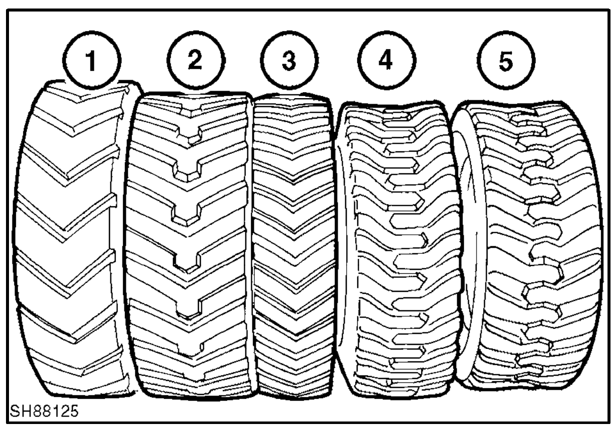
TIRES/WHEELS

TIRE OPTIONS

1. 8.25 x 15 HST-Hollow segmented
2. 12.00 x 16.5 HST-Hollow segmented
3. 8.25 x 15 Chevron tread
4. 12.00 x 16.5 R4-Cleat tread
5. 12.00 x 16.5 PHD- Premium heavy-duty
6. 14.00 x 17.5 cleat tread (not shown)
7. Solid Tires (not shown)

NOTE: *Solid tires are available and can be obtained from your New Holland dealer.*



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Tire Pressures

Tire	Pressure
8.25 x 15 Chevron tread	50 PSI (414 kPa)
7.50 x 15 HST-Hollow segmented	N/A
12.00 x 16.5 R4-Cleat tread	50 PSI (345 kPa)
12.00 x 16.5 PHD- Premium heavy-duty	50 PSI (345 kPa)
12.00 x 16.5 HST-Hollow segmented	N/A
14.00 x 17.5 - cleat tread	60 PSI (410 kPa)

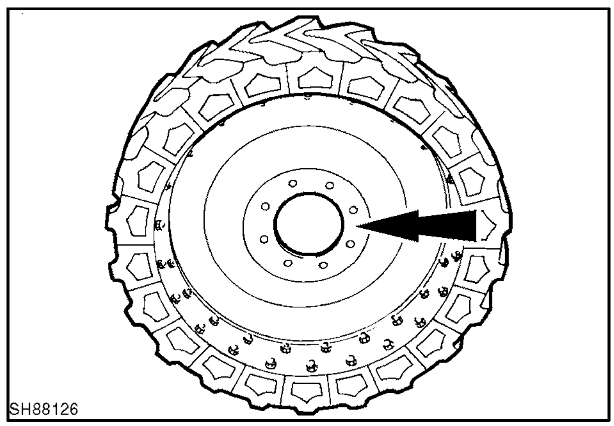
MAINTAIN PROPER TIRE INFLATION!

NOTE: *Iatco “Air Boss” segmented tires are approved for all new generation New Holland loader models. These tires must be mounted with the wheel dish “in” to the frame (narrowest wheel tread position). Reversing the wheels with the dish “out” is not recommended, as increased axle and frame loading occurs, which may lead to eventual axle bearing and/or main frame failure.*

TIRE AND TRACK INSTALLATION

Tire Installation on Loader

The 8.25 x 15 HST-Hollow segmented and the 12.00 x 16.5 HST-Hollow segmented tires must be mounted with the wheel dish “IN” to the frame (narrowest wheel tread position). Reversing the wheels with the dish “OUT” is not recommended, as increased axle and frame loading occurs. This may lead to eventual axle bearing and/or main frame failures.



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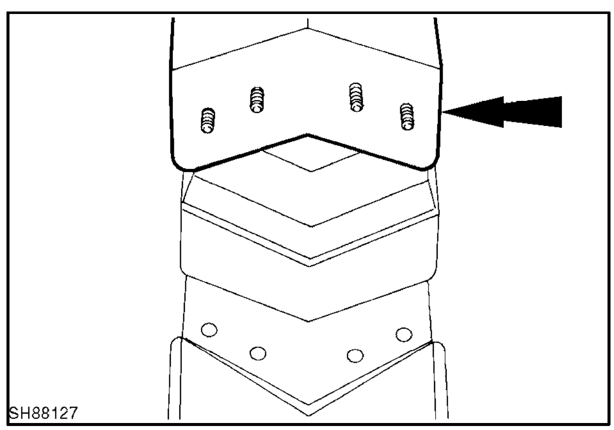
Op. 44 511 28

When replacing the sections of the hollow segmented tires, torque the section hardware to 10 ft. lbs. (13.6 N·m).



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Track Installation on Loader

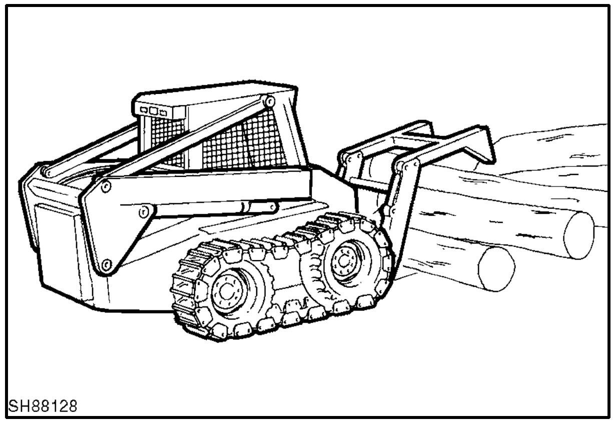
Correct tire/track combinations are important to prevent damage to the tracks, tires/wheels, and loader main frame.

Installing tracks on skid-steer loaders equipped with segmented tires, solid tires, foam-filled tires, or any hard-type non-pneumatic tires is not recommended. If these tire combinations are used with steel tracks, track or loader main frame damage may occur.

These tires **do not** provide a cushion when debris comes between the track and tire. A pneumatic tire will absorb this type of stress and, in severe cases, may deflate before damage to the loader or track occurs.

New Holland only recommends pneumatic tires be installed with tracks.

IMPORTANT: *Tracks are not to be installed on the LS190 skid steers equipped with 14.00 x 17.5 tires. The tracks will interfere with the fenders, boom, and attachments.*



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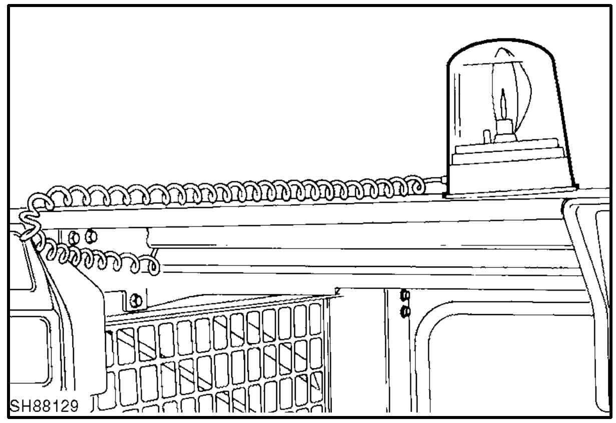
BUCKET AND TIRE COMBINATION CHART

Tire Size	Description	Machine Width Including Tires	Recommended Bucket
8.25 x 15	Chevron Tread	66″ (1676 mm)	66 - 72-LP-D&F 72-M&F-LM 78-LP 84-M&F-LM 84-LP
8.25 x 15	HST Hollow Segmented Tires	65″ (1651 mm)	66 - 72-LP-D&F 72-M&F-LM 78-LP 84-M&F-LM 84-LP
12 x 16.5	Cleat Tread	72″ (1829 mm)	72-LP-D&F 72-M&F-LM 78-LP 84-M&F-LM 84-LP
12 x 16.5	HD 2000	72″ (1829 mm)	72-LP-D&F 72-M&F-LM 78-LP 84-M&F-LM 84-LP
12 x 16.5	HST Hollow Segmented Tires	70″ (1778 mm)	72-LP-D&F 72-M&F-LM 78-LP 84-M&F-LM 84-LP
14 x 17.5 (LS190 only)	Cleat Tread	76.25″ (1937 mm)	84-M&F-LM 84-LP

Op. 55 000

WARNING LIGHT (ROTARY BEACON)

The beacon light is a visual alerting device for bystanders and other machine operators. The beacon light's magnetic base mounts the light securely to any part of the roof or frame.



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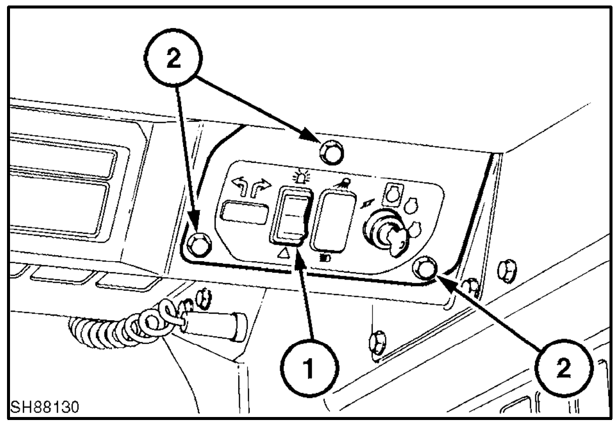
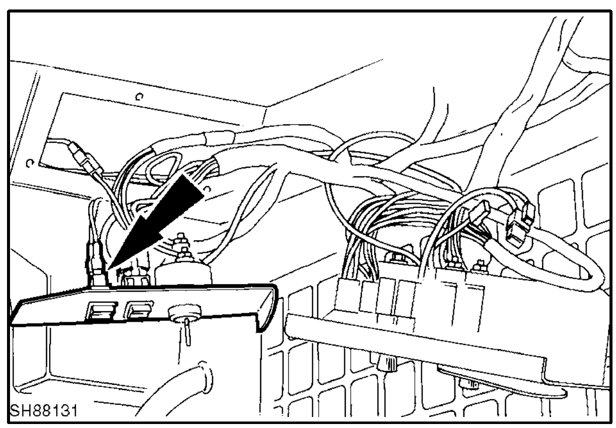
The beacon light switch, 1, is located in the ignition key switch panel in the upper right corner of the overhead dash.

To remove the switch, disconnect the negative (-) ground battery cable, remove the key switch panel hardware, 2, and tilt the panel down.



54

Disconnect wires from the switch, squeeze the switch retaining tabs in, and remove the switch from the panel.



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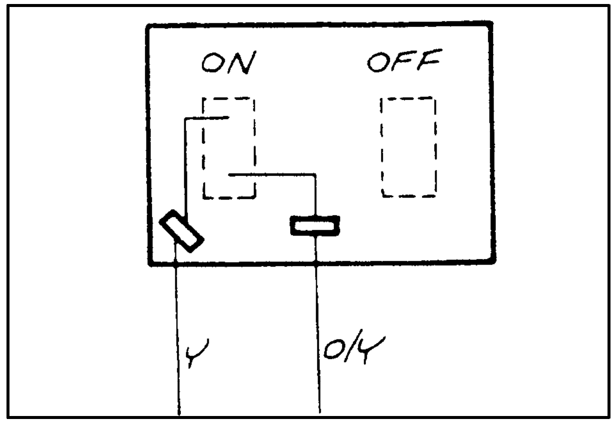
Beacon Switch Wiring



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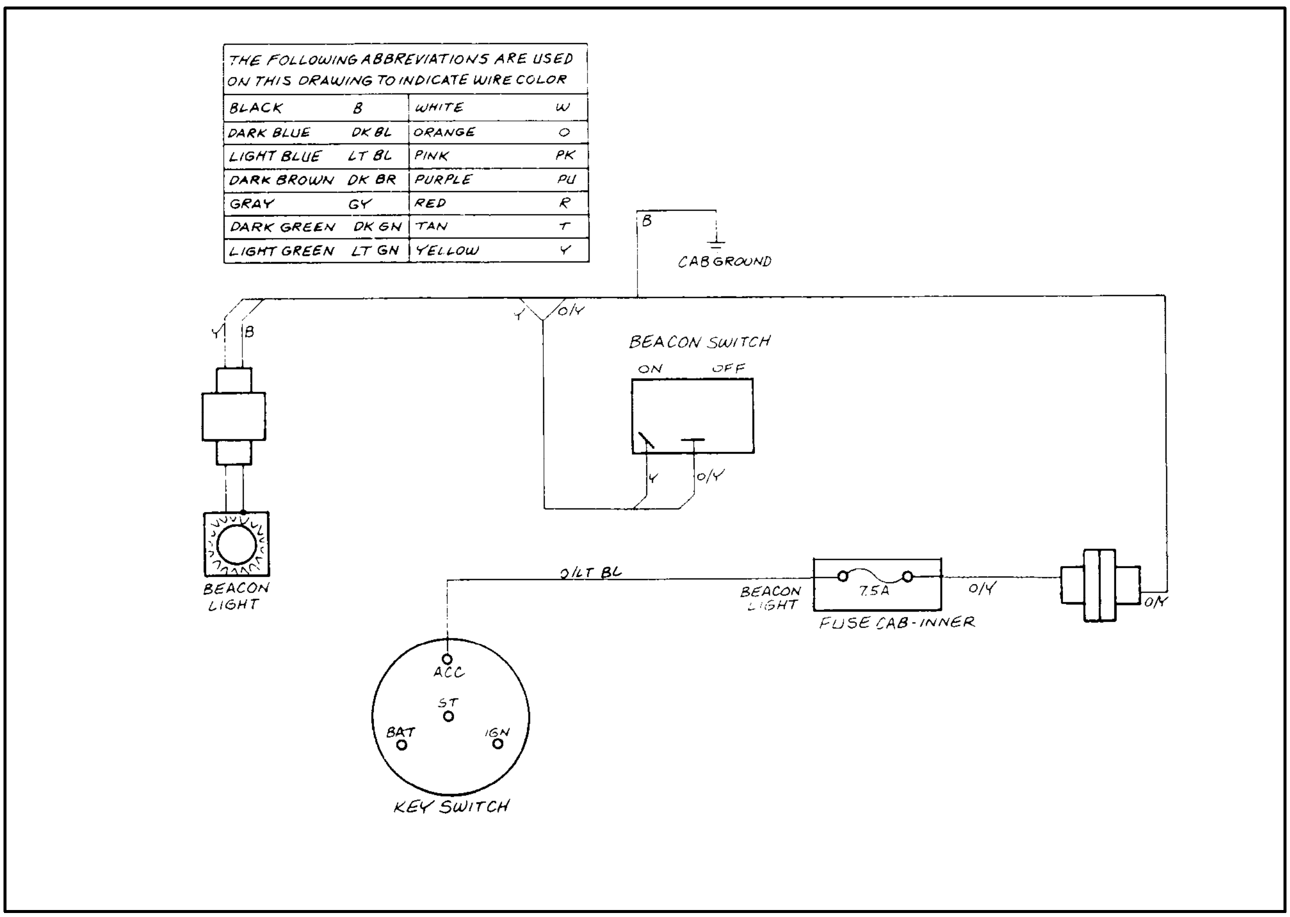
Beacon Wiring Diagram

NOTE: *When attaching ground wires, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to size on top of the heaviest wire.*



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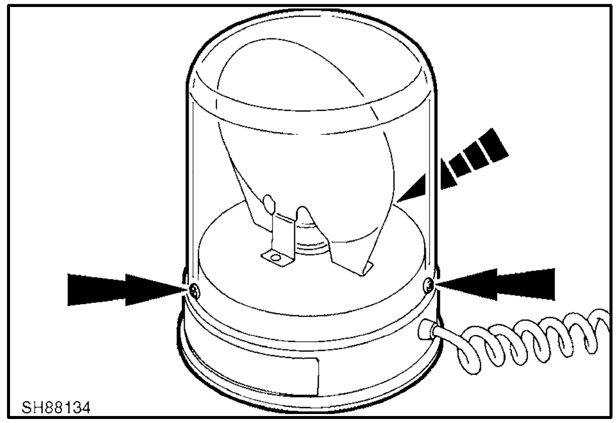
Beacon Bulb Replacement
Bulb only #69AG13009AA (H1 12V 55W)

To replace the bulb, remove the three screws attaching the lens to the base and lift the lens from the base.



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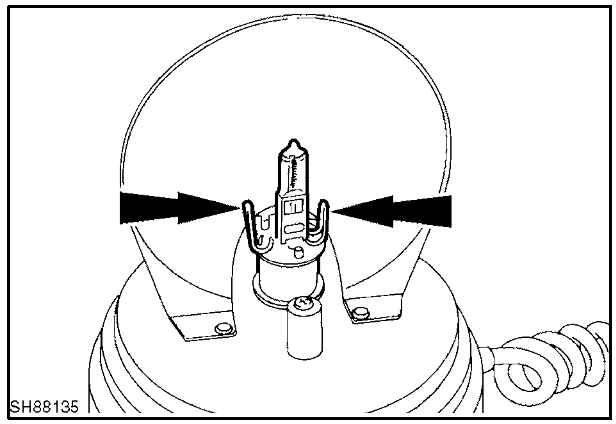
Squeeze the bulb retaining tabs to separate the bulb from the holder.

Remove the bulb assembly from the wire connector.



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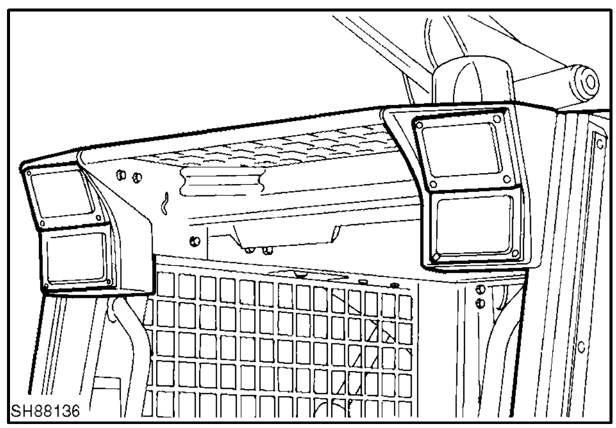
Op. 55 000

WARNING LIGHTS (FOUR-WAY FLASHERS/TURN SIGNAL/HORN)

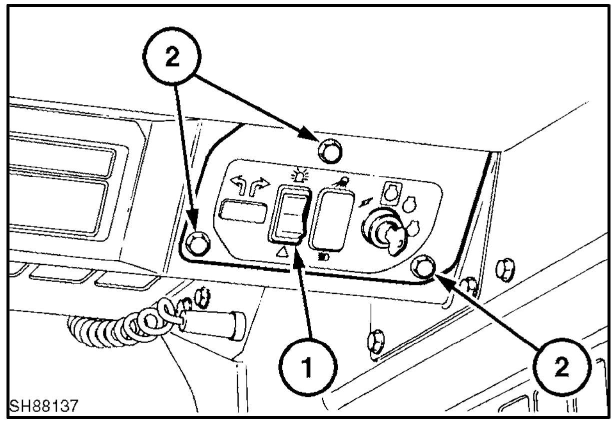
The four-way flashing lights on the front and rear of the loader provide a visual alerting device to bystanders and other machine operators.



60

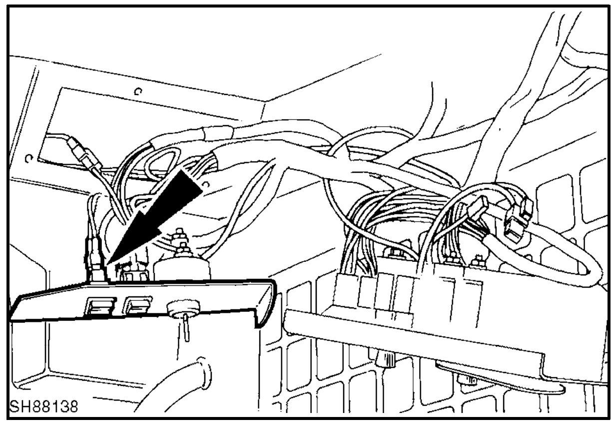
The warning light switch, 1, is located in the ignition key switch panel in the upper right corner of the overhead dash.

To remove the switch, disconnect the negative (-) ground battery cable, remove the key switch panel hardware, 2, and tilt the panel down.



61

Disconnect the wires from the switch. Squeeze the switch retaining tabs in and remove the switch from the panel.



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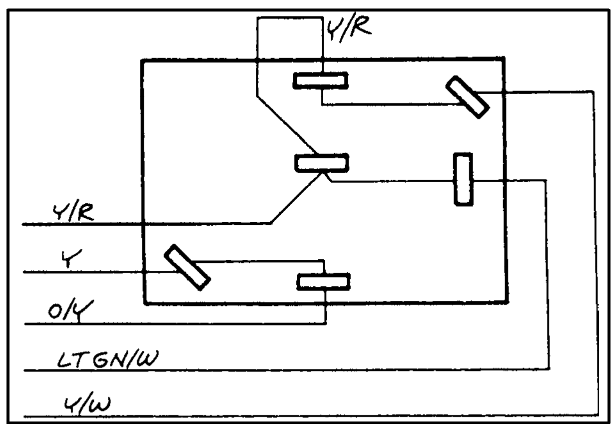
Warning Light Switch Wiring



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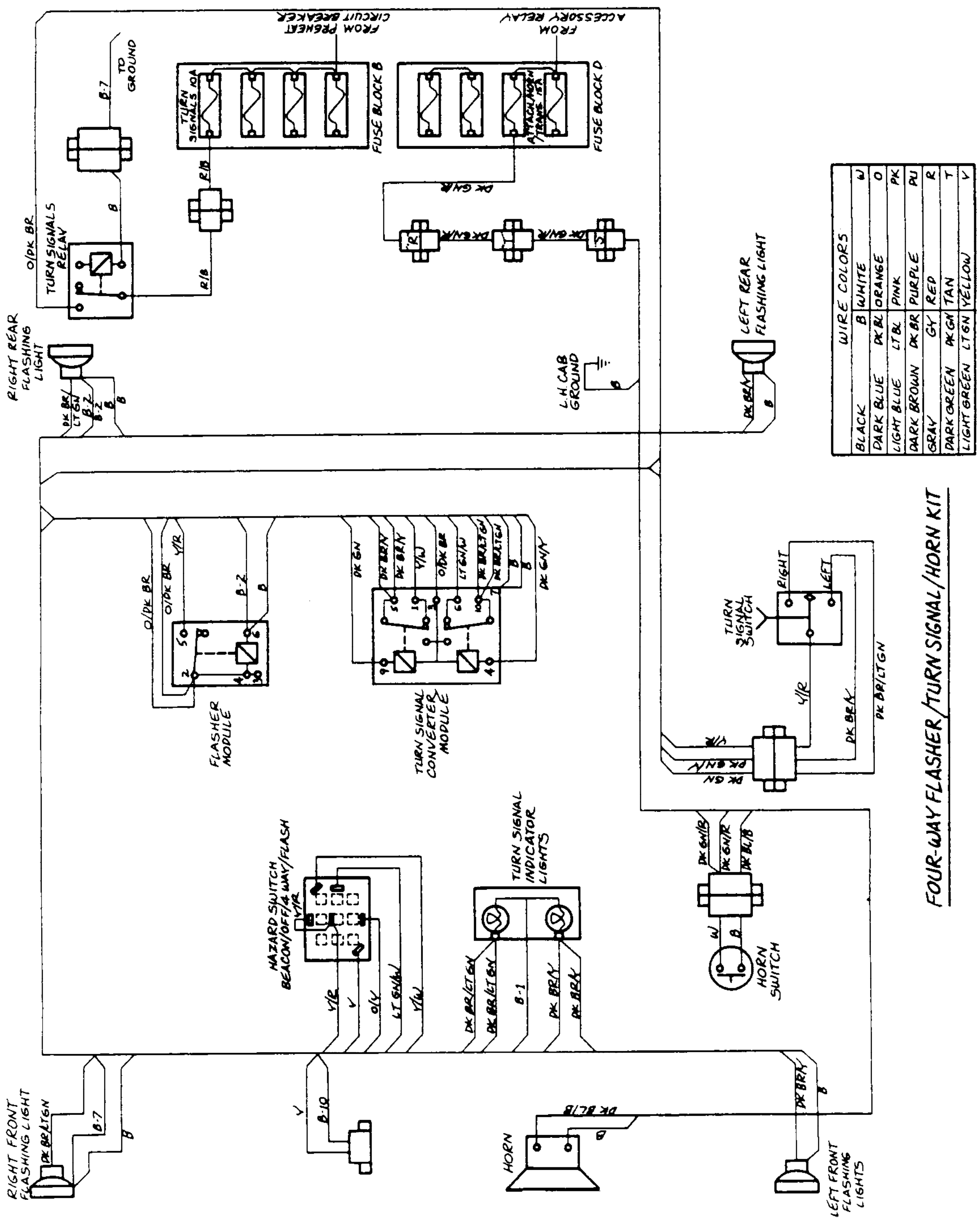

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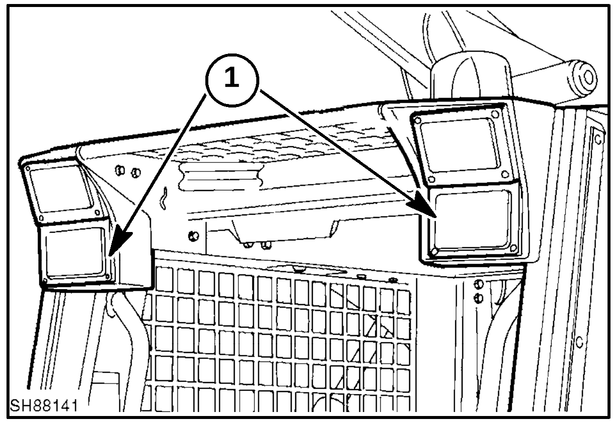
Warning Light (Four-way) Wiring Diagram

NOTE: *When attaching ground wires, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to size on top of the heaviest wire.*

Warning Light Bulb Replacement
Amber lens with bulb #9841566
Bulb only #529068



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Op. 55 404 10

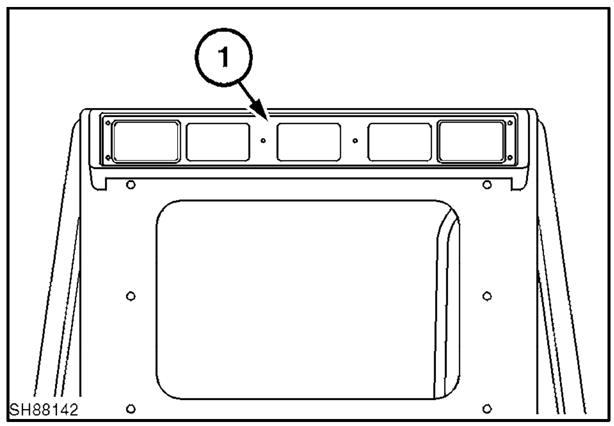
Front Light

1. Remove the bezel, 1, retaining screws and remove lens from support.
2. Disconnect the wire harness from the bulb holder.
3. Rotate the light bulb holder and element assembly from the lens and remove from the lens.
4. Insert the new bulb into the lens and rotate to lock into position, using caution not to touch the bulb element.

IMPORTANT: *Touching the light bulb element may damage the element and cause a premature failure.*

Op. 55 404 10

Rear Light



66

1. Remove the bezel, 1, retaining hardware and remove the lens from the light bar.

NOTE: *The remaining light lens will be loose in the light bar.*

2. Disconnect the wire harness from the bulb holder.
3. Rotate the light bulb holder and element assembly from the lens and remove from the lens.
4. Insert the new bulb into the lens and rotate it to lock into position, using caution not to touch the bulb element.

IMPORTANT: *Touching the light bulb element may damage the element and cause a premature failure.*

LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
Arm pads (cab)	
Remove and replace (2)	0.5
Armrest (seat)	
Remove and replace (1)	0.25
Attachment 12-Volt Electric Power Supply	
Remove and replace outlet	0.25
Remove and replace wire harness	0.5
Back-Up Alarm	
Remove and replace back-up alarm	0.25
Remove and replace back-up alarm linkage and adjust	1.0
Remove and replace back-up alarm wire harness	0.5
Block Heater (engine)	
Remove and replace block heater (engine)	0.5
High Flow Hydraulics	
Remove and replace gear pump	1.0
Remove and replace selector valve	1.0
Remove and replace wire harness	0.5
Horn	
Remove and replace horn button	0.5
Remove and replace horn	0.25
Remove and replace horn wire harness	0.5
Seat/Shoulder Belt	
Remove and replace belt (must replace complete assembly)	1.0
Warning Light (rotary beacon)	
Replace bulb	0.25
Warning Lights (four-way flashing lights)	
Remove and replace switch	0.5
Remove and replace lamp bulb or lamp assembly (1)	0.25
Remove and replace wire harness	2.0

SECTION 90 – PLATFORM, CAB, BODYWORK, AND DECALS

Chapter 1 – Cab and Seat

CONTENTS

GENERAL INFORMATION

Op. 90 108

SAFETY DECALS

The safety decals located on the skid steer are intended for the personal safety of you and those working with you.

Keep the decals legible. If they are not, replace as required.

SEAT AND SEAT PAN SUPPORT

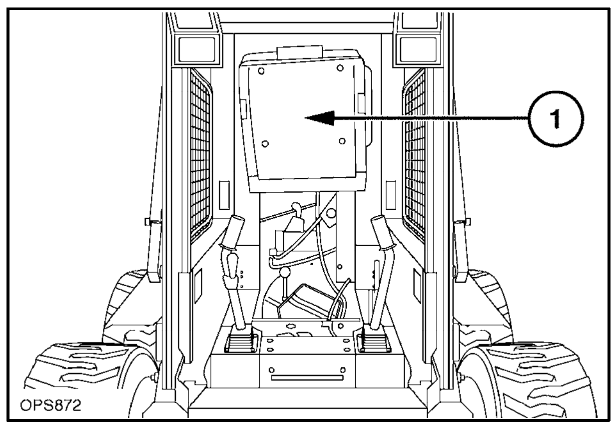
Incorporated in the seat and seat belt buckle are switches that tie the seat and seat belt into the EIC (Electronic Instrument Cluster) Advanced Warning System. When the seat belt is unbuckled and/or the operator is out of the operator's seat, the boom and bucket control valve spools will be locked in the neutral position. The operator will have to properly sequence the system to unlock the controls, sit in the seat and buckle the seat belt.

1

The seat and seat pan support can be locked up in the raised position as shown at 1.

CAUTION

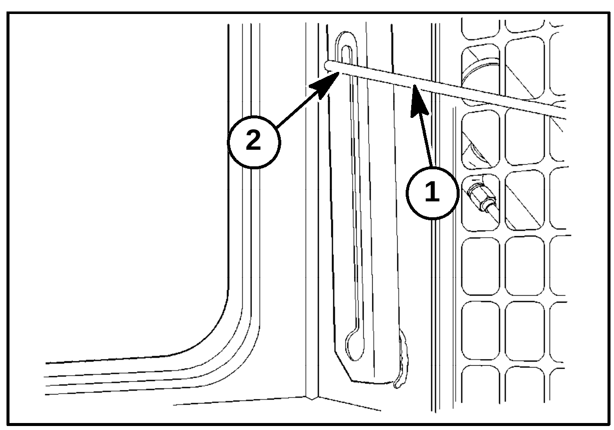
Do not work under a raised seat unless it is securely latched in the raised position.



2

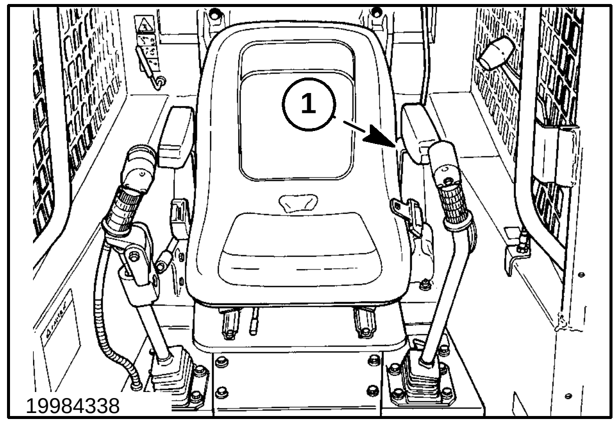
The seat/pan support assembly support rod, 1, is shown in the raised latched position at 2.

To lower the seat assembly, raise the seat upward to the top of the cab and pull the support rod, 1, forward to unlatch and lower the seat assembly.



3

When the operator's seat is returned to the operating position, make sure it is securely latched at 1.



4

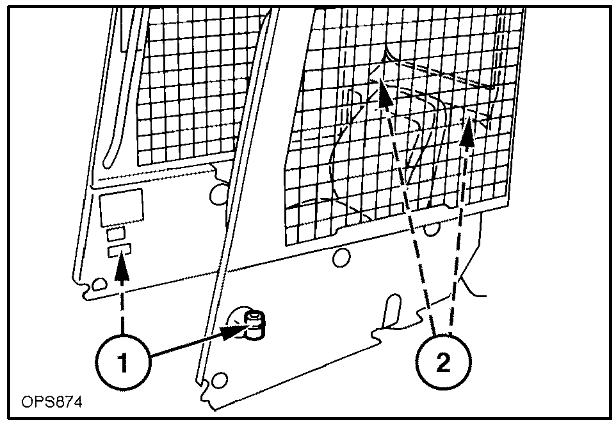
CAUTION

Do not operate the skid steer unless the operator's seat is securely latched in the operating position.

Op. 90 152

CAB INNER SHELL

The operator's seat and inner shell assembly (shown removed) are isolated on rubber mounts located at 1, one each side at front and at 2, one each side at rear.



5

Op. 90 120 10

SEAT REMOVAL

This section describes how to remove the seat and seat pan support assembly.

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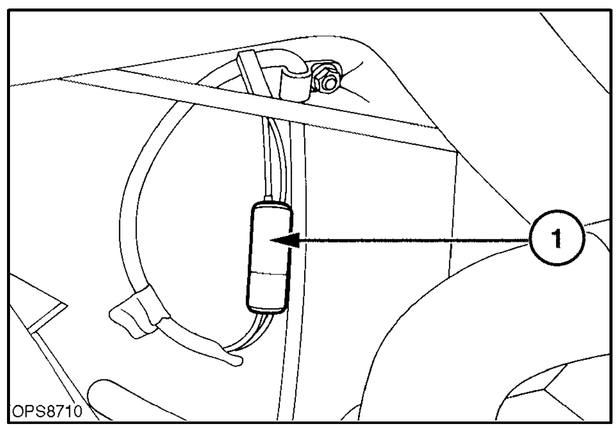
SEAT PAN SUPPORT REMOVAL

1. Disconnect the negative (–) battery cable.

IMPORTANT:*: Disconnect the (–) negative ground cable. Failure to disconnect the battery may result in damage to the EIC (Electronic Instrument Cluster) monitoring system and other electrical components.*



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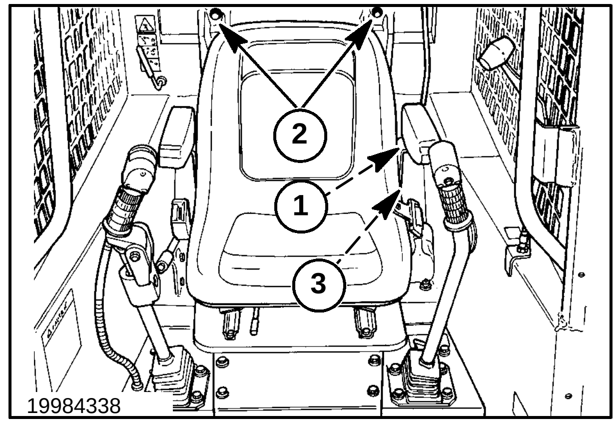
2. Disconnect the seat and seat belt wire harness connector, 1.

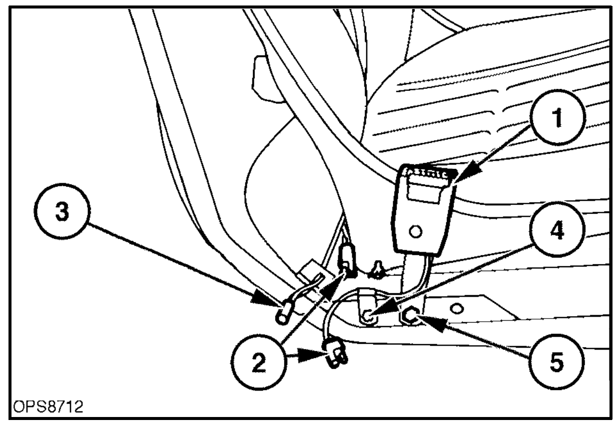
3. Remove retaining pin from latch rod at 1, and remove rod.
4. Remove the seat pan support hardware at 2.
5. Unlatch the seat pan support at 3, and lift the seat and pan support assembly from the loader.



7

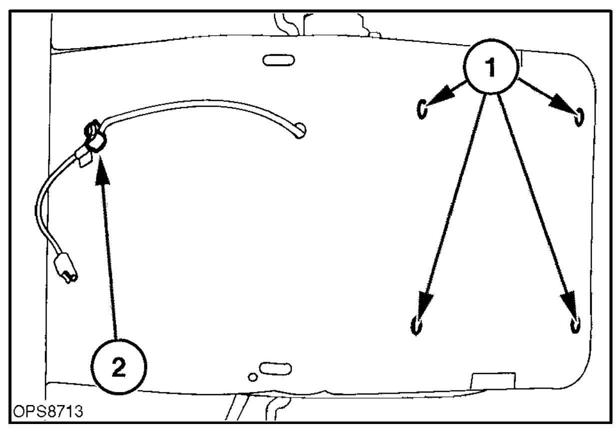
6. The right side of the seat and pan support assembly shows the seat belt buckle, 1, wire harness, 2, and seat latch rod, 3.
7. To remove the seat belt buckle, remove the wire harness retaining clamp, 4, and buckle hardware, 5.

NOTE: *When reinstalling the seat belt buckle hardware, 5, tighten the pivot bolt tight enough to hold the belt in a set position but will allow movement of the buckle to the front or rear as required by the operator.*



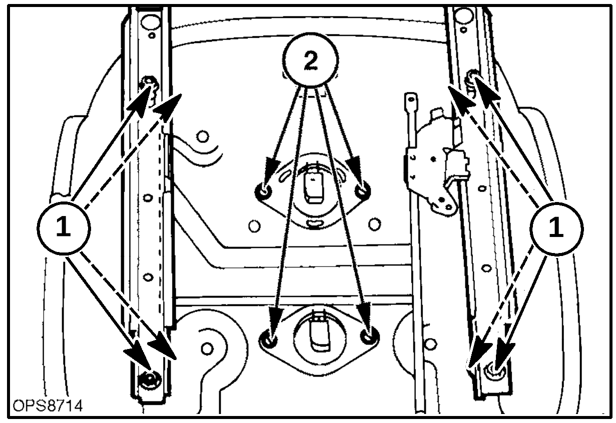
8

8. Remove the seat retaining hardware, 1, to separate the seat and seat track from the seat pan support. Remove the wire clamp at 2, if the seat/seat belt wire harness is being replaced.
9. Holding the seat in place, unplug the seat switch(es). Disconnect the wire harness from the switch(es) by releasing the latch away from the switch.



9

10. To remove the seat tracks from the seat assembly remove the track retaining hardware, 1.



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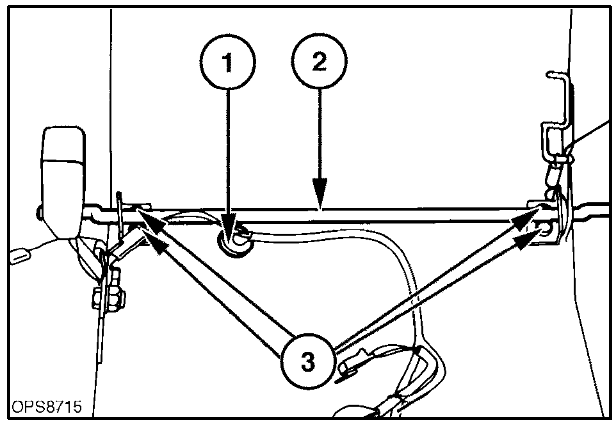
Op. 55 201 15

11. Remove the switch(es) from the seat pan, 2. Note the standard seat uses one switch and the deluxe seat uses two switches as shown.

12. To remove the seat/seat belt wire harness remove the grommet at 1, and pull the harness from the seat pan.

13. Remove the seat pan latch rod, 2, by removing the retaining hardware, 3.



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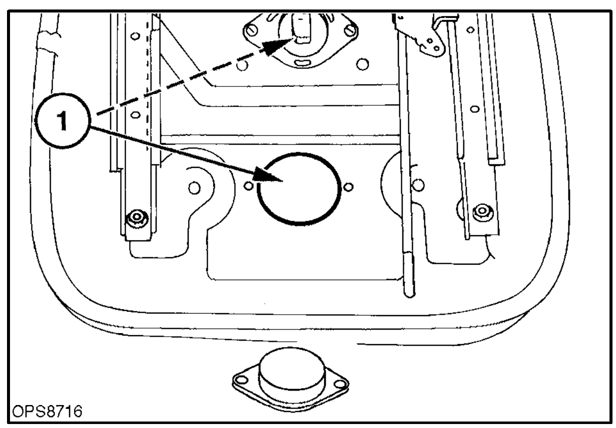
SEAT, SWITCH AND PAN REINSTALLATION

1. Install the switch(es) into the seat pan, making sure the switch is seated into the hole in the seat pan, 1.

IMPORTANT: *If the switch is not seated properly when the retaining hardware is tightened, the switch flange will be broken.*

2. Reconnect the wire harness to the switch(es) and reinstall the seat retaining hardware. Make sure the harness connector latches are engaged.



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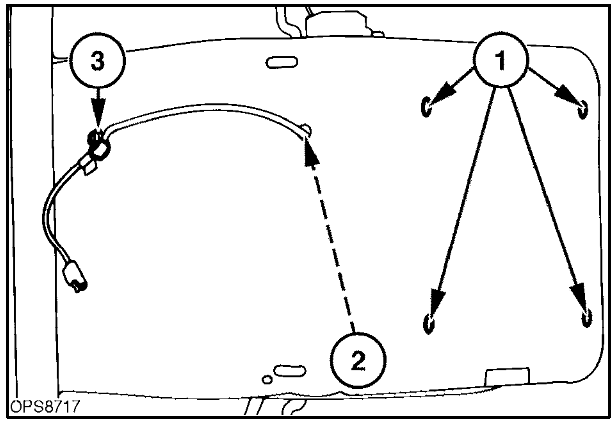
3. Reattach the seat to the seat pan support with retaining hardware at 1.

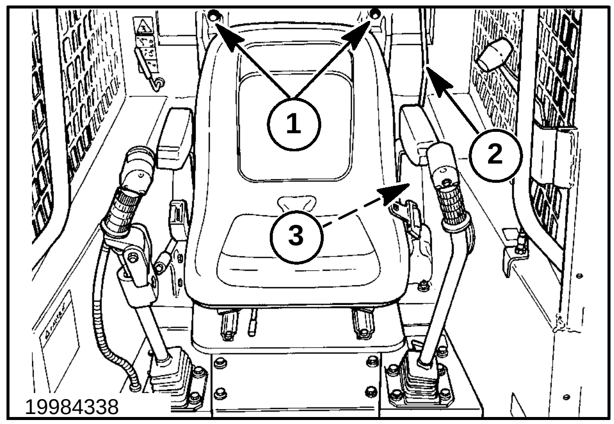
NOTE: *If the seat/seat belt wire harness was removed reinstall the wire grommet in seat pan at 2, and wire clamp on back of seat, 3, to retain the wire harness.*



13

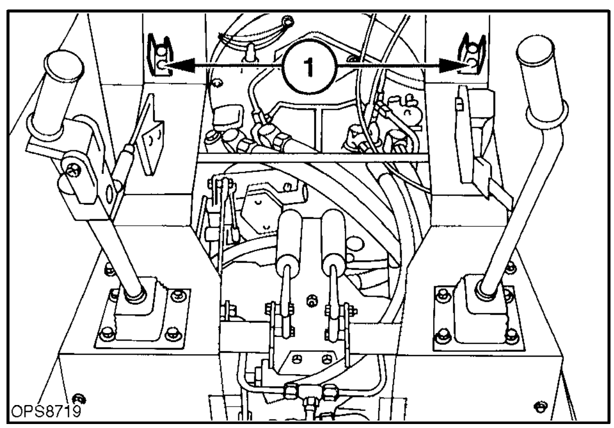
4. Reinstall the seat and seat pan support assembly into the loader and attach with hardware at 1.

   If the seat pan latch rod, 2, or latch plates, 3, were removed they may require adjustment to ensure proper seat latching.



14

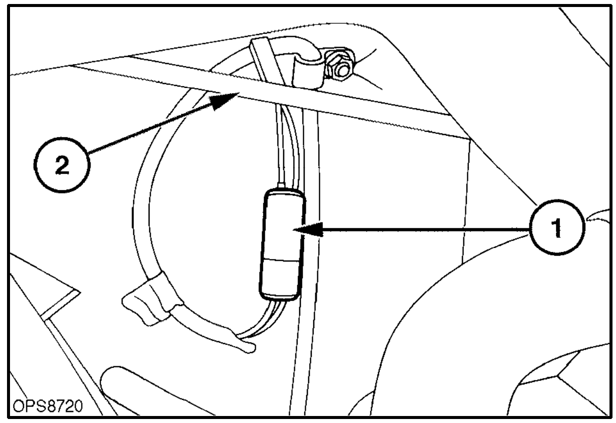
5. To adjust the latches, 1, lower the seat down to the operating position and slide the latches, 1, to obtain full engagement of latches and latch rod. After the latches are adjusted release latch rod, raise seat and lower seat to operating position. Try lifting on the front of the seat to verify seat pan support is latched securely.



15

6. Reconnect the seat/seat belt wire harness connector to the main wire harness behind the seat at 1.

NOTE: *Position the seat/seat belt and main wire harness to the front of the boom lock linkage, 2, to prevent interference. If the wires are to the back side of the linkage it will not stay connected when the seat is raised.*



16

CAB INNER SHELL

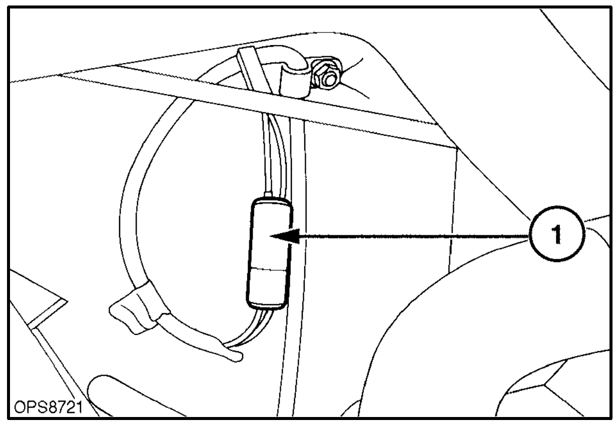
This section describes how to remove and install the cab inner shell.

Op. 90 152 34

REMOVAL

1. Disconnect the negative (-) battery cable.

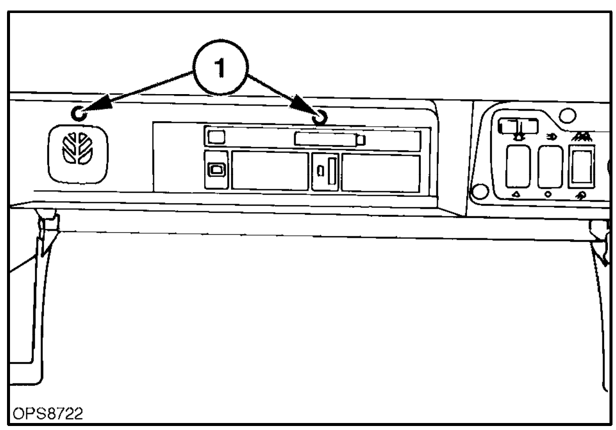
IMPORTANT: *Disconnect the (-) negative ground cable. Failure to disconnect the battery may result in damage to the EIC (Electronic Instrument Cluster) monitoring system and other electrical components.*



17

2. Disconnect the seat and seat belt wire harness connector, 1.
3. Remove the EIC board retaining hardware, 1, and remove the EIC board from the overhead dash area.
4. Unplug the two wire harness connectors from the EIC, taking care to not stress or bend the plastic locking ramps on the connectors.

NOTE: *Note the positioning of the connectors to the EIC board and reconnect in the correct position. If the connector is not connected properly, damage to the EIC may occur.*

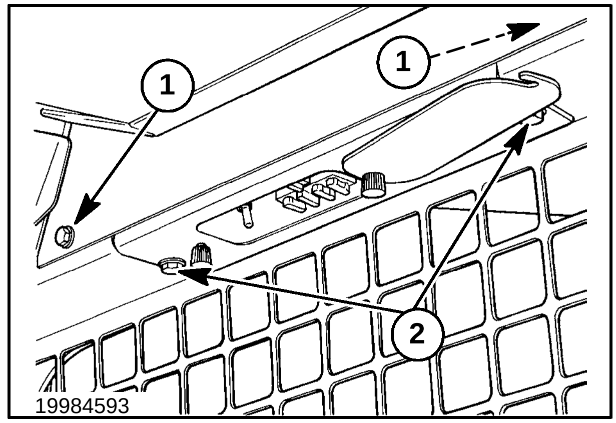


18

IMPORTANT:*: Do not service the EIC board with magnetized tools, wrenches, screwdrivers, etc., or magnets. Severe damage to the EIC board may occur.*

5. Remove the right and left headliner supports retaining hardware, 1, right side shown, and remove both supports and headliner.
6. Remove the fuse panel retaining hardware, 2, and lower the fuse panel.

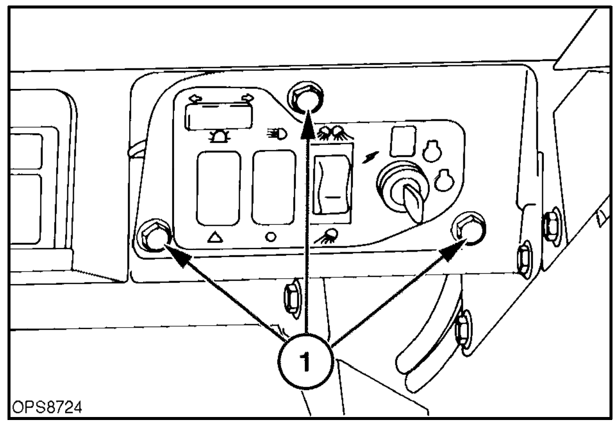
   DO NOT remove any wires from any switches or fuse blocks.



19

7. Remove the ignition switch panel hardware, 1, and lower the switch panel.

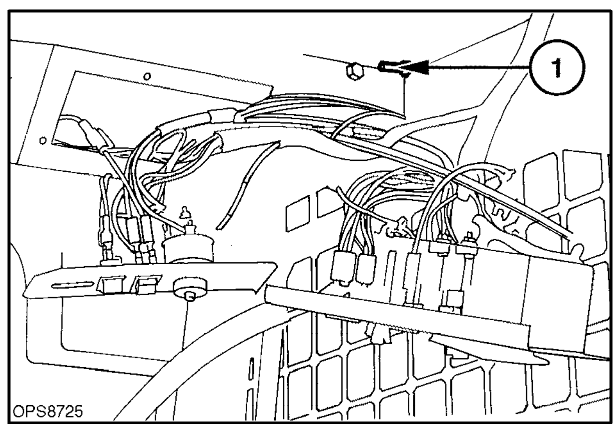
   DO NOT remove any wires from any switches.



20

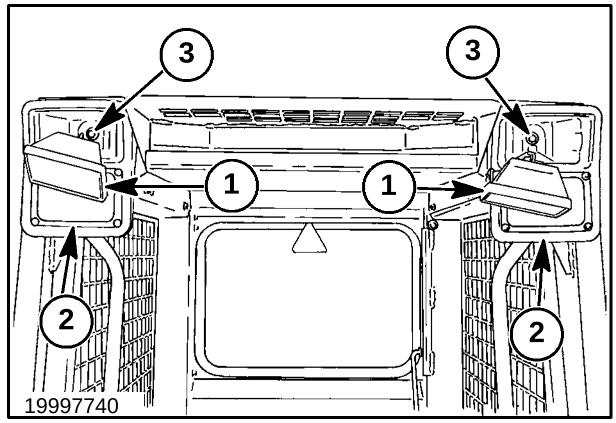
8. Remove any ground wires attached to cab ground terminal at 1.
9. Remove any wire harness ties or clamps in the upper cab area at this time. Remove the wire harness, fuse and switch panels from the right cab side sheet.
10. If the unit is equipped with front lights the light harness and light bulbs must be removed.

IMPORTANT: *Touching the light bulb element may damage the element and cause a premature failure.*



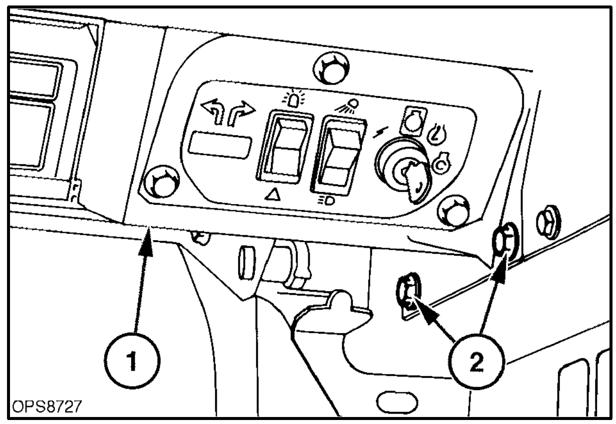
21

11. Remove and unplug the front lights, 1. Remove the front light pods, 2, from the cab at 3.



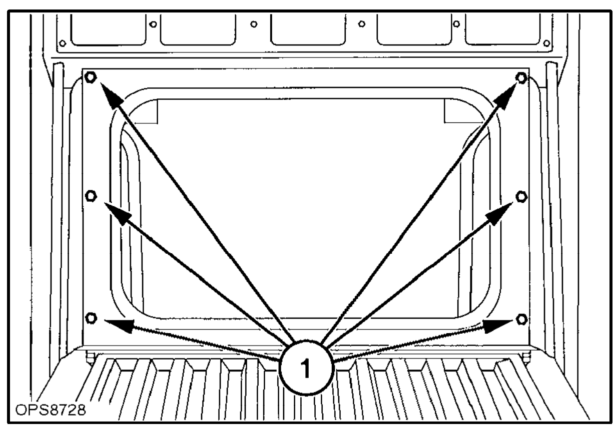
22

12. Remove the front cross support, 1, by removing hardware, 2, separating the cross member from the right and left side panels.



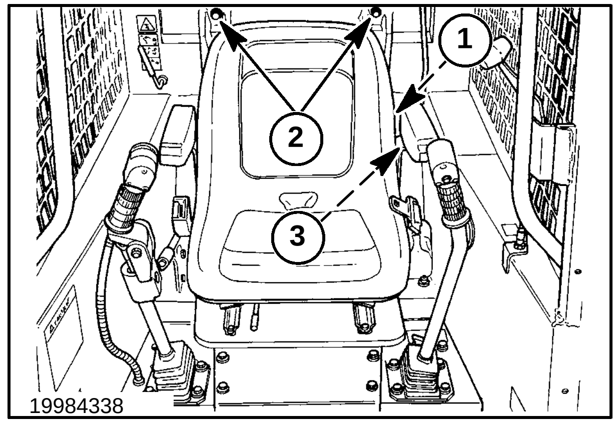
23

13. Remove the rear window and frame assembly retaining hardware, 1, and lift the window and frame from the loader.



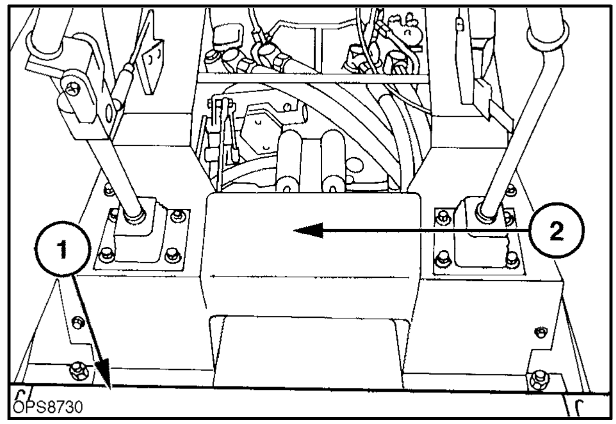
24

14. Remove retaining pin from latch rod at 1, and remove rod.
15. Disconnect the seat/seat belt wire harness from the main harness unless previously unplugged. Remove the seat pan support hardware at 2.
16. Unlatch the seat pan support at 3, and lift the seat and pan support assembly from the loader.



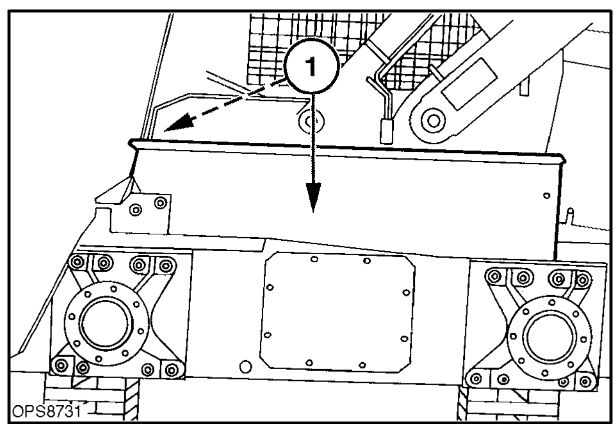
25

17. Remove the four retaining screws from the front shield, 1, and the eight retaining bolts from the step shield, 2. Remove both shields from the loader.



26

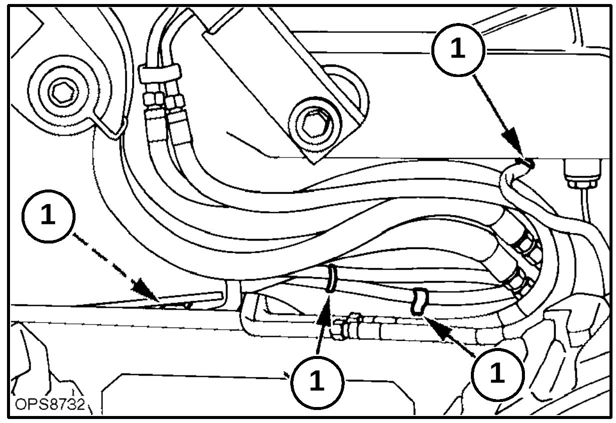
18. Remove the right and left fenders, 1, to access the front isolator mount bolts and wire harness.



27

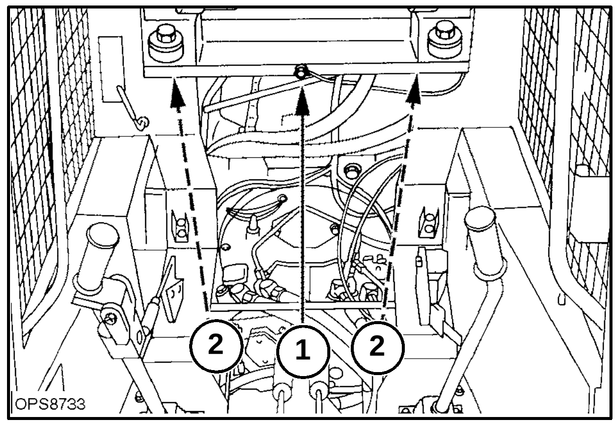
19. Remove all wire harness retaining clamps and ties, 1, from the side panels.

    Cut wire tie at keeper bar at left front to rear of cab pivot.



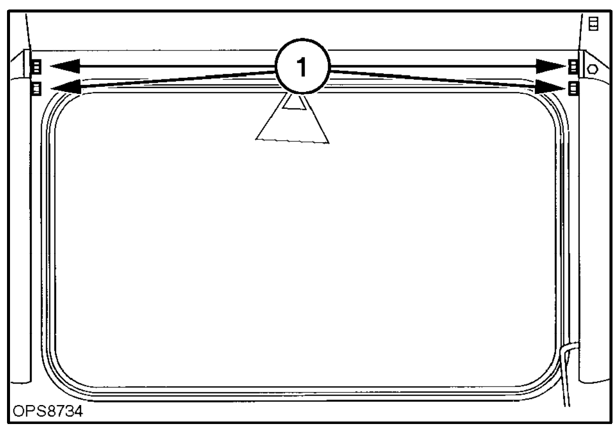
28

20. Remove any wire harness clamps and cut wire ties along the rear of the seat support, 1, and side panels, 2.



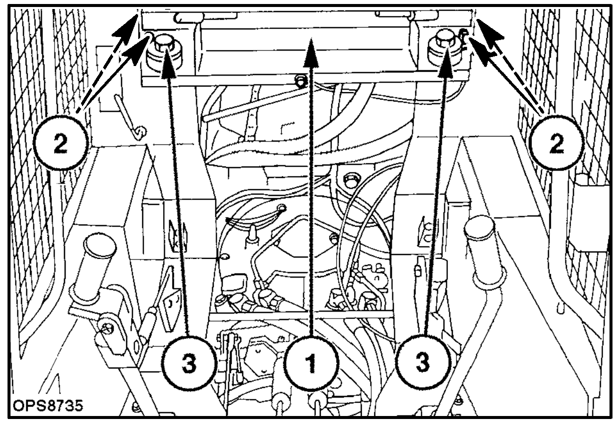
29

21. Remove the upper rear support retaining hardware, 1, right and left side and remove support.



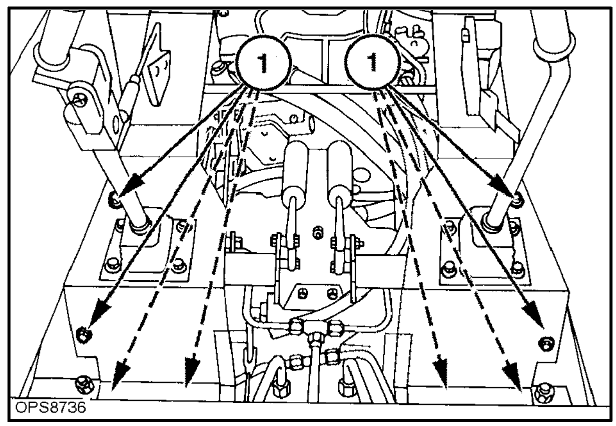
30

22. Remove the rear seat support, 1, by removing the attaching hardware at 2, and the isolator mount hardware, 3.



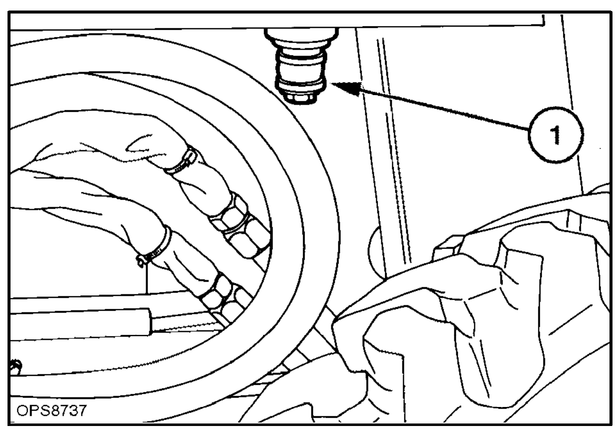
31

23. Remove the right and left hydrostatic control handle assembly retaining hardware, 1. Unhook the hydrostatic control linkage and auxiliary boom hydraulic linkage. Unplug any electrical connections, high flow switch or horn and lift the control assemblies from the loader.



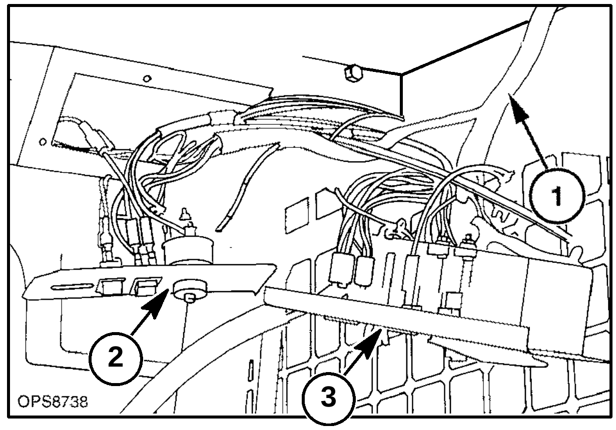
32

24. Remove the left and right side shield isolator and hardware at 1, right side shown.



33

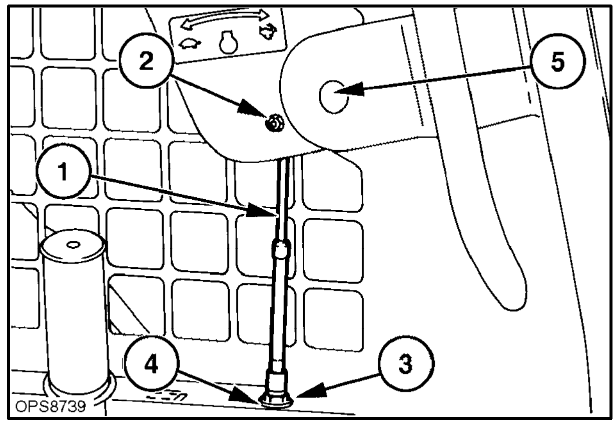
25. Lift the wire harness, 1, switch panel, 2, fuse panels, 3, from the right side shield. Remove any remaining wire ties or clamps from the wire harness and right side shield, if not previously removed.



34

26. Remove the throttle control cable, 1, from the control lever at 2. Remove the cable retaining nut, 3, and slide the cable down through the right side shield at 4.

27. Remove the control lever pivot bolt, 5, from the lever and support.



35

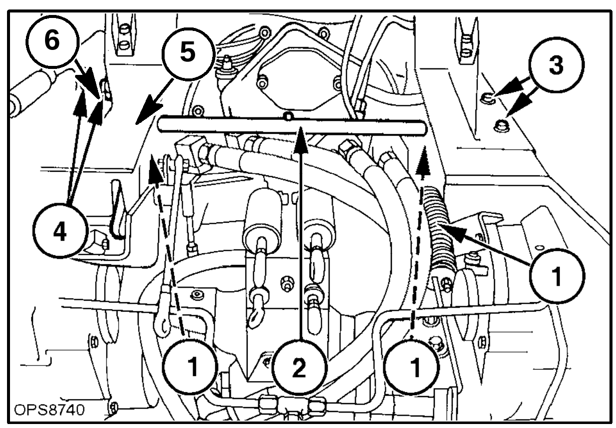
28. Remove the cotter pins from the parking brake control link spring at 1. Unhook the spring link from the control rod, 2.

29. Remove the control rod support hardware, 3.

30. Remove the control lever hardware, 4.

31. Rotate the control rod, 2, down to remove link from the side shield at 5, and slide the rod from the support at 6.

Now the side shields can be removed from the loader ROPS frame.



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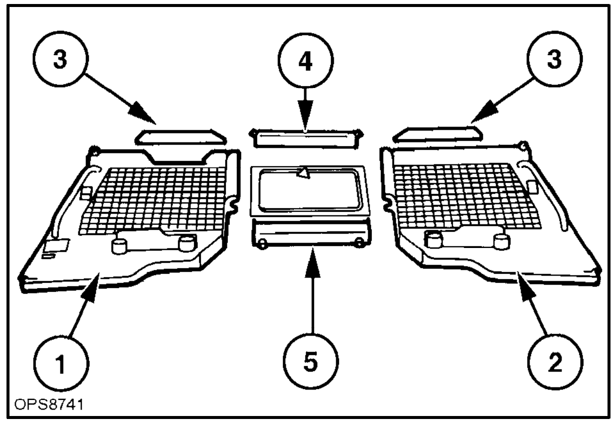
Cab inner shell removed from the loader ROPS.

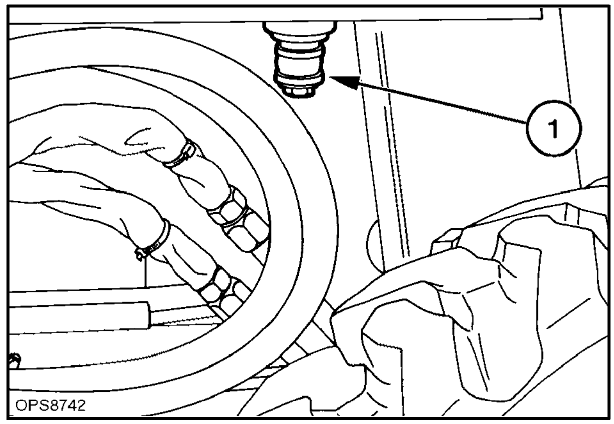
1. Right side shield
2. Left side shield
3. Headliner supports
4. Upper rear support
5. Lower seat support
6. Front support (dash) not shown



37

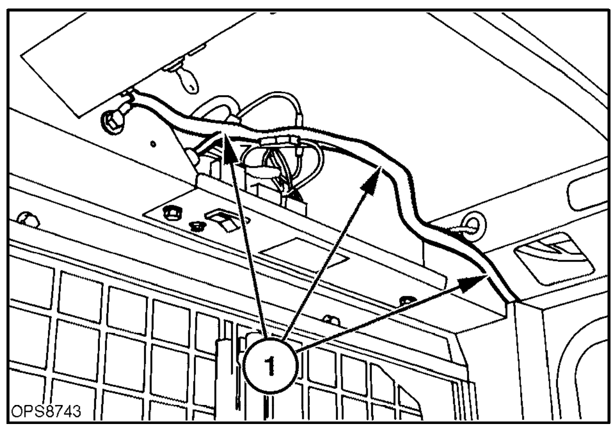
REINSTALLATION

1. Position the right and left side shields inside the loader frame.
2. Install the front side isolators and retaining hardware, 1. Do not tighten at this time.



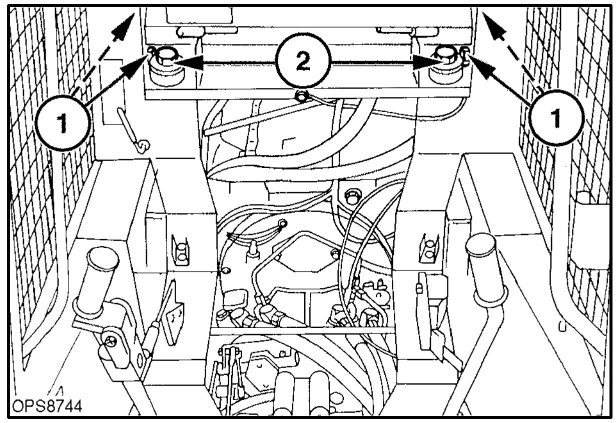
38

3. Lay the main cab wire harness along the inside of the right side shield, 1, at the top and right rear corner.



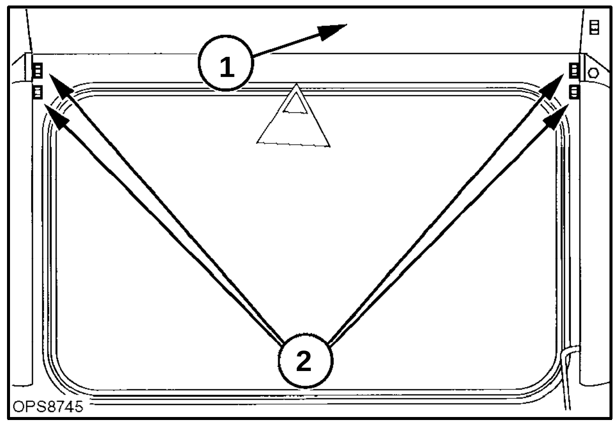
39

4. Position the side shields and install the rear lower support hardware at 1. Install the rear isolators and retaining hardware at 2. Do not tighten at this time.



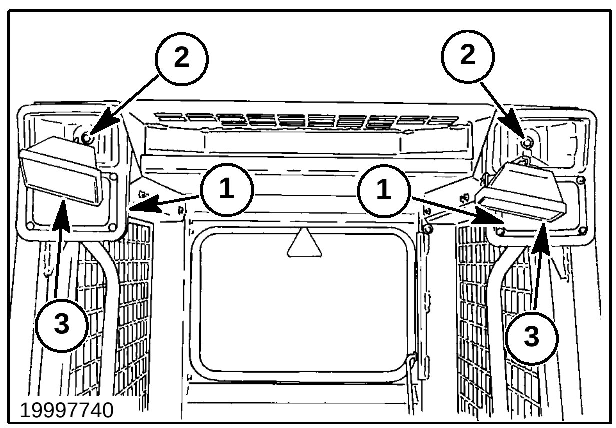
40

5. Install the upper rear support, 1, and retaining hardware, 2. Do not tighten at this time.



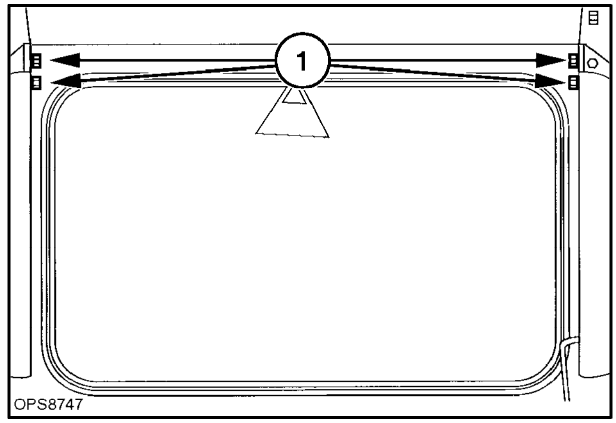
41

6. Install the front cross member, 1, and retaining hardware, 2. Do not tighten at this time.
7. Position the inner shell assembly squarely with the ROPS frame. Make sure the wire harness is positioned to prevent damage to the harness when the inner shell isolators and support hardware is tightened.
8. Tighten the front support hardware.
9. Install the light pads, 1, with one long bolt, 2, and washers for each pod. Plug each light into the harness connectors and install by pushing left side in first.



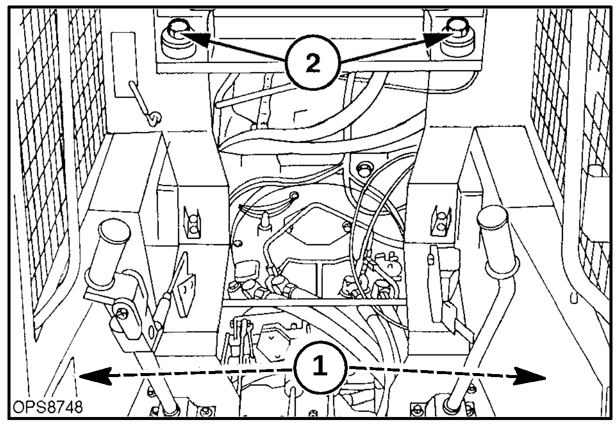
42

10. Tighten the upper rear support hardware, 1.



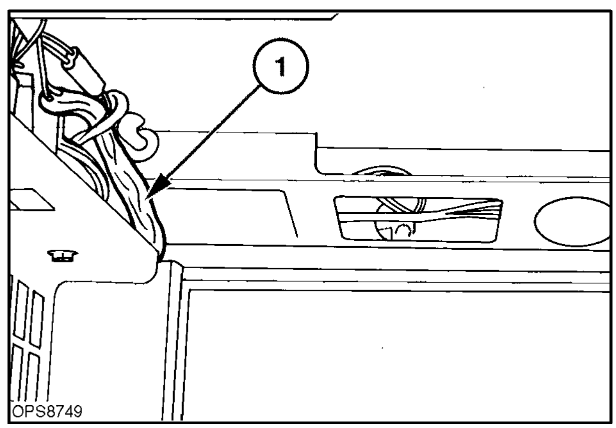
43

11. With the inner shell positioned and cross supports securely tightened, tighten the front, 1, and rear, 2, isolator support hardware at this time.



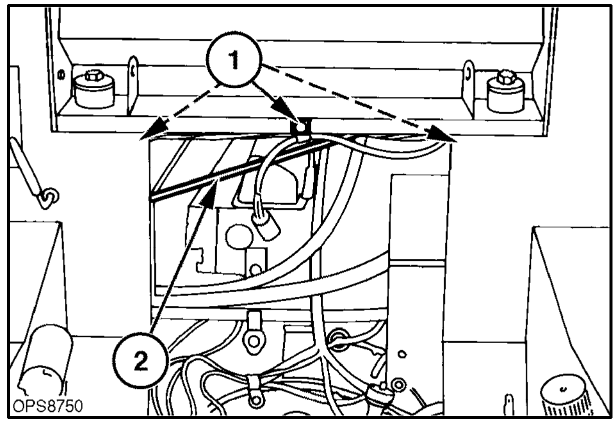
44

12. Reinstall all wire harness retaining clamps and plastic ties to secure the harness, 1, in the upper right rear corner of the operator’s cab.



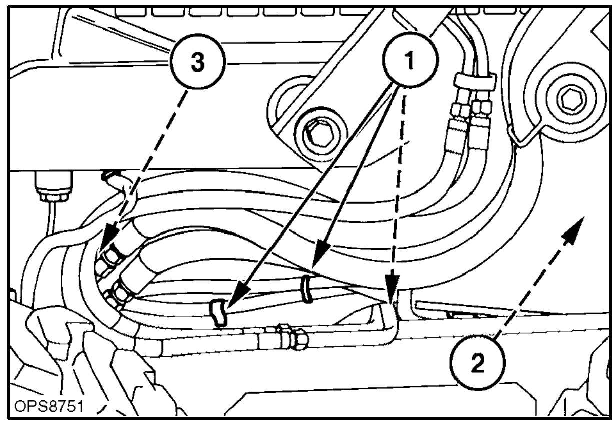
45

13. Reinstall the wire harness clamps and ties, 1, along the rear of the operator's seat. Make sure the harness is positioned to the inside of the boom lock linkage at 2, to prevent interference.



46

14. Reinstall the wire harness clamps and ties along the left side of the operator's cab at 1.
15. Position the rear of the harness and engine relay/fuse panel and install harness clamps and ties at 2.
16. With the harness positioned pull a loop (excess) of harness through the support at 3, to retain the excess wire harness.

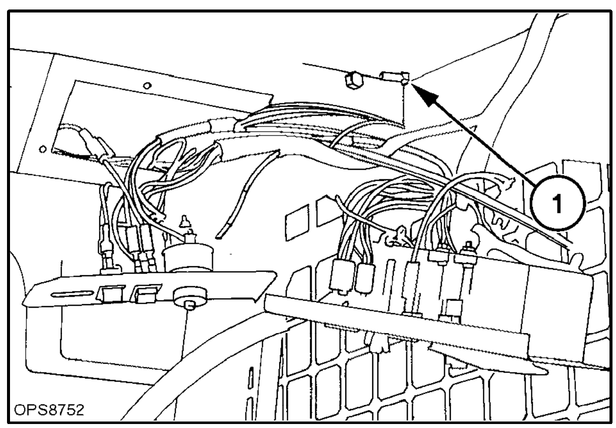


47

17. Reinstall the light pods, light wire harness and lights.
18. Reconnect the wire harness to all switches and EIC (Electronic Instrument Cluster) previously removed.

NOTE: *Plug the two wire harness connectors into the EIC, noting the correct positioning of the connectors. If the connectors are not connected properly, damage to the EIC may occur.*

IMPORTANT: *Do not service the EIC board with magnetized tools, wrenches, screwdrivers, etc. or magnets. Severe damage to the EIC board may occur.*



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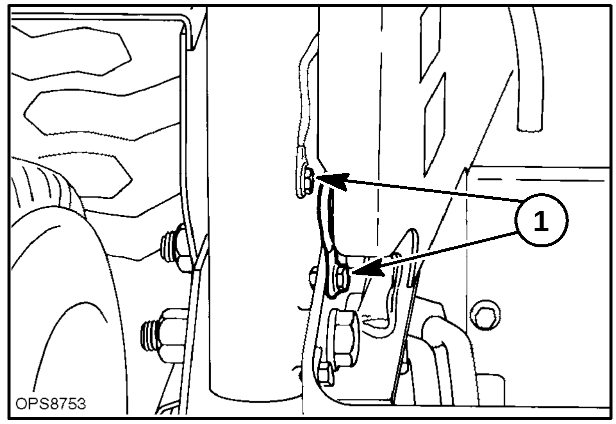
19. Remove any paint from the ground surface and attach ground wires at 1.

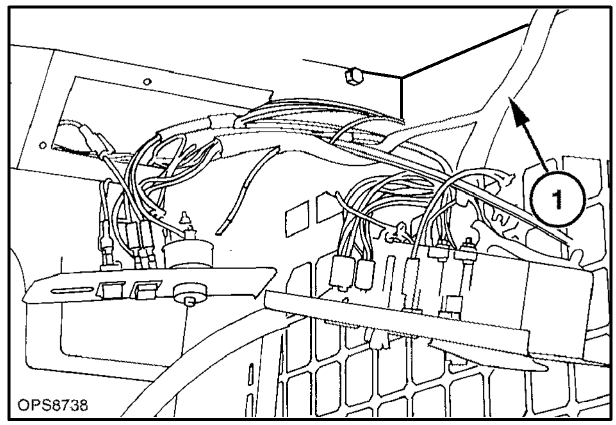
NOTE: *When attaching ground wires, always place the heaviest ground wire next to the ground surface and then stack the remaining ground wires according to size on top of the heaviest wire.*

20. Remove any paint from the ground surface and attach the ground strap, 1, from the cab inner shell to the lower main frame.



49

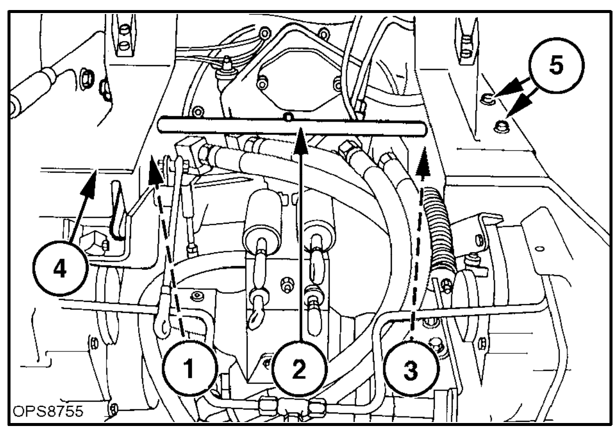
21. Reinstall the wire harness along the right side shield at 1. Install wire clamps and ties to prevent harness damage. Install the service/run switch, fuse panel and ignition switch panel.



50

22. Reinstall the parking brake control rod and pivot bearings. Install the right bearing into the right support, 1.

    Slide control rod, 2, into right bearing, place the left bearing and support over rod at 3, and rotate control rod link into cab at 4. Attach the left bearing support to the cab at 5.



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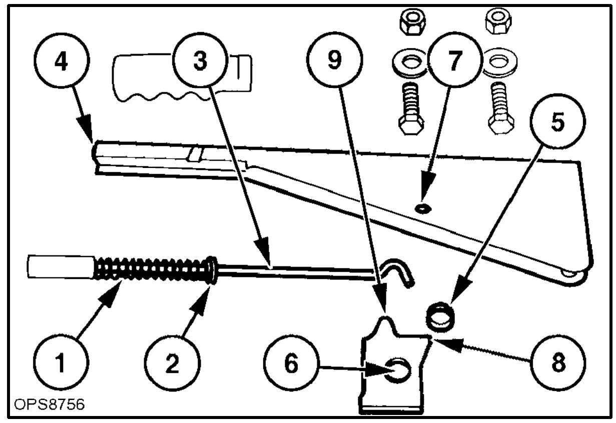
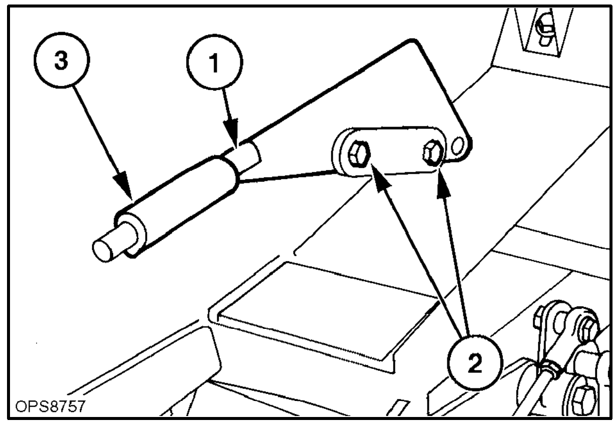
23. Assemble the brake handle by sliding the spring, 1, and washer, 2, over the end of rod, 3. Insert the rod and spring assembly into the handle at 4. Insert bushing, 5, into latch plate, 6, and insert the latch plate into handle at 7, with the extended area, 8, to the rear (engine side) of lever and position the rod assembly, 3, so the hook is back of the latch plate at 9.



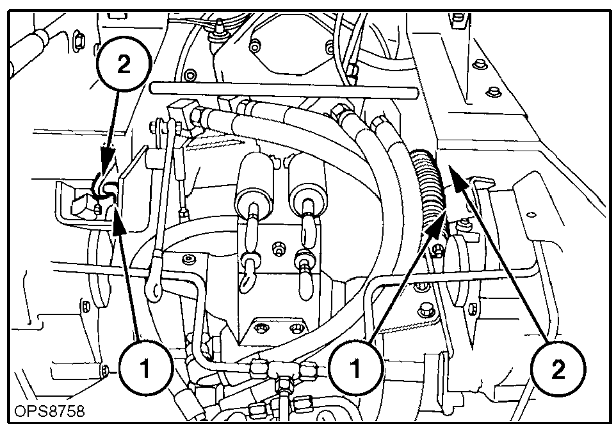
52

24. Attach the handle assembly, 1, to the control link at 2. Slide the handle grip, 3, over end of handle, 1. Use silicone or weather strip glue to hold grip in position.



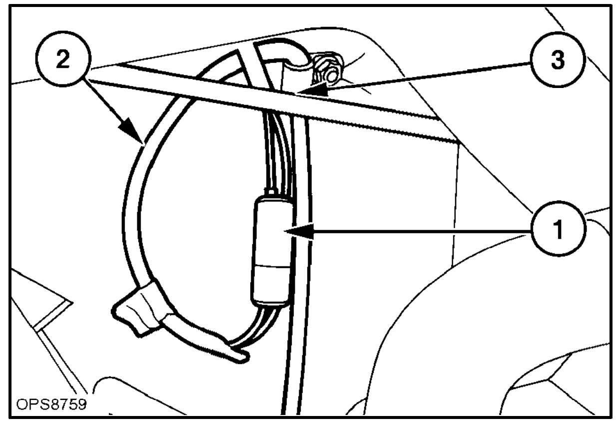
53

25. Reconnect the spring links, 1, to the control rod at 2 and install the cotter pins.



54

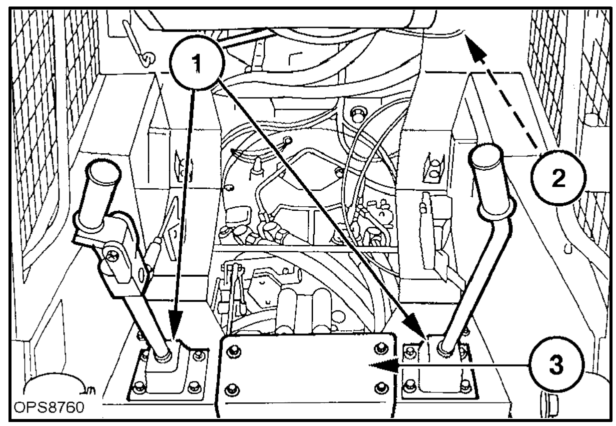
26. Reinstall the seat/seat pan support assembly and connect the seat/seat belt wire harness to the main wire harness, 1. Make sure the seat wire harness, 2, is to the inside of the boom lock linkage at 3, to prevent interference when the seat pan support assembly is pivoted up to the raised, latched position.
27. Reinstall the headliner and supports.



55

28. Reinstall the right and left hydrostatic control lever assemblies, 1.

    After the assemblies are installed check the levers for parallel, external stop and neutral adjustment. If adjustment is required refer to the operator's manual for detailed adjustment information.
29. Reinstall the rear window assembly, 2.
30. Install the step shield, 3.



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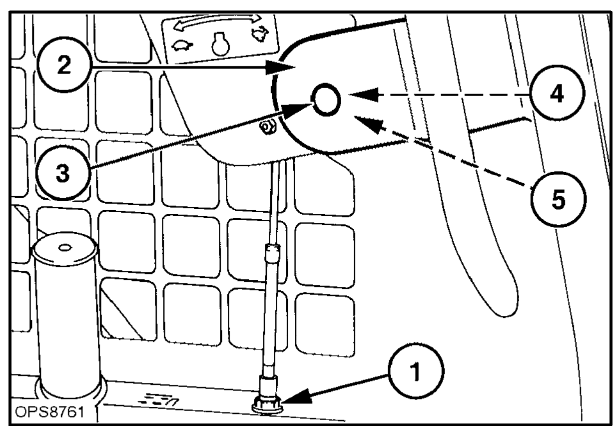
31. Slide the throttle cable up through the hole in the left cab panel and secure with retaining nut at 1. Attach the control lever, 2, to the cab panel at 3, with 3/8″ x 1-1/2″ cap screw; friction disc, 4; spring, 5; 3/8″ flat washer and locknut. Tighten the pivot hardware to hold the control lever in set position. Over tightening will require more effort to set throttle.
32. Reconnect the (-) negative ground battery cable.
33. Reinstall any shields and fenders previously removed.



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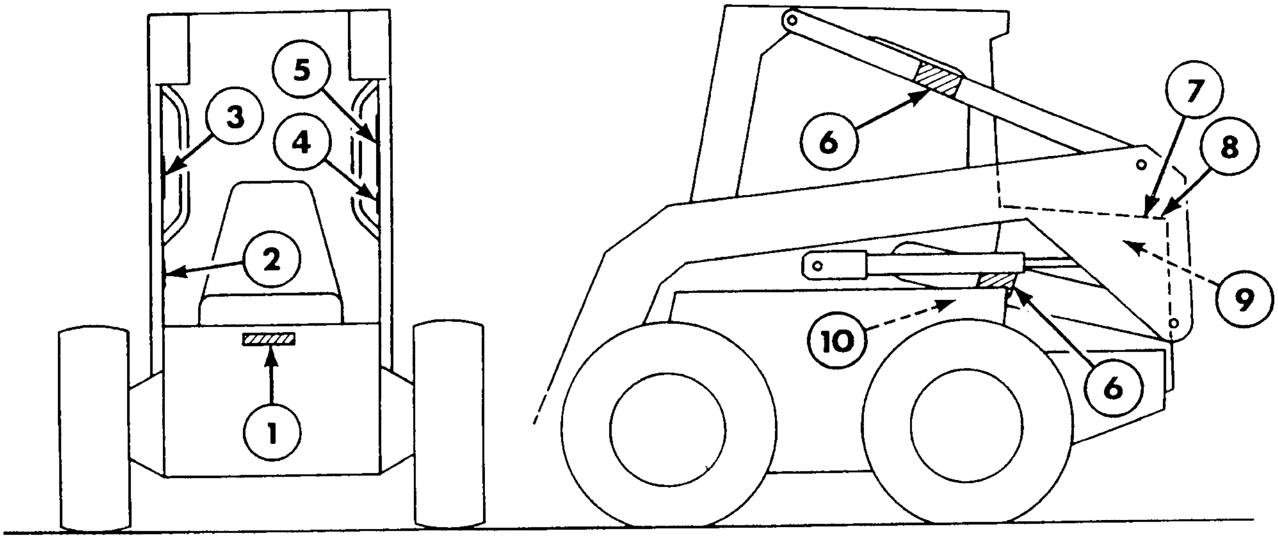
SAFETY DECALS

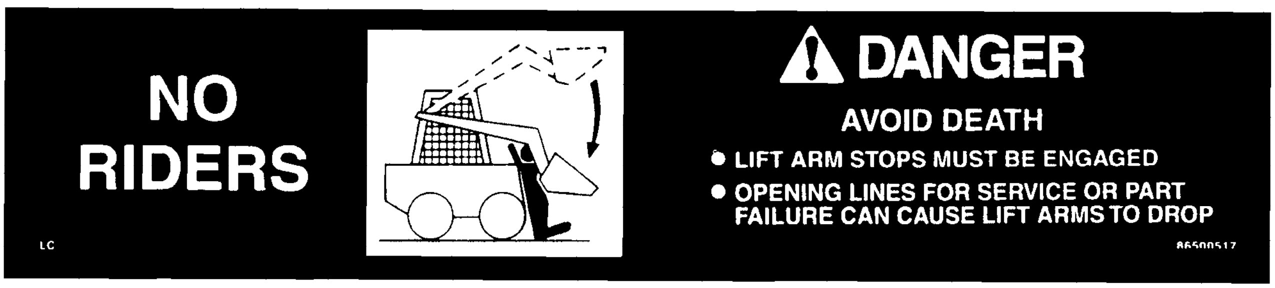
The following safety decals have been placed on your machine in the areas indicated. They are intended for the personal safety of you, and those working with you. Please take this manual, walk around your machine and note the content and location of these warning signs. Review these decals with your machine operators.

Keep the decals legible. If they are not, obtain replacements from your New Holland dealer. The decal part numbers are listed with each decal.



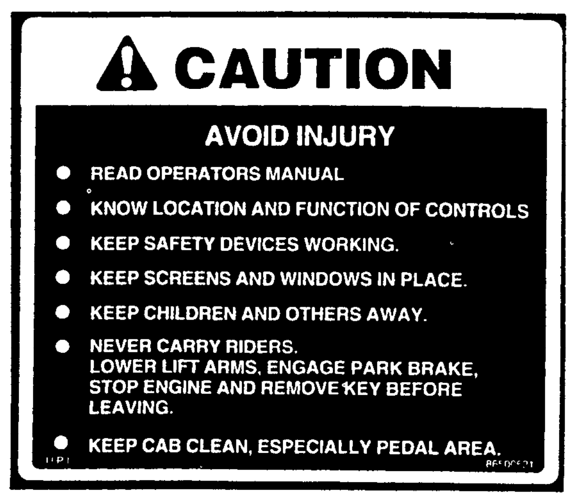
1. Danger: Do not allow passengers to ride on the skid steer at any time. Do not get under boom unless supported by the boom lock pins.

   Part #86521685



2. Caution: Do not allow anyone to operate the skid steer without proper instruction.

   Part #86521688



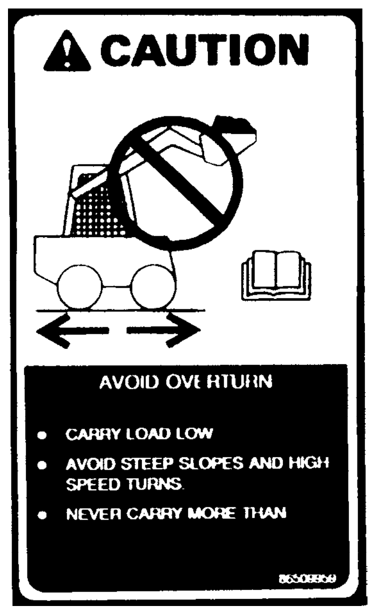
3. Danger: Before exiting the skid steer, lower the lift arms and attachment to the ground or rest lift arms on the boom stops. Stop engine and engage the parking brake.

   Part #86521683

4. Warning: Do not overload! never lift more than the maximum SAE load rating of the skid steer. Never transport a loaded bucket at full height. Operate the skid steer with the load as low as possible.

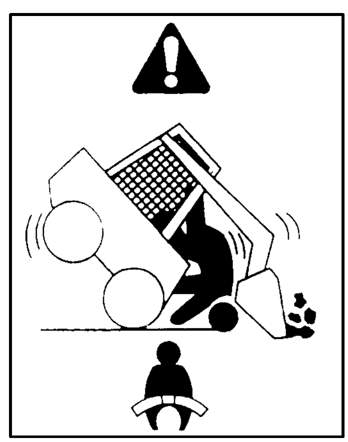
   LS180 - 2200 lbs. (998 kg) (Mfg. Rating)
   Part #86521718

   LS190 - 2800 lbs. (1270 kg) (Mfg. Rating)
   Part #86548195



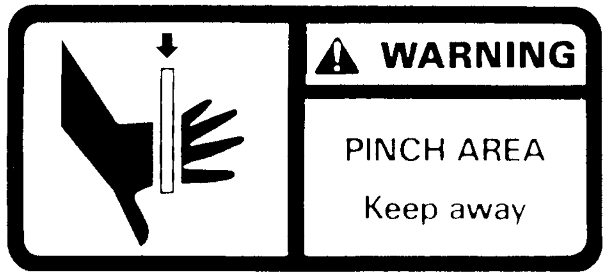
5. Warning: Never operate the skid steer without the seat belt securely fastened.

   Part #86521686



6. Warning: keep clear of moving parts. Keep bystanders clear of the skid steer at all times unless the boom is down on the ground or the boom is resting on the boom lock pins and engine is off. Never extend any part of the body outside of the operator's area.

   Part #86521673

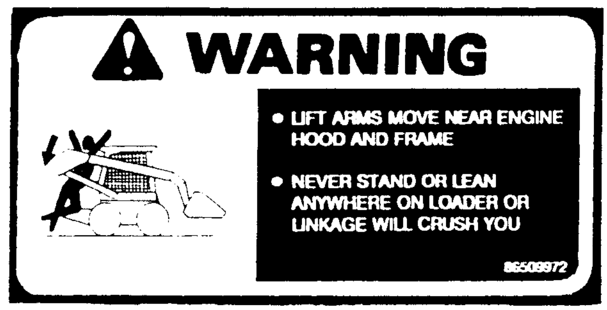


7. Warning: Keep clear! rotating fan - stop engine.

   Part #9828825

8. Warning: do not allow anyone near the skid steer while the engine is running and the skid steer is operational.

   Part #86509972

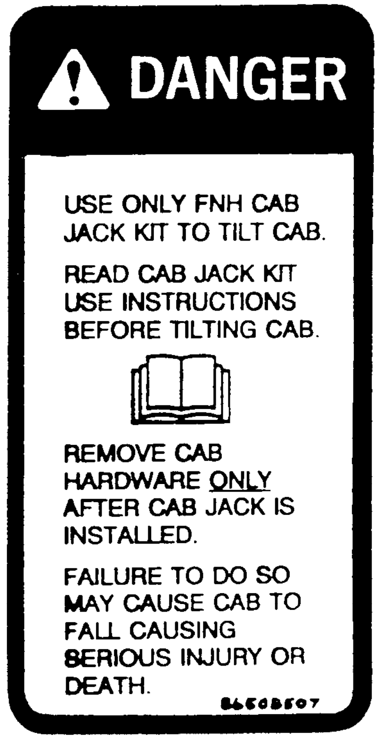


9. Caution: Do not spray ether into air intake. Explosion and injury could result.

   Part #796286

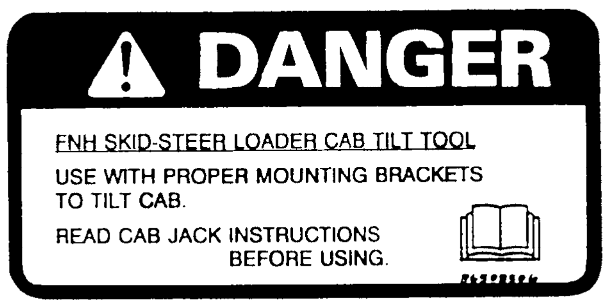
10. Danger: Use only the New Holland cab jack kit to tilt the cab. Read instructions before tilting cab. Do not remove cab hardware until cab jack is installed. Failure to do so may cause cab to fall causing serious injury or death.

    Part #86521713



11. Danger: Located on the cab tilting jack. New Holland skid steer cab tilting tool. Read cab tilting instructions and use with proper mounting brackets before tilting cab.

    Part #86508506



LABOR GUIDE

The following labor amounts are listed as a guide only. Working conditions and experience will vary the time it actually takes to complete each job.

Job Description	Hours
Remove and replace seat, seat support	1.5 hr.
Remove and replace switches (1)	0.5 hr.
Remove and replace seat support lock linkage	0.5 hr.
Remove and replace cab inner shell	6.5 hrs.

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