

2653B
Tech Manual
TM108019



JOHN DEERE
GOLF

Thanks, JD

JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER
EQUIPMENT DIVISION

Trim and Surrounds Mower
2653B
(SN 030001-)

TM108019 MARCH 2011

TECHNICAL MANUAL



JOHN DEERE

North American Version
Litho In U.s.a.

INTRODUCTION

Manual Description

This technical manual is written for an experienced technician and contains sections that are specifically for this product. It is a part of a total product support program.

The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

- Table of Contents
- Specifications and Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

Note: Depending on the particular section or system being covered, not all of the above groups may be used.

The bleed tabs for the pages of each section will align with the sections listed on this page. Page numbering is consecutive from the beginning of the Safety section through the last section.

We appreciate your input on this manual. If you find any errors or want to comment on the layout of the manual please contact us.

Safety

Specifications and Information

Engine

Electrical

Power Train

Hydraulics

Steering

Brakes

Attachments

Miscellaneous

All information, illustrations and specifications in this manual are based on the latest information at the time of publication. The right is reserved to make changes at any time without notice.

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John Deere Worldwide Commercial and
Consumer Equipment Division

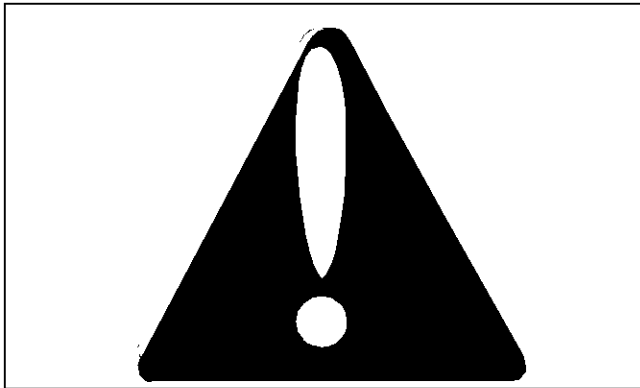
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Previous Editions

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SAFETY

Recognize Safety Information



MIF

This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

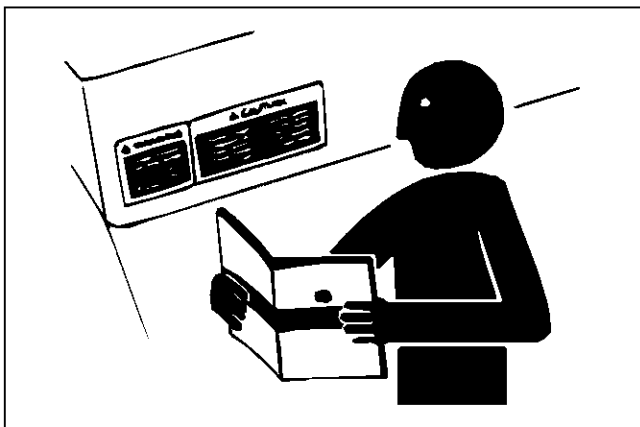
Follow recommended precautions and safe servicing practices.

Understand Signal Words

A signal word - DANGER, WARNING, or CAUTION - is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

Replace Safety Signs

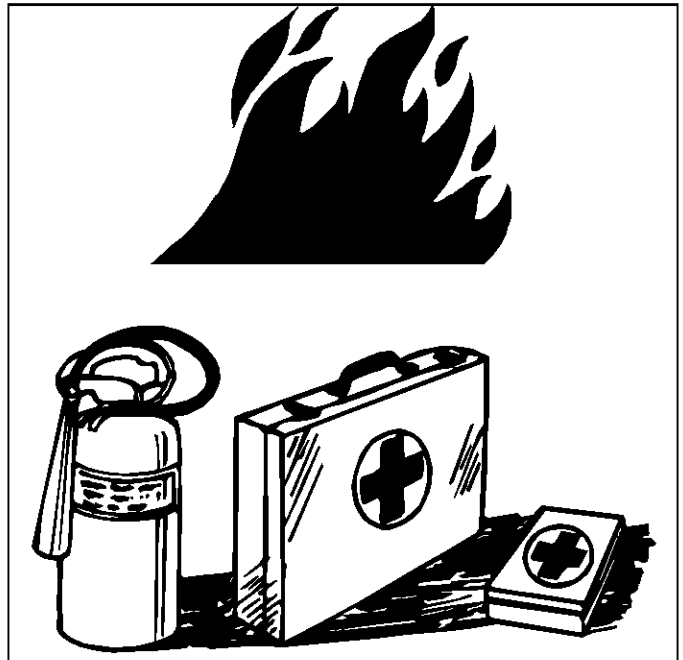


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Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



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

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

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

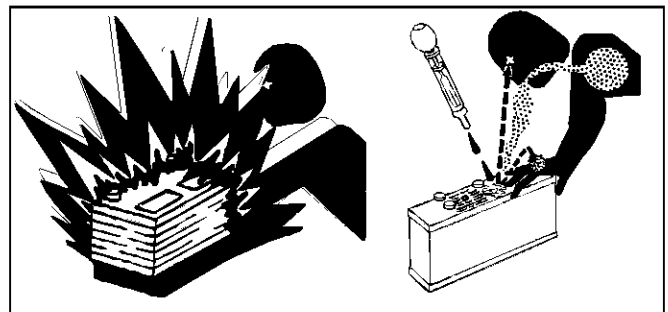
Do not store oily rags; they can ignite and burn spontaneously.

Be prepared if a fire starts.

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 in Handling and Servicing Batteries



MIF

Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away

SAFETY

from the top of 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 battery to 16°C (60°F).

Prevent Acid Burns

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid acid burns by:

1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Using proper jump start procedure.

If you spill acid on yourself:

6. Flush your skin with water.
7. Apply baking soda or lime to help neutralize the acid.
8. Flush your eyes with water for 10-15 minutes.
9. Get medical attention immediately.

If acid is swallowed:

10. Drink large amounts of water or milk.
11. Then drink milk of magnesia, beaten eggs, or vegetable oil.
12. Get medical attention immediately.

Use Care Around High-Pressure Fluid Lines

Avoid High-Pressure Fluids



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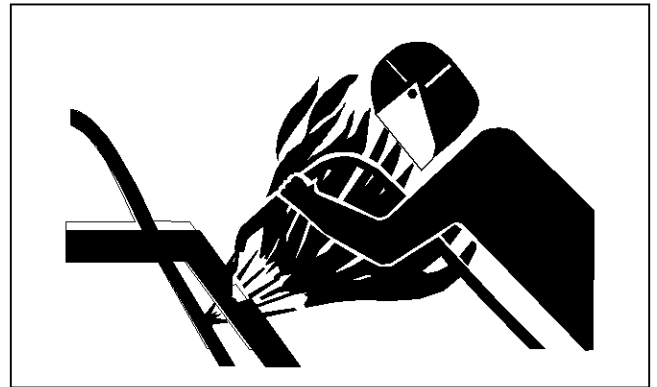
Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid injury from escaping fluid under pressure by stopping the engine and relieving pressure in the system before disconnecting or connecting hydraulic or other lines. Tighten all connections before applying pressure.

Search 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

Avoid Heating Near Pressurized Fluid Lines

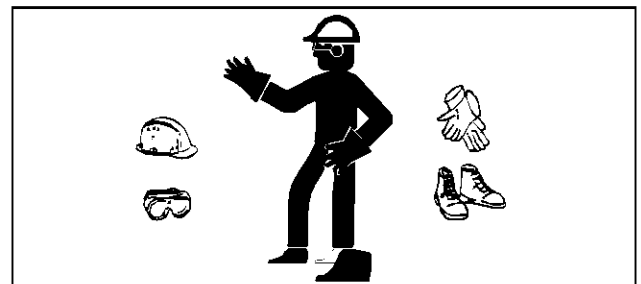


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Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

Use Safe Service Procedures

Wear Protective Clothing



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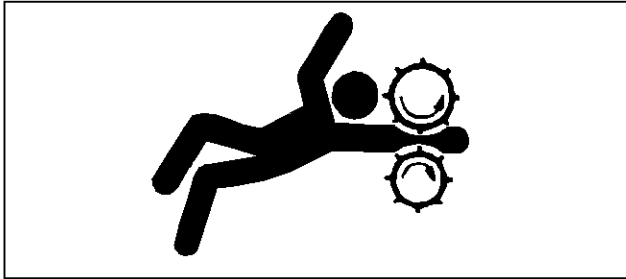
Wear close-fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

SAFETY

Service Machines Safely



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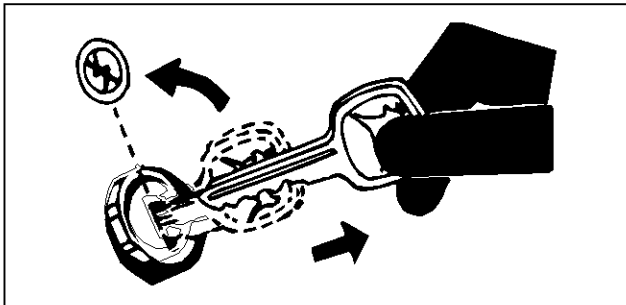
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

Use Proper Tools

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards. Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, use the correct size tools. **DO NOT** use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches. Use only service parts meeting John Deere specifications.

Park Machine Safely

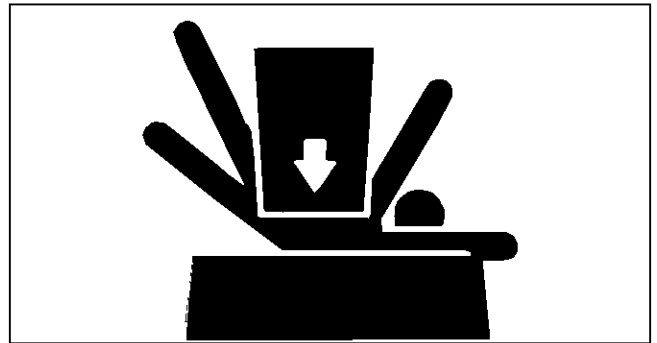


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Before working on the machine:

13. Lower all equipment to the ground.
14. Stop the engine and remove the key.
15. Disconnect the battery ground strap.
16. Hang a "DO NOT OPERATE" tag in operator station.

Support Machine Properly and Use Proper Lifting Equipment



MIF

If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

Lifting heavy components incorrectly can cause severe injury or machine damage. Follow recommended procedure for removal and installation of components in the manual.

Work in Clean Area

Before starting a job:

17. Clean work area and machine.
18. Make sure you have all necessary tools to do your job.
19. Have the right parts on hand.
20. Read all instructions thoroughly; do not attempt shortcuts.

Using High-Pressure Washers

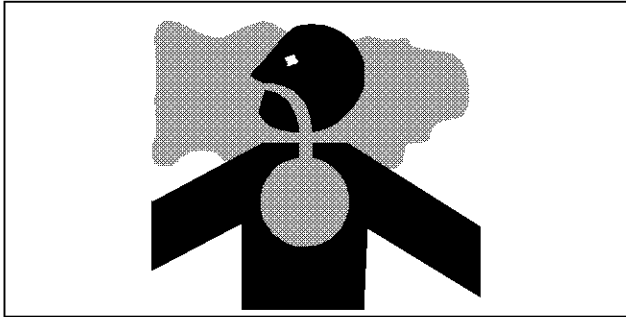
Directing pressurized water at electronic/electrical components or connectors, bearings, hydraulic seals, fuel injection pumps or other sensitive parts and components may cause product malfunctions. Reduce pressure and spray at a 45 to 90 degree angle.

Illuminate Work Area Safely

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

SAFETY

Work in Ventilated Area



MIF

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.

WARNING: California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Remove Paint Before Welding or Heating

Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. Do all work outside or in a well ventilated area. Dispose of paint and solvent properly. Remove paint before welding or heating: If you sand or grind paint, avoid breathing the dust. Wear an approved respirator. If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

Avoid Harmful Asbestos Dust

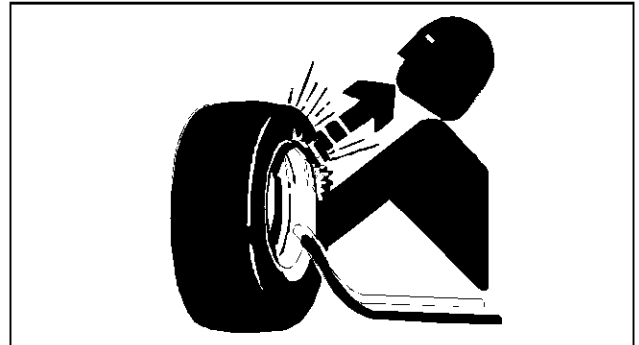
Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special

vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos. Keep bystanders away from the area.

Service Tires Safely



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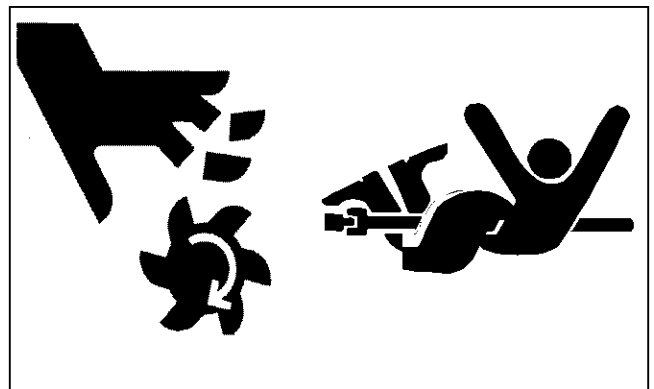
Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job. Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and NOT in front of or over the tire assembly. Use a safety cage if available.

Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

Avoid Injury from Rotating Blades and Drive Shafts

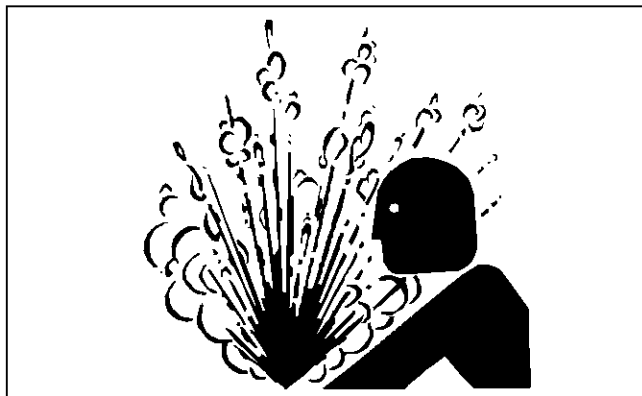


MIF

Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades or drive shafts.

SAFETY

Service Cooling System Safely

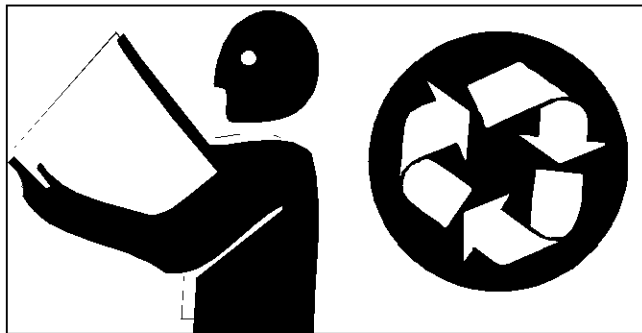


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Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off machine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve the pressure before removing completely.

Handle Chemical Products Safely



MIF

Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques. Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment includes such items as oil, fuel, coolant, brake fluid, filters, and batteries. Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them. Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

LIVE WITH SAFETY



MIF

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

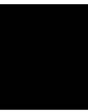
SAFETY



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SPECIFICATIONS AND INFORMATION GENERAL INFORMATION

General Information

Metric Fastener Torque Values

Property Class and Head Markings	  	   	 	   
Property Class and Nut Markings	  	  	  	  

MIF (TS1163)

	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated ¹		Dry ¹		Lubricated ¹		Dry ¹		Lubricated ¹		Dry ¹		Lubricated ¹		Dry ¹	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

1. "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a $\pm 10\%$ variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same class. Make sure fastener threads are clean and that you properly start

thread engagement. This will prevent them from failing when tightening.

When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

Reference: JDS-G200.

SPECIFICATIONS AND INFORMATION GENERAL INFORMATION

Metric Fastener Torque Values - Grade 7

Size	Steel or Gray Iron Torque		Aluminum Torque	
	N•m	lb-ft	N•m	lb-ft
M6	11	8	8	6
M8	24	18	19	14
M10	52	38	41	30
M12	88	65	70	52
M14	138	102	111	82
M16	224	165	179	132

SPECIFICATIONS AND INFORMATION GENERAL INFORMATION

Inch Fastener Torque Values

SAE Grade and Head Markings	1 or 2 ¹ No Marks 	5 5.1 5.2   	8 8.2  
SAE Grade and Nut Markings	2 No Marks 	5  	8  

MIF (TS1162)

	Grade 1				Grade 2 ¹				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated ²		Dry ²		Lubricated ²		Dry ²		Lubricated ²		Dry ²		Lubricated ²		Dry ²	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

1. "Grade 2" applies for hex cap screws (not hex bolts) up to 152 mm (6 in.) long. "Grade 1" applies for hex cap screws over 152 mm (6 in.) long, and for all other types of bolts and screws of any length.

2. "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a $\pm 10\%$ variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start

thread engagement. This will prevent them from failing when tightening.

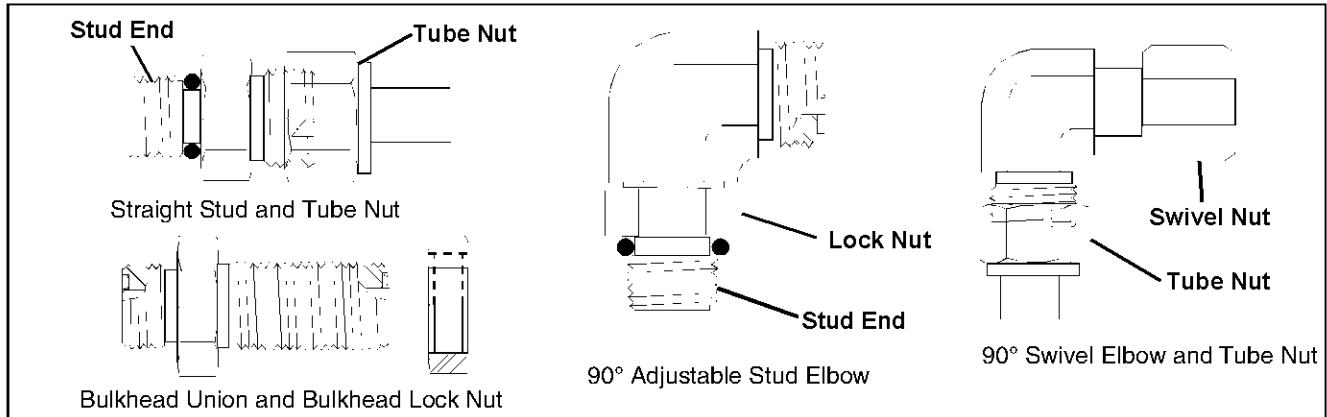
When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

Reference: JDS-G200.

SPECIFICATIONS AND INFORMATION GENERAL INFORMATION

Face Seal Fittings with Inch Stud Ends Torque



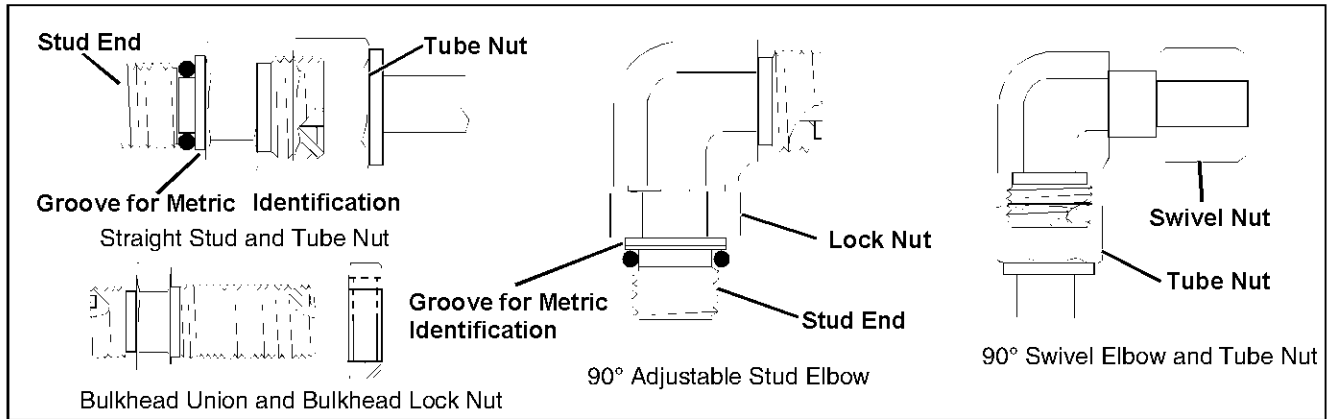
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Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

Note: Torque tolerance is +15%, -20%.

SPECIFICATIONS AND INFORMATION GENERAL INFORMATION

Face Seal Fittings with Metric Stud Ends Torque

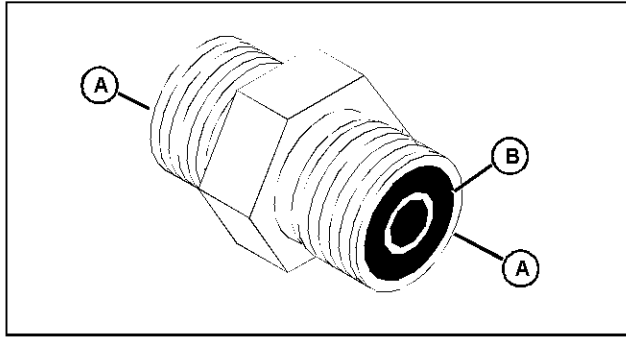


MIF

Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Lock Nut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12x1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14x1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16x1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18x1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22x1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27x2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30x2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33x2	41	158	116	71	52
28										M38x2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42x2	50	190	140	85	63
38	-24	1.50	38.10	2-12	60	217	160	217	160	M48x2	55	217	160	98	72

Note: Torque tolerance is +15%, -20%.

O-Ring Face Seal Fittings



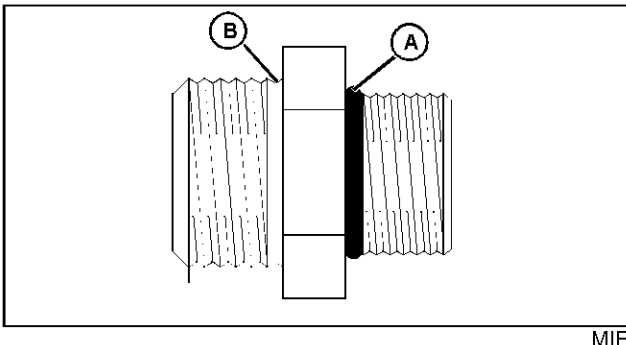
1. Inspect the fitting sealing surfaces (A). They must be free of dirt or defects.
2. Inspect the O-ring (B). It must be free of damage or defects.
3. Lubricate O-ring and install into groove using petroleum jelly to hold in place.
4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

Important: Avoid Damage! DO NOT allow hoses to twist when tightening fittings. Use two wrenches to tighten hose connections: one to hold the hose, and the other to tighten the swivel fitting.

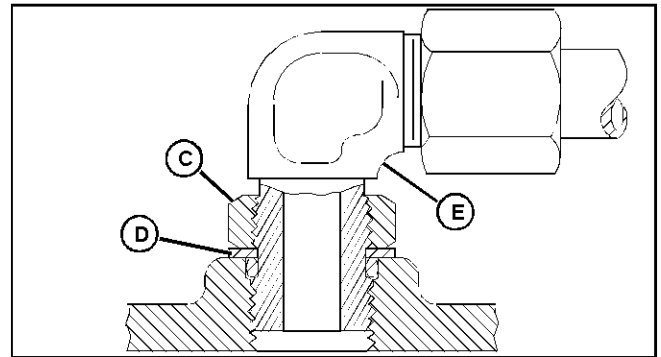
6. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting.

O-Ring Boss Fittings

1. Inspect O-ring boss seat. It must be free of dirt and defects. If repeated leaks occur, inspect for defects with a magnifying glass. Some raised defects can be removed with a slip stone.



2. Put hydraulic oil or petroleum jelly on the O-ring (A). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (B) of fitting. Remove tape.



3. For angle fittings, loosen special nut (C) and push special washer (D) against threads so O-ring can be installed into the groove of fitting.
4. Turn fitting into the boss by hand until special washer or washer face (straight fitting) contacts boss face and O-ring is squeezed into its seat.
5. To position angle fittings (E), turn the fitting counter-clockwise a maximum of one turn.
6. Tighten straight fittings to torque value shown on chart. For angle fittings, tighten the special nut to value shown in the chart while holding body of fitting with a wrench.

Straight Fitting or Special Nut Torque

Thread Size	Torque ¹		Number of Flats ²
	N•m	lb-ft	
3/8-24 UNF	8	6	2
7/16-20 UNF	12	9	2
1/2-20 UNF	16	12	2
9/16-18 UNF	24	18	2
3/4-16 UNF	46	34	2
7/8-14 UNF	62	46	1-1/2
1-1/16-12 UN	102	75	1
1-3/16-12 UN	122	90	1
1-5/16-12 UN	142	105	3/4
1-5/8-12 UN	190	140	3/4
1-7/8-12 UN	217	160	1/2

1. Torque tolerance is ± 10 percent.

2. To be used if a torque wrench cannot be used. After tightening fitting by hand, put a mark on nut or boss, then tighten special nut or straight fitting the number of flats shown.

Diesel Fuel - North America

In general, diesel fuels are blended to satisfy the low air temperature requirements of the geographical area in which they are sold.

In North America, diesel fuel is usually specified to **ASTM D975** and sold as either **Grade 1** for cold air temperatures or **Grade 2** for warm air temperatures.

If diesel fuels being supplied in your area DO NOT meet any of the above specifications, use diesel fuels with the following equivalent properties:

- Cetane Number 40 (Min)

A cetane number greater than 50 is preferred, especially for air temperatures below -20°C (-4°F) or elevations above 1500 m (5000 ft).

- Cold Filter Plugging Point (CFPP)

The temperature at which diesel fuel begins to cloud or jell. Use diesel fuels with a CFPP which is at least 5°C (9°F) below the expected low air temperature.

- Sulfur Content of 0.05% (Max)

Diesel fuels for highway use in the United States now require sulfur content to be less than 0.05%.

If diesel fuel being used has a sulfur content greater than 0.5%, reduce the service interval for engine oil and filter by 50%.



Caution: Avoid Injury! California Proposition 65 Warning: Diesel engine exhaust and some of its elements from this product are known to the State of California to cause cancer, birth defects, or other reproductive harm.

Consult your local diesel fuel distributor for properties of the diesel fuel available in your area.

Diesel Fuel - Europe

In general, diesel fuels are blended to satisfy the low air temperature requirements of the geographical area in which they are sold.

In Europe, diesel fuel is usually specified to **EN590** and sold in 5 different classes or 6 different grades.

If diesel fuels being supplied in your area DO NOT meet any of the above specifications, use diesel fuels with the following equivalent properties:

- Cetane Number 40 (Min)

A cetane number greater than 50 is preferred, especially for air temperatures below -20°C (-4°F) or elevations above 1500 m (5000 ft).

- Cold Filter Plugging Point (CFPP)

The temperature at which diesel fuel begins to cloud or jell. Use diesel fuels with a CFPP which is at least 5°C (9°F) below the expected low air temperature.

- Sulfur Content of 0.05% (Max)

If diesel fuel being used has a sulfur content greater than 0.5%, reduce the service interval for engine oil and filter by 50%.

Consult your local diesel fuel distributor for properties of the diesel fuel available in your area.

Diesel Fuel Lubricity

Diesel fuel must have adequate lubricity to ensure proper operation and durability of fuel injection system components. Fuel lubricity should pass a minimum of 3300 gram load level as measured by the BOCLE scuffing test.

Diesel Fuel Storage

Important: Avoid Damage! DO NOT USE GALVANIZED CONTAINERS - diesel fuel stored in galvanized containers reacts with zinc coating in the container to form zinc flakes. If fuel contains water, a zinc gel will also form. The gel and flakes will quickly plug fuel filters and damage fuel injectors and fuel pumps.

It is recommended that diesel fuel be stored ONLY in a clean, approved POLYETHYLENE PLASTIC container WITHOUT any metal screen or filter. This will help prevent any accidental sparks from occurring. Store fuel in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark; this includes any appliance with a pilot light.

Important: Avoid Damage! Keep all dirt, scale, water, or other foreign material out of fuel.

Keep fuel in a safe, protected area and in a clean, properly marked ("DIESEL FUEL") container. DO NOT use deicers to attempt to remove water from fuel. DO NOT depend on fuel filters to remove water from fuel. It is recommended that a water separator be installed in the storage tank outlet. BE SURE to properly discard unstable or contaminated diesel fuel and/or their containers when necessary.

4-Cycle Diesel Engine Oil - North America

Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oils are PREFERRED:

- **PLUS-50™-SAE 15W-40.**
- **TORQ-GARD SUPREME™-SAE 5W-30.**

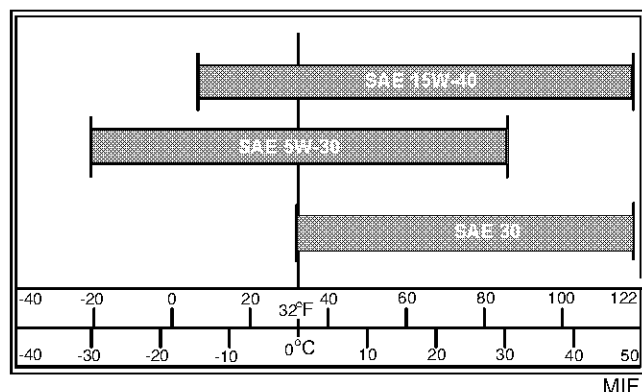
The following John Deere oils are also recommended, based on their specified temperature range:

- **TURF-GARD™-SAE 10W-30.**
- **PLUS-4™-SAE 10W-30.**
- **TORQ-GARD SUPREME™-SAE 30.**

Other oils may be used if above John Deere oils are not available, provided they meet one of the following specifications:

- SAE 15W-40-API Service Classification CF-4 or higher.
- SAE 5W-30-API Service Classification CC or higher.
- SAE 10W-30-API Service Classification CF or higher.
- SAE 30-API Service Classification CF or higher.

Important: Avoid Damage! If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval for oil and filter by 50%.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX, ENOIL in JDS-G135.
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.
- Lubrication Sales Manual PI7032.

4-Cycle Diesel Engine Oil - Europe

Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oils are PREFERRED:

- **TORQ-GARD SUPREME™-SAE 15W-40.**
- **UNI-GARD™-SAE 15W-40.**
- **TORQ-GARD SUPREME™-SAE 5W-30.**
- **UNI-GARD™-SAE 5W-30.**

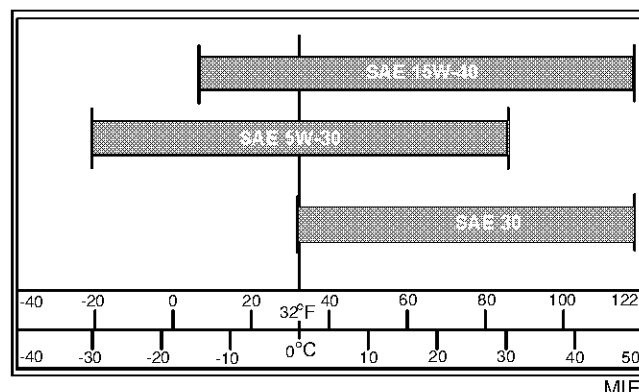
The following John Deere oils are also recommended, based on their specified temperature range:

- **TORQ-GARD SUPREME™-SAE 10W-30.**
- **UNI-GARD™-SAE 10W-30.**
- **TORQ-GARD SUPREME™-SAE 30.**
- **UNI-GARD™-SAE 30.**

Other oils may be used if above John Deere oils are not available, provided they meet the following specification:

- CCMC Specification D4 or Mercedes Benz MB228.1 or higher.

Important: Avoid Damage! If diesel fuel with sulfur content greater the 0.5% is used, reduce the service interval for oil and filter by 50%.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX, ENOIL in JDS-G135.
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

Hydrostatic Transmission and Hydraulic Oil - North America and Europe

Use the following oil viscosity based on the air temperature range. Operating outside of the recommended oil air temperature range may cause premature hydrostatic transmission or hydraulic system failures.

Important: Avoid Damage! DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission. DO NOT mix any other oils in this transmission.

The following John Deere transmission and hydraulic oil is **PREFERRED**:

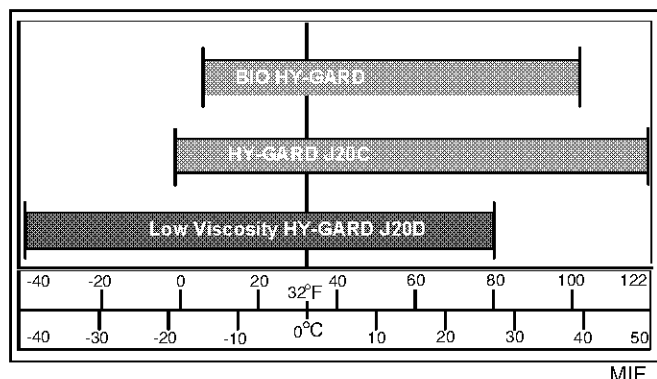
- **HY-GARD-JDM J20C.™**

Low Viscosity HY-GARD™ J20D.™

Use John Deere BIO HY-GARD™ oil when a biodegradable fluid is required.

Other oils may be used if above recommended John Deere oil is not available, provided they meet the following specification:

- John Deere Standard JDM J20C or J20D.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ANTI in JDS-G135.
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.
- Lubrication Sales Manual PI7032.

Biodegradable Oil

Application

Important: Avoid Damage! Biodegradable oils, other than BIO HY-GARD™, are not recommended.

When use of a biodegradable lubricant is desired or required, BIO HY-GARD is recommended. BIO HY-GARD may be used under normal mowing conditions.

DO NOT USE biodegradable lubricants in machines for the following operations:

- Any machine used for scalping procedure.
- Any verticut operation in temperatures exceeding 32°C (90°F).
- If the natural color of the fluid has become black, it is possible an overheating problem exists. Change the fluid.
- If the fluid becomes milky, water contamination may be a problem. Investigate the source of the contamination.
- Take fluid level reading when system is cold.
- Mixing of biodegradable oil and mineral oil will reduce the biodegradability of the lubricant in the machine. Mixing of HY-GARD and BIO HY-GARD will not result in performance deterioration.

Converting From HY-GARD to BIO HY-GARD

Systems being converted from HY-GARD to BIO HY-GARD should follow the procedure listed below to obtain maximum lubricant biodegradability.

1. Park machine on a level surface.
2. Lower cutting units, stop engine, set park brake and remove key from ignition.
3. Drain hydraulic reservoir.
4. Replace hydraulic filter.
5. Fill reservoir with BIO HY-GARD to appropriate level.
6. Start engine and bring to medium idle.
7. Turn steering wheel full stroke several times and cycle cutting units several times.
8. Stop engine and check hydraulic oil level. Add BIO HY-GARD to appropriate level.
9. Operate machine under normal operating conditions for a minimum of two hours.
10. Repeat steps 1-8.
11. Follow recommended maintenance schedules.

Reel Support Bearing Grease - North America

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

The following John Deere grease is **PREFERRED**:

- **Corn Head Grease-AH80490/AN102562.**
- Cotton Picker Spindle Grease.

Other greases may be used if above preferred John Deere greases are not available, provided they meet the following specifications:

- Polyurea Grease-NLGI Grade 0.
- Calcium Complex Grease-NLGI Grade 0.

Important: Avoid Damage! DO NOT mix any other greases (including calcium, lithium, lithium complex, and lithium 12-hydroxy based greases) with above recommended greases; they are NOT COMPATIBLE. For best results, completely remove all non-compatible grease from housing and fill with above preferred grease or one of the other greases, which are compatible with each other. DO NOT use any BIO-GREASE.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS-G135.
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.
- Lubrication Sales Manual PI7032.

Reel Support Bearing Grease - Europe

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

The following John Deere grease is **PREFERRED**:

- **Corn Head Grease-AH80490/AN102562.**
- Cotton Picker Spindle Grease

Other greases may be used if above preferred John Deere greases are not available, provided they meet the following specifications:

- Polyurea Grease-NLGI Grade 0.
- Calcium Complex Grease-NLGI Grade 0.

Important: Avoid Damage! DO NOT mix any other greases (including calcium, lithium, lithium complex, and lithium 12-hydroxy based greases) with above recommended greases; they are NOT COMPATIBLE. For best results, completely remove all non-compatible grease from housing and fill with above preferred grease or one of the other greases, which are compatible with each other. DO NOT use any BIO-GREASE.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS-G135.
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.
- Lubrication Sales Manual PI7032.

Chassis and Roller Water Resistant Grease

This grease is specially formulated to prevent corrosion and water washout when used in a wet environment.

The following water resistant grease is **PREFERRED**:

- **Special Purpose HD Water Resistant Grease - TY24425.**

The following water resistant grease may also be used:

- **Multi-Purpose HD Lithium Complex Grease - TY24416.**

Other greases may be used if they meet or exceed the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.

Alternative Lubricants

Conditions in certain geographical areas outside the United States and Canada may require different lubricant recommendations than the ones printed in this Technical Manual or the Operator's Manual. Consult with your John Deere Dealer, or Sales Branch, to obtain the alternative lubricant recommendations.

Important: Avoid Damage! Use of alternative lubricants could cause reduced life of the component.

If alternative lubricants are to be used, it is recommended that the factory fill be thoroughly removed before switching to any alternative lubricant.

Synthetic Lubricants

Synthetic lubricants may be used in John Deere equipment if they meet the applicable performance requirements (industry classification and/or military specification) as shown in this manual.

The recommended air temperature limits and service or lubricant change intervals should be maintained as shown in the Operator's Manual.

Avoid mixing different brands, grades, or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements. Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Lubricant Storage

All machines operate at top efficiency only when clean lubricants are used. Use clean storage containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides. Make sure all containers are properly marked as to their contents. Dispose of all old, used containers and their contents properly.

Oil Filters

Important: Avoid Damage! Filtration of oils is critical to proper lubrication performance. Always change filters regularly.

The following John Deere oil filters are PREFERRED:

- **Automotive and Light Truck Engine Oil Filters.**

Most John Deere filters contain pressure relief and anti-drainback valves for better engine protection.

Other oil filters may be used if above recommended John Deere oil filters are not available, provided they meet the following specification:

- ASTB Tested in Accordance with SAE J806.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil filter for your customers:

- Module DX,FILT in JDS-G135.
- Section 540, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.
- Lawn & Grounds Care Tune-Up Guide PI672.

Coolant

Recommended Engine Coolant

Important: Avoid Damage! Using incorrect coolant mixture can cause overheating and damage to the radiator and engine:

- **Do not operate engine with plain water.**
- **Do not exceed a 50% mixture of coolant and water.**
- **Aluminum engine blocks and radiators require approved ethylene-glycol based coolant.**

The engine cooling system is filled to provide year-round protection against corrosion and cylinder liner pitting, and winter freeze protection to -37 degrees C (-34 degrees F). If protection at lower temperatures is required, consult your John Deere dealer for recommendations.

The following coolants are preferred:

- John Deere COOL-GARD II™ Premix
- John Deere COOL-GARD Premix
- John Deere COOL-GARD PG Premix

John Deere COOL-GARD II Premix and John Deere COOL-GARD Premix are available in a concentration of 50% propylene glycol.

John Deere COOL-GARD PG Premix is available in a concentration of 55% propylene glycol.

Additional recommended coolants:

- John Deere COOL-GARD II Concentrate in a 40% to 60% mixture of concentrate with water.
- John Deere COOL-GARD Concentrate in a 40% to 60% mixture of concentrate with water.

If the recommended coolants are unavailable, use an ethylene glycol or propylene glycol base coolant that meets the following specification:

- ASTM D3306 prediluted (50%) coolant.
- ASTM D3306 coolant concentrate in a 40% to 60% mixture of concentrate with water.

Check container label before using to be sure it has the appropriate specifications for your machine. Use coolant with conditioner or add conditioner to coolant before using.

Water Quality

- Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized water is recommended with ethylene glycol base engine coolant concentrate.

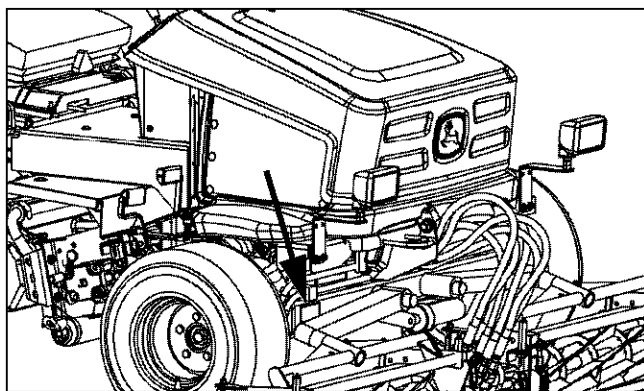
Identification Numbers

Machine Identification Number Locations

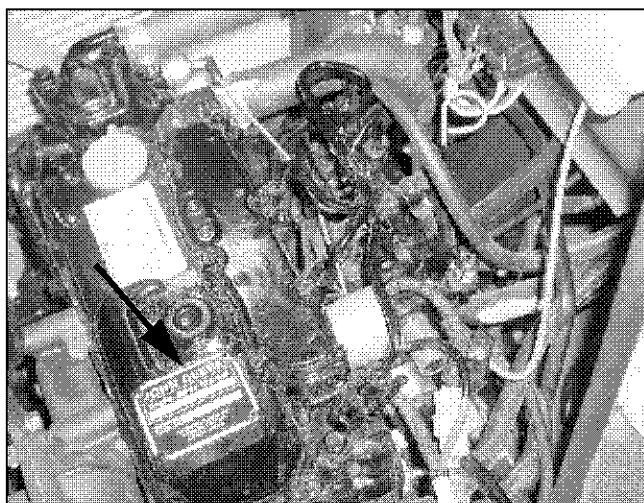
When ordering parts or submitting a warranty claim, it is **IMPORTANT** that the machine product identification number and component serial number are included.

The location of the machine identification number and component serial numbers are shown.

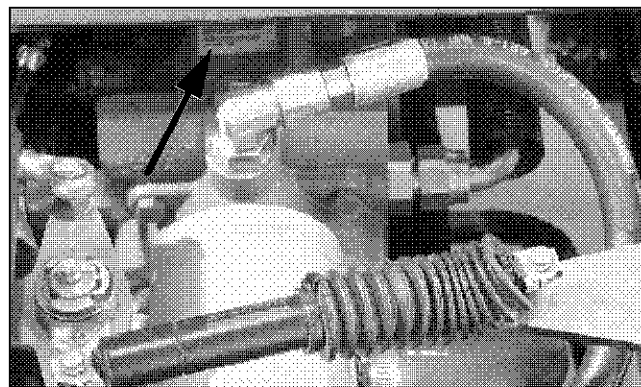
Machine Identification Number



Diesel Engine Serial Number

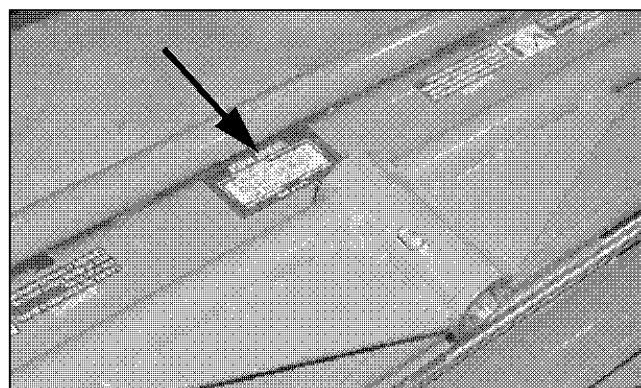


Hydrostatic Pump Serial Number



MX24081

Cutting Unit Serial Number



MX24308

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ENGINE - DIESEL SPECIFICATIONS

Specifications

General Vehicle Specifications

Diesel Engine

Make.....	Yanmar
Model.....	3TNV70
Type.....	4-cycle diesel
Gross Output Power.....	14.6 kW (19.5 hp)
Bore.....	70 mm (2.756 in.)
Stroke.....	74 mm (2.913 in.)
Cylinders.....	3
Valves.....	Overhead
Displacement.....	0.854 L (52.1 cu in.)
Firing Order.....	1-3-2
Direction of Rotation.....	Counterclockwise (viewed from flywheel)
Combustion System.....	Indirect injection type
Compression Ratio.....	23:1
Oil Capacity with Filter (Approximate).....	2.13 L (2.25 qt)
Cooling.....	Liquid with pump and radiator
Cooling System Capacity (Approximate).....	3.5 L (3.7 qt)
Total Hydraulic System Capacity with Reservoir (Approximate).....	28.4 L (7.5 gal)
Governor.....	Centrifugal
Slow Idle (No Load).....	1400 ± 50 rpm
Fast Idle (No Load).....	3150 ± 50 rpm
Fuel Filter/Water Separator.....	Replaceable element fuel water separator
Air Filter.....	Dry replaceable primary and secondary elements
Weight (Approximate).....	98 kg (216 lb)

Test and Adjustment Specifications

12V Alternator Drive Belt Deflection at 98 N (22 lb-force).....	10-15 mm (0.40-0.60 in.)
Valve Clearance.....	0.15-0.25 mm (0.006-0.010 in.)
Cylinder Compression Pressure.....	3137-3344 kPa (455-485 psi)
Cylinder Compression Pressure (Minimum).....	2448-2654 kPa (355-385 psi)
Pressure Difference between Cylinders (Maximum).....	200-296 kPa (29-43 psi)
Engine Oil Pressure @ 3150 RPM.....	290-441 kPa (42-64 psi)
Engine Oil Pressure @ 1400 RPM.....	60 kPa (9 psi)
Fuel Transfer Pump Pressure (Minimum).....	25 kPa (4.3 psi)
Fuel Transfer Pump Flow Volume (Min in One Minute) 400 mL (13.5 oz.)	
Slow Idle Speed.....	1400 ± 50 rpm
Fast Idle Speed.....	3150 ± 50 rpm
Fuel Injection Nozzle	
New Nozzle Opening Pressure (5 Hours or Less Usage).....	12 800-13 800 kPa (1856.5-2001.5 psi)
Used Nozzle Opening Pressure.....	12 300-13 300 kPa (1784-1929 psi)

ENGINE - DIESEL SPECIFICATIONS

Leakage at Just Below Minimum Opening Pressure No leakage for 5 sec (minimum)

Chatter and Spray Pattern at Opening Pressure

Slow Hand Lever Movement (At Opening) Chatter sound

Slow Hand Lever Movement (After Opening) Fine stream, 5-10° spray pattern

Fast Hand Lever Movement (After Opening) Fine atomized spray, 5-10° spray pattern

Fuel Injection Timing 21° ± 1°

Cooling System Pressure 74.5-102 kPa (10.8-14.8 psi)

Radiator Cap Valve Opening Pressure 74.5-102 kPa (10.8-14.8 psi)

Thermostat Begin Opening Temperature 69.5-72.5°C (157-163°F)

Thermostat Fully Open Temperature 85°C (185°F)

Lift Height Above 85°C (185°F) (Minimum) 8 mm (0.315 in.)

Cylinder Pressure (Maximum Applied) 2448 kPa (355 psi)

Repair Specifications

Cooling System Capacity (Approximate) 3.5 L (3.7 qt)

Engine Oil Capacity with Filter (Approximate) 2.13 L (2.25 qt)

Rocker Arm

Rocker Arm Shaft OD Wear Limit 11.94 mm (0.4701 in.)

Rocker Arm ID Wear Limit 12.07 mm (0.475 in.)

Rocker Arm Oil Clearance Wear Limit 0.13 mm (0.005 in.)

Push Rod Bend 0.00-0.03 mm (0.000-0.001 in.)

Cylinder Head Distortion

Standard 0.05 mm (0.002 in.)

Wear Limit 0.15 mm (0.006 in.)

Allowable Removed Material (Maximum) 0.20 mm (0.008 in.)

Valve Grinding

Intake Valve Face Margin 0.90-1.1 mm (0.035-0.043 in.)

Exhaust Valve Face Margin 1.0-1.2 mm (0.039-0.047 in.)

Valve Face Margin Wear Limit 0.50 mm (0.020 in.)

Intake Valve Face Angle 30°

Exhaust Valve Face Angle 45°

Valve Stem

Intake Valve Stem Standard OD 5.960-5.975 mm (0.2346-0.2352 in.)

Exhaust Valve Stem Standard OD 5.945-5.960 mm (0.2341-0.2346 in.)

Valve Stem OD Wear Limit (Both) 5.90 mm (0.232 in.)

Valve Recession

Valve Standard Recession (Both) 0.4-0.6 mm (0.0157-0.0236 in.)

Valve Recession Wear Limit (Both) 0.9 mm (0.035 in.)

Valve Guides

ENGINE - DIESEL SPECIFICATIONS

Valve Guide Standard ID	6.00-6.01 mm (0.236-0.237 in.)
Valve Guide ID Wear Limit	6.08 mm (0.239 in.)
Intake Valve Guide-to-Valve Stem Standard Oil Clearance	0.025-0.052 mm (0.001-0.002 in.)
Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance	0.040-0.067 mm (0.002-0.003 in.)
Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both)	0.17 mm (0.007 in.)
Valve Guide Height	9.8-10.0 mm (0.386-0.394 in.)
Valve Stem Seal Height	10.9-11.2 mm (0.429-0.441 in.)

Valve Springs

Spring Free Length	37.8 mm (1.488 in.)
Spring Inclination (Maximum)	1.3 mm (0.051 in.)

Piston-to-Cylinder Head Clearance	0.75-0.89 mm (0.029-0.035 in.)
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Connecting Rod Bearings

Connecting Rod Bearing ID	41.982-42.002 mm (1.653-1.654 in.)
Connecting Rod Bearing Oil Clearance Wear Limit	0.11 mm (0.004 in.)

Piston Rings

Top Piston Ring Thickness Wear Limit	1.45 mm (0.057 in.)
Middle Piston Ring Thickness Wear Limit	1.45 mm (0.057 in.)
Oil Control Ring Thickness Wear Limit	2.95 mm (0.116 in.)
Top Piston Ring Groove Side Clearance	0.06-0.10 mm (0.002-0.004 in.)
Middle Piston Ring Groove Side Clearance	0.050-0.090 mm (.002-0.004 in.)
Oil Control Ring Groove Side Clearance	0.020-0.060 mm (0.0008-0.0024 in.)
Top Piston Ring Standard End Gap	0.15-0.30 mm (0.006-0.012 in.)
Middle Piston Ring Standard End Gap	0.18-0.33 mm (0.007-0.013 in.)
Oil Control Ring Standard End Gap	0.15-0.35 mm (0.006-0.014 in.)
Top Piston Ring End Gap Wear Limit	0.39 mm (0.015 in.)
Middle Piston Ring End Gap Wear Limit	0.42 mm (0.0165 in.)
Oil Control Ring End Gap Wear Limit	0.44 mm (0.017 in.)

Piston Pins

Piston Pin Standard OD	21.995-22.000 mm (0.8659-0.8661 in.)
Piston Pin OD Wear Limit	21.965 mm (0.865 in.)

Piston Pin Bores

Bore Standard ID	22.000-22.009 mm (0.8661-0.8665 in.)
Bore ID Wear Limit	22.04 mm (0.868 in.)

Piston Pin Bushings

Bushing Standard ID	22.025-22.038 mm (0.867-0.868 in.)
Bushing ID Wear Limit	22.068 mm (0.869 in.)
Piston Pin-to-Bushing Standard Oil Clearance	0.025-0.047 mm (0.001-0.002 in.)
Piston Pin-to-Bushing Oil Clearance Wear Limit	0.105 mm (0.004 in.)

Pistons

Diameter Measuring Point Distance (A)	22-25 mm (0.866-0.984 in.)
Standard Size Piston Standard OD	69.96-69.99 mm (2.754-2.755 in.)

ENGINE - DIESEL SPECIFICATIONS

Standard Size Piston OD Wear Limit	69.91 mm (2.753 in.)
Oversize Piston Standard OD	70.21-70.24 mm (2.764-2.765 in.)
Oversize Piston OD Wear Limit.....	70.16 mm (2.763 in.)

Connecting Rods

Connecting Rod Side Play.....	0.20-0.40 mm (0.008-0.016 in.)
Connecting Rod Bearing Clearance.....	0.20-0.50 mm (0.001-0.002 in.)
Connecting Rod Bearing Clearance Wear Limit	0.11 mm (0.004 in.)
Connecting Rod Bearing ID.....	41.98-42.00 mm (1.653-1.654 in.)

Cylinder Bore

Piston-to-Cylinder Bore Clearance.....	0.03-0.05 mm (0.001-0.002 in.)
Cylinder Standard Roundness	0.00-0.01 mm (0.0000-0.0004 in.)
Cylinder Roundness Wear Limit.....	0.03 mm (0.001 in.)
Cylinder Standard Taper	0.00-0.01 mm (0.0000-0.0004 in.)
Cylinder Taper Wear Limit	0.03 mm (0.001 in.)
Standard Size Cylinder Bore Standard ID	70.01-70.02 mm (2.756-2.757 in.)
Standard Size Cylinder Bore ID Wear Limit	70.20 mm (2.764 in.)
Oversize Cylinder Bore Standard ID.....	70.26-70.27 mm (2.766-2.767 in.)
Oversize Cylinder Bore ID Wear Limit	70.45 mm (2.774 in.)

Crankshaft and Main Bearings

Crankshaft End Play.....	0.111-0.250 mm (0.004-0.010 in.)
Crankshaft End Play Wear Limit.....	0.28 mm (0.011 in.)
Crankshaft Bend (Maximum).....	0.02 mm (0.001 in.)
Crankshaft Connecting Rod Journal Standard OD	41.95-41.96 mm (1.6517-1.652 in.)
Crankshaft Connecting Rod Journal OD Wear Limit	41.90 mm (1.650 in.)
Crankshaft Main Bearing Journal Standard OD	46.95-46.96 mm (1.848-1.849 in.)
Crankshaft Main Bearing Journal OD Wear Limit	46.90 mm (1.847 in.)
Main Bearing Standard Oil Clearance.....	0.020-0.050 mm (0.001-0.002 in.)
Main Bearing Oil Clearance Wear Limit	0.120 mm (0.005 in.)

Camshaft

Camshaft Bend	0.00-0.02 mm (0.000-0.001 in.)
Camshaft Bend Wear Limit	0.05 mm (0.002 in.)
Camshaft Lobe Height	34.135-34.265 mm (1.344-1.349 in.)
Camshaft Lobe Height Wear Limit	33.89 mm (1.334 in.)
Gear Housing and Flywheel End Journal OD	39.94-39.96 mm (1.572-1.573 in.)
Gear Housing and Flywheel End Journal OD Wear Limit.....	39.905 mm (1.571 in.)
Intermediate Journal OD	39.910-39.935 mm (1.571-1.572 in.)
Intermediate Journal OD Wear Limit	39.875 mm (1.570 in.)
Intermediate and Flywheel End Bearing ID	40.00-40.025 mm (1.575-1.576 in.)
Intermediate and Flywheel End Bearing ID Wear Limit	40.100 mm (1.579 in.)
Gear Housing End Bearing ID.....	40.00-40.075 mm (1.575-1.578 in.)
Gear Housing End Bearing ID Wear Limit	40.150 mm (1.581 in.)
Bearing-to-Camshaft Gear Housing End Journal Clearance	0.040-0.135 mm (0.002-0.005 in.)
Bearing-to-Camshaft Gear Housing End Journal Clearance (Wear Limit)	0.245 mm (0.010 in.)
Bearing-to-Camshaft Intermediate Journal Clearance	0.065-0.115 mm (0.003-0.004 in.)
Bearing-to-Camshaft Intermediate Journal Clearance (Wear Limit)	0.225 mm (0.009 in.)

ENGINE - DIESEL SPECIFICATIONS

Bearing-to-Camshaft Flywheel End Journal Clearance	0.040-0.085 mm (0.002-0.003 in.)
Bearing-to-Camshaft Flywheel End Journal Clearance (Wear Limit)	0.195 mm (0.008 in.)
Camshaft End Play	0.05-0.15 mm (0.002-0.006 in.)
Camshaft End Play (Wear Limit)	0.25 mm (0.010 in.)
Timing Gear Backlash Clearance	0.06-0.12 mm (0.002-0.005 in.)
Timing Gear Backlash Clearance (Wear Limit)	0.14 mm (0.0055 in.)

Camshaft Followers

Cam Follower OD	20.927-20.960 mm (0.824-0.825 in.)
Cam Follower OD Wear Limit	20.91 mm (0.823 in.)
Cam Follower Bore ID	21.00-21.021 mm (0.827-0.828 in.)
Cam Follower Bore ID Wear Limit	21.04 mm (0.828 in.)
Follower-to-Bore Oil Clearance	0.040-0.094 mm (0.002-0.004 in.)
Follower-to-Bore Oil Clearance Wear Limit	0.13 mm (0.005 in.)

Idler Gear

Idler Gear Shaft Standard OD	36.95-36.975 mm (1.455-1.456 in.)
Idler Gear Shaft OD Wear Limit	36.90 mm (1.453 in.)
Idler Gear Bushing Standard ID	37.00-37.025 mm (1.457-1.458 in.)
Idler Gear Bushing ID Wear Limit	37.07 mm (1.4596 in.)
Oil Clearance	0.025-0.075 mm (0.001-0.003 in.)
Oil Clearance Wear Limit	0.175 mm (0.007 in.)

Oil Pump

Outer Rotor-to-Housing Clearance	0.12-0.21 mm (0.005-0.008 in.)
Outer Rotor-to-Housing Clearance Wear Limit	0.30 mm (0.012 in.)
Inner Rotor Tip-to-Outer Rotor Tip Clearance (Maximum)	0.16 mm (0.006 in.)
Rotor-to-Pump Housing Side Clearance	0.02-0.07 mm (0.001-0.003 in.)
Rotor-to-Pump Housing Side Clearance Wear Limit	0.12 mm (0.005 in.)
Inner Rotor Shoulder OD	45.98-46.00 mm (1.810-1.811 in.)
Timing Gear Cover Pilot Hole ID	46.13-46.18 mm (1.816-1.818 in.)
Inner Rotor-to-Pilot Hole Oil Clearance Wear Limit	0.25 mm (0.010 in.)

Fuel Injection Nozzles

Separator Plate Contact Surface	0.10 mm (0.004 in.)
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Torque Specifications

Cylinder Head Mounting Cap Screw

Initial	27-29 N•m (20-22 lb-ft)
Final	54-58 N•m (40-43 lb-ft)

General Specifications

12V Alternator Sheave Retaining Nut	27 N•m (20 lb-ft)
Hydrostatic Pump Plate-to-Flywheel Housing Cap Screw	68 N•m (50 lb-ft)
Glow Plug	14.7-19.6 N•m (11-14 lb-ft)
Rocker Arm Assembly Mounting Cap Screw	26 N•m (19 lb-ft)
Connecting Rod Cap Screw	22.6-27.5 N•m (17-20 lb-ft)

ENGINE - DIESEL TOOLS AND MATERIALS

Flywheel Mounting Cap Screw	80.4-86.4 N•m (59-64 lb-ft)
Crank Hub Cap Screw	113-123 N•m (83-90 lb-ft)
Main Bearing Cap Screw	75.5-81.5 N•m (56-60 lb-ft)
Camshaft Thrust Plate Cap Screw	11 N•m (96 lb-in.)
Timing Gear Cover Mounting Cap Screw	9 N•m (78 lb-in.)
Timing Gear Housing Mounting Cap Screw	11 N•m (96 lb-in.)
Vibration Isolator Mounting Cap Screw	44 N•m (33 lb-ft)
Engine-to-Subframe Cap Screw (Apply Thread Lock and Sealer)	80 N•m (59 lb-ft)
Engine Mount Cap Screw (Apply Thread Lock and Sealer)	85 N•m (63 lb-ft)

Fuel Injection Pump

Injection Pump Mounting Nut	23-28 N•m (17-21 lb-ft)
Injection Pump Drive Gear Nut	59-69 N•m (44-51 lb-ft)
High-Pressure Line Nut	29-34 N•m (22-25 lb-ft)

Fuel Injection Nozzles

Injection Nozzle	49-59 N•m (36-43 lb-ft)
Leak-Off Fitting Nut	24-33 N•m (18-24 lb-ft)
Nozzle Fitting	29-49 N•m (21-36 lb-ft)

Tools and Materials

Special or Required Tools

Note: Order tools according to information given in the U.S. *SERVICEGARD™ Catalog* or in the *European Microfiche Tool Catalog (MTC)*.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge 0-700 kPa (0-100 psi)	JT07034	Used for engine oil pressure test.
Adapter	JDG472	Used for cylinder compression check and radiator bubble test.
Adapter	JDG560	Used for cylinder compression check and radiator bubble test.
Adapter Set	D01110AA	Used for fuel injection nozzle test.
Belt Tension Gauge	JDG529 or JDST28	Used to adjust the coolant pump/ alternator drive belt tension.
Bushing, Bearing, and Seal Driver Set	N/A	Used for removing and installing bushings, bearings, and seals.

ENGINE - DIESEL TOOLS AND MATERIALS

Special or Required Tools

Tool Name	Tool No.	Tool Use
Compression Gauge Assembly	JT01682	Used for cylinder compression check.
Connector	JT03349	Used for engine oil pressure test.
Cooling System Pressure Pump	D05104ST	Used for cooling system pressure test.
Cylinder Leakdown Tester	JT03502	Used to test cylinders for compression pressure leakdown.
Dial Indicator with Magnetic Base	N/A	Used to measure valve lift, end play, and backlash.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used for fuel injection nozzle test.
Digital Pulse Tachometer	JT07270	Used to set slow idle speed and check fast idle speed.
Flex Hone (with 300-Grit Stone)	N/A	Used to deglaze cylinder bores.
Fuel Pump Pressure Test Kit	JDG356	Used for fuel pump pressure test.
Hose Assembly	JT03017	Used for engine oil pressure test.
Lifting Bracket (2 used)	JT01748	Used with hoist for removing and installing cylinder head and flywheel.
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers when removing and installing camshaft.
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.
™PLASTIGAG E Bearing Clearance Measurement Tool	N/A	Used to measure clearances.
Radiator Pressure Test Kit (Adapters)	JDG692	Used for cooling system pressure test.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ridge Reamer	N/A	Used to remove ridges from cylinder bore.
Rigid Hone (with 180-Grit Stone)	N/A	Used with drill press to rebore cylinder to use oversize pistons and rings.
Straightedge	N/A	Used to measure drive belt deflection.
Straight Adapter	23622	Used for fuel injection nozzle test.
Valve Spring Compressor	JDE138	Used to remove valves.
Valve Guide Driver	JDG10500	Used to remove valve guides from cylinder head.
Valve Guide Installer	JDG10501	Used to install valve guides to cylinder head.
Valve Seal Installer	JDG10503	Used to install valve seal on guides.
Feeler Gauge	N/A	Used to check valve clearance.
12 mm End Wrench	N/A	Used to loosen and tighten locknut.
Flat Blade Screwdriver	N/A	Used to hold and turn adjusting screw.
17 mm Wrench	N/A	Used to turn crankshaft sheave.
Air Pressure Regulator	N/A	Used to pressurize the air intake system to check for leaks.
Test Fitting	N/A	Used to connect air pressure regulator.
Graduated Container	N/A	Used to measure fuel amount.
17 mm Open End Wrench (2 used)	N/A	Used to loosen nut on high-pressure fuel injector line.
Container	N/A	Used to hold diesel fuel released during test.

ENGINE - DIESEL TOOLS AND MATERIALS

Special or Required Tools

Tool Name	Tool No.	Tool Use
Timing Tool (Made from High-Pressure Pipe, Nut, and a Clear Plastic Straw ¹)	N/A	Used to view fuel movement during timing adjustment.
Thermometer	N/A	Used to measure temperature at which thermostat opens.
Glass Container	N/A	Used to hold heated water for test.
Heating Unit	N/A	Used to heat water for test.
Hoist	N/A	Used to remove cylinder head from block.
Drill Press	N/A	Used with rigid hone to rebore cylinder to use oversize pistons and rings.
Puller	N/A	Used to remove crankshaft sheave.
Knife-Edge Puller	N/A	Used with press to remove gear from crankshaft.
Press	N/A	Used with knife-edge puller to remove gear from crankshaft.
Dial Indicator	N/A	Used with V-blocks to inspect crankshaft for bend.
V-Block (2 used)	N/A	Used with dial indicator to inspect crankshaft for bend.
Magnetic Pickup Tool	N/A	Used to remove cam followers from cylinder block.

1. Straw from an aerosol can of WD40™, carburetor cleaner, brake parts cleaner, etc.

Other Material

Other Material

Part No.	Part Name	Part Use
PM38655 (U.S.)/ PM38628 (Canada)	John Deere High-Flex Form-in-Place Gasket	Used to seal crankcase extension housing, rear oil seal case, and flywheel housing to engine block. Used to seal oil pan to timing gear housing and engine block.
PM37477 (U.S.)/ PM38621 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of crankshaft sheave cap screws before installation.
PM37397 (U.S.)/ PM38613 (Canada)	Pipe Sealant	Applied to threads of dual temperature coolant switch before installation.
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

ENGINE - DIESEL THEORY OF OPERATION

Theory of Operation

Cooling System Operation

Function

The coolant pump circulates coolant through the cooling system, drawing hot coolant from the engine block, circulating it through the radiator for cooling.

Theory of Operation

The pressurized cooling system includes the radiator, water pump, fan and thermostat.

During the warm-up period, the thermostat remains closed and the impeller-type coolant pump draws coolant from the bypass tube. Coolant from the pump flows to the cylinder block water jacket and up through the cylinder head providing a fast warm-up period.

Once the engine has reached operating temperature, the thermostat opens and coolant is pumped from the bottom of the radiator via the lower radiator hose into the cylinder block. Here it circulates through the block and around the cylinders.

From the block, coolant is then directed through the cylinder head, and into thermostat housing. With the thermostat open, 85°C (185°F), warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

When coolant system pressure exceeds 90 kPa (13 psi), a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

When temperature is reduced, a vacuum is produced in the radiator and coolant is drawn back out of the coolant recovery tank through a valve in the radiator cap.

A coolant temperature sensor informs the operator of the engine coolant temperature and warns of a high-temperature condition by lighting a lamp.

Lubrication System Operation

Function

A full pressure system lubricates engine parts with clean oil.

Theory of Operation

The pressure lubrication system consists of an oil strainer, positive displacement crankshaft-driven pump, oil pressure regulating valve, full flow oil filter, and an electrical pressure warning switch.

The pump draws lubrication oil from the oil pan through a strainer and a suction tube. The oil pressure regulating valve maintains pressure at a specified level that prevents

over-pressurization of the system. The oil is then pumped through an oil passage to the oil filter, then to the engine block main oil galley.

From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals and the idler gear shaft. Also, an oil passage from the main oil galley, through an external oil line, routes lubricating oil to the fuel injection pump.

Drilled cross-passages in the crankshaft distribute the oil from the main bearings to connecting rod bearings. Lube oil holes in main bearing oil grooves are provided to direct oil to the camshaft bearings.

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft. The hollow shaft distributes oil to the rocker arms, tappets and valves.

The oil pressure switch activates an indicator light to alert the operator to shut down the engine if oil pressure drops below specification.

Fuel and Air System Operation

Function

Fuel system supplies fuel to injection nozzles.

The air intake system filters air needed for combustion.

Fuel System

An electric fuel transfer pump provides pressurized fuel to the injection pump. The transfer pump draws fuel from a vented fuel tank, then sends it to an in-line filter. Low-pressure fuel from the fuel pump flows through the fuel filter to the fuel gallery of the injection pump. After the injection pump gallery is full, excess fuel is returned, along with leak-off fuel from the nozzles, through the return line to the fuel tank.

If the unit ever runs out of fuel, there are two air bleed lines that allow air to escape from the top of the filter and the injection pump. These two lines allow the system to be self bleeding.

The engine speed is controlled by the throttle lever and cable. The cable is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (ignition ON), the engine can be started. When the ignition is turned off, return springs on the shutoff shaft, extend the solenoid, moving the shutoff linkage to the shutoff position.

The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles.

The injection nozzle prevents flow until high pressure is

ENGINE - DIESEL THEORY OF OPERATION

reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines have trapped fuel whenever injection is not taking place.

A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

Air System

Air enters the air filter through the inlet hose. The primary and secondary elements filter the air before entering the intake manifold.

An air filter restriction indicator has a button that exposes a red indicator when the air filter needs servicing. The air filter restriction indicator is exposed when the vacuum reaches a specified level. A small amount of vacuum is always present due to some restriction of air movement through the filter elements. The unloading valve is like a one-way valve. It ejects heavy dirt particles from the air stream during engine operation, but does not let air into the air filter housing. The operator can squeeze the valve to let the large particles out.

Diesel Engine Troubleshooting

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.



Caution: Avoid Injury! The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Coolant in the radiator is extremely hot during operation.

Symptom: Engine Will Not Start

Procedure

1. Starting procedure being used is correct for conditions?

Yes: Go to next step.

No: Use correct procedure for conditions. See the Operator's Manual.

2. Battery 12.7 VDC or higher?

Yes: Go to next step.

No: Charge and check battery.

3. No open circuits in wiring?

Yes: Go to next step.

No: Repair or replace as needed.

4. Starting motor functioning properly?

Yes: Go to next step.

No: Repair or replace starting motor.

5. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

6. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of proper viscosity and type. Replace oil filter.

7. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

8. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

9. No air leak in fuel system?

Yes: Go to next step.

No: Repair fuel system.

10. Fuel lines not plugged, pinched or cracked?

Yes: Go to next step.

No: Repair or replace fuel lines as needed.

11. Correct volume of fuel supplied to injection pump?

Yes: Go to next step.

No: Replace fuel pump.

12. Intake and/or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

13. Intake and/or exhaust valve not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

14. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

15. Piston rings, piston or cylinder not worn?

Yes: Go to next step.

No: Replace piston and/or rings; bore or hone cylinder. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

16. Crankshaft pin or bearing not seized?

Yes: Go to next step.

No: Regrind crankshaft and replace bearings. (See "Crankshaft and Main Bearings" on page 88.)

17. Is injection pump timing correct?

No: (See "Injection Pump Static Timing Check" on page 53.)

ENGINE - DIESEL DIESEL ENGINE TROUBLESHOOTING

Symptom: Engine Starts but Does Not Continue Running - No Exhaust Smoke

Procedure

1. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

2. Engine oil of proper viscosity and type?

Yes: Go to next step.

No: Replace engine oil and filter with oil of proper viscosity and type.

3. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

4. No air leak in fuel system?

Yes: Go to next step.

No: Repair fuel system.

5. Fuel lines not plugged, pinched or cracked?

Yes: Go to next step.

No: Repair or replace fuel lines as needed.

6. Correct volume of fuel supplied to injection pump?

Yes: Go to next step.

No: Replace fuel pump.

7. Correct volume of fuel supplied to injection pump?

Yes: Go to next step.

No: Replace fuel pump.

8. Valve clearance correct?

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

Symptom: Engine Starts but Does Not Continue Running - Excess Exhaust Smoke

Procedure

1. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

4. Intake and/or exhaust valve not seized?

Yes: Go to next step.

No: Repair as necessary. (See "Recondition Cylinder Head" on page 70.)

5. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

6. Piston rings, piston or cylinder not worn?

No: Replace piston and/or rings, bore or hone cylinder. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Low Engine Output - Exhaust Color NORMAL

Procedure

1. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

2. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

3. Fuel lines not clogged, cracked or pinched?

Yes: Go to next step.

No: Clean or replace fuel lines.

4. No air leakage into fuel system?

Yes: Go to next step.

No: Repair fuel supply system.

5. Proper volume of fuel to injection pump?

Yes: Go to next step.

No: Check or replace fuel pump.

6. Intake and exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

7. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

8. Intake or exhaust valves not seized?

ENGINE - DIESEL DIESEL ENGINE TROUBLESHOOTING

Yes: Go to next step.

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

9. Cylinder head gasket not leaking compression?

No: Replace head gasket. (See "Remove and Install Cylinder Head" on page 69.) Resurface head and block if necessary. (See "Cylinder Head" on page 71.)

Symptom: Low Engine Output - Exhaust Color WHITE

Procedure

1. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Even volume of fuel being injected?

Yes: Go to next step.

No: Repair or replace fuel injection pump or fuel injectors.

4. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

5. Intake or exhaust valve stems not worn?

Yes: Go to next step.

No: Replace valve guides and valves. (See "Recondition Cylinder Head" on page 70.)

6. Is injection pump timing correct?

Yes: Go to next step.

No: Time injection pump. (See "Injection Pump Static Timing Check" on page 53.)

7. Piston rings installed correctly?

Yes: Go to next step.

No: Install piston rings correctly. (See "Remove and Install Piston and Connecting Rod" on page 76.)

8. Piston ring ends staggered?

Yes: Go to next step.

No: Stagger piston ring ends. (See "Remove and Install Piston and Connecting Rod" on page 76.)

9. Piston, rings, or cylinder not worn?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

10. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Low Engine Output - Exhaust Color BLACK

Procedure

1. Is engine NOT being run under high-altitude or high-temperature conditions?

Yes: Go to next step.

No: Reduce load.

2. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Air filter elements not clogged?

Yes: Go to next step.

No: Clean or replace air filter elements.

4. Exhaust pipe not clogged?

Yes: Go to next step.

No: Clean exhaust pipe.

5. Engine running cool enough?

Yes: Go to next step.

No: Adjust fan belt tension. (See "Check and Adjust Alternator Drive Belt Tension" on page 42.) Check thermostat. (See "Test Thermostat" on page 55.) Replace if faulty.

6. Cooling system filled to correct level?

Yes: Go to next step.

No: Check for leaks and fill system to correct level.

7. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

8. Correct pattern from fuel injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

ENGINE - DIESEL DIESEL ENGINE TROUBLESHOOTING

9. Is injection pump timing correct?

Yes: Go to next step.

No: Time injection pump. (See "Injection Pump Static Timing Check" on page 53.)

10. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

11. Intake or exhaust valve not seized?

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

Symptom: Exhaust Color WHITE Under Load

Procedure

1. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Engine not running too cool?

Yes: Go to next step.

No: Check thermostat. (See "Test Thermostat" on page 55.) Replace if faulty.

4. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump.

5. Correct pattern from fuel injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

6. Is injection pump timing correct?

Yes: Go to next step.

No: Time injection pump. (See "Injection Pump Static Timing Check" on page 53.)

7. Piston rings installed correctly?

Yes: Go to next step.

No: Install piston rings correctly. (See "Remove and Install Piston and Connecting Rod" on page 76.)

8. Pistons, rings or cylinders not worn?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

9. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Exhaust Color BLACK Under Load

Procedure

1. Is engine NOT being run under high-altitude or high-temperature conditions?

Yes: Go to next step.

No: Reduce load.

2. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Air filter elements not clogged?

Yes: Go to next step.

No: Clean or replace air filter elements.

4. Exhaust pipe not clogged?

Yes: Go to next step.

No: Clean exhaust pipe.

5. Even volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

6. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

7. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

8. Is injection pump timing correct?

Yes: Go to next step.

No: Time injection pump. (See "Injection Pump Static Timing Check" on page 53.)

9. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

10. Intake or exhaust valves not seized?

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

Symptom: Exhaust Temperature Too High

Procedure

1. Cooling system filled to correct level?

Yes: Go to next step.

No: Check for leaks and fill system to correct level.

2. Engine running cool enough?

Yes: Go to next step.

No: Adjust fan belt tension. (See "Check and Adjust Alternator Drive Belt Tension" on page 42.) Check thermostat. (See "Test Thermostat" on page 55.) Replace if faulty.

3. Exhaust pipe not clogged?

Yes: Go to next step.

No: Clean exhaust pipe.

4. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

5. Intake or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

6. Intake or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

7. Intake or exhaust valves not leaking compression?

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

8. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Engine Runs Rough - Misfiring

Procedure

1. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

2. Intake or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

3. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

4. Is injection pump timing correct?

Yes: Go to next step.

No: Time injection pump. (See "Injection Pump Static Timing Check" on page 53.)

5. Backlash of timing gear not excessive?

Yes: Go to next step.

No: Repair gears as needed. (See "Timing Gear Backlash Check" on page 96.)

6. Combustion chambers clean of foreign matter?

Yes: Go to next step.

No: Clean combustion chambers. (See "Remove and Install Cylinder Head" on page 69.)

7. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

8. Intake or exhaust valves not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

9. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Engine Runs Rough - Uneven Combustion Sound

Procedure

1. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel. Check fuel filter.

3. Intake and exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

4. Even volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

5. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

6. Air filter elements not clogged?

Yes: Go to next step.

No: Clean or replace air filter elements.

7. Exhaust pipe not clogged?

No: Clean exhaust pipe.

Symptom: Engine Runs Rough - Engine Surges DURING IDLING

Procedure

1. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel. Check fuel filter.

2. Even volume of fuel injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Intake and exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)

4. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

5. Intake or exhaust valves not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

6. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine

Cylinder" on page 83.)

Symptom: Engine Runs Rough - Engine Surges UNDER LOAD

Procedure

1. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel. Check fuel filters.

2. Even volume of fuel injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

4. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Engine Runs Rough - Excessive Engine Vibration

Procedure

1. Even volume of fuel injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

2. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

3. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

4. Crankshaft pin or bearing not worn or seized?

Yes: Go to next step.

No: Regrind crankshaft and replace bearings. (See "Crankshaft and Main Bearings" on page 88.)

5. Connecting rod bolts torqued properly?

ENGINE - DIESEL DIESEL ENGINE TROUBLESHOOTING

No: Replace damaged components. (See "Remove and Install Piston and Connecting Rod" on page 76.)

Symptom: Excessive Fuel Consumption

Procedure

1. Engine not running too cool?

Yes: Go to next step.

No: Check thermostat. (See "Test Thermostat" on page 55.) Replace if faulty.

2. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Correct pattern from fuel injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

4. Intake or exhaust valves not leaking compression?

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

Symptom: Excessive Oil Consumption

Procedure

1. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of proper viscosity and type. Replace oil filter.

2. No external or internal oil leak?

Yes: Go to next step.

No: Repair as needed.

3. Intake or exhaust valve stems not worn?

Yes: Go to next step.

No: Replace valve guides and valves. (See "Recondition Cylinder Head" on page 70.)

4. Piston rings installed correctly and properly staggered?

Yes: Go to next step.

No: Install piston rings correctly. (See "Remove and Install Piston and Connecting Rod" on page 76.)

5. Pistons, rings or cylinders not worn?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod"

on page 76. See "Bore Engine Cylinder" on page 83.)

6. Piston rings not broken or seized?

No: Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Fuel Oil in Crankcase

Procedure

1. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

2. Intake or exhaust valve not seized or broken?

Yes: Go to next step.

No: Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 70.)

3. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

4. Pistons rings, piston or cylinders not worn?

No: Replace pistons and rings; bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

Symptom: Coolant in Crankcase

Procedure

1. Cylinder head gasket not leaking?

Yes: Go to next step.

No: Replace head gasket. Resurface head and block if necessary. (See "Remove and Install Cylinder Head" on page 69.)

2. Is cylinder block not cracked?

No: Replace cylinder block.

Symptom: Low Oil Pressure

Procedure

1. Oil at correct level?

Yes: Go to next step.

No: Add oil.

2. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of proper viscosity and

type. Replace oil filter.

3. No external or internal oil leak?

Yes: Go to next step.

No: Repair as needed.

4. Oil pressure regulator valve not worn or damaged?

Yes: Go to next step.

No: Clean or replace regulator valve. (See "Remove, Inspect and Install Oil Pump" on page 103.)

5. Crankshaft pin or bearing not worn?

Yes: Go to next step.

No: Regrind crankshaft and replace bearings. (See "Crankshaft and Main Bearings" on page 88.)

6. Connecting rod bolts torqued properly?

Yes: Go to next step.

No: Replace damaged components. Tighten to correct specification.

7. Is engine not worn excessively?

No: Repair engine as needed.

Symptom: Engine Is Overheating

Procedure

1. Is engine NOT being run under high-altitude or high-temperature conditions?

Yes: Go to next step.

No: Reduce load on engine.

2. Cooling system filled to correct level?

Yes: Go to next step.

No: Check for leaks and fill system to correct level.

3. Is radiator clear of debris?

Yes: Go to next step.

No: Clean radiator fins.

4. Is radiator core free from blockage?

Yes: Go to next step.

No: Clean or replace radiator.

5. Is fan operating correctly?

Yes: Go to next step.

No: Adjust fan belt tension. (See "Check and Adjust Alternator Drive Belt Tension" on page 42.)

6. Is thermostat operating correctly?

Yes: Go to next step.

No: Check thermostat. (See "Test Thermostat" on page 55.) Replace if faulty.

7. Is lower radiator hose not collapsed?

Yes: Go to next step.

No: Replace lower radiator hose.

8. Is cylinder head gasket not leaking?

Yes: Go to next step.

No: Replace head gasket. Resurface head and block if necessary. (See "Remove and Install Cylinder Head" on page 69. See "Recondition Cylinder Head" on page 70.)

9. Is cylinder block not cracked?

No: Replace cylinder block.

Symptom: Low Engine Coolant Temperature

Procedure

1. Is thermostat operating correctly?

No: Check thermostat. (See "Test Thermostat" on page 55. Replace if faulty.)

Symptom: Low Compression

Procedure

1. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See "Recondition Cylinder Head" on page 70.)

2. Intake or exhaust valve not seized?

Yes: Go to next step.

No: Replace valve guides and valves. (See "Recondition Cylinder Head" on page 70.)

3. Pistons, rings or cylinders not worn or seized?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod" on page 76. See "Bore Engine Cylinder" on page 83.)

4. Piston rings installed correctly and properly staggered?

No: Install piston rings correctly. (See "Remove and Install Piston and Connecting Rod" on page 76.)

Starting Motor Diagnostics



Caution: Avoid Injury! The engine may start to rotate at any time. Keep hands away from moving parts when testing.

ENGINE - DIESEL DIESEL ENGINE TROUBLESHOOTING

Important: Avoid Damage! If starting motor continues to run after turning ignition switch to OFF position, disconnect negative (-) lead from battery as soon as possible.

Note: To test specific electrical components, see *Electrical section* and refer to either *Diagnostics or Tests and Adjustments* for further guidance.

Symptom: Starter Does Not Rotate

Procedure

1. Is there a click sound from starter solenoid?

Yes: Go to next step.

No: Check that all starting conditions are met.

2. Are battery cables clean and tight?

Yes: Go to next step.

No: Tighten or clean as necessary.

3. Is battery fully charged? (See "Battery Test" on page 215.)

Yes: Go to next step.

No: Charge battery. (See "Charge Battery" on page 216.)

4. Does crankshaft rotate freely?

Yes: Go to next step.

No: Repair engine as needed.

5. Are starting circuit and key switch working correctly?

Yes: Go to next step.

No: Repair as necessary. (See "System: Cranking Circuit Diagnosis" on page 147.)

Starter Rotates Slowly

Procedure

1. Are battery cables clean and tight?

Yes: Go to next step.

No: Tighten or clean as necessary.

2. Is battery fully charged? (See "Battery Test" on page 215.)

Yes: Go to next step.

No: Charge battery. (See "Charge Battery" on page 216.)

3. Does crankshaft rotate freely?

Yes: Go to next step.

No: Repair engine as needed.

4. Are starting motor and solenoid functioning correctly? (See "Starting Motor Solenoid Test" on page 219. See "Starting Motor Cranking Amperage Draw Test" on page 218.)

No: Replace starting motor. (See "Remove and Install Starting Motor" on page 114.)

Symptom: Starter Rotates but Does Not Crank

Procedure

1. Does the pinion mesh with ring gear?

No: Faulty starter drive. Replace.

No: Check for worn pinion or ring gear, and incorrect starting motor alignment.

ENGINE - DIESEL TESTS AND ADJUSTMENTS

Tests and Adjustments

Check and Adjust Alternator Drive Belt Tension

Reason

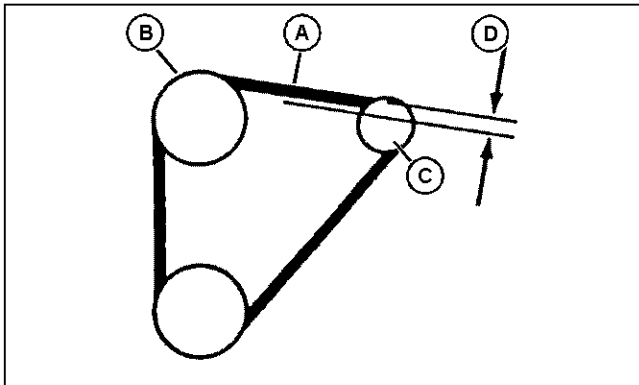
To maintain correct alternator drive belt tension.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Belt Tension Gauge	JDG529 or JDST28	Used to measure drive belt deflection.
Straightedge	N/A	Used to measure drive belt deflection.

Check Procedure

1. Park machine on a level surface.
2. Place mower-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.



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6. Apply approximately 98 N (22 lb-force) (A) to the belt at the midpoint between the fan/coolant pump pulley (B) and the alternator pulley (C). Check belt deflection (D) using JDG529 or JDST28 Belt Tension Gauge and a straightedge and compare to specification.

Check Results

If deflection is not within specification, perform adjustment procedure.

Adjustment Procedure

1. Loosen both alternator mounting cap screws.
2. Apply force to front alternator housing only (near the belt) until tension is correct.
3. Tighten cap screws.

Specifications

Belt Tightening

Applied Force 98 N (22 lb-force)

Deflection 10-15 mm (0.40-0.60 in.)

Adjust Valve Clearance

Reason

To be sure valves are fully opening at the correct time, and not remaining open too long or wearing valve train unnecessarily.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Feeler Gauge	N/A	Used to check valve clearance.
12 mm End Wrench	N/A	Used to loosen and tighten locknut.
Flat Blade Screwdriver	N/A	Used to hold and turn adjusting screw.
17 mm Wrench	N/A	Used to turn crankshaft sheave.

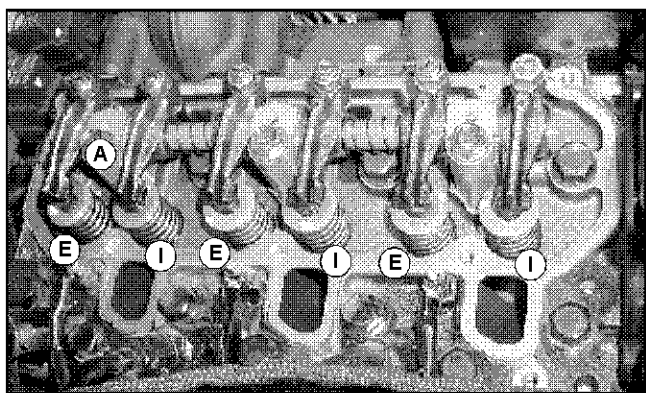
Procedure

1. Park machine on a level surface.
2. Place mower-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.
6. Engine must be cool (room temperature) before valve clearance is checked.
7. Be sure ignition is off and key is removed before attempting to turn engine by hand.
8. Remove rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)

Note: Top dead center (TDC) is where the piston is at its highest point of travel during the compression stroke. The valves (E and I) must be checked with piston at or near TDC.

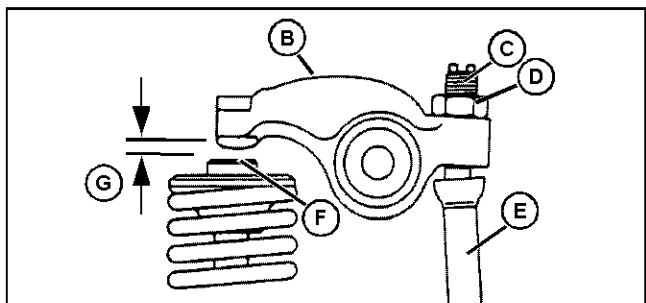
Cylinder number one (A) is located toward the front of machine (flywheel side).

ENGINE - DIESEL TESTS AND ADJUSTMENTS

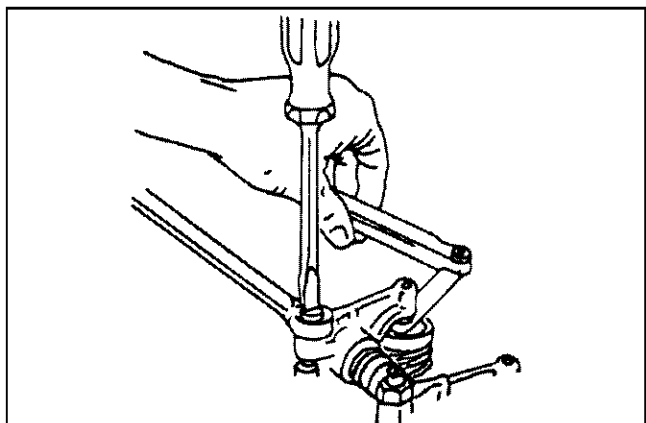


(E) Identifies the Exhaust Valves, (I) Identifies the Intake Valves

9. Using a 17 mm wrench, turn the crankshaft sheave in the direction of engine rotation while watching the rocker arms of the number one cylinder (A). When the intake valve has completely closed (raised up), turn the crankshaft an additional half turn.



10. Try to move rocker arms (B) and push rods (E) for the cylinder to be adjusted. If both rocker arms and push rods are loose, the piston is near TDC on the compression stroke and you may proceed to step 11.

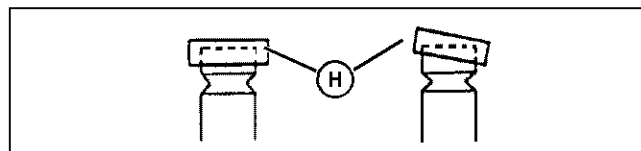


11. Slide feeler gauge of appropriate size between valve cap (F) and rocker arm. There should be a slight drag on the feeler gauge when the clearance (G) is to specification.

12. To adjust a valve, loosen locknut (D) and turn adjusting

screw (C) until blade of feeler gauge has a slight drag when inserted between rocker arm and valve cap. Hold adjusting screw while tightening locknut.

13. Check valve clearance after tightening locknut.



Left valve cap shows normal position.

14. Check that valve cap (H) on end of valve stem remained seated on valve and inside valve spring retainer.

15. Repeat steps 9 through 14 for cylinders two and three.

16. Install rocker arm cover.

Specifications

Valve Clearance 0.15-0.25 mm (0.006-0.010 in.)

Check Valve Lift

Reason

To test for excessive wear on camshaft lobes, cam followers, rocker arms, valve stems, and valve caps, and for worn or bent push rods.

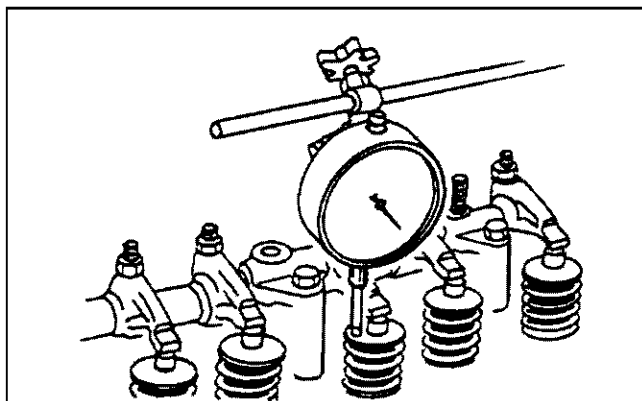
Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator with Magnetic Base	N/A	Used to measure valve lift.

Procedure

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.
6. Remove rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)
7. Check that valve clearance is within specification. Adjust if necessary. (See "Adjust Valve Clearance" on page 42.)

ENGINE - DIESEL TESTS AND ADJUSTMENTS



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8. Fasten dial indicator to engine and position indicator tip on valve retainer. Valve must be fully closed and rocker arm must move freely.
9. Set the dial indicator to zero.
10. Rotate crankshaft while observing dial indicator as valve is moved to full open (down) position.
11. Repeat for each valve.

Results

The valve lift should be the same for all valves. If one or more valves have less travel than the others, remove and inspect the camshaft, followers, and push rods. (See "Remove, Inspect and Install Camshaft" on page 93.) If camshaft, followers, and push rods are within specification, remove and inspect the cylinder head. (See "Remove and Install Cylinder Head" on page 69.)

Test Cylinder Compression

Reason

To determine the condition of the pistons, rings, cylinder walls, and valves.

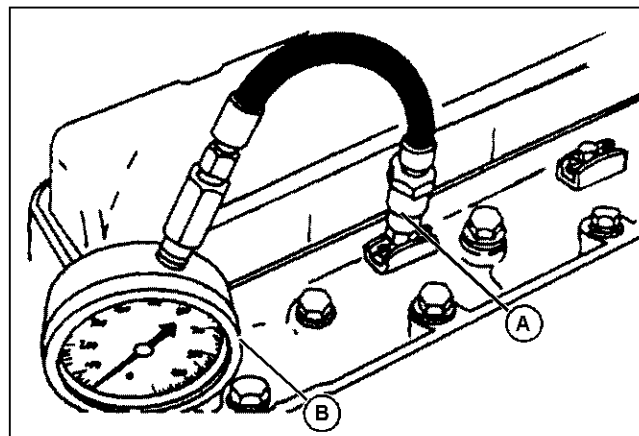
Special or Required Tools

Tool Name	Tool No.	Tool Use
Compression Gauge Assembly	JT01682	Used to measure cylinder compression.
Adapter	JDG472	Used to install gauge assembly.
Adapter	JDG560	Used to install gauge assembly.

Procedure

1. Run engine for five minutes to bring to operating temperature. Shut off engine.
2. Raise hood.

3. Move fuel shutoff valve on fuel filter to OFF position.
4. Remove injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)



T6333EU

5. Install JDG472 or JDG560 Adapter (A).
6. Install JT01682 Compression Gauge Assembly (B).

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

7. Disconnect the fuel control solenoid connector.

Important: Avoid Damage! Do not overheat the starting motor during this test.

8. Crank the engine for five seconds with the starting motor. Minimum cranking speed is 250 rpm.
9. Record the pressure reading for each cylinder. Compare the pressure readings with specifications.

Results

- If the pressure reading is below specification, squirt clean engine oil into the cylinders through the injector ports and repeat the test.
- If the pressure increases significantly, check piston, rings, and cylinder walls for wear or damage.
- If the pressure does not increase significantly, check for leaking valves, valve seats, or cylinder head gasket.

Specifications

Cylinder Compression

Pressure 3137-3344 kPa (455-485 psi)

Cylinder Compression Pressure

(Minimum) 2448-2654 kPa (355-385 psi)

Pressure Difference between Cylinders

(Maximum) 200-296 kPa (29-43 psi)

ENGINE - DIESEL TESTS AND ADJUSTMENTS

Test Engine Oil Pressure

Reason

To determine if the engine bearings or the lubrication system components are worn.

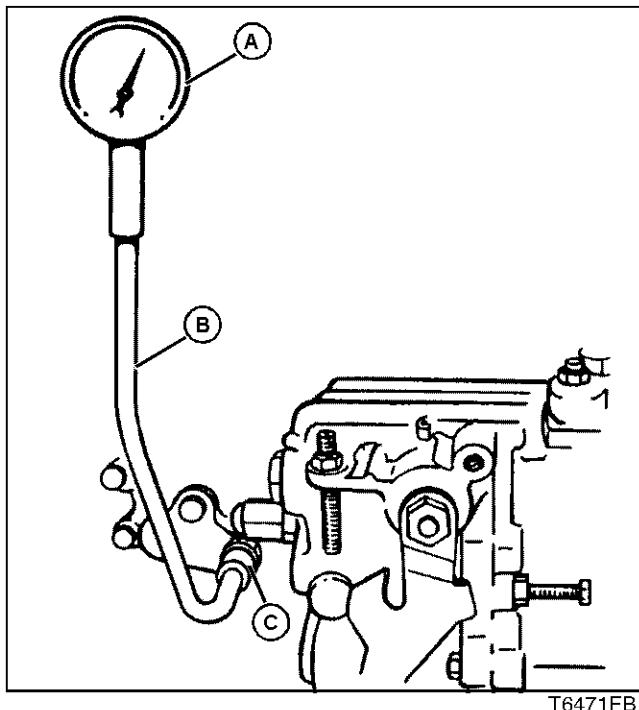
Special or Required Tools

Tool Name	Tool No.	Tool Use
Connector	JT03349	Used to connect gauge to oil pressure switch port.
Hose Assembly	JT03017	Used to connect gauge to oil pressure switch port.
Pressure Gauge 0-700 kPa (0-100 psi)	JT07034	Used to measure engine oil pressure.

Note: The connector, hose assembly, and gauge are found in other **SERVICEGARD™** test kits.

Procedure

1. Raise hood.



T6471FB

2. Remove the oil pressure switch.
3. Install JT03349 Connector (C).
4. Connect JT03017 Hose Assembly (B) and JT07034 Pressure Gauge (A).

Important: Avoid Damage! Do not run the engine if there is insufficient oil pressure!

5. Start the engine. If the pressure reading is below 60 kPa (8.7 psi) at slow idle rpm, stop the engine.
6. If the oil pressure is at least 60 kPa (8.7 psi), run the engine approximately five minutes to heat the oil. Check the oil pressure at engine rated speed.

Results

- If oil pressure is not within specification, inspect the oil pump and oil pressure regulating valve for wear or damage. Replace parts as needed. (See "Remove, Inspect and Install Oil Pump" on page 103.)
- If oil pump is within specifications, the engine may have parts worn beyond specification.

Specifications

Engine Oil Pressure @ 3150 RPM 290-441 kPa (42-64 psi)

Engine Oil Pressure @ 1400 RPM 60 kPa (9 psi)

Leak Test Air Intake System

Reason

Check for leaks in the air intake system.

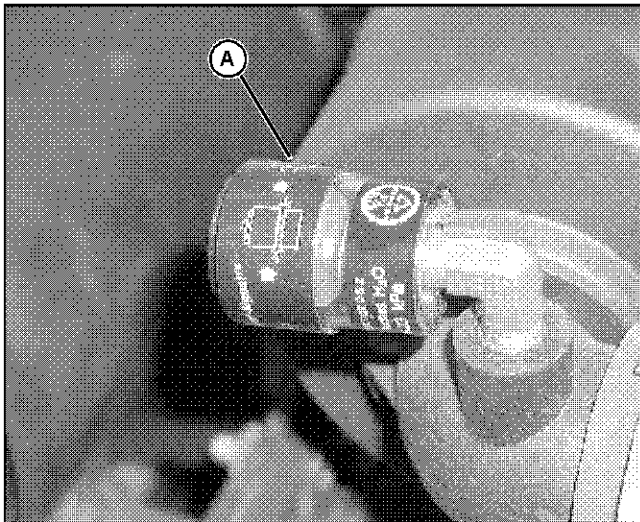
Special or Required Tools

Tool Name	Tool No.	Tool Use
Air Pressure Regulator	N/A	Used to pressurize the air intake system to check for leaks.
Test Fitting	N/A	Used to connect air pressure regulator.

Procedure

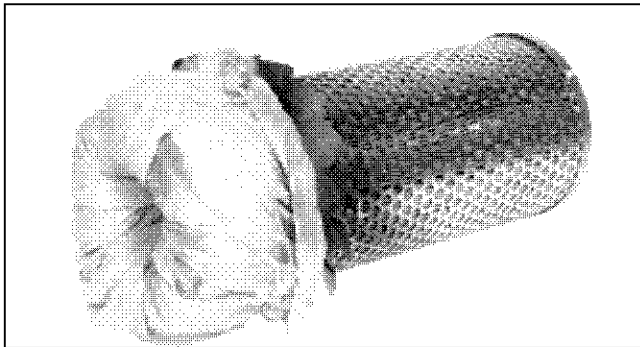
1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.

ENGINE - DIESEL TESTS AND ADJUSTMENTS



MX23402

6. Remove the air filter restriction indicator (A) and install the test fitting.
7. Connect the air pressure regulator to the manifold using the hose and fitting from the air cleaner.
8. Remove the air cleaner cover and the main filter element.



M82124

9. Put a large plastic bag into and over the end of the main filter element. Install the main filter element and cover.
10. Pressurize the air intake system 34-69 kPa (5-10 psi). If the air intake system cannot be pressurized, turn the engine slightly to close valves.
11. Spray a soap solution over all the connections from the air cleaner to the intake manifold and check for leaks.

Results

Find leaks and repair or replace parts as necessary.

Test Fuel Pump Pressure

Reason

To determine supply pump operating pressure.

Special or Required Tools

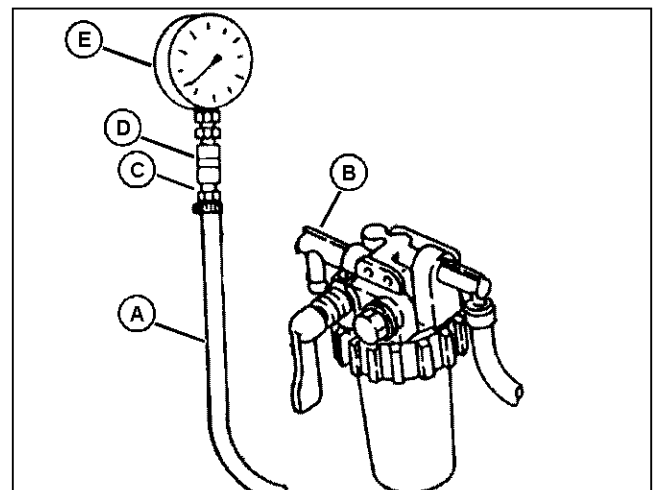
Tool Name	Tool No.	Tool Use
Fuel Pump Pressure Test Kit	JDG356	Used to measure pump operating pressure.

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Procedure

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.



M82145A

6. Disconnect supply pump-to-filter hose (A) at fuel filter (B).
7. Assemble hose coupling (C), coupling reducer (D), and gauge (E).
8. Connect gauge/fitting assembly to supply pump-to-filter hose.

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

9. Disconnect wire connector to fuel shutoff solenoid.
10. Turn key to the run position. Compare reading on gauge

ENGINE - DIESEL TESTS AND ADJUSTMENTS

to specification.

Results

If pressure is below specification, replace fuel pump.

Specifications

Fuel Transfer Pump Pressure
(Minimum) 25 kPa (4.3 psi)

Test Fuel Transfer Pump Flow

Reason

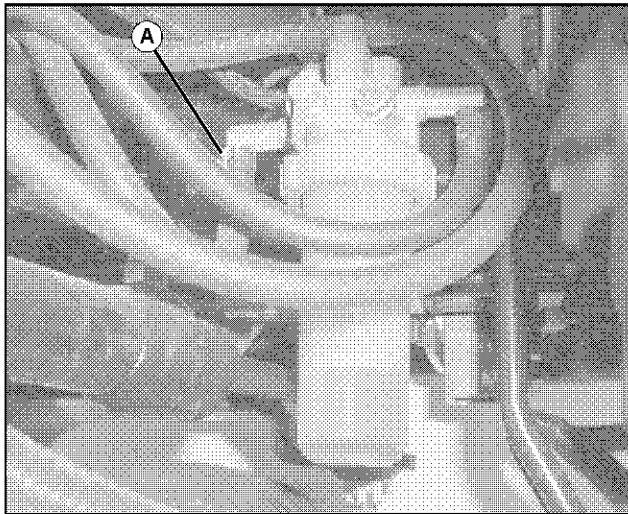
To determine fuel transfer pump output volume.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Graduated Container	N/A	Used to measure fuel amount.

Procedure

1. Park unit on level surface, park brake locked, transmission in neutral, engine off.
2. Access engine.



MX23397

3. Disconnect fuel supply hose (A) from fuel filter.
4. Place hose in graduated container. Turn key switch to ON position for 30 seconds.

Results

If fuel volume is below specification, replace fuel transfer pump.

Specifications

Fuel Transfer Pump Flow
Volume (Min in One Minute) 400 mL (13.5 oz)

Leak Test Fuel System

Reason

Tests the fuel system plumbing for external leakage. This test also determines if air is entering the fuel system at connections, allowing fuel to siphon back to tank.

Procedure

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.
6. Disconnect the fuel supply line and return line at the fuel tank.
7. Place the fuel return line into a suitable container to catch drained fuel.



Caution: Avoid Injury! Do not apply more than 103 kPa (15 psi) air pressure to the fuel system. Damage to the injection pump or personal injury may result.

8. Apply 34-69 kPa (5-10 psi) air pressure to fuel supply hose until all fuel is drained from the system.
9. Plug the end of the fuel return hose.
10. Apply 34-69 kPa (5-10 psi) air pressure to the fuel system at the fuel supply line. Do not exceed a maximum pressure of 103 kPa (15 psi).
11. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

Results

Find leaks and repair or replace parts as necessary.

Bleed Fuel System

Reason

Any time the fuel system has been opened up for service (lines disconnected or filter removed), it is necessary to bleed air from the system.

Procedure

Note: The engine is equipped with an automatic air venting system, which makes the fuel system self-bleeding.

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.

ENGINE - DIESEL TESTS AND ADJUSTMENTS

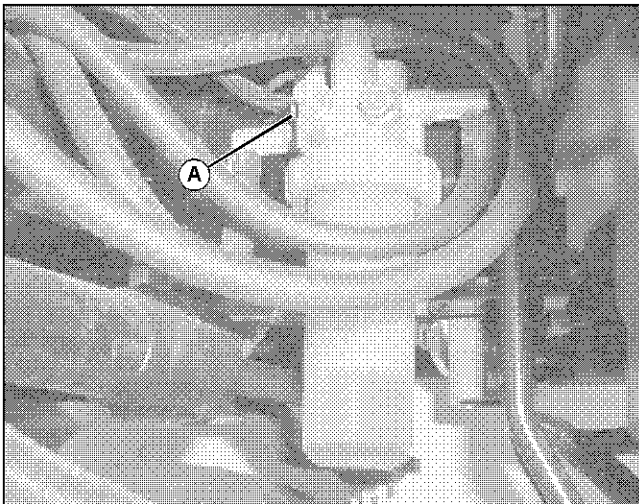
3. Lower attachments to the ground.
4. Lock park brake.



Caution: Avoid Injury! Fuel vapors are explosive and flammable:

- Shut engine off before filling fuel tank.
- Do not smoke while handling fuel.
- Keep fuel away from flames or sparks.
- Fill fuel tank outdoors or in well ventilated area.
- Clean up spilled fuel immediately.
- Use clean approved non-metal container to prevent static electric discharge.
- Use clean approved plastic funnel without screen or filter to prevent static electric discharge.

5. Ensure fuel is in the fuel tank. Add fuel if necessary.



MX23397

6. Open fuel shutoff valve (A).
7. Turn key to run position for two minutes prior to starting engine. The fuel pump will pressurize the fuel and remove any air in the system.
8. Start engine. If engine will not start, repeat previous step.

Adjust Slow Idle Speed

Important: Avoid Damage! The slow idle adjustment is the only adjustment that can be made on this engine.

The fast idle and torque capsule adjustments are pre-set by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable only by authorized diesel service facilities.

Reason

To achieve proper slow idle speed setting. Provides adequate rpm to keep engine running smoothly without stalling.

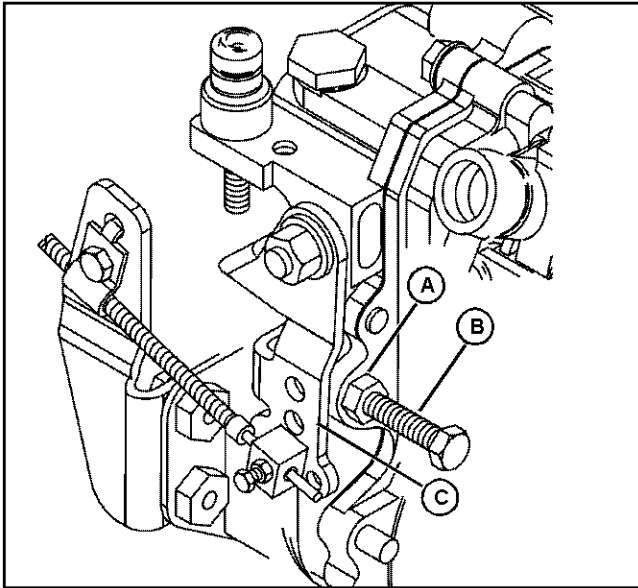
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to set slow idle speed.

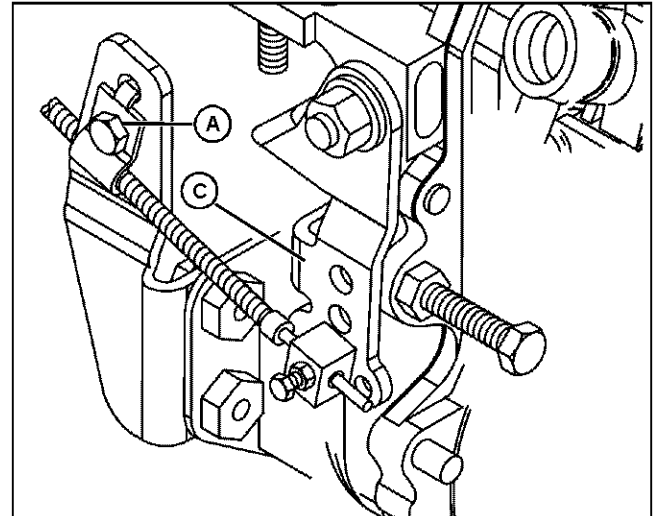
Procedure

1. Park machine on a level surface.
2. Place mower-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.
6. Start engine and run for five minutes to bring machine to operating temperature.
7. Move throttle lever to slow idle position.
8. Use JT07270 Digital Pulse Tachometer to check engine speed at crankshaft sheave.

ENGINE - DIESEL TESTS AND ADJUSTMENTS

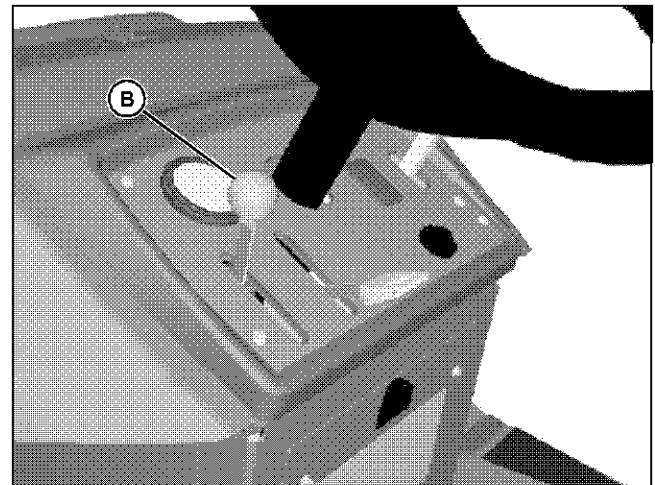


MX23233



MX23233

6. Locate and loosen throttle clamp screw (A) on side of fuel injection pump.



MX24323

7. Move throttle lever (B) toward fast idle position until throttle lever is **2-3 mm (0.080-0.120 in.)** away from end of frame slot.
8. Hold throttle control lever (C) against fast idle stop. Pull throttle cable tight. Tighten clamp screw.
9. Move throttle lever through full range. Check to be sure governor control lever moves through complete range, and linkage is not binding.

9. Visually check that the injection pump throttle lever (C) is against the slow idle stop screw. Check slow idle speed and compare to specification.

10. If slow idle speed does not meet specification, loosen jam nut (A) and turn screw (B). After adjustment, tighten jam nut.

11. After slow idle speed adjustment, adjust throttle cable. (See "Adjust Throttle Cable" on page 49.)

Specifications

Slow Idle Speed **1400 ± 50 rpm**

Adjust Throttle Cable

Reason

To ensure that throttle linkage is adjusted correctly, and allow full fast idle and slow idle positions of governor throttle lever.

Procedure

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.

ENGINE - DIESEL TESTS AND ADJUSTMENTS

Fast Idle Speed Check

Reason

To achieve the proper fast idle setting.



Caution: Avoid Injury! DO NOT attempt to adjust fuel control assembly unless you are a factory trained technician with authorization to service CARB/EPA Certified Engines.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to set slow idle speed.

Procedure

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.

Note: Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.

6. Start engine and run for five minutes to obtain normal operating temperature.
7. Move throttle lever to fast idle position.
8. Use JT07270 Digital Pulse Tachometer to check engine speed at crankshaft sheave. Check fast idle speed and compare to specification.
9. Turn key switch to stop position.

Note: The fast idle speed adjustment screw is sealed to prevent adjustment by unauthorized personnel.

Results

- If engine DOES NOT meet fast idle speed specification, have injection pump inspected by a CARB/EPA Certified Authorized Diesel Service (ADS) center.

Specifications

Fast Idle Speed 3150 ± 50 rpm

Test Fuel Injection System



Caution: Avoid Injury! 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 connections before applying pressure. Search 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Reason

To stop fuel flow to the cylinders (one at a time), while engine is running, to determine what effect that cylinder has on overall engine performance.

Special or Required Tools

Tool Name	Tool No.	Tool Use
17 mm Open End Wrench (2 used)	N/A	Used to loosen nut on high-pressure fuel injector line.

Procedure

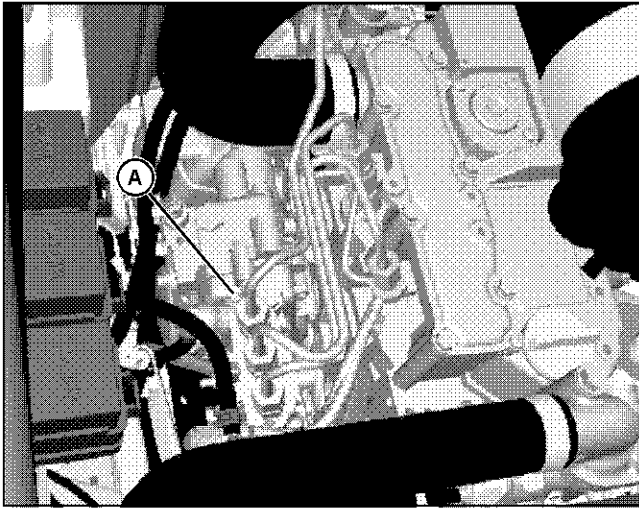
1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.



Caution: Avoid Injury! This test will cause diesel fuel to be released from fuel system. Injection pump is capable of producing extremely high pressure. Eye protection must be worn. Do not open fuel injector connectors more than 1/8 of a turn. Do not place hands near injectors during test. Do not allow any debris to enter intake manifold during test. Do not smoke.

6. Start engine and run at slow idle.

ENGINE - DIESEL TESTS AND ADJUSTMENTS



7. Using two 17 mm open end wrenches, loosen nut (A) on one high-pressure fuel injector line at injection pump, while holding lower nut stationary with second wrench. Loosen nut only 1/8 of a turn (45°).
8. Listen for engine speed to drop and exhaust noise to change.
9. Tighten nut and allow engine to return to original speed before loosening next cylinder's fuel line nut.
10. Compare sound and speed of each cylinder as it is disabled.
11. Tighten fuel line nuts and stop engine.

Results

When fuel flow is stopped to a cylinder, engine rpm should drop, engine should begin to vibrate and run roughly, and exhaust noise will be uneven until fuel flow is restored.

If test produces the results described above but engine performance remains poor, test the following

- Clogged air cleaner elements, leaking air filter outlet hoses, or clamps.
- Restriction in exhaust system.
- Presence of coolant or diesel fuel in crankcase oil.

If defeating a single cylinder has no effect on overall engine performance, test the following

- Fuel injection nozzle opening pressure, spray pattern, and leakage for that cylinder. (See "Test Fuel Injection Nozzle" on page 51.)
- Cylinder compression or cylinder leakage. (See "Test Cylinder Compression" on page 44.)
- Fuel supply pump pressure.
- Fuel shutoff solenoid opening fully.
- Injection pump timing correct.

If the above test results are within specifications, remove injection pump and have tested at an Authorized Diesel Service (ADS) Center.

Test Fuel Injection Nozzle

Reason

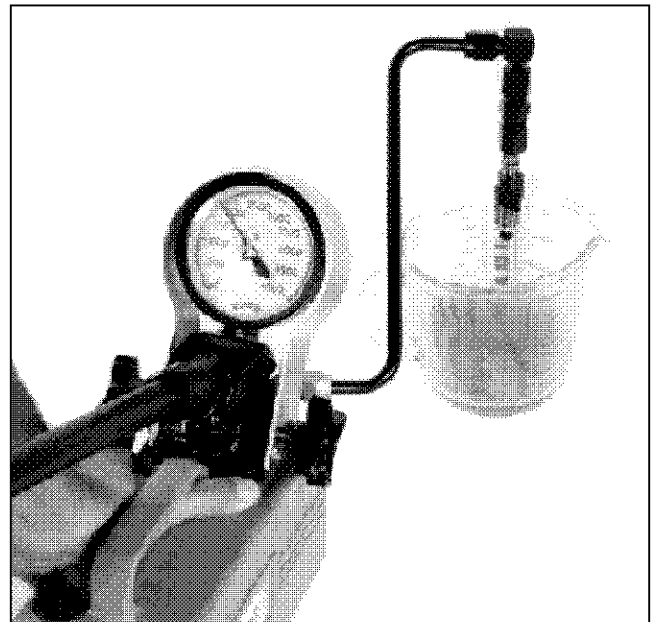
To determine opening pressure, leakage, chatter and spray patterns of fuel injection nozzle.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzle.
Adapter Set	D01110AA	Used to install diesel fuel injection nozzle tester.
Straight Adapter	23622	Used to install diesel fuel injection nozzle tester.
Container	N/A	Used to hold diesel fuel released during test.

Connections

Important: Avoid Damage! Use clean, filtered diesel fuel when testing injection nozzles for best results.



Connect fuel injection nozzle to D01109AA Diesel Injection Nozzle Tester using parts from D01110AA Adapter Set and

ENGINE - DIESEL TESTS AND ADJUSTMENTS

23622 Straight Adapter.

Pressure Test Procedure

Test fuel injection nozzle opening pressure following the nozzle tester manufacturer's instructions. Compare to specification.

Pressure Test Results

If pressure reading does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.) If necessary, add or remove shims to change opening pressure.

Leakage Test Procedure

Test fuel injection nozzle leakage following the nozzle tester manufacturer's instructions.

1. Dry nozzle completely using a lint-free cloth.
2. Pressurize nozzle to just below minimum opening pressure and hold.
3. Watch for leakage from nozzle spray orifice. Keep track of time elapsed before leakage begins. Compare to specification.

Leakage Test Results

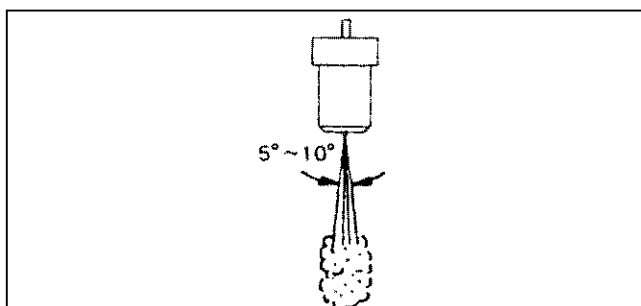
If leakage time does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

Chatter and Spray Pattern Test Procedure

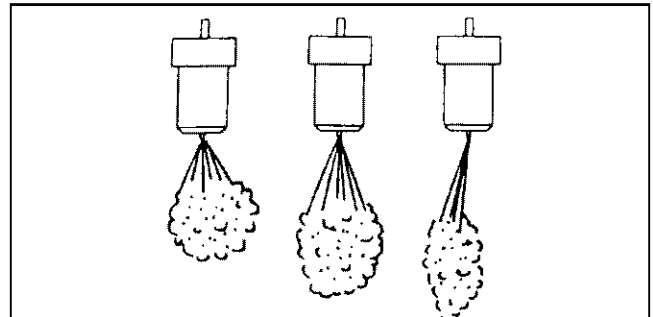
Test fuel injection nozzle chatter and spray pattern following the nozzle tester manufacturer's instructions.

1. Pressurize nozzle until nozzle opening pressure is reached.
2. Listen for "chatter" sound and watch spray pattern.

Chatter and Spray Pattern Test Results



Correct spray pattern.



Incorrect spray patterns.

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)
- If there is excessive difference in spray angle or injection angle, incomplete atomizing, or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 110.)

Specifications

Fuel Injection Nozzle

New Nozzle Opening Pressure (5 Hours or Less Usage)
..... 12 800-13 800 kPa (1856.5-2001.5 psi)

Used Nozzle Opening Pressure
..... 12 300-13 300 kPa (1784-1929 psi)

Leakage at Just Below Minimum Opening Pressure
..... No leakage for 5 sec (minimum)

Chatter and Spray Pattern at Opening Pressure

Slow Hand Lever Movement

(at Opening) Chatter sound

Slow Hand Lever Movement (after Opening)

..... Fine stream, 5-10° spray pattern

Fast Hand Lever Movement (after Opening)

..... Fine atomized spray, 5-10° spray pattern

ENGINE - DIESEL TESTS AND ADJUSTMENTS

Injection Pump Static Timing Check

Reason

To make sure that the injection pump timing is set to engine manufacturer's specification.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Timing Tool (Made from High-Pressure Pipe, Nut, and a Clear Plastic Straw ¹)	N/A	Used to view fuel movement during timing adjustment.

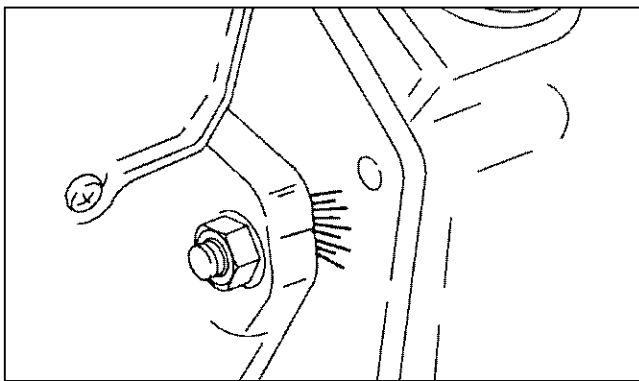
1. Straw from an aerosol can of WD40™, carburetor cleaner, brake parts cleaner, etc.

Procedure

Important: Avoid Damage! The injection pump timing should be correct. The timing is set at the factory, and will not normally change during the life of the engine. Check and adjust the timing only as the last option, or if there is reason to believe the timing has been altered.

Check the fuel, fuel supply system, injectors, air intake system and cylinder compression before continuing.

1. Park machine on a level surface.
2. Place mow-transport lever in TRANSPORT position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Turn key to OFF position.
6. Raise hood.
7. Remove air cleaner assembly. (See "Remove and Install Air Cleaner Assembly" on page 58.)



M57132

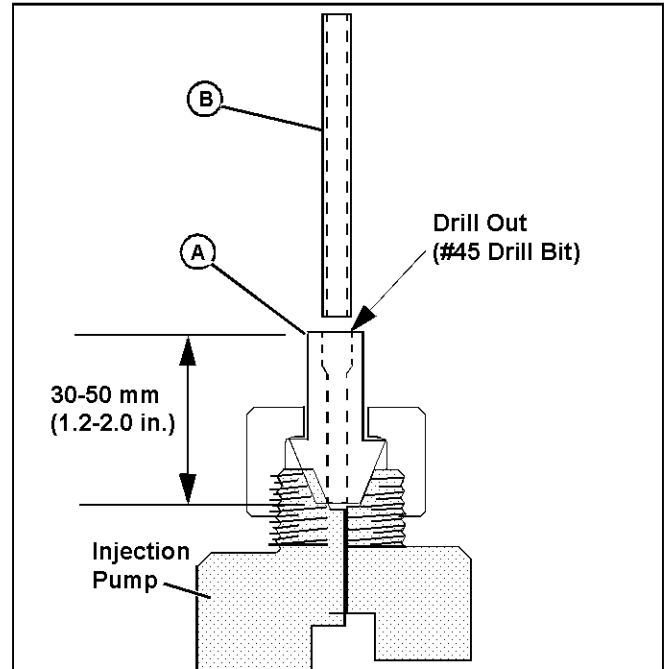
8. If injection pump was removed, align the arrow or line on

the injection pump flange on the mark noted during pump removal.

Note: Normal rotation, as viewed from the flywheel end, is counterclockwise. The number one fuel injection line is closest to the flywheel.

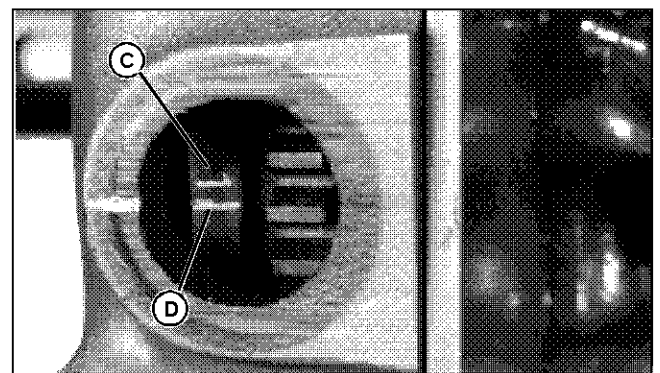
9. Clean areas around injectors and top of injection pump and remove the fuel injection lines.

10. Cover openings on injectors and the number two and three delivery valves on injection pump to keep dirt from entering system.



MIF

11. Install the timing tool (A) and clear straw (B) on the number one delivery valve of injection pump.



M37500

12. Identify which set of timing marks is for number one cylinder (C) and mark flywheel (D) accordingly.

13. Turn ignition switch to the on position and listen for fuel shutoff solenoid to click on. (Fuel shutoff solenoid must be on and stay on during test).

ENGINE - DIESEL TESTS AND ADJUSTMENTS

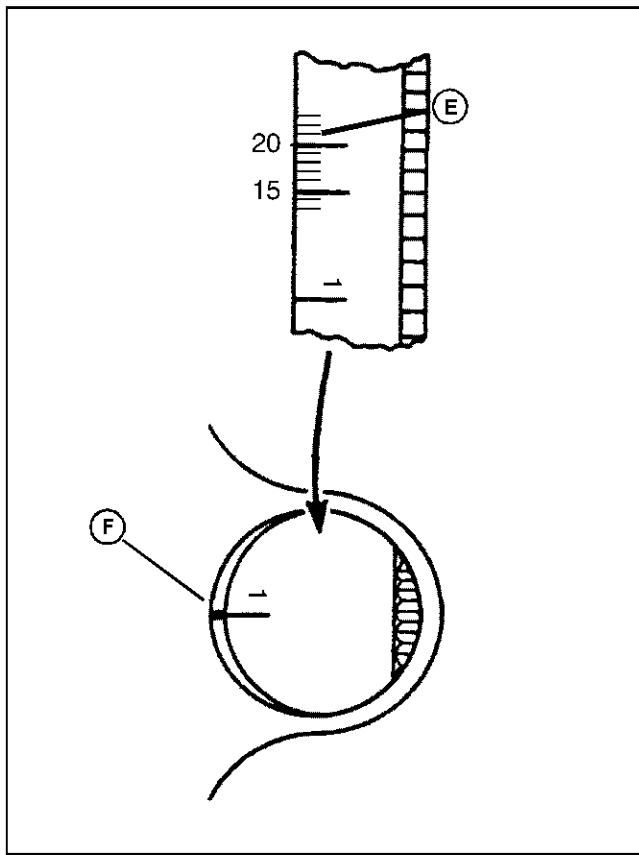
14. Turn the flywheel counterclockwise (as viewed from the flywheel end) until the timing tool straw shows fuel movement.

15. Turn the flywheel clockwise (back) until the No. 1 cylinder top dead center (TDC) mark and pump timing marks have gone past the mark on the flywheel housing by at least 50 mm (2 in.).

16. Snap the straw with your finger until the level of the fuel, or a bubble, is set part way up the straw. This will be the point to watch for fuel movement.

Note: If there is no fuel movement, engine may be on exhaust stroke. Rotate flywheel 360° and repeat test.

17. Slowly turn the flywheel counterclockwise (as viewed from the flywheel end) until the fuel in the straw just starts to move. Stop rotating the flywheel the instant the fuel begins to move.



T6471cs

18. Check the injection pump timing marks on the flywheel. The 21° mark (E) on the flywheel must line up with the line (F) in the timing hole of the flywheel housing.

Results

- If the timing is not within specifications, loosen the three pump mounting nuts and turn the pump toward the engine block to retard the timing or away from the block to advance the timing. Recheck the timing.

- If the timing did not change, remove pump and have tested by an authorized diesel injection service shop.
- If the timing is correct, remove timing tool, install injector lines, install air cleaner assembly and hood.

Specifications

Fuel Injection Timing 21 °± 1°

Pressure Test Cooling System

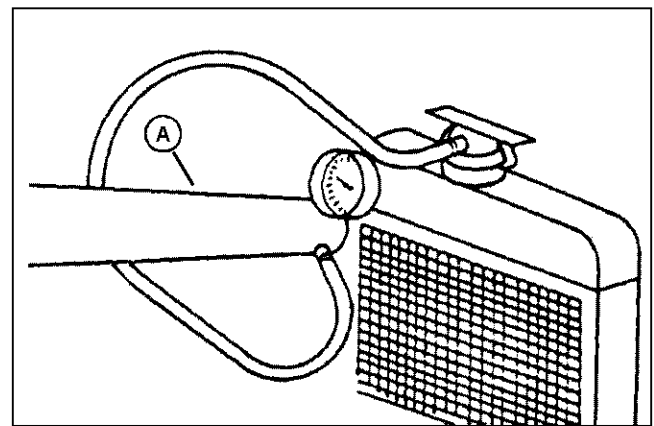
Reason

Inspect the cooling system for leaks.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to pressurize cooling system to check for leaks.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to connect pressure pump to radiator.

Procedure



T6333AW

1. Remove the cap and attach the pressure pump (A) to radiator.
2. Apply pressure according to minimum specification, but not in excess of maximum specification.
3. Check for leaks throughout the cooling system. After 15 seconds, the pressure should be at or above minimum specification.

Results

- Pressure should hold to minimum specification. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket,

ENGINE - DIESEL TESTS AND ADJUSTMENTS

cracked block, or cylinder head may be the cause.

Specifications

Cooling System

Pressure 74.5-102 kPa (10.8-14.8 psi)

Pressure Test Radiator Cap

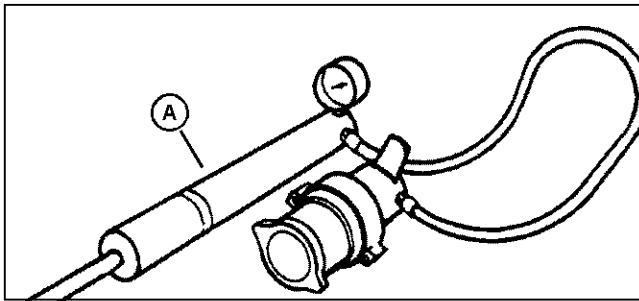
Reason

Test the radiator cap for operating in the correct pressure range.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to apply pressure to radiator cap to check for valve opening.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to connect the pressure pump to the radiator cap.

Procedure



T6333AX

1. Install the radiator cap on the pressure pump (A).
2. Apply pressure. Pressure valve in the cap should open at specification.

Results

If the cap leaks, retighten and test again. Replace the cap if pressure is not within specification.

Specifications

Radiator Cap Valve

Opening Pressure. 74.5-102 kPa (10.8-14.8 psi)

Test Thermostat

Reason

To determine opening temperature of thermostat.

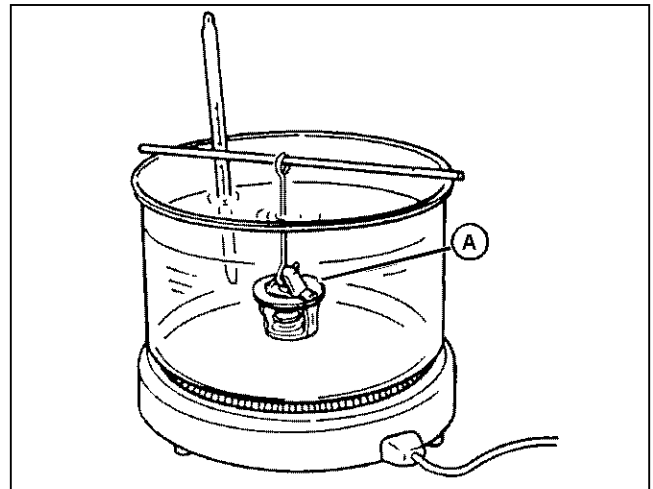
Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	N/A	Used to measure temperature at which thermostat opens.
Glass Container	N/A	Used to hold heated water for test.
Heating Unit	N/A	Used to heat water for test.

Procedure



Caution: Avoid Injury! Do not allow thermostat or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



M82122A

1. Suspend thermostat (A) and thermometer in a container of water.
2. Heat and stir the water. Observe opening action of thermostat and compare temperatures with specifications.
3. Remove thermostat and observe its closing action as it cools.

Results

- If thermostat does not open according to specifications, replace thermostat.
- If closing action is not smooth and slow, replace thermostat.

ENGINE - DIESEL REPAIR

Specifications

Begin Opening 69.5-72.5° C (157-163° F)
Fully Open 85° C (185° F)
Minimum Lift Height
(Above 85° C [185° F]) 8 mm (0.315 in.)

Repair

Remove and Install Alternator Drive Belt

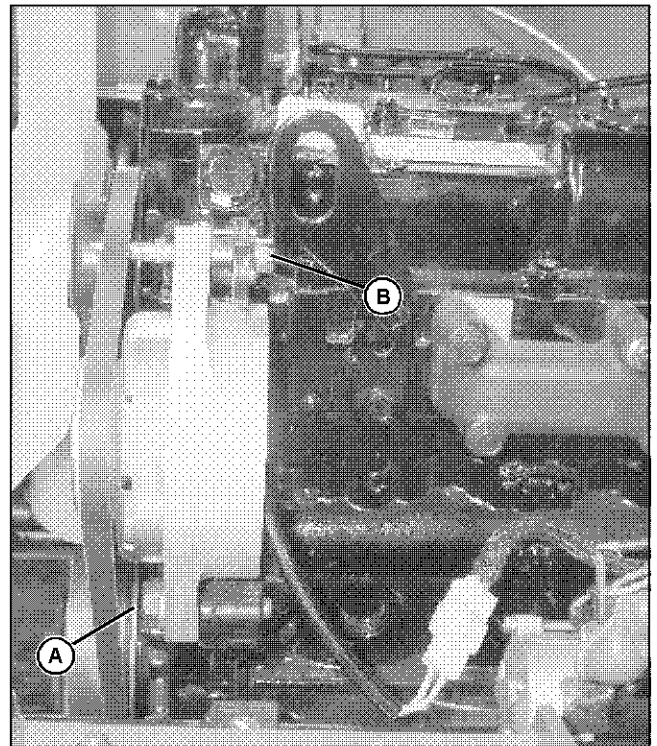
Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)



Caution: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

2. Remove hydrostatic pump. (See “Remove Hydrostatic Pump” on page 259.)



MX24285

3. Loosen cap screw (A) on bottom mounting bracket of alternator.

4. Loosen cap screw (B) on top mounting bracket of alternator.

5. Swing alternator towards engine and remove belt.

Installation

Installation is done in the reverse order of removal.

- Adjust belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 42.)

ENGINE - DIESEL REPAIR

Remove, Inspect and Install Radiator

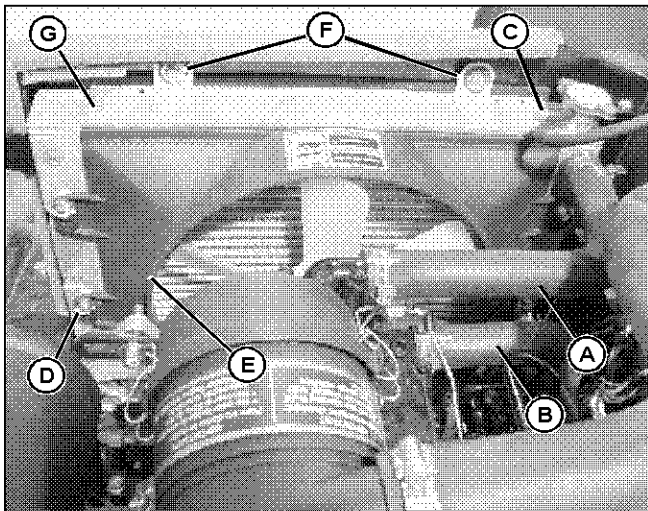
Removal

Caution: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Raise hood.

Caution: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

3. Attach a 12-inch hose to drain valve located on lower left side of radiator.
4. Drain coolant from radiator/engine into container large enough to hold full capacity of cooling system.



MX24020

5. Remove upper radiator hose (A) and lower radiator hose (B).
6. Remove recovery tank hose (C) from radiator.
7. Remove four cap screws (D) and washers securing fan shroud (E).
8. Remove two cap screws (F), nuts and flat washers.
9. Remove radiator (G) and fan shroud.

Inspection

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment, including eye protection.

Important: Avoid Damage! Do not apply high-pressure spray directly at fins when cleaning the radiator, as this could result in damage. Direct the spray parallel to the fins.

1. Check radiator for debris lodged in fins. Clean radiator using compressed air or pressure washer.
2. Inspect radiator for bent fins, cracks, and damaged seams. Repair or replace radiator if necessary.

Installation

Installation is done in the reverse order of removal.

- Make sure locating pins fit into mounting holes.
- Close drain cock on bottom of radiator and fill radiator with proper mix of coolant.
- Run engine and check for leaks at coolant hoses. Add coolant to recovery tank as necessary.

Specifications

Cooling System Capacity

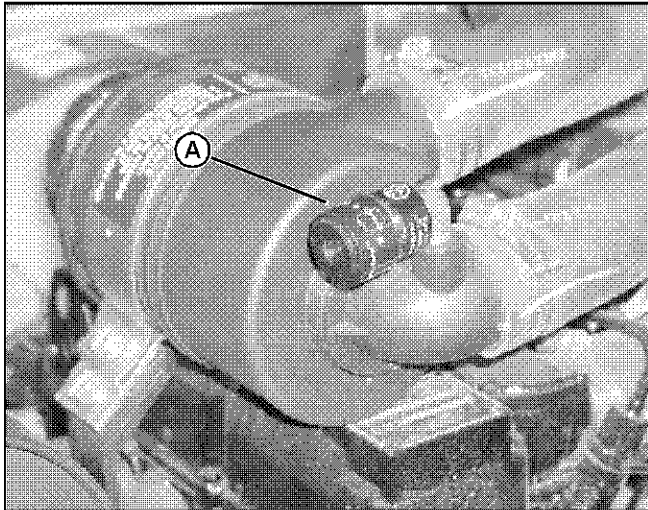
(Approximate)..... 3.5 L (3.7 qt)

Remove and Install Air Filter Restriction Indicator

Removal

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.

ENGINE - DIESEL REPAIR



MX23401

6. Remove air restriction indicator (A).
7. Inspect housing for cracks or other damage. Replace as needed.

Installation

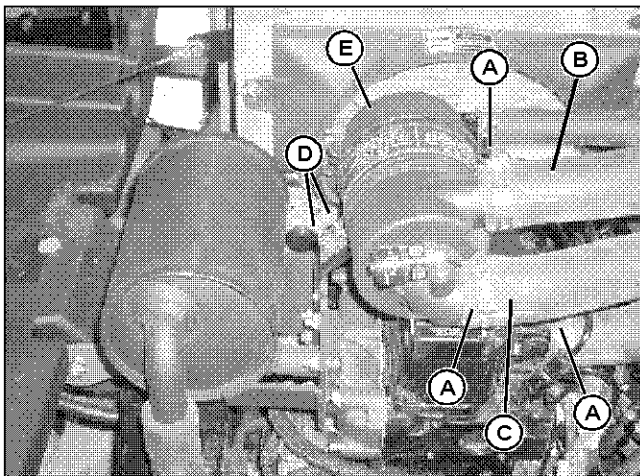
Installation is done in the reverse order of removal.

- Install air restriction indicator (A) onto adapter until snug.

Remove and Install Air Cleaner Assembly

Removal

1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock park brake.
5. Raise hood.



MX24041

6. Loosen hose clamps (A).

7. Remove intake hose (B).
8. Remove air cleaner-to-intake manifold hose (C).
9. Remove flange head cap screws and nuts (D).
10. Remove air cleaner housing (E).
11. Inspect all parts for wear or damage. Replace as needed.
12. Inspect hoses for cracking or damage. Replace as needed.

Installation

Installation is done in reverse order of removal.

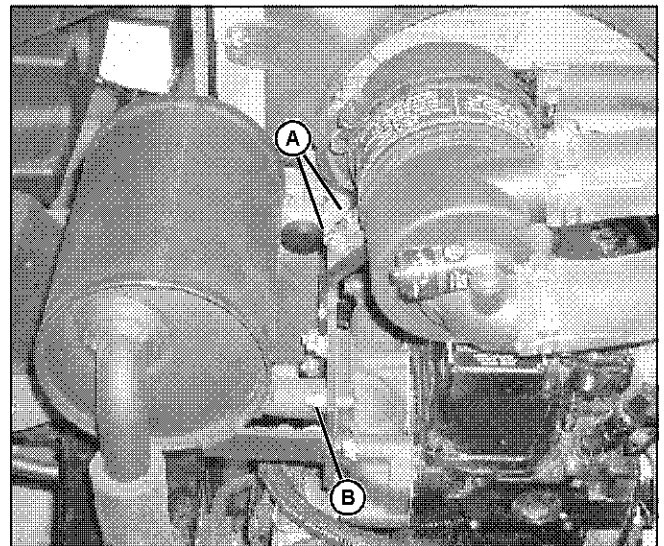
Remove and Install Muffler

Removal



Caution: Avoid Injury! To prevent possible burns, allow engine to cool before removing muffler.

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Raise hood.



MX24041

3. Remove two cap screws (A) and nuts retaining air cleaner to bracket.
4. Remove four flange nuts (B) securing muffler to exhaust manifold.
5. Remove muffler and gasket.

Installation

Installation is done in the reverse order of removal.

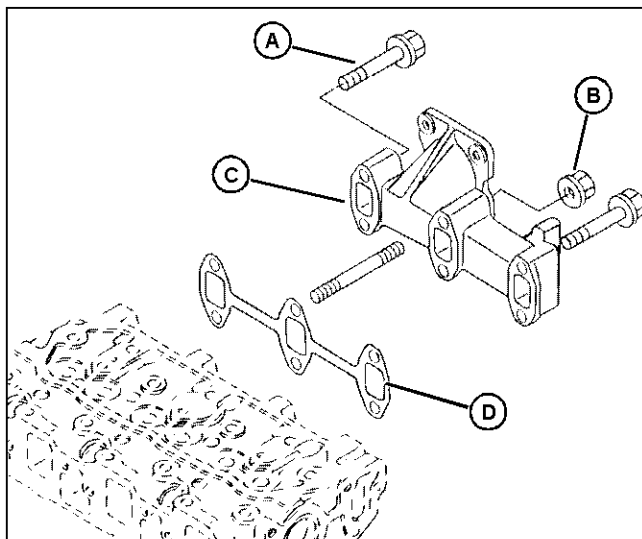
- Install new gasket on exhaust manifold.

- Securely tighten muffler-to-manifold nuts.

Remove and Install Exhaust Manifold

Removal

1. Remove muffler and gasket. (See "Remove and Install Muffler" on page 58.)



2. Remove four cap screws (A).
3. Remove two nuts (B).
4. Remove manifold (C) and gasket (D).
5. Clean all mating surfaces thoroughly.

Installation

Installation is done in the reverse order of removal.

- Install new gasket between exhaust manifold and cylinder head.
- Tighten mounting cap screws and nuts to specifications.

Specifications

Exhaust Manifold Mounting

Cap Screw Torque 28 N•m (21 lb-ft)

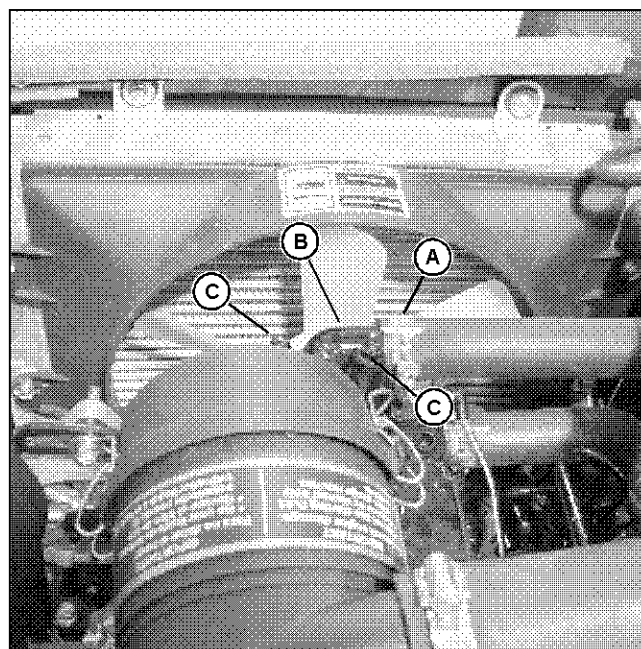
Remove and Install Thermostat

Removal



Caution: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Allow the engine to cool.
3. Raise hood.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.
6. Attach a 12-inch hose to drain valve located on lower left side of radiator.
7. Drain coolant from radiator/engine into container large enough to hold full capacity of cooling system.



8. Remove radiator hose (A) from thermostat housing (B).
9. Remove two cap screws (C).
10. Remove thermostat housing.
11. Remove thermostat.
12. If thermostat is to be reinstalled, test thermostat. (See "Test Thermostat" on page 55.)

Installation

ENGINE - DIESEL REPAIR

Installation is done in the reverse order of removal.

- Install thermostat in housing with spring end inside coolant pump.
- Place gasket over thermostat and place cover over thermostat on coolant pump.
- Fill cooling system to specifications.
- Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specifications

Cooling System Capacity

(Approximate)..... 3.5 L (3.7 qt)

Remove and Install Coolant Temperature Switch

Other Material

Part No.	Part Name	Part Use
PM37397 (U.S.)/ PM38613 (Canada)	Pipe Sealant	Applied to threads of dual temperature coolant switch before installation.
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

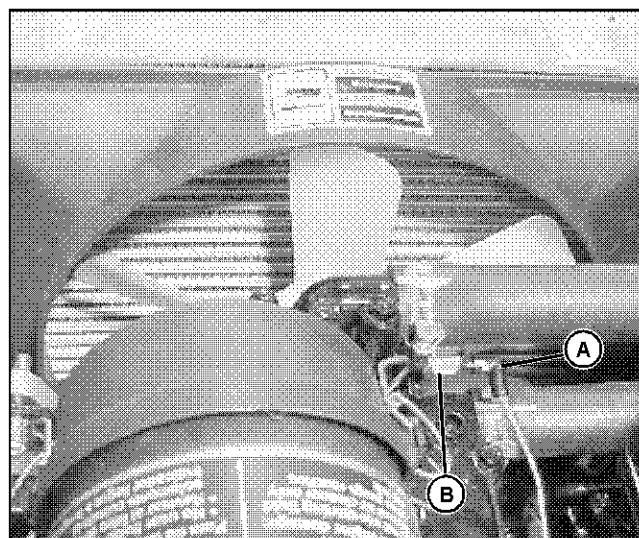
Removal



Caution: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Allow the engine to cool.
3. Raise hood.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.
6. Remove air cleaner assembly.
7. Attach a 12-inch hose to drain valve located on lower left side of radiator.
8. Drain coolant from radiator/engine into container large enough to hold full capacity of cooling system.

Note: Use dielectric grease on all non-sealed electrical connections before connecting.



MX24020

9. Disconnect electrical connector (A).
10. Remove switch and copper washer (B).
11. Test switch. (See "Engine Coolant Temperature Switch Test" on page 228.)

Installation

Installation is done in the reverse order of removal.

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

- Apply PM37397 Pipe Sealant to coolant temperature switch threads.
- Fill cooling system to specifications.

Specifications

Cooling System Capacity

(Approximate)..... 3.5 L (3.7 qt)

ENGINE - DIESEL REPAIR

Fill Cooling System

Filling Cooling System

Note: John Deere COOL-GARD coolant is recommended when adding new coolant to the cooling system.

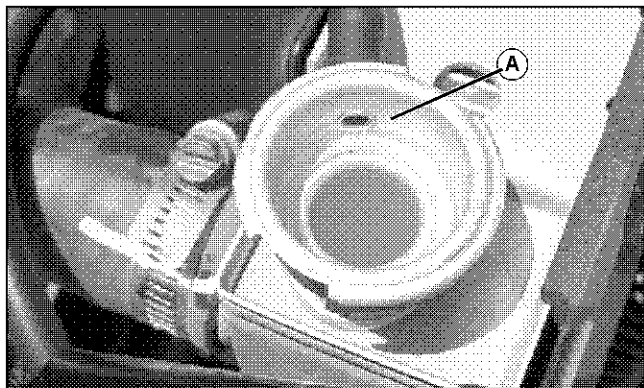
Follow the directions on the container for correct mixture ratio.

Important: Avoid Damage! Using incorrect coolant mixture can damage the radiator:

- Do not operate engine without coolant or with plain water.
- Use antifreeze approved for use in aluminum engines.
- Do not exceed a 50% antifreeze mixture for the coolant.
- Do not pour coolant or water into the radiator when the engine is hot.
- Do not add Stop Leak or other additives.

1. Park the vehicle safely. See "Park Machine Safely" in the Safety section.
2. Allow engine and radiator to cool.
3. With engine cool, slowly open radiator cap to first stop to release any built up pressure.

Note: Cooling system capacity is 3.5 L (3.7 qt).

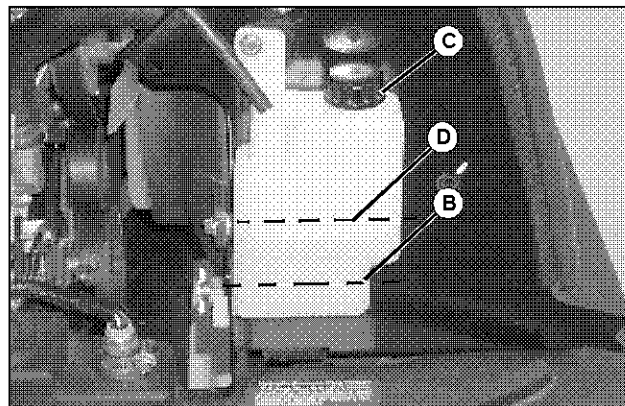


MX41580

4. Remove radiator cap and add coolant until level is at base of neck (A) in fill port.
5. Install and tighten radiator cap.
6. Remove cap from recovery tank.
7. Add coolant to recovery tank until level reaches high line.
8. Install and tighten recovery tank cap.
9. Run engine until it reaches operating temperature to

ensure thermostat opens.

10. Stop engine and allow engine and radiator to cool.



MX23381

11. Check recovery tank coolant level:
 - If engine is warm, coolant level should be between the high line (D) and the low line (B).
 - If engine is cold, coolant level should be at the low line (B).
12. If necessary, remove recovery tank cap (C) and add coolant to achieve proper level. Install and tighten recovery tank cap.
13. With engine cool, slowly open radiator cap to first stop to release any built up pressure.
14. Remove radiator cap and check coolant level inside radiator.
 - Coolant level should be at base of neck in fill port.
 - If necessary, add coolant until radiator completely full.
15. Install and tighten radiator cap.

Specifications

Cooling System Capacity

(Approximate) 3.5 L (3.7 qt)

ENGINE - DIESEL REPAIR

Remove Engine

Removal

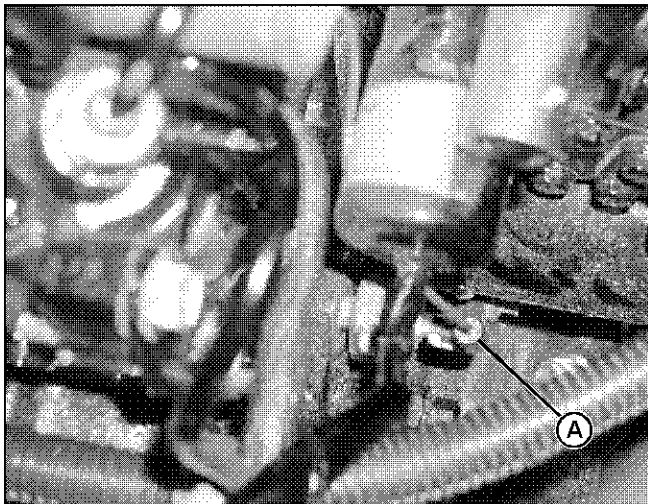
1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Close fuel shutoff valve located on fuel filter housing.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jack stands. Never work on machine while supported only on mechanical or hydraulic jack.

3. Raise and support machine with jack stands.
4. Place 5-gallon container under sump and drain hydraulic fluid.
5. Remove hood.
6. Remove air cleaner assembly. (See "Remove and Install Air Cleaner Assembly" on page 58.)
7. Remove radiator. (See "Remove, Inspect and Install Radiator" on page 57.)
8. Remove hydrostatic pump. (See "Remove Hydrostatic Pump" on page 259.)
9. Remove muffler assembly. (See "Remove and Install Muffler" on page 58.)
10. On firewall side of engine, label and disconnect the following:

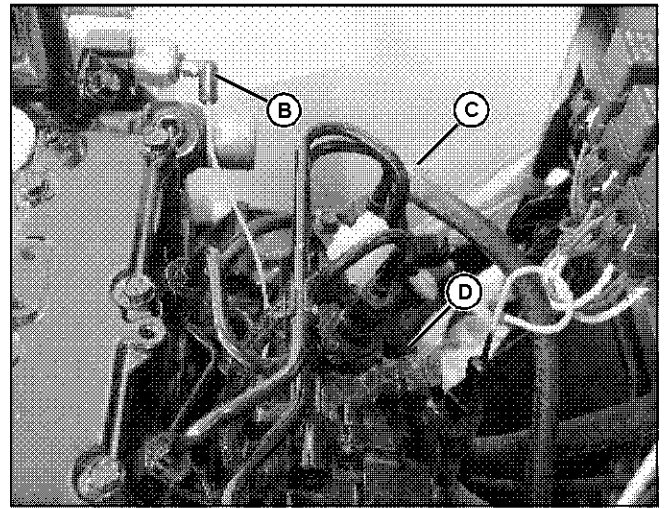
Note: Use dielectric grease on all non-sealed electrical connections before connecting.



MX24338

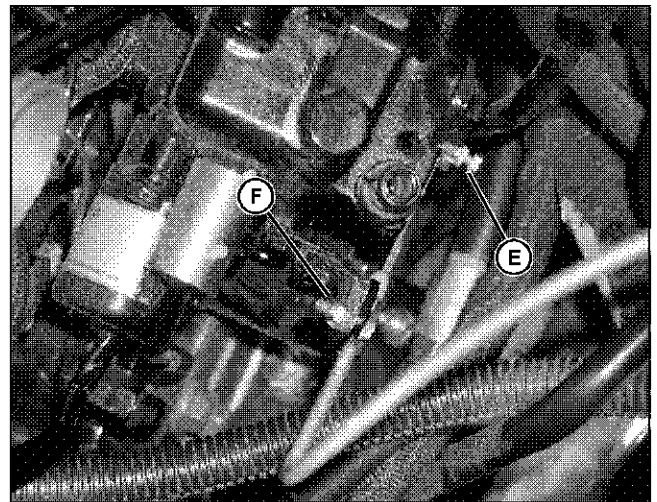
- Engine oil pressure switch wire lead (A).

Note: Use dielectric grease on all non-sealed electrical connections before connecting.



MX24339

- Coolant temperature sensor wire lead (B).
- Fuel return line (C).
- Fuel supply line (D).



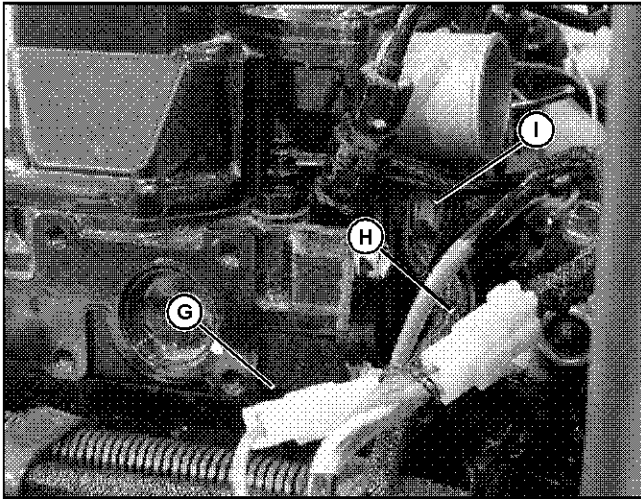
MX24341

- Loosen throttle cable lock screw (E) and clamp (F). Move throttle cable away from engine.

11. On left side of engine, label and disconnect the following:

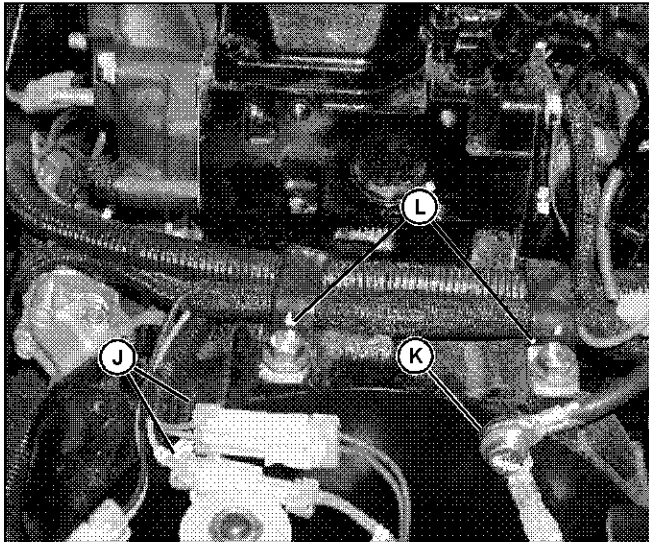
Note: Use dielectric grease on all non-sealed electrical connections before connecting.

ENGINE - DIESEL REPAIR



MX24340

- Glow plug wire connector (G).
- Fuel shut-off solenoid wire connector (H).
- Cap screw (I) securing wire harness to cylinder head.

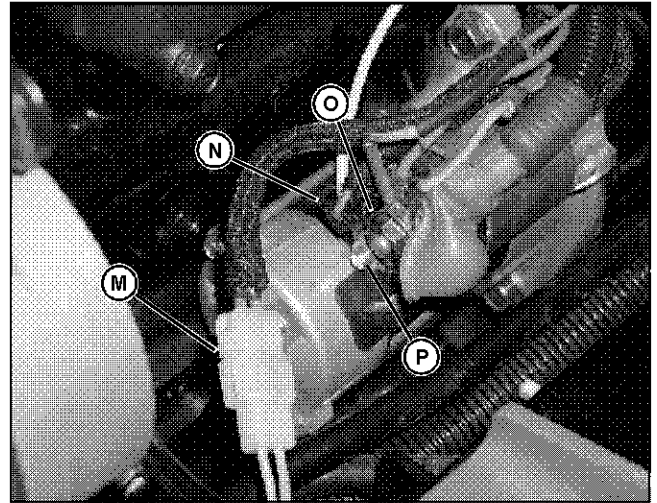


MX24342

- Mow solenoid connectors (J).
- Cap screws (K) and star washer securing negative (-) battery cable and ground strap to engine.
- Cap screws (L) securing engine harness to engine.

12. On front side of engine, label and disconnect the following:

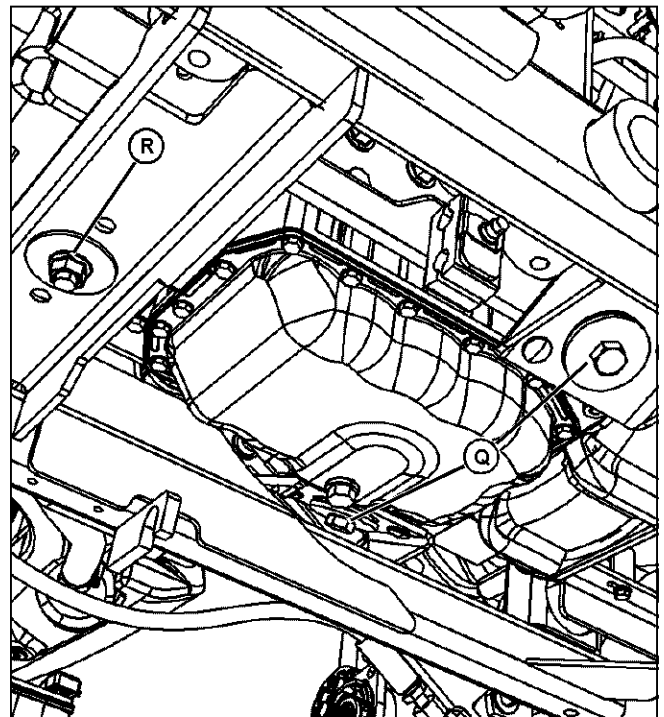
Note: Use dielectric grease on all non-sealed electrical connections before connecting.



MX24343

- Alternator wire harness connector (M).
- Brown wire (N).
- Flange nut (O) securing wires on positive (+) starting motor terminal.
- Flange nut (P) securing white wire to starting motor solenoid output terminal.

13. Connect a hoist to lifting eyes on engine.



MX24346

14. Remove two engine mount flange nuts and cap screws (Q), flange nut (R), and flat washers.

15. If fuel lines have not been previously disconnected, disconnect them now.

16. Lift engine and remove from machine.

ENGINE - DIESEL REPAIR

17. Remove subframe from engine. (See "Remove and Install Subframe" on page 64.)

Remove and Install Subframe

Other Material

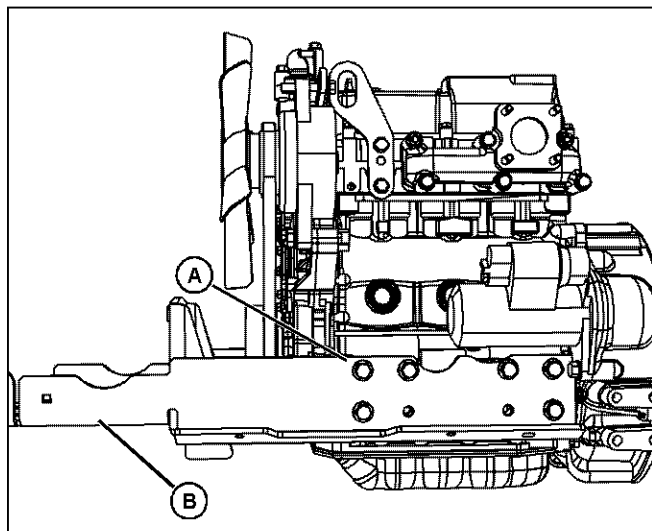
Part No.	Part Name	Part Use
PM37477 (U.S.)/ PM38621 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of Engine Mounting Cap Screws.

Removal

1. Remove engine from vehicle. (See "Remove Engine" on page 62.)



Caution: Avoid Injury! Engine subframe is heavy. Support subframe and engine properly before removing cap screws securing subframe to engine.



MX24347

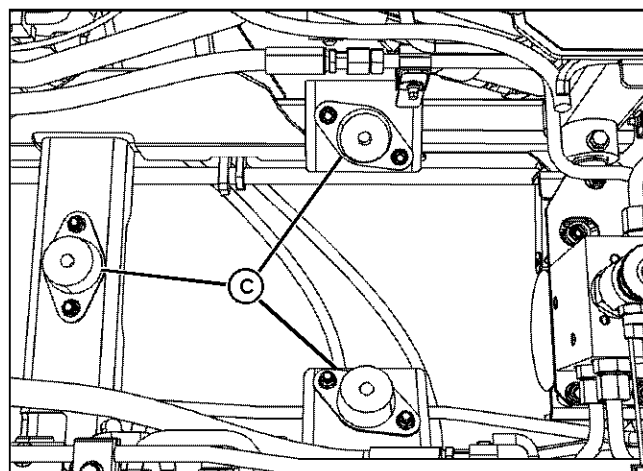
2. Remove 12 engine-to-subframe cap screws (A) and remove subframe (B) from engine.

Installation

Important: Avoid Damage! Thread lock and sealer MUST be used on the twelve M10 x 20 cap screws securing subframe to engine block. Cap screws must be torqued to specifications.

Note: An alignment tool is required to properly install subframe to engine.

1. Secure subframe to engine with twelve M10 x 20 cap screws and torque to specifications.



MX24348

2. Inspect vibration isolators (C) on machine frame for wear or damage. Replace as necessary. Torque vibration isolator mounting cap screws to specifications.

3. Install engine. (See "Install Engine" on page 64.)

Specifications

Vibration Isolator

Mounting Cap Screw Torque. 44 N•m (33 lb-ft)

**Engine-to-Subframe Cap Screw Torque
(Apply Thread Lock and Sealer) 80 N•m (59 lb-ft)**

Install Engine

Other Material

Part No.	Part Name	Part Use
PM37477 (U.S.)/ PM38621 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of Engine Mounting Cap Screws.
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Installation

1. Install subframe on to engine. (See "Remove and Install Subframe" on page 64.)

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

2. Install engine in reverse order from removal.

3. Torque engine mount cap screws and flange nuts to specifications.



Caution: Avoid Injury! When filling engine with oil use care not to fill too fast. Excess oil will flow out crankcase breather and run into intake manifold and into engine cylinder. Attempting to start engine with oil in cylinder will severely damage engine.

4. Replace fluids, hydraulic, coolant, and engine oil.
5. Connect negative (-) battery cable.
6. Perform throttle cable adjustment. (See "Adjust Throttle Cable" on page 49.)
7. Bleed fuel system. (See "Bleed Fuel System" on page 47.)
8. Bleed hydraulic system. (See "Bleed Hydraulic System" on page 309.)
9. Install hood.
10. Remove machine from jack stands.

Specifications

Engine Oil Capacity with Filter

(Approximate) 2.13 L (2.25 qt)

Cooling System Capacity

(Approximate) 3.5 L (3.7 qt)

Total Hydraulic System Capacity with Reservoir

(Approximate) 28.4 L (7.5 gal)

Engine Mount Cap Screw Torque

(Apply Thread Lock and Sealer) 85 N•m (63 lb-ft)

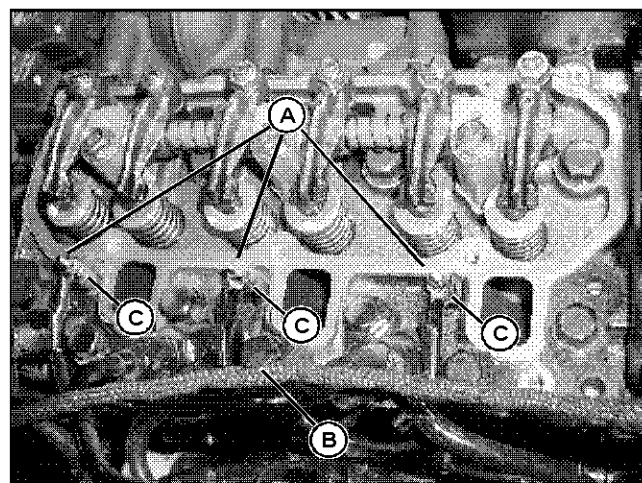
Remove and Install Glow Plug

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Remove air cleaner assembly. (See "Remove and Install Air Cleaner Assembly" on page 58.)
3. Remove intake manifold/rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)



MX23586

4. Remove nut, lock washer, and flat washer (A) from each glow plug.
5. Remove wiring harness (B).
6. Remove glow plugs (C).
7. Test glow plugs. (See "Glow Plug Test" on page 219.)

Installation

Installation is done in reverse order of removal.

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

- Tighten glow plugs to specifications.

Specifications

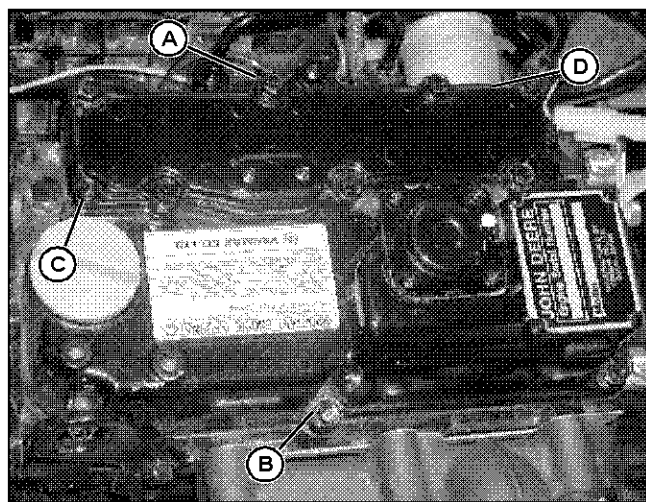
Glow Plug Torque 14.7-19.6 N•m (11-14 lb-ft)

Remove and Install Intake Manifold (Rocker Arm Cover)

Removal

Note: If the rocker arm cover is to be removed with the engine removed, go directly to step 4.

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Remove air cleaner assembly. (See "Remove and Install Air Cleaner Assembly" on page 58.)



3. Remove six long (A) and three short (B) cap screws securing cover to cylinder head.
4. Remove two self-tapping machine screws (C) to remove intake cover (D).
5. Remove the rocker arm cover.

Installation

Important: Avoid Damage! Do not overtighten the cap screws securing rocker arm cover to engine.

Installation done in reverse order of removal.

- Clean the cylinder head surface and install the rocker arm cover to the cylinder head.
- Inspect the rocker arm cover O-ring before reinstalling the rocker arm cover. Replace if damaged.
- Inspect the intake cover gasket before reinstalling. Replace if damaged.
- Securely tighten the cap screws.

Remove and Install Rocker Arm Assembly

Removal

1. Remove intake manifold/rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)
2. Remove rocker arm assembly mounting cap screws.

Important: Avoid Damage! Note placement of valve caps and push rods for reassembly. Valve caps and push rods MUST be reinstalled in the same positions as removed.

3. Pull rocker arm assembly straight up off cylinder head.
4. Remove valve caps and push rods if needed.

Installation

Important: Avoid Damage! Be sure valve caps are in place on end of valve stems before installing rocker arms. Valve caps and push rods must be reinstalled in same locations as removed.

1. Install valve caps and push rods in block if removed.
2. Align rocker arm supports with cylinder head. Align rockers with valve stems and push rods.
3. Install mounting cap screws on rocker arm supports and evenly tighten to pull rocker assembly to head. Tighten cap screws.
4. Adjust valve clearance. (See "Adjust Valve Clearance" on page 42.)
5. Install intake manifold/rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)

Specifications

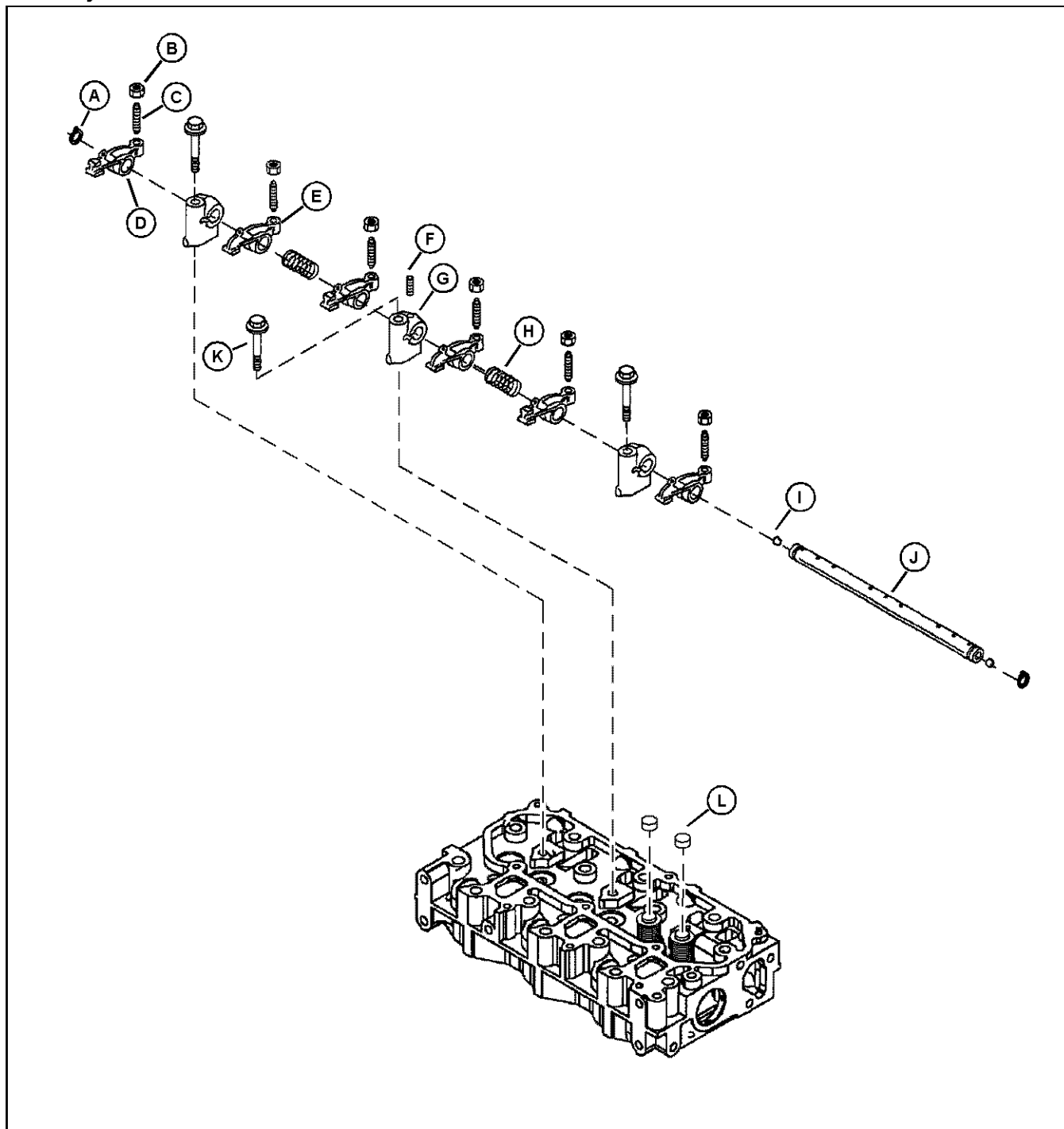
Rocker Arm Assembly

Cap Screw Torque 26 N•m (19 lb-ft)

ENGINE - DIESEL REPAIR

Disassemble and Assemble Rocker Arm Assembly

Disassembly



MX23585

- A- Snap Ring (2 used)
- B- Nut (6 used)
- C- Stud (6 used)
- D- Rocker Arm (3 used)
- E- Rocker Arm (3 used)
- F- Set Screw

- G- Rocker Arm Support (3 used)
- H- Spring (2 used)
- I- Ball (2 used)
- J- Shaft
- K- Cap Screw (3 used)
- L- Valve Stem Cap (6 used)

1. Mark all parts for location before disassembly to aid

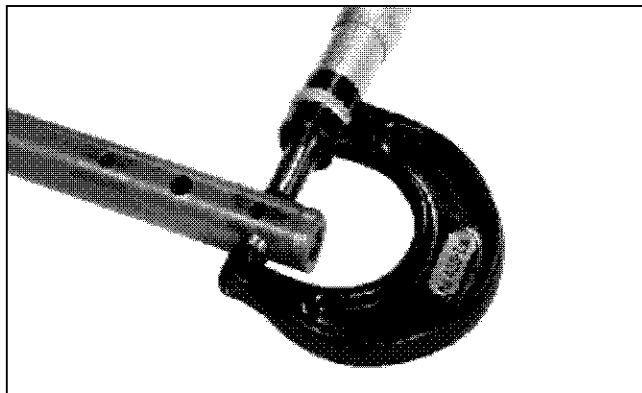
ENGINE - DIESEL REPAIR

assembly.

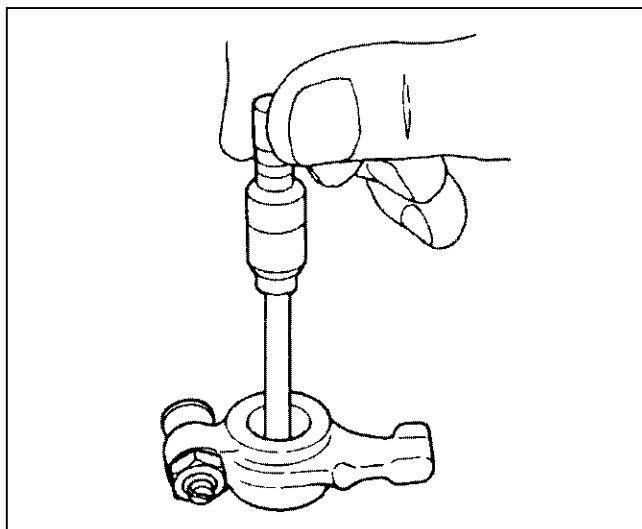
Note: The rocker arm shaft fits tightly in the rocker arm supports. Clamp the support in a padded vise, then twist and pull out on rocker arm shaft to remove.

2. Remove end retaining rings and slide components off rocker shaft.
3. Remove set screw from center support. Remove rocker shaft from center support.
4. Clean all parts of varnish and oil.

Rocker Arm Inspection

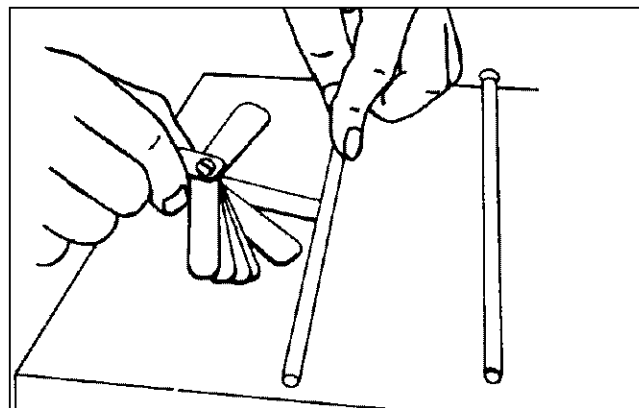


1. Measure outer diameter of rocker arm shaft at each rocker arm location. Replace rocker arm shaft if measurement is less than wear limit.



2. Measure inside diameter of rocker arms. Replace rocker arms if inner diameter is more than wear limit.
3. If shaft and arm oil clearance (arm ID minus shaft OD) exceeds wear limit, replace all parts.
4. Check the rocker arm-to-valve stem cap contact surface for wear. Replace rocker arm and/or valve stem cap if worn.

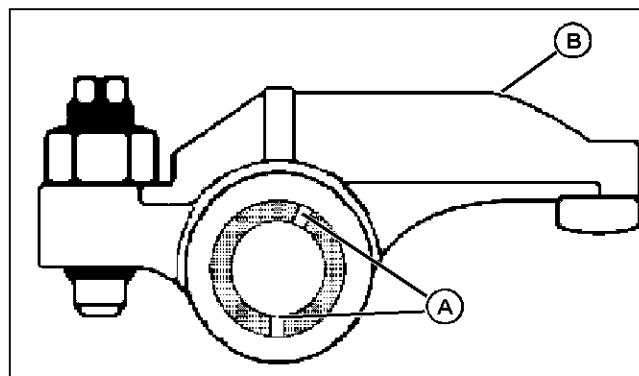
Push Rod Inspection



1. Lay push rod on flat surface and roll while checking for a gap under center of rod. Use feeler gauge to check dimension.
2. Check the surface of the adjusting screw that contacts the push rod for wear. Replace push rod and/or adjusting screw if worn.

Assembly

Note: Ensure the lubrication holes (A) in the rocker arm shaft are in the correct orientation to the rocker arms (B).



1. Assemble rocker arm shaft into center support, aligning set screw hole in support with hole in rocker arm shaft.
2. Install remaining parts of rocker arm assembly in location as noted in disassembly.

Specifications

Rocker Arm Shaft OD

Wear Limit. 11.94 mm (0.4701 in.)

Rocker Arm ID Wear Limit. 12.07 mm (0.475 in.)

Rocker Arm Oil Clearance

Wear Limit. 0.13 mm (0.005 in.)

Push Rod Bend 0.00-0.03 mm (0.000-0.001 in.)

ENGINE - DIESEL REPAIR

Remove and Install Cylinder Head

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hoist	N/A	Used to remove cylinder head from block.
Lifting Bracket (2 used)	JT01748	Used to remove cylinder head from block.

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Shut off fuel valve on fuel filter/water separator.
3. Allow engine to cool, and cooling system pressure to return to zero. Drain coolant from engine and radiator.
4. Remove muffler. (See "Remove and Install Muffler" on page 58.)
5. Remove upper and lower radiator hoses from coolant pump.
6. Disconnect wiring from coolant temperature sensor.
7. Remove upper alternator bracket and belt from coolant pump.
8. Remove coolant pump. (See "Remove and Install Coolant Pump (Thermostat Included)" on page 105.)

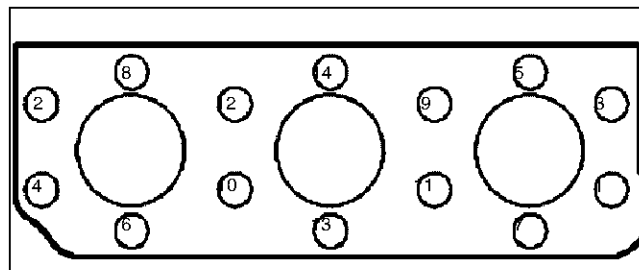


Caution: Avoid Injury! Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- Search 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.

Important: Avoid Damage! When removing injection lines, always use a backup wrench.

9. Remove high-pressure fuel lines and fuel leak-off line running from fuel injection pump to nozzles.
10. Remove intake manifold/rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)
11. Disconnect glow plug wiring harness from engine harness.
12. Remove rocker arm assembly, push rods, and valve caps from cylinder head. (See "Remove and Install Rocker Arm Assembly" on page 66.)
13. Remove exhaust manifold. (See "Remove and Install Exhaust Manifold" on page 59.)



MX23588

Top of drawing is exhaust manifold side.

14. Remove cylinder head cap screws in the order shown.
15. Using lift brackets and hoist, pull head straight up from block.

ENGINE - DIESEL REPAIR

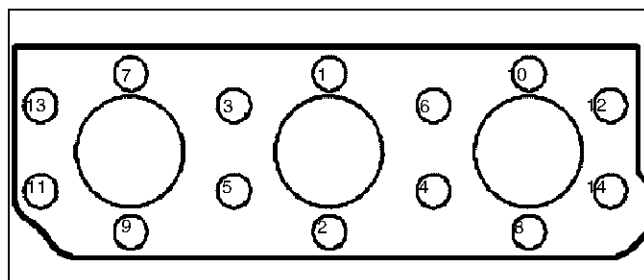
16. Disassemble and inspect cylinder head and valves. (See "Recondition Cylinder Head" on page 70.)

Installation

1. Clean all threads in top of cylinder block with a flat bottom tap, and blow debris from hole.
2. Clean top of cylinder block and check for flatness.

Important: Avoid Damage! If cylinder head was resurfaced, check piston-to-cylinder head clearance.

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. If cylinder head was resurfaced, check piston-to-cylinder head clearance. (See "Measure Piston-to-Cylinder Head Clearance" on page 75.)
4. Clean threads of cylinder head cap screws and dip in clean oil before installing. Install all cap screws finger tight before tightening with wrench.



Top of drawing is exhaust manifold side.

5. Tighten cylinder head cap screws to specification in sequence shown above in two steps of torque from specifications.
 6. Install exhaust manifold. (See "Remove and Install Exhaust Manifold" on page 59.)
 7. Install rocker arm assembly, push rods, and valve caps. (See "Remove and Install Rocker Arm Assembly" on page 66)
 8. Install intake manifold/rocker arm cover. (See "Remove and Install Intake Manifold (Rocker Arm Cover)" on page 65.)
- Note: Use dielectric grease on all non-sealed electrical connections before connecting.**
9. Connect fuel lines, radiator hoses, and wires.
 10. Install coolant pump. (See "Remove and Install Coolant Pump (Thermostat Included)" on page 105.)
 11. Install muffler. (See "Remove and Install Muffler" on page 58.)
 12. Install upper alternator bracket and belt.

Specifications

Cylinder Head Mounting Cap Screws

Initial Torque. 27-29 N•m (20-22 lb-ft)

Cylinder Head Mounting Cap Screws

Final Torque 54-58 N•m (40-43 lb-ft)

Important: Avoid Damage! Cylinder head mounting cap screws must be checked for proper torque after 50 hours of engine operation.

Recondition Cylinder Head

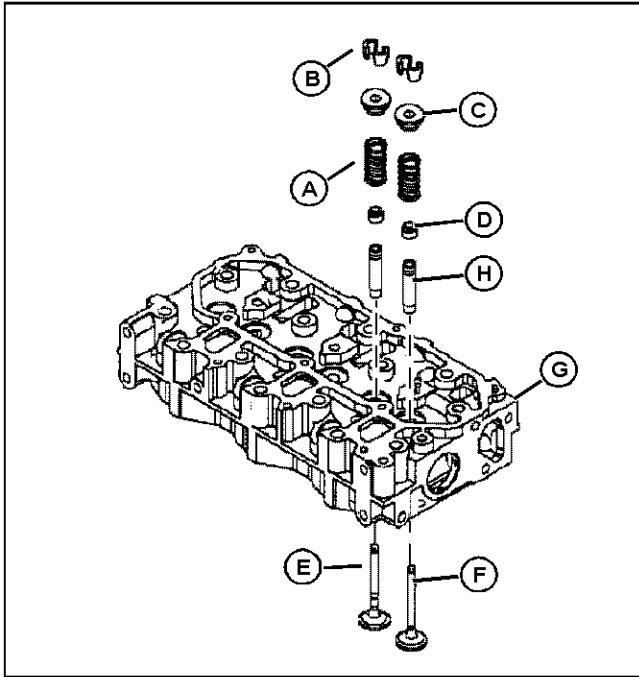
Special or Required Tools

Tool Name	Tool No.	Tool Use
Valve Spring Compressor	JDE138	Used to remove valves.
Valve Guide Driver	JDG10500	Used to remove valve guides from cylinder head.
Valve Guide Installer	JDG10501	Used to install valve guides to cylinder head.
Valve Seal Installer	JDG10503	Used to install valve seal on guides.

Note: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Disassembly

1. Check valve recession before disassembly. (See "Valve Recession Measurement" on page 72.)



MX5433

2. Compress valve springs (A) using JDE138 Valve Spring Compressor.

Note: It may be necessary to tap on valve spring retainer (B) while initially operating compressor to break retainer free from collet halves (C).

3. Remove collet halves (C) from retainer.
4. Slowly release compressor and valve spring.

Important: Avoid Damage! Do not reuse stem seals (D). Used seals will leak.

5. Remove valve spring, retainer (B), stem seal (D), and valve (E or F) from head (G).

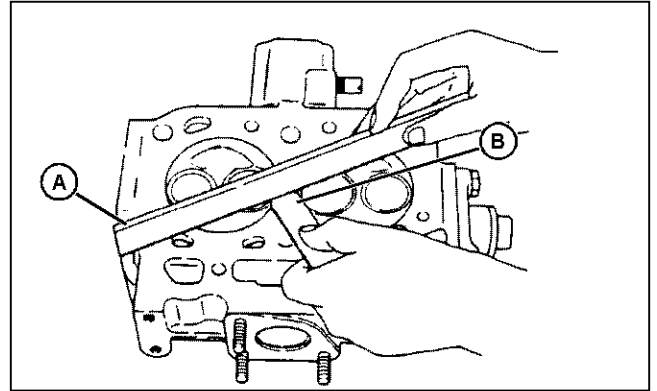
Note: Valve seats are not replaceable.

6. Intake and exhaust valve guides (H) are press fit. Remove guides only if replacement is necessary.

Inspection and Replacement

Before inspection, thoroughly clean all components of carbon or dirt.

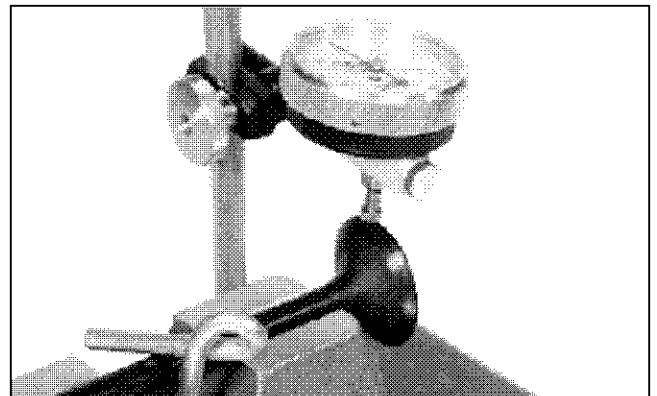
Cylinder Head



M82028A

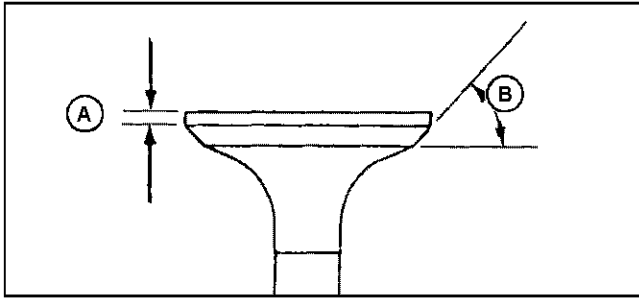
1. Measure cylinder head flatness. Place a straightedge (A) along each of the four sides and each diagonal. Measure clearance between straightedge and gasket surface with a feeler gauge (B).
2. If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat, but do not remove more than maximum amount specified.
3. Inspect for cracks or other damage.
4. Inspect condition of valve seats.
5. If cylinder head was resurfaced, measure valve recession. (See "Valve Recession Measurement" on page 72.)

Intake and Exhaust Valves



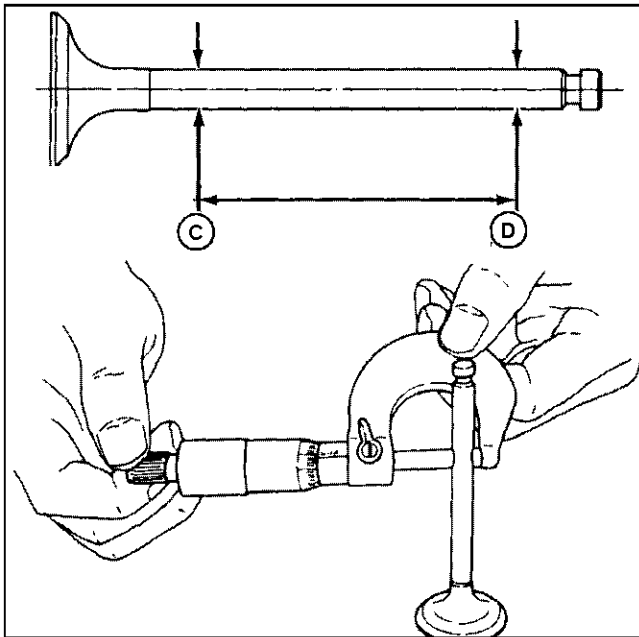
M35307

1. Check valve for out-of-round, bent, or warped condition using a valve inspection center and dial indicator. Replace valve if necessary.



M82030A

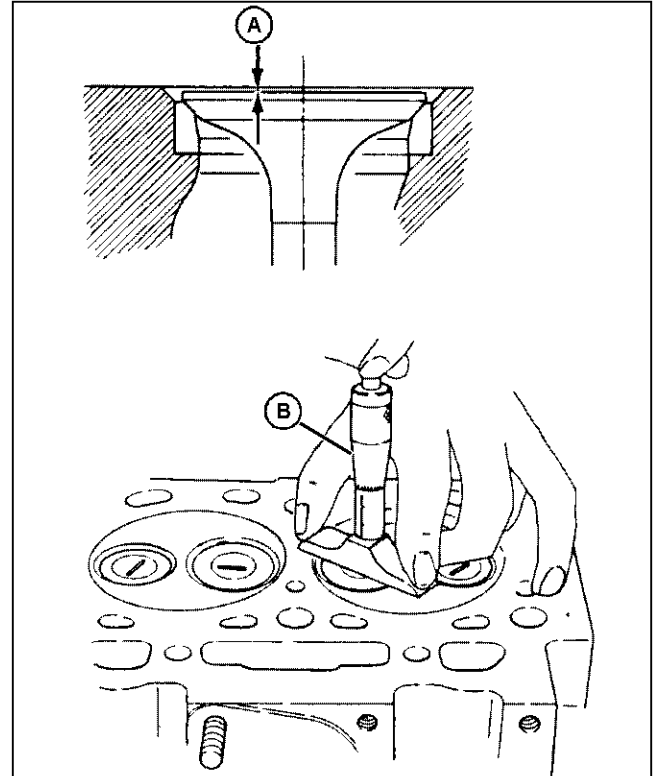
2. If valve faces are worn, burned, or pitted, grind valves to proper face angle (B). If valve face margin (A) is less than specification after grinding, replace valve.



M82031A

3. Measure valve stem diameter at the two locations (C and D) shown above. Replace valve if measurement exceeds wear limit.

Valve Recession Measurement

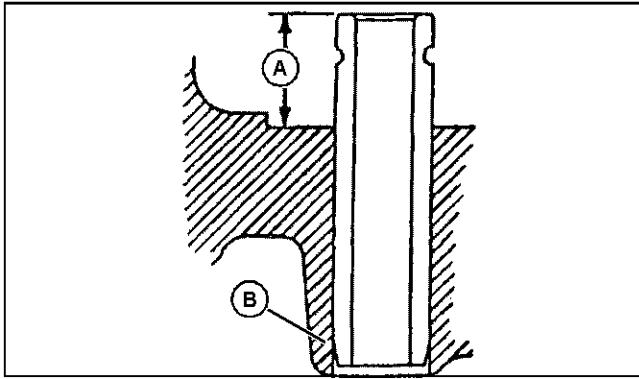


M82032A

Measure valve recession (A) using a depth gauge (B). Replace valve or cylinder head if measurement exceeds wear limit.

Valve Guide Measurement

1. Clean valve guides using a valve guide brush.
2. Measure valve guide inside diameter using a ball or telescoping snap gauge.
 - If valve guide inside diameter exceeds wear limit, replace guide.
 - If valve guide inside diameter is less than wear limit, determine guide-to-stem clearance (valve guide diameter minus valve stem diameter).
 - If clearance exceeds replacement specification, replace valve guides.
 - Remove valve guides using JDG10500 Valve Guide Removal Tool.

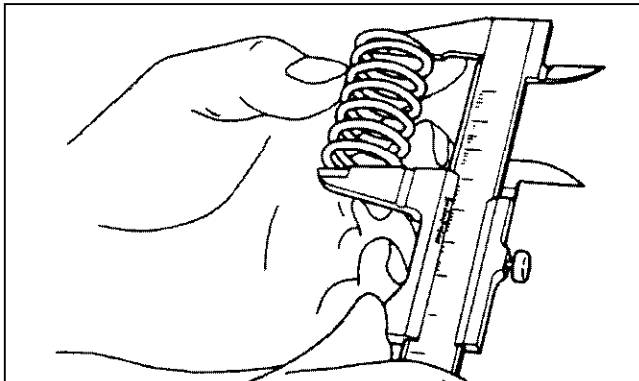


M82193A

3. Install valve guides with tapered end (B) down using JDG10501 Valve Guide Driver. Push valve guides down until driver touches valve spring seat. Check that tops of valve guides are projecting the specified height (A) from the valve spring seat in the cylinder head.

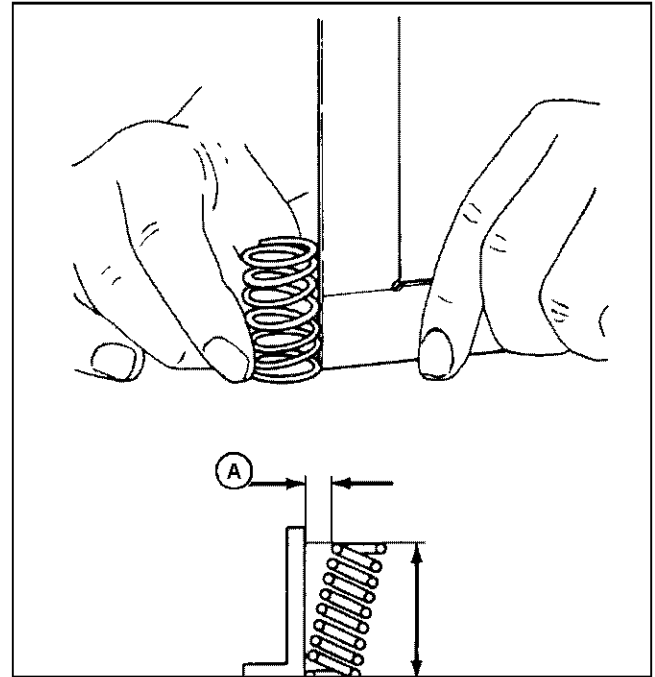
4. Ream inside diameter of valve guides using a 6 mm valve guide reamer.

Valve Springs



M82034A

1. Measure spring free length. Replace spring if measurement exceeds specification.

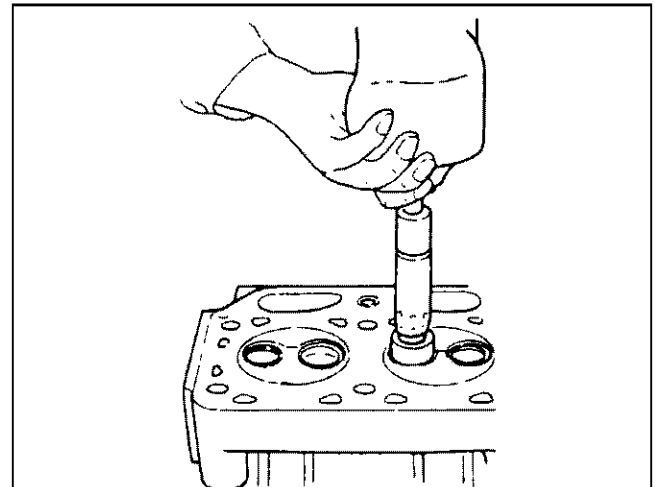


M82035A

2. Measure spring inclination. Replace spring if measurement exceeds specification.

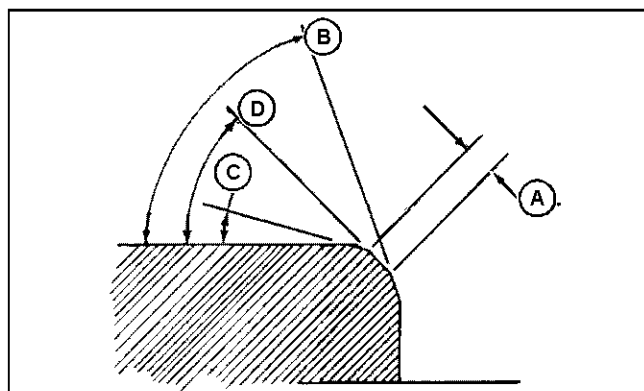
Valve Seat Grinding

Note: Lightly grind valve seats for only a few seconds to avoid excessive valve seat width. If valve guide is to be replaced, always replace guide before grinding valve seat, as seat grinder pilot is centered by guide.



M82039A

1. Grind intake valve seat using a 30° seat grinder, and exhaust valve seat using a 45° seat grinder. Follow tool manufacturer's instructions.



M82040A

2. Measure valve seat width (A) after grinding. Seat width must be less than valve face width.
3. If seat (A) is too wide after grinding, grind lower seat surface (B) using a 70° seat grinder until seat width is close to specifications.
4. Grind upper seat surface (C) using a 15° seat grinder until seat width is narrowed to specification.
5. Dimension (D) is 30° for intake and 45° for exhaust seat.

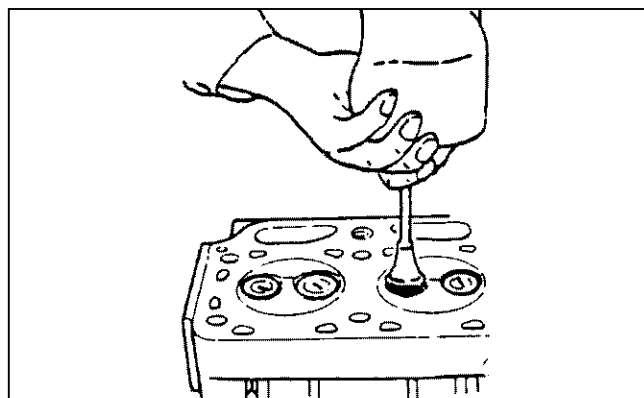
Note: If valve recession exceeds maximum specification, replace cylinder head.

6. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.
7. Lap valves. (See "Valve Lapping" on page 74.)

Valve Lapping

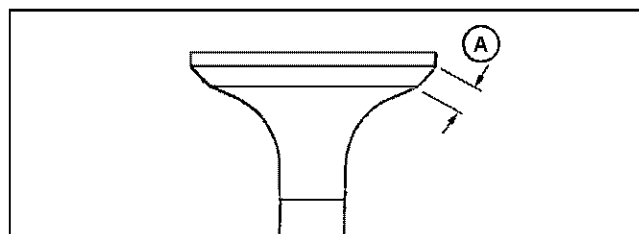
Note: Use a rubber-type lapping tool for valves without a lapping tool groove slit.

If seat does not make proper contact, lap the valve into the seat.



M82041A

1. Apply small amount of fine lapping compound to face of valve.
2. Turn valve to lap valve to seat.



M82030B

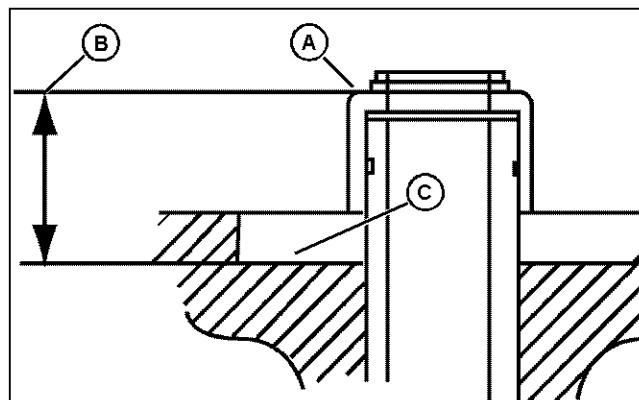
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface (A) of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

Assembly

Important: Avoid Damage! Intake and exhaust valve stem seals must be installed to the proper height.

Identify seals by the color of the seal spring:
White spring seals are intake seals.
Black spring seals are exhaust seals.

Ensure seals are installed correctly.



MX23596

1. Apply oil to lip of valve stem seal. Install seal to valve guide using JDG10503 Valve Stem Seal Installer. Push seal down until installer touches valve spring seat. Check that top of the seal (I) is projecting the specified height (J) from the valve spring seat (K) in the cylinder head.
2. Apply clean engine oil on intake and exhaust valve stems and install valves.
3. Install valve springs and retainers.
4. Use valve spring compressor to compress spring and retainer, and install collets as removed.
5. Repeat for all valves.
6. After valves have been assembled, tap on top of valve stems with a plastic hammer to seat retainers.

ENGINE - DIESEL REPAIR

7. Measure valve recession if new valves were installed.
(See "Valve Recession Measurement" on page 72.)

Specifications

Cylinder Head Distortion

Standard	0.05 mm (0.002 in.)
Wear Limit	0.15 mm (0.006 in.)
Allowable Removed Material (Maximum).	0.20 mm (0.008 in.)

Valve Grinding

Intake Valve

Face Margin. 0.90-1.1 mm (0.035-0.043 in.)

Exhaust Valve

Face Margin. 1.0-1.2 mm (0.039-0.047 in.)

Valve Face Margin Wear Limit. 0.50 mm (0.020 in.)

Intake Valve Face Angle. 30°

Exhaust Valve Face Angle. 45°

Valve Stem

Intake Valve Stem OD. 5.960-5.975 mm (0.2346-0.2352 in.)

Exhaust Valve Stem OD 5.945-5.960 mm (0.2341-0.2346 in.)

Valve Stem OD

Wear Limit (Both) 5.90 mm (0.232 in.)

Valve Recession

Valve Recession (Both) . 0.4-0.6 mm (0.0157-0.0236 in.)

Valve Recession Wear Limit (Both) . 0.9 mm (0.035 in.)

Valve Guides

Valve Guide Standard ID 6.00-6.01 mm (0.236-0.237 in.)

Valve Guide ID Wear Limit. 6.08 mm (0.239 in.)

Intake Valve Guide-to-Valve Stem Standard

Oil Clearance. 0.025-0.052 mm (0.001-0.002 in.)

Exhaust Valve Guide-to-Valve Stem Standard

Oil Clearance. 0.040-0.067 mm (0.002-0.003 in.)

Valve Guide-to-Valve Stem Oil

Clearance Wear Limit (Both) 0.17 mm (0.007 in.)

Valve Guide Height. 9.8-10.0 mm (0.386-0.394 in.)

Valve Stem Seal Height . 10.9-11.2 mm (0.429-0.441 in.)

Valve Springs

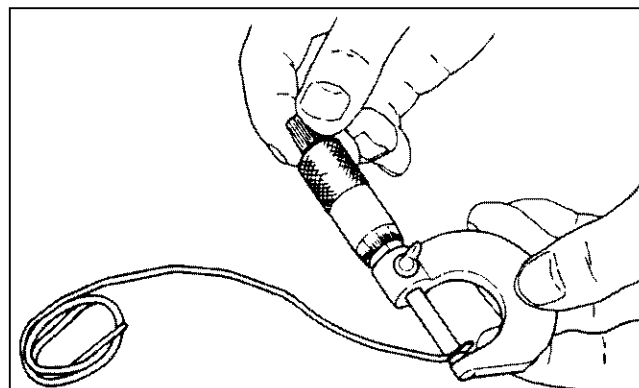
Spring Free Length. 37.8 mm (1.488 in.)

Spring Inclination (Maximum). 1.3 mm (0.051 in.)

Measure Piston-to-Cylinder Head Clearance

Procedure

1. Place three 10 mm (0.4 in.) long pieces of 1.5 mm (0.06 in.) diameter soft wire in three positions on the flat part of the piston head.
2. Install the cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence. (See "Remove and Install Cylinder Head" on page 69.)
3. Slowly turn the crankshaft one complete revolution.
4. Remove the cylinder head and gasket.



M82042A

5. Measure the thickness of the flattened section of each piece of wire. Calculate the average thickness of the wires to obtain the piston-to-cylinder head clearance specification.

6. If clearance is less than specification, replace cylinder head. (See "Remove and Install Cylinder Head" on page 69.)

Specifications

Piston-to-Cylinder Head

Clearance 0.75-0.89 mm (0.029-0.035 in.)

ENGINE - DIESEL REPAIR

Remove and Install Piston and Connecting Rod

Special or Required Tools

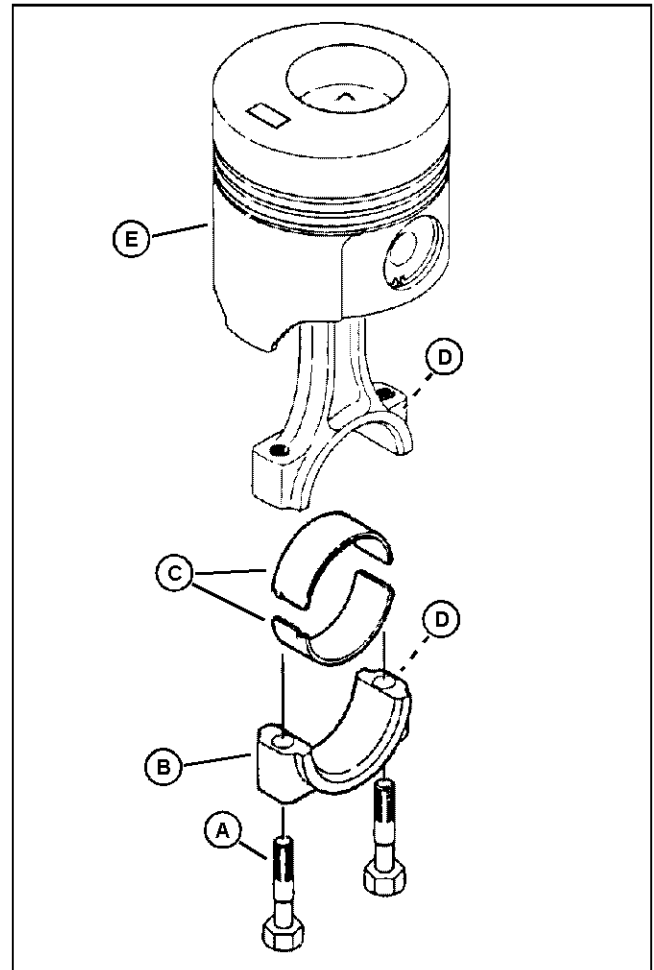
Tool Name	Tool No.	Tool Use
Ridge Reamer	N/A	Used to remove ridges from cylinder bore.
Bushing, Bearing, and Seal Driver Set	N/A	Used to remove piston pin bushing.

Removal

Note: The engine must be removed from the machine to perform this procedure.

1. Remove the oil pan, crankcase extension and oil pickup tube. (See "Remove and Install Oil Pan, Crankcase Extension and Pickup Tube" on page 102.)
2. Remove the cylinder head. (See "Remove and Install Cylinder Head" on page 69.)
3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed. If necessary, remove any ridge from top of cylinder bore using a ridge reamer.
4. Measure the connecting rod side play. (See "Connecting Rod Side Play Check" on page 82.)
5. Measure the crankshaft end play. (See "Crankshaft End Play Check" on page 88.)
6. Measure the connecting rod bearing clearance. (See "Check Connecting Rod Bearing Clearance" on page 82.)

Important: Avoid Damage! Keep the connecting rods and rod caps together. Rods and caps are a matched set. Note the stamped numbers on each part.



MX23625

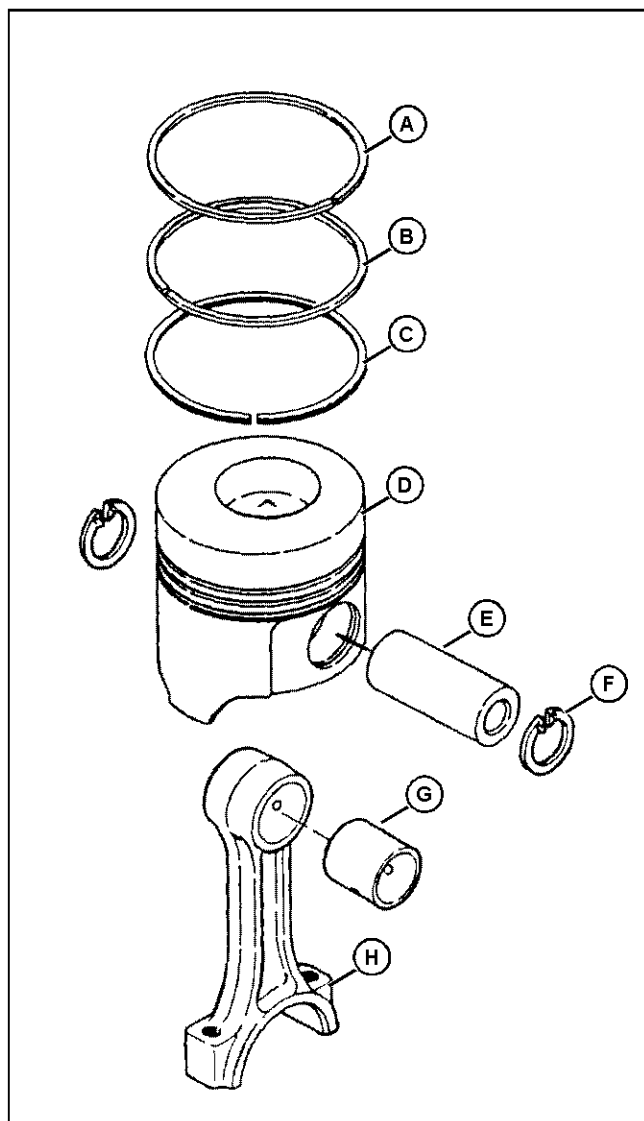
7. Remove the rod cap screws (A), connecting rod cap (B), and bearing inserts (C).

Important: Avoid Damage! The pistons and cylinders are matched. Pistons must be installed in the cylinders from which they are removed.

8. Note the connecting rod stamped number (D) in relation to the cylinders. Start at the flywheel end with cylinder No. 1, then No. 2, etc.
9. Push the piston and connecting rod (E) out of the cylinder bore using a wooden dowel.
10. Disassemble and inspect all parts for wear or damage.
11. Inspect cylinder bore. (See "Bore Engine Cylinder" on page 83.)

Disassembly

Important: Avoid Damage! Pistons must be installed on the same connecting rod they were removed from.



M82197AB

- A- Top Piston Ring
- B- Middle Piston Ring
- C- Oil Control Ring with Expander
- D- Piston
- E- Piston Pin
- F- Snap Ring
- G- Piston Pin Bushing
- H- Connecting Rod

1. Put a mark on each piston and connecting rod to aid in assembly.
2. Remove piston rings (A-C), starting with the first compression ring, by gently spreading them open just enough to clear the outside diameter of the piston. This can be done by hand or with a ring expander.
3. Remove piston pin retaining rings (F) and piston pin (E). Excessive pressure should not be necessary to remove piston pin.

Note: The piston pin bushing (G) is a press fit in the connecting rod. Remove the bushing only if replacement is necessary. (See "Piston Pin Bushing" on page 79.)

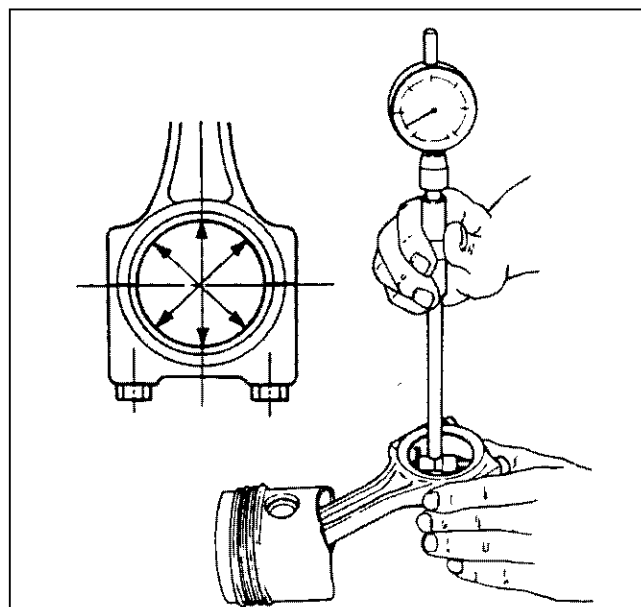
4. Inspect all parts for wear or damage. Replace as necessary.

Inspection and Replacement

1. Inspect all parts for wear or damage. Replace as necessary. (See Connecting Rod Bearing, Piston Ring Groove, Piston Ring End Gap, Piston Pin Bore, Piston Pin Bushing, and Piston Diameter procedures below.)
2. Measure the crankshaft connecting rod journal diameter. (See "Crankshaft and Main Bearings" on page 88.)

Connecting Rod Bearing

1. Install the connecting rod cap and bearing inserts on the connecting rod. Install the old connecting rod cap screws and tighten to specification.

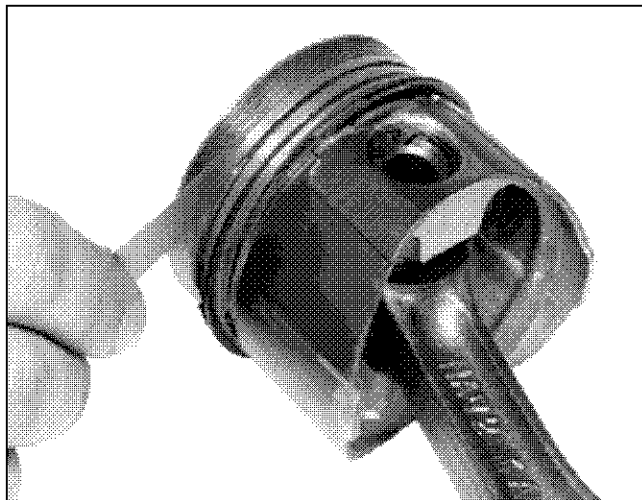


M82048A

2. Measure the connecting rod bearing diameter. Replace the bearing inserts if bearing diameter is not within specification.
3. Measure the oil clearance between the bearing inserts and the crankshaft, and verify that the clearance is within specification. If the bearing oil clearance exceeds the wear limit, grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.

ENGINE - DIESEL REPAIR

Piston Ring Groove



M35360

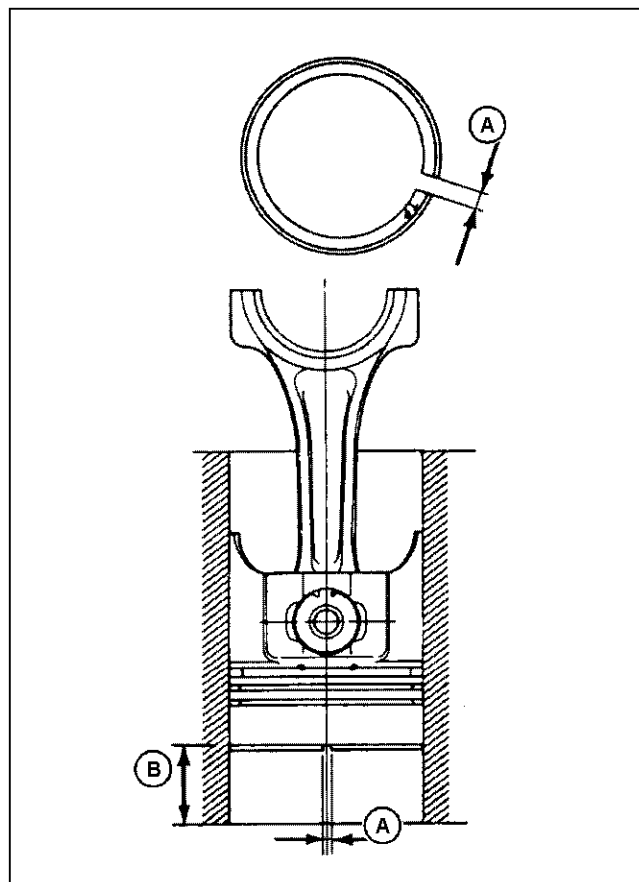
1. Using a micrometer, measure the thickness of each piston ring. Replace piston rings if rings do not meet specification.

Note: Piston ring groove side clearance must be checked using new rings or known good rings meeting thickness specifications.

2. With the rings installed on the piston, measure the piston ring groove side clearance. Measure at several places around each piston.
3. Replace the piston if the clearances exceed specification.

Piston Ring End Gap

Note: Piston ring end gap must be checked using known good cylinder bore meeting specifications. (See "Bore Engine Cylinder" on page 83.)

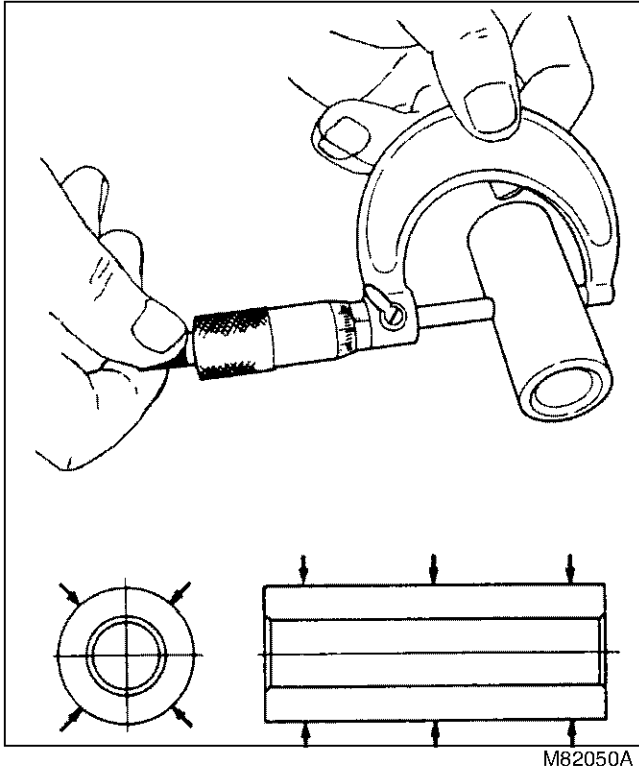


M82049A

1. Push ring into cylinder bore, using a piston, until ring installed depth (B) is approximately 30 mm (1.18 in.) from bottom of cylinder bore.
2. Measure piston ring end gap (A). If ring end gap exceeds wear limit, replace ring.

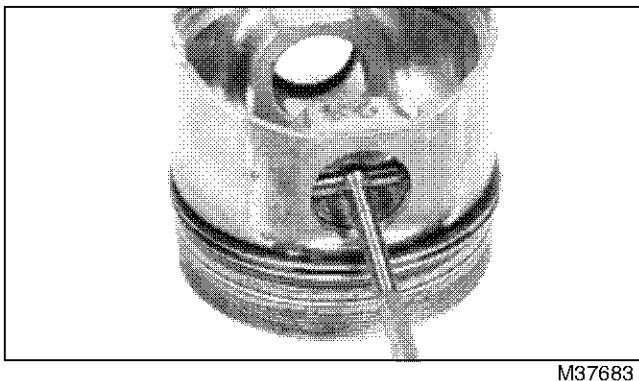
ENGINE - DIESEL REPAIR

Piston Pin



Measure the piston pin diameter at six places. Replace any pin that is not within specification.

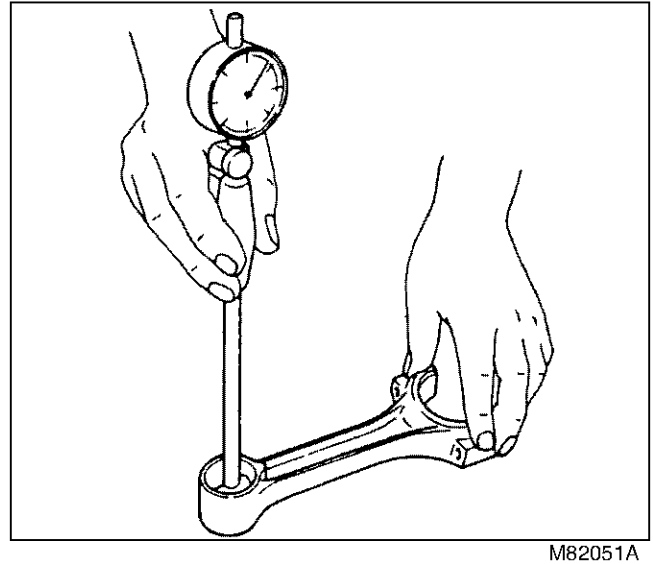
Piston Pin Bore



1. Measure the pin bore diameter in the piston. If the piston pin bore exceeds the wear limit, replace the piston.
2. If the piston pin-to-piston oil clearance (bore ID minus pin OD) exceeds the wear limit, replace the piston, piston pin, or both.

Piston Pin Bushing

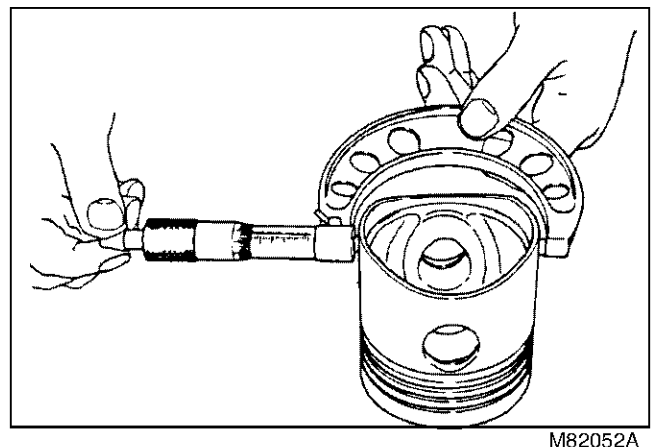
Note: The piston pin bushing is a press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.



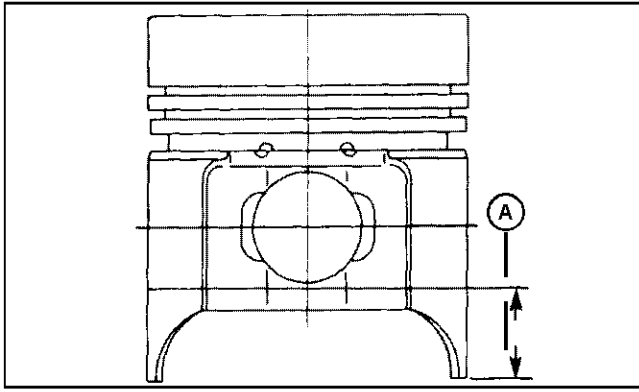
1. Measure the piston pin bushing diameter in the connecting rod. If the bushing diameter exceeds the wear limit, replace bushing.
2. If piston pin-to-bushing oil clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

Piston Diameter

Note: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



ENGINE - DIESEL REPAIR



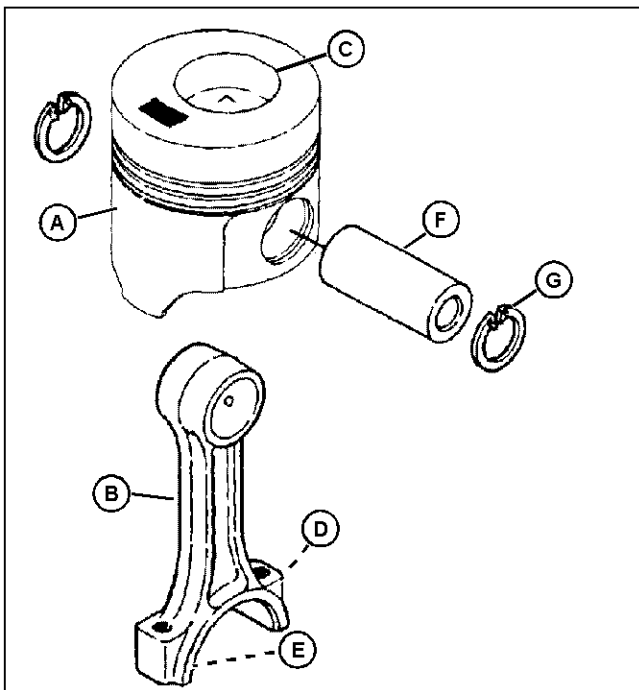
M82200A

Measure the piston diameter perpendicular to the piston pin bore at distance (A). If the piston diameter is less than the wear limit, install a new piston.

Assembly

1. Apply clean engine oil to all parts during assembly.
2. Install piston pin bushing in connecting rod with oil holes aligned, if removed. (See "Piston Pin Bushing" on page 79.)

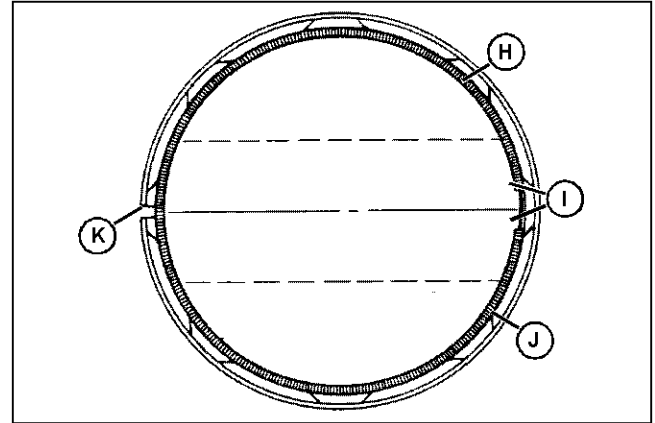
Important: Avoid Damage! The pistons must be installed on the same connecting rod they were removed from.



MX23626

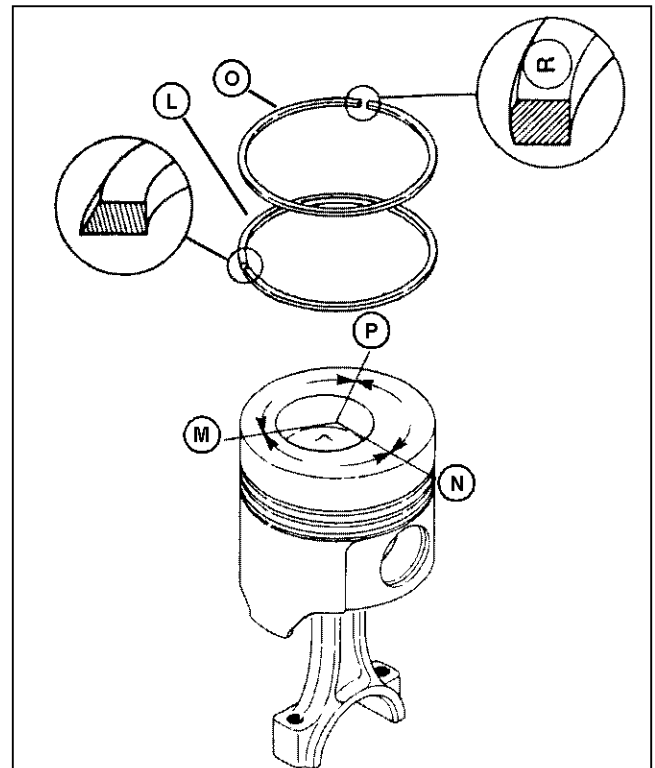
3. Assemble the piston (A) to the connecting rod (B) with piston recess (C) on the same side as the connecting rod stamped number (D). If a new connecting rod is used, assemble the piston to the connecting rod with piston recess opposite the connecting rod bearing insert groove (E).

4. Install piston pin (F) and snap rings (G).



M82046A

5. Install an oil ring expander (H) in the bottom ring groove of the piston, with the ends (I) above either end of the piston pin.
6. Install oil ring (J) over the expander with the ring gap (K) opposite (180°) the expander ends.



M82199A

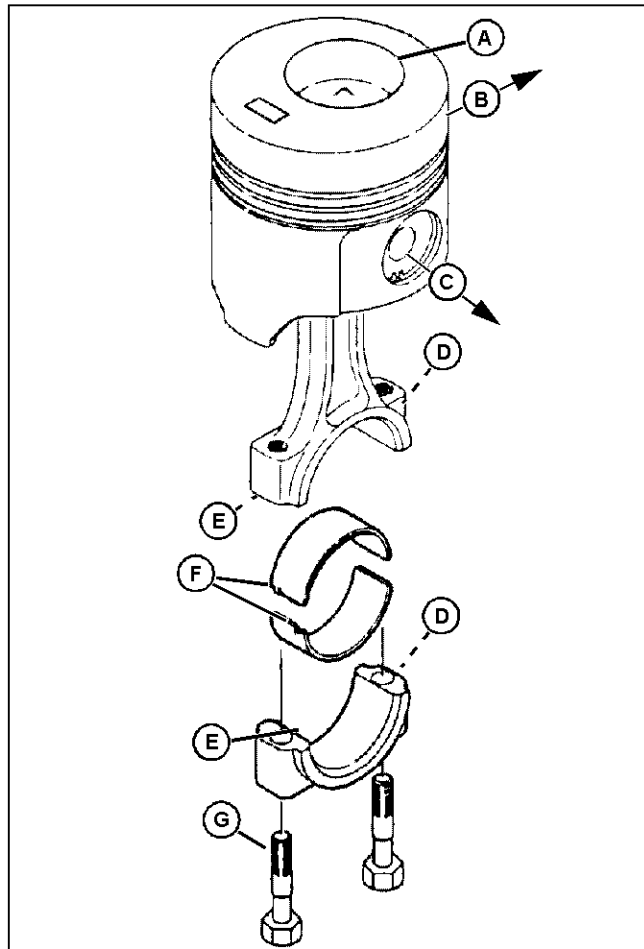
7. Install the middle piston ring (L), with the manufacturer's mark (near the ring gap) toward the top of the piston, in the middle groove. Turn the ring until the middle piston ring gap (M) is 120° away from the oil ring gap (N).
8. Install the top piston ring (O), with the manufacturer's mark (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the top piston ring gap (P) is 120° away from the middle ring gap (M).

ENGINE - DIESEL REPAIR

Installation

1. Apply clean engine oil to all parts during installation.
2. Always replace the connecting rod cap screws. Do not reuse cap screws.
3. Assemble the piston and connecting rod. (See "Assembly" on page 80.)

Important: Avoid Damage! Pistons must be installed in the cylinders from which they were removed and in the same direction. Be careful not to damage the crankshaft rod journals while installing pistons.



MX23625

- A- Piston Recess
- B- Fuel Injection Pump Side
- C- Flywheel Side
- D- Stamped Number
- E- Groove
- F- Tang
- G- Cap Screw

4. Install the piston and connecting rod into the cylinder from which it was removed. The stamped number (D) on the connecting rod and the piston recess (A) on top of

piston should point toward the fuel injection pump.

Important: Avoid Damage! Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

5. Install the bearing inserts to the connecting rod and rod cap, aligning tangs (F) with grooves (E).

Important: Avoid Damage! Connecting rod caps must be installed on the same connecting rods they were removed from.

6. Match the connecting rods to caps using stamped numbers (D). Install the rod caps.
7. Dip the entire connecting rod cap screws (G) in clean engine oil. Install new cap screws and tighten to specification.
8. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.
9. Install the cylinder head. (See "Remove and Install Cylinder Head" on page 69.)
10. Install the oil pan, crankcase extension and oil pickup tube. (See "Remove and Install Oil Pan, Crankcase Extension and Pickup Tube" on page 102.)

Specifications

Connecting Rod Bearings

Connecting Rod Bearing ID . 41.982-42.002 mm (1.653-1.654 in.)

Connecting Rod Bearing Oil Clearance

Wear Limit. 0.11 mm (0.004 in.)

Piston Rings

Top Piston Ring Thickness

Wear Limit. 1.45 mm (0.057 in.)

Middle Piston Ring Thickness

Wear Limit. 1.45 mm (0.057 in.)

Oil Control Ring Thickness

Wear Limit. 2.95 mm (0.116 in.)

Top Piston Ring Groove

Side Clearance 0.06-0.10 mm (0.002-0.004 in.)

Middle Piston Ring Groove

Side Clearance 0.050-0.090 mm (0.002-0.004 in.)

Oil Control Ring Groove

Side Clearance 0.020-0.060 mm (0.0008-0.0024 in.)

Top Piston Ring

Standard End Gap 0.15-0.30 mm (0.006-0.012 in.)

Middle Piston Ring

ENGINE - DIESEL REPAIR

Standard End Gap 0.18-0.33 mm (0.007-0.013 in.)
Oil Control Ring
Standard End Gap 0.15-0.35 mm (0.006-0.014 in.)
Top Piston Ring End Gap
Wear Limit 0.39 mm (0.015 in.)
Middle Piston Ring End Gap
Wear Limit 0.42 mm (0.0165 in.)
Oil Control Ring End Gap
Wear Limit 0.44 mm (0.017 in.)

Piston Pins

Piston Pin OD Wear Limit 21.965 mm (0.865 in.)

Piston Pin Bores

Bore ID Wear Limit 22.04 mm (0.868 in.)

Piston Pin Bushings

Bushing ID Wear Limit 22.07 mm (0.869 in.)
Pin-to-Bushing
Clearance Wear Limit 0.105 mm (0.004 in.)

Pistons

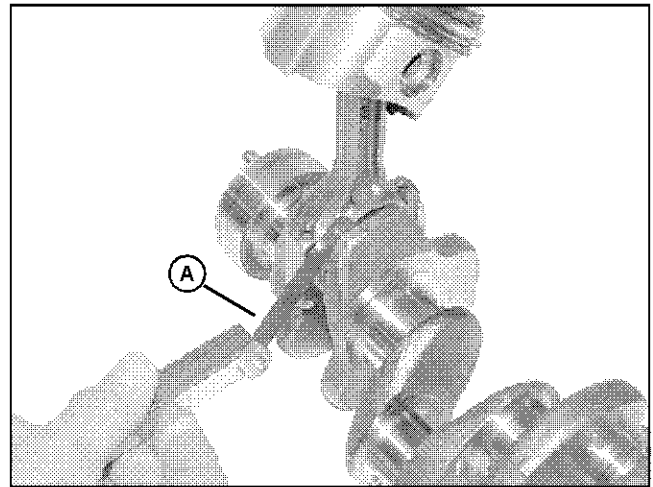
Diameter Measuring Point
Distance (A) 22-25 mm (0.866-0.984 in.)
Standard Size Piston
OD Wear Limit 69.915 mm (2.753 in.)
Oversize Piston
OD Wear Limit 70.165 mm (2.763 in.)
Connecting Rod
Cap Screw 22.6-27.5 N•m (17-20 lb-ft)

Connecting Rod Side Play Check

Note: Connecting rod side play check may be performed with crankshaft and connecting rod installed or removed from cylinder block. If performing check with crankshaft and connecting rod installed in block, go directly to step 2.

Important: Avoid Damage! Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Install connecting rod on crankshaft. Tighten connecting rod cap screws to specification.
2. Hold connecting rod to one side of journal.



3. Measure connecting rod side play using a feeler gauge (A). Replace connecting rod and crankshaft, as necessary, if side play exceeds specification.

Specifications

Connecting Rod

Side Play 0.20-0.40 mm (0.008-0.016 in.)

Connecting Rod

Cap Screw Torque 22.6-27.5 N•m (17-20 lb-ft)

Check Connecting Rod Bearing Clearance

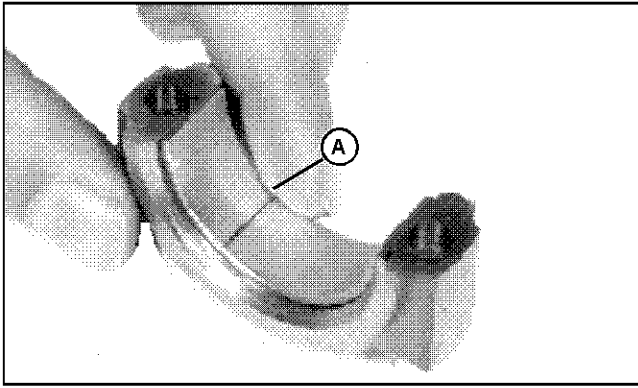
Special or Required Tools

Tool Name	Tool No.	Tool Use
PLASTIGAGE [™] Bearing Clearance Measurement Tool (or Equivalent)	N/A	Used between bearing insert and crankshaft journal to measure clearance.

Important: Avoid Damage! Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.

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M35351

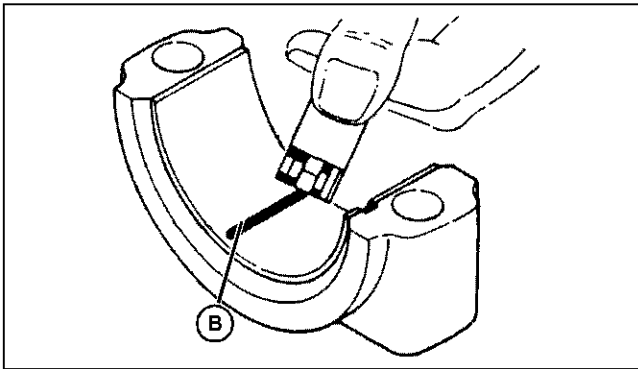
3. Put a piece of PLASTIGAGE (A), or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.

Important: Avoid Damage! Rotating the crankshaft will cause PLASTIGAGE to smear, resulting in a false reading. Do not allow crankshaft to rotate after installing bearing cap.

Note: Lightly lubricate bolts with engine oil before installing.

5. Install connecting rod end cap and original cap screws. Tighten cap screws to specification.
6. Remove cap screws and connecting rod cap.

Note: The flattened PLASTIGAGE will be found on either the bearing insert or the crankshaft journal.



M82117A

7. Use the graduation marks on the envelope to compare the width of the flattened PLASTIGAGE (B) at its widest point.
8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
9. If clearance exceeds specification, replace bearing

inserts and inspect crankshaft. (See "Inspection and Replacement" on page 89.)

10. Remove PLASTIGAGE.

Specifications

Connecting Rod Bearing

Clearance Wear Limit. 0.11 mm (0.004 in.)

Connecting Rod

Cap Screw. 22.6-27.5 N•m (17-20 lb-ft)

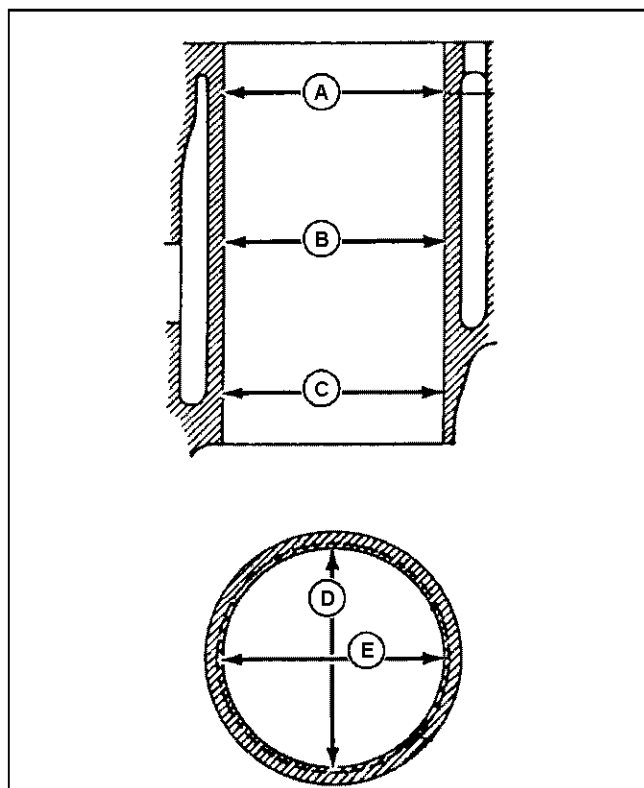
Bore Engine Cylinder

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flex Hone (with 300-Grit Stone)	N/A	Used to deglaze cylinder bores.
Rigid Hone (with 180-Grit Stone)	N/A	Used with drill press to rebore cylinder to use oversize pistons and rings.
Drill Press	N/A	Used with rigid hone to rebore cylinder to use oversize pistons and rings.

Inspection

Note: If engine has had a previous major overhaul, the cylinders may have been bored oversize. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



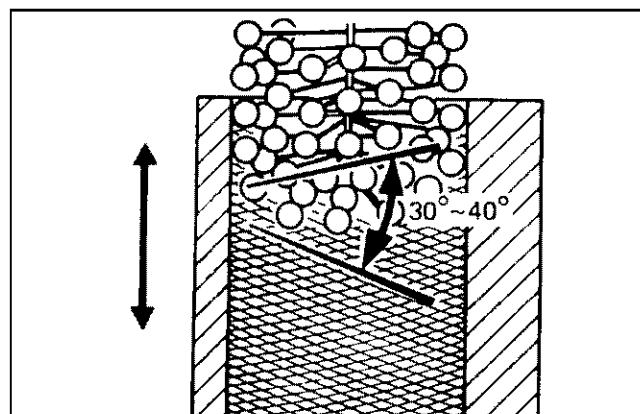
M82053A

1. Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft center-line (D) and direction of crankshaft rotation (E).
2. If cylinder bore inner diameter exceeds wear limit, have cylinder rebored. (See "Reboring" on page 84.)
3. If cylinder is rebored, oversize pistons and rings must be installed.
4. If cylinder bore exceeds oversize bore inner diameter, replace the cylinder block.
5. If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both; or rebore cylinder and install oversize pistons and rings.
6. Slightly uneven wear, flaws, or minor damage may be corrected by deglazing. (See "Deglazing" on page 84.)

Deglazing

Important: Avoid Damage! If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex hone with 300-grit stone.



M82054A

2. Use flex hone as instructed by manufacturer to obtain a 30-40° crosshatch pattern as shown.

Important: Avoid Damage! Do not use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

Reboring

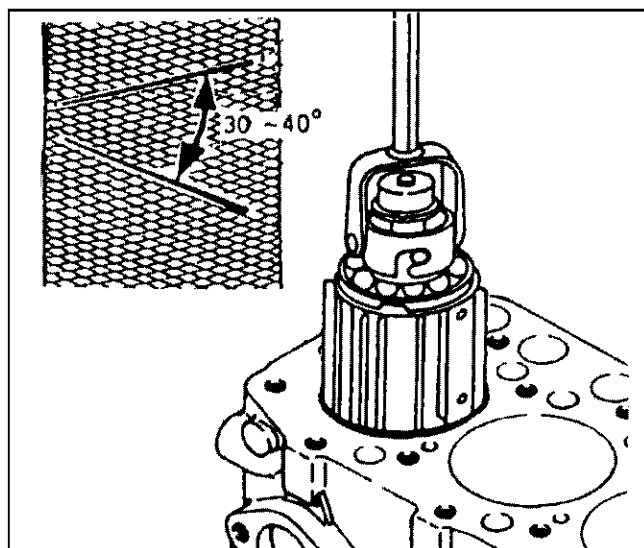
Note: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

1. Align center of bore to drill press center.

Important: Avoid Damage! Follow hone manufactures recommendations for stone grit and RPM. Check stone for wear or damage.

2. Adjust rigid hone so lower end is even with lower end of cylinder bore.
3. Adjust rigid hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Rigid hone should turn by hand. Adjust if too tight.

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M52959

5. Run drill press at hone manufacturer's recommended rpm. Move rigid hone up and down in order to obtain a 30-40° crosshatch pattern.

Note: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

Note: Finish should not be smooth. It should have a 30-40° crosshatch pattern.

7. Remove rigid hone when cylinder is within 0.03 mm (0.001 in.) of desired size.

8. Use a flex hone with 300-grit stone, at manufacturer's recommended rpm, for honing to final size.

9. Check bore for size, taper, and out-of-round. (See "Inspection" on page 83.)

Important: Avoid Damage! Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

10. Remove excess abrasive residue from cylinder walls using a clean dry rag. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

Specifications

Piston-to-Cylinder Bore

Clearance 0.03-0.05 mm (0.001-0.002 in.)

Cylinder Standard Roundness . 0.00-0.01 mm (0.0000-0.0004 in.)

Cylinder Roundness Wear Limit . . . 0.03 mm (0.001 in.)

Cylinder Standard Taper 0.00-0.01 mm (0.0000-0.0004 in.)

Cylinder Taper Wear Limit 0.03 mm (0.001 in.)

Standard Size Cylinder Bore

Standard ID 70.01-70.02 mm (2.756-2.757 in.)

Standard Size Cylinder Bore

ID Wear Limit 70.20 mm (2.764 in.)

Oversize Cylinder Bore

Standard ID 70.26-70.27 mm (2.766-2.767 in.)

Oversize Cylinder Bore

ID Wear Limit 70.45 mm (2.774 in.)

Remove and Install Crankshaft Rear Oil Seal

Special or Required Tools

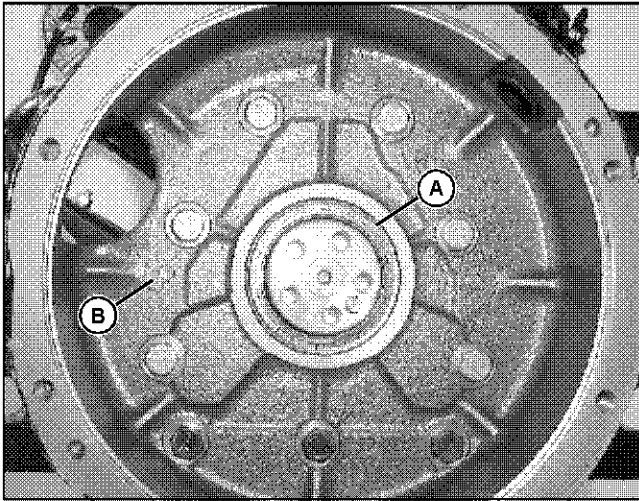
Tool Name	Tool No.	Tool Use
Hoist	N/A	Used with lifting brackets to remove flywheel from crankshaft.
Lifting Bracket (2 used)	JT01748	Used with hoist to remove flywheel from crankshaft.
Bushing, Bearing, and Seal Driver Set	N/A	Used to install crankshaft rear oil seal.

Important: Avoid Damage! Flywheel is heavy! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lifting brackets to lift flywheel from crankshaft.

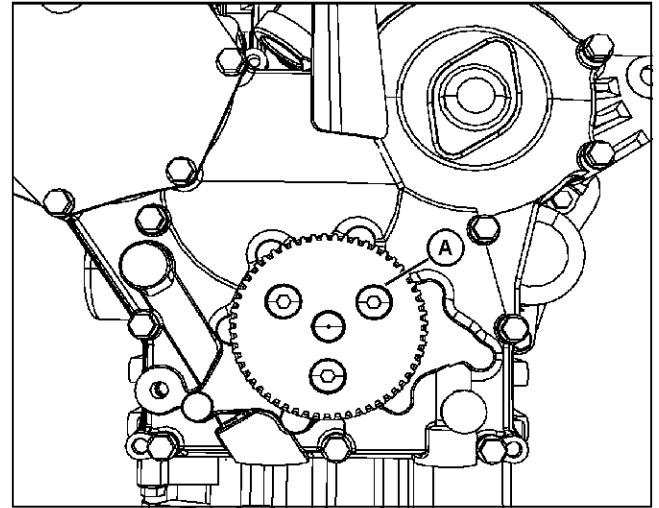
Note: Engine removal is necessary to replace rear oil seal. (See "Remove Engine" on page 62.)

1. Remove flywheel. (See "Remove and Install Flywheel" on page 92.)

Note: It is not necessary to remove flywheel housing (B) to remove oil seal (A).



MX23654



MX24370

2. Carefully pry oil seal (A) from flywheel housing (B).
3. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of flywheel housing.
4. Install flywheel. Tighten flywheel mounting cap screws to specification.

Specifications

Flywheel Mounting Cap Screw Torque

..... 80.4-86.4 N•m (59-64 lb-ft)

Remove and Install Crankshaft Front Oil Seal

Special or Required Tools

Tool Name	Tool No.	Tool Use
Puller	N/A	Used to remove crankshaft sheave.
Bushing, Bearing, and Seal Driver Set	N/A	Used to install crankshaft front oil seal.

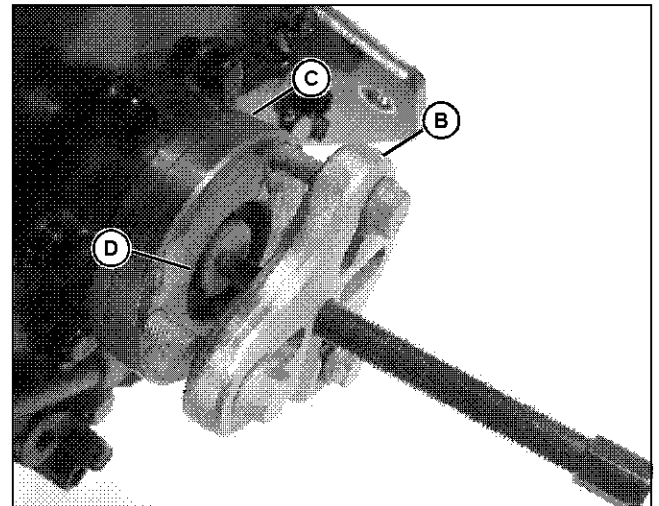
Procedure

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Remove alternator belt. (See "Remove and Install Alternator Drive Belt" on page 56.)

3. Remove three crankshaft sheave socket head cap screws (A) and remove sheave from crank hub.



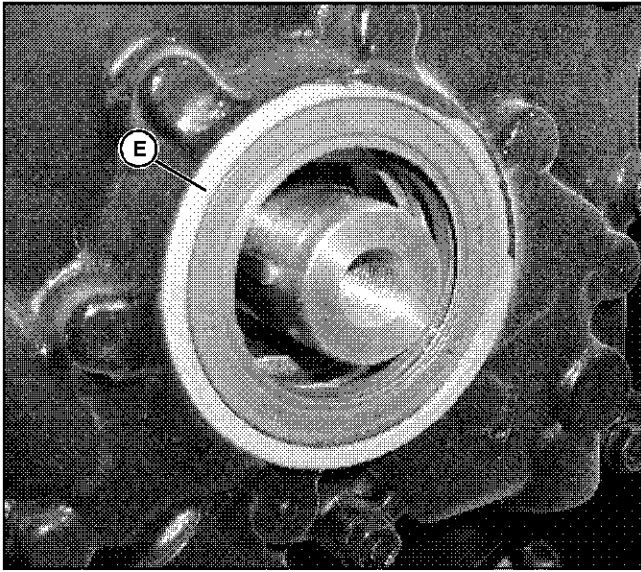
Caution: Avoid Injury! Crank hub may suddenly release when removing. Injury can occur when crank hub releases. Keep the surrounding area of the crank hub clear of personnel.



MX23936

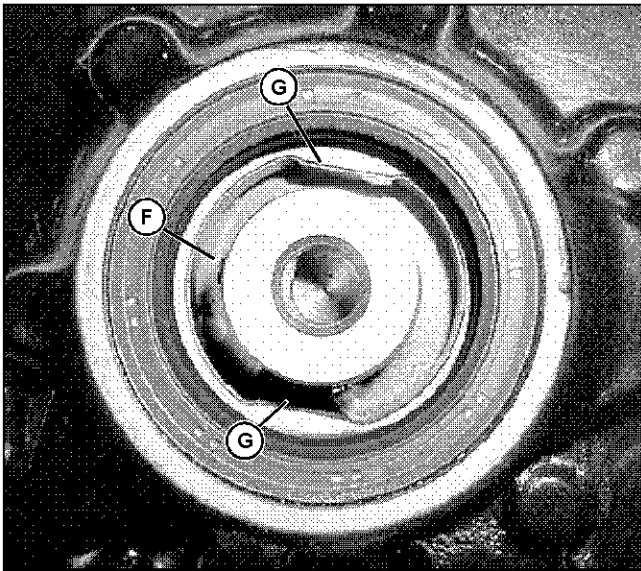
4. Remove crank hub cap screw, washer and O-ring.
5. Install puller (B) to crank hub (C) using a thread protector (D) for the crankshaft end.
6. Remove crank hub.

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MX23937

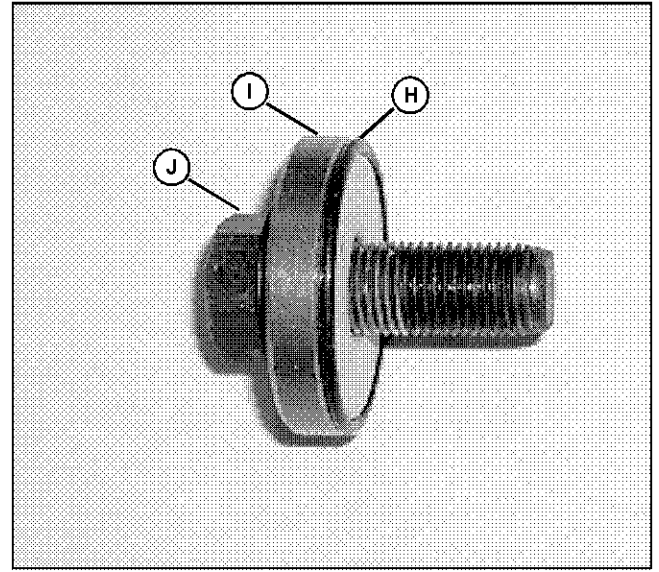
7. Carefully pry oil seal (E) from timing gear cover.
8. Install new oil seal using a bushing, bearing, and seal driver set. Install seal with lip toward engine. Install seal flush with surface of cover.
9. Coat lip of seal with clean engine oil.



MX23944

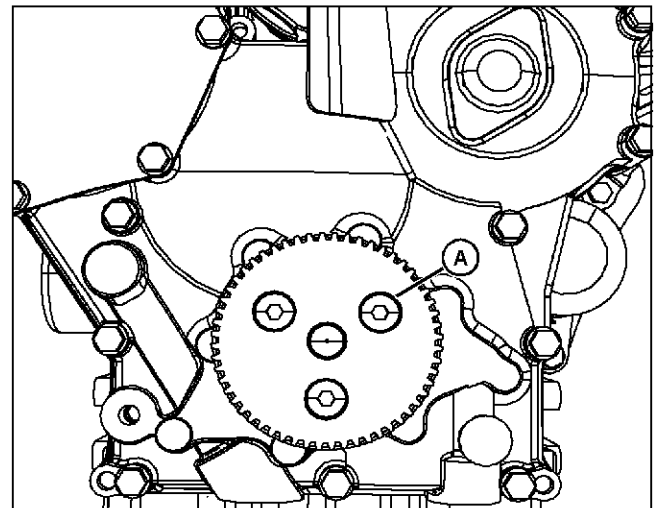
10. Align keyway and flats on crank hub with key in crankshaft (F) and flats (G) of oil pump gear and install crank hub.

Note: Applying a small amount of petroleum jelly to the O-ring will hold it in position for assembly.



MX23937

11. Install a new O-ring (H) to the shoulder of the crank hub washer (I).
12. Assemble crank hub washer to crank hub cap screw (J) with O-ring facing away from cap screw head.
13. Install assembled crank hub cap screw, washer and O-ring to crank hub.
14. Tighten crank hub cap screw to specification.



MX24370

15. Install sheave and three crankshaft sheave socket head cap screws (A) to crank hub.
16. Install alternator belt. (See "Remove and Install Alternator Drive Belt" on page 56.)

Specifications

Crank Hub Cap Screw Torque 113-123 N•m (83-90 lb-ft)

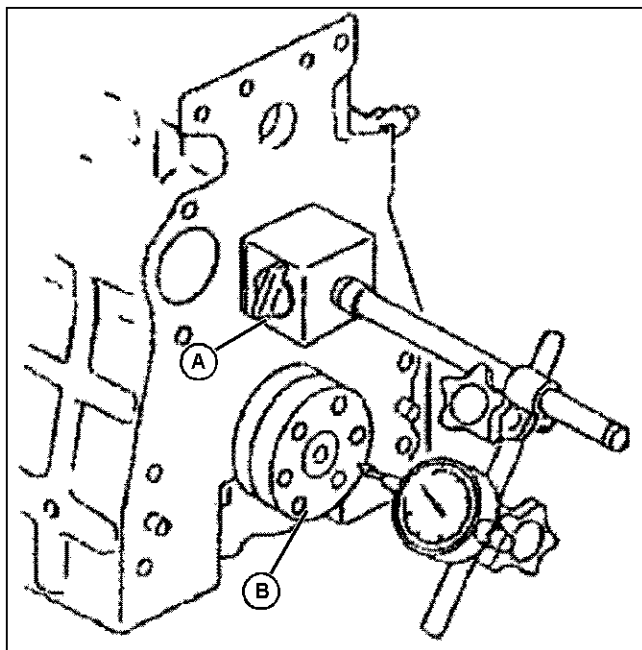
ENGINE - DIESEL REPAIR

Crankshaft End Play Check

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator with Magnetic Base	N/A	Used to measure crankshaft end play.

Note: Follow this procedure with crankshaft installed in cylinder block.



MX26629

1. Fasten dial indicator base (A) to cylinder block and position indicator tip on flywheel end (B) of crankshaft.
2. Push crankshaft toward the rear as far as possible.
3. Set the dial indicator to zero.
4. Pull crankshaft forward as far as possible.
5. If crankshaft end play exceeds specification, remove crankshaft and inspect thrust bearing and crankshaft for wear. Replace parts as needed.

Specifications

Crankshaft End Play

Wear Limit 0.28 mm (0.011 in.)

Crankshaft and Main Bearings

Special or Required Tools

Tool Name	Tool No.	Tool Use
Knife-Edge Puller	N/A	Used with press to remove gear from crankshaft.
Press	N/A	Used with knife-edge puller to remove gear from crankshaft.
Dial Indicator	N/A	Used with V-blocks to inspect crankshaft for bend.
V-Block (2 used)	N/A	Used with dial indicator to inspect crankshaft for bend.

Removal

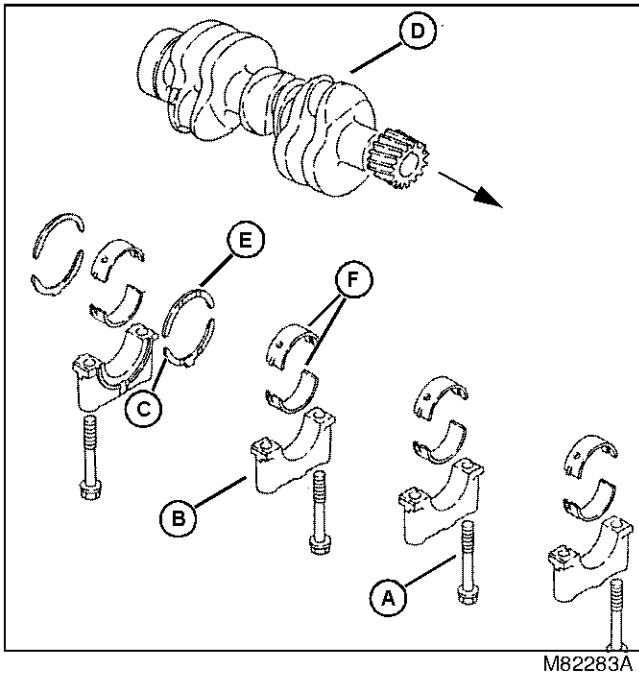
1. Check crankshaft end play. (See "Crankshaft End Play Check" on page 88.)
2. Remove oil pan, crankcase extension and pickup tube. (See "Remove and Install Oil Pan, Crankcase Extension and Pickup Tube" on page 102.)
3. Remove flywheel. (See "Remove and Install Flywheel" on page 92.)
4. Remove flywheel housing. (See "Remove and Install Flywheel Housing" on page 92.)
5. Remove timing gear cover, timing gears, and timing gear housing of engine. (See "Remove and Install Timing Gear Cover" on page 98. See "Remove and Install Timing Gear Housing" on page 101.)
6. Check crankshaft bearing clearance. (See "Inspection and Replacement" on page 89.)

Important: Avoid Damage! Connecting rod end caps must be installed on the same connecting rods from which they were removed. Note stamped numbers on caps and rods.

7. Remove connecting rod cap screws and end caps. Push pistons and connecting rods away from crankshaft.

Important: Avoid Damage! Main bearing caps must be installed on the same main bearings from which they were removed.

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Arrow points to front of engine.

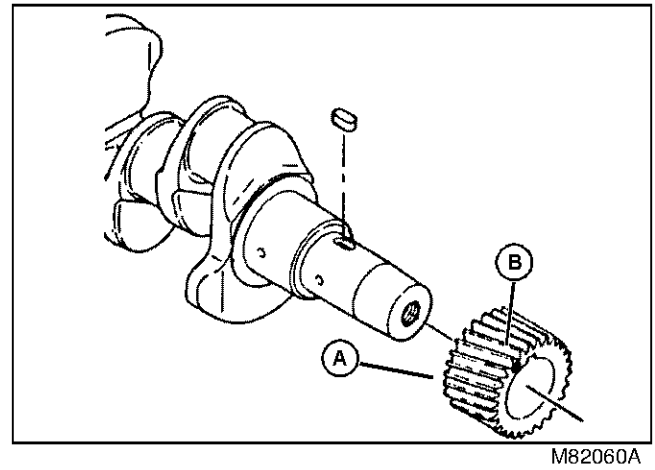
8. Remove main bearing cap screws (A), caps (B), and cap thrust bearing (C).
9. Remove crankshaft (D).
10. Remove block thrust bearing (E) and main bearing inserts (F).
11. Inspect all parts for wear or damage. (See "Inspection and Replacement" on page 89.)

Inspection and Replacement

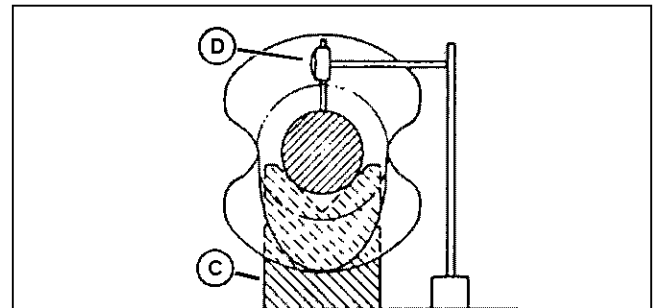
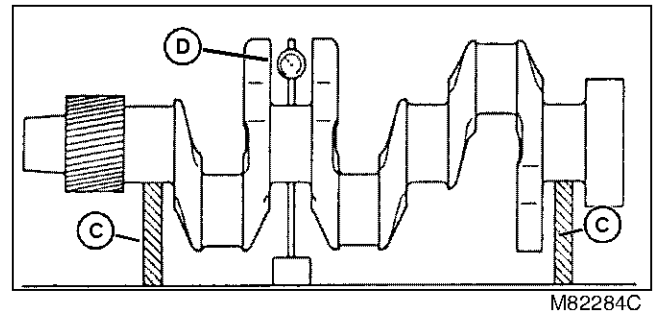
1. Inspect crankshaft gear for chipped or broken teeth. If replacement is necessary, remove gear from crankshaft using a knife-edge puller and a press.



Caution: Avoid Injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.



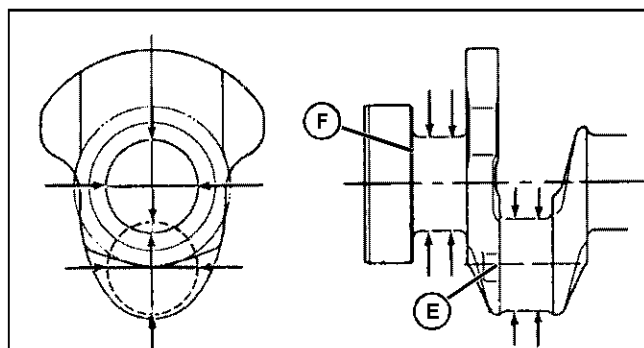
2. Heat gear to approximately 150°C (300°F). Install gear (A) with timing mark (B) toward press table.
3. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



4. Inspect crankshaft for bend using V-blocks (C) and a dial indicator (D). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.

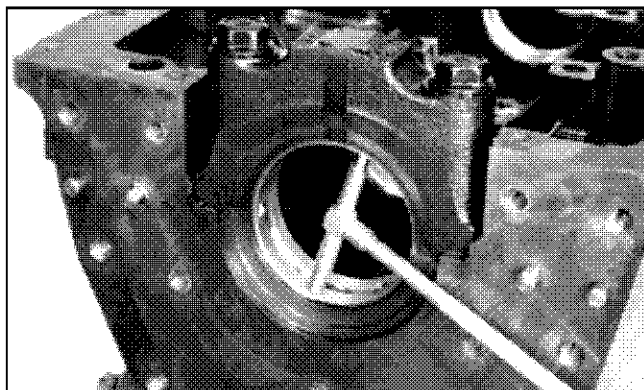
Note: If engine has had a previous major overhaul, journals may have been ground and undersize bearing inserts installed.

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M82062A

5. Measure crankshaft connecting rod journals (E) and main bearing journal (F) diameters. Measure several places around each journal.
6. If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.
7. If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.
8. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specification.



M82063

9. Measure main bearing diameter.
10. Subtract the crankshaft main bearing journal outer diameter from the main bearing inner diameter to obtain the main bearing oil clearance.
 - If crankshaft is within specification but main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
 - If crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersize bearing inserts.
 - If crankshaft is worn past the wear limit, replace the crankshaft.
11. Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.

12. Inspect crankshaft for cracks or damage. Replace if necessary.

Installation

1. Apply clean engine oil on all parts during installation.

Important: Avoid Damage! Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surfaces.

2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.
3. Install block thrust bearings with oil grooves facing away from engine block.

Note: Main bearing caps have raised arrows. The center two are stamped with numbers. The main bearing cap at the gear train end and the thrust main bearing (flywheel end) do not have a number. Both correspond to their location on the engine block. Install bearing caps beginning with number 1, then 2, then thrust main bearing, and then gear train end. Install all bearing caps with the arrow pointing toward the flywheel end.

4. Install crankshaft.
5. Install smooth bearing inserts in main bearing caps, aligning tangs with slots in caps.
6. Install cap thrust bearings with oil grooves facing away from cap.
7. Install main bearing caps in their original locations with arrows pointing toward flywheel side of engine.

Important: Avoid Damage! Do not use high speed power tools or air wrenches to tighten main bearing cap screws.

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. Do not tighten to specification at this time.
9. Using a soft-faced hammer, tap the front end of the crankshaft and then the rear end of the crankshaft to align the thrust bearings.
10. Tighten main bearing cap screws to specification. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

Important: Avoid Damage! The connecting rod caps must be installed on the same connecting rods from which they were removed. Never reuse connecting rod cap screws. Replace with new.

11. Match the connecting rod caps to the rods using

ENGINE - DIESEL REPAIR

stamped numbers. Install the caps to the rods.

12. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws to the rods and tighten to specification.

13. Install the flywheel housing. (See "Remove and Install Flywheel Housing" on page 92.)

14. Install the flywheel. (See "Remove and Install Flywheel" on page 92.)

15. Install the timing gear housing, timing gears and timing gear cover. (See "Remove and Install Timing Gear Housing" on page 101.)

16. Install the front oil seal. (See "Remove and Install Crankshaft Front Oil Seal" on page 86.)

17. Install the pickup tube, crankcase extension and oil pan. (See "Remove and Install Oil Pan, Crankcase Extension and Pickup Tube" on page 102.)

Specifications

Crankshaft Bend (Maximum) 0.02 mm (0.001 in.)

Crankshaft Connecting Rod Journal

Standard OD 41.95-41.96 mm (1.6517-1.652 in.)

Crankshaft Connecting Rod Journal

OD Wear Limit 41.90 mm (1.650 in.)

Crankshaft Main Bearing Journal

Standard OD 46.95-46.96 mm (1.848-1.849 in.)

Crankshaft Main Bearing Journal

OD Wear Limit 46.90 mm (1.847 in.)

Main Bearing Standard Oil

Clearance 0.020-0.050 mm (0.001-0.002 in.)

Main Bearing Oil Clearance

Wear Limit 0.120 mm (0.005 in.)

Connecting Rod

Cap Screw Torque 22.6-27.5 N•m (17-20 lb-ft)

Main Bearing Cap Screw Torque . . . 75.5-81.5 N•m (56-60 lb-ft)

Crankshaft Main Bearing Clearance Check

Special or Required Tools

Tool Name	Tool No.	Tool Use
PLASTIGAGE TM	N/A	Used to measure main bearing clearance.

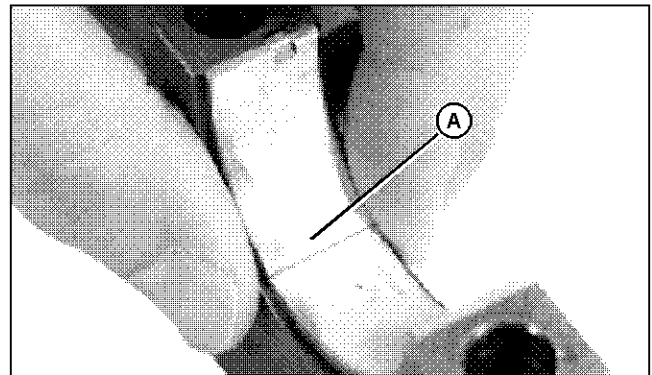
Note: The engine must be removed to perform this test.

1. Remove the oil pan, oil pickup, crankcase extension, and balancer assembly.

Important: Avoid Damage! Main bearing caps must be installed to the same location and in the same direction to prevent crankshaft and main bearing damage.

2. Remove the main bearing cap.

3. Wipe oil from the bearing insert and the crankshaft journal.



M35382

4. Put a piece of PLASTIGAGE (A), or equivalent, along the full width of the bearing insert approximately 6 mm (0.25 in.) off center.

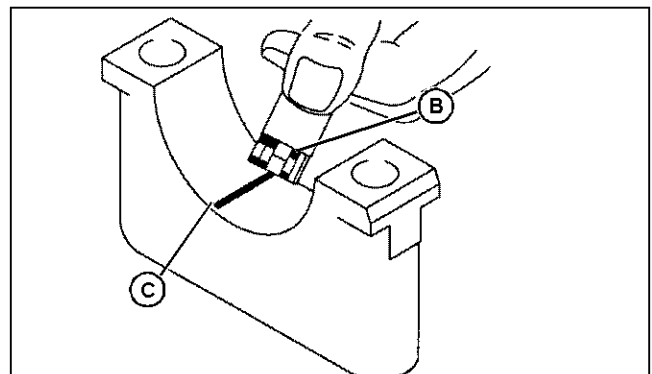
Important: Avoid Damage! Rotating the crankshaft will cause PLASTIGAGE to smear, resulting in a false reading. Do not allow crankshaft to rotate after installing bearing cap.

Note: Lightly lubricate bolts with engine oil before installing.

5. Install main bearing cap and bolts. Tighten bolts to specification.

6. Remove bolts and main bearing cap.

Note: The flattened PLASTIGAGE will be found on either the bearing insert or crankshaft journal.



M82119A

7. Use the graduation marks on the envelope (B) to compare the width of the flattened PLASTIGAGE (C) at its

widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.

8. If clearance exceeds specification, replace main bearing.

9. Remove PLASTIGAGE.

Specifications

Main Bearing Oil Clearance

Wear Limit 0.120 mm (0.005 in.)

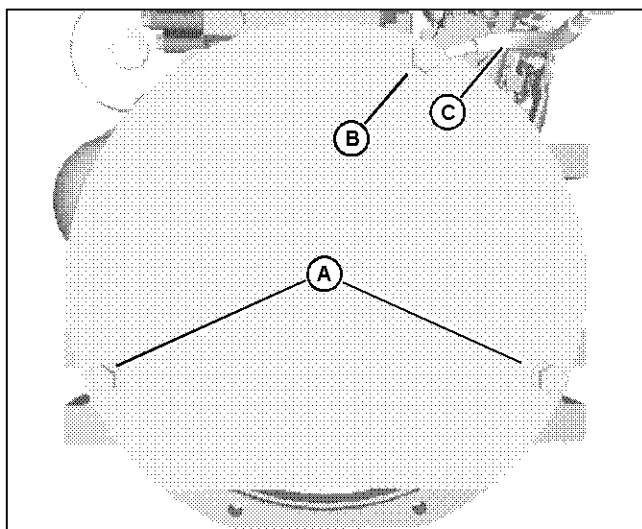
Main Bearing

Cap Screw Torque 75.5-81.5 N•m (56-60 lb-ft)

Remove and Install Flywheel

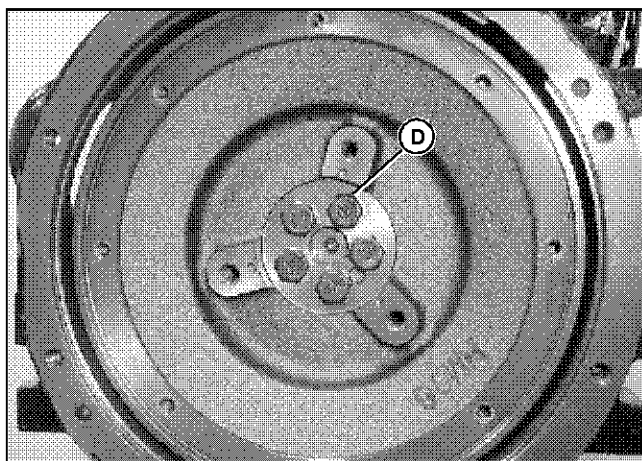
Removal

1. Remove starting motor. (See "Remove and Install Starting Motor" on page 114.)



MX24360

2. Remove two flange head cap screws (A) and flange head cap screw (B) securing negative (-) battery cable and ground strap (C).



3. Remove five flywheel mounting cap screws (D).

4. Remove flywheel.

5. Inspect flywheel for damage. Replace as needed.

Installation

Installation done in reverse order of removal.

Important: Avoid Damage! Always install new flywheel mounting cap screws.

- Apply lubrication oil to the flywheel mounting cap screws and tighten to specification.

Specifications

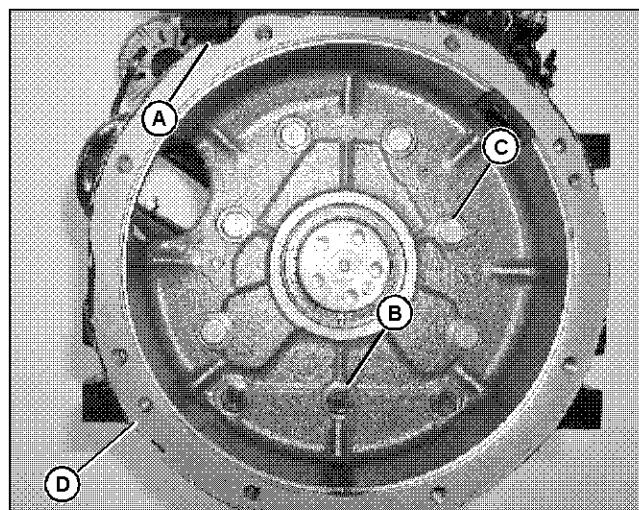
Flywheel Mounting

Cap Screw Torque 80.4-86.4 N•m (59-64 lb-ft)

Remove and Install Flywheel Housing

Removal

1. Remove flywheel. (See "Remove and Install Flywheel" on page 92.)



MX23910

2. Remove cap screw (A).

3. Remove three cap screws (B).

4. Remove six cap screws (C).

5. Remove flywheel housing (D).

Installation

Installation is done in reverse order of removal.

ENGINE - DIESEL REPAIR

Remove, Inspect and Install Camshaft

Important: Avoid Damage! Always replace camshaft followers when installing a new camshaft. Always replace camshaft when replacing camshaft followers. The components wear as a set and replacing only one will accelerate the wear of the other.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Knife-Edge Puller	N/A	Used with arbor press for removing gear from camshaft.
Arbor Press	N/A	Used with knife-edge puller for removing gear from camshaft.
V-Block (2 used)	N/A	Used to hold camshaft during inspection.
Dial Indicator	N/A	Used to measure camshaft bend.
Micrometer	N/A	Used to measure camshaft lobe height.
Bushing Driver Set	N/A	Used to replace worn camshaft bushing.

Other Material

Part No.	Part Name	Part Use
PM38655 (U.S.)/ PM38628 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to camshaft bore plug before reinstallation.

Camshaft Removal

1. Remove engine. (See "Remove Engine" on page 62.)
2. Remove rocker arm assembly and push rods. (See "Remove and Install Rocker Arm Assembly" on page 66.)
3. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)
4. Check camshaft end play. (See "Camshaft End Play Check" on page 95.)
5. Check backlash of timing gears. (See "Timing Gear Backlash Check" on page 96.)

Note: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn

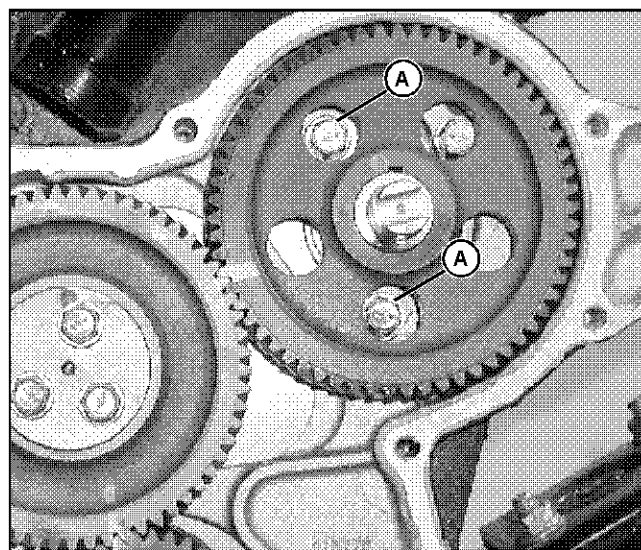
engine until oil pan is upward, to hold cam followers away from camshaft.

6. Hold cam followers away from camshaft using a D15001NU Magnetic Follower Holder Kit, or equivalent.

Note: Due to the odd number of teeth on the idler gear, timing marks will align only periodically.

7. Rotate the crankshaft and align all timing marks.

Important: Avoid Damage! Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

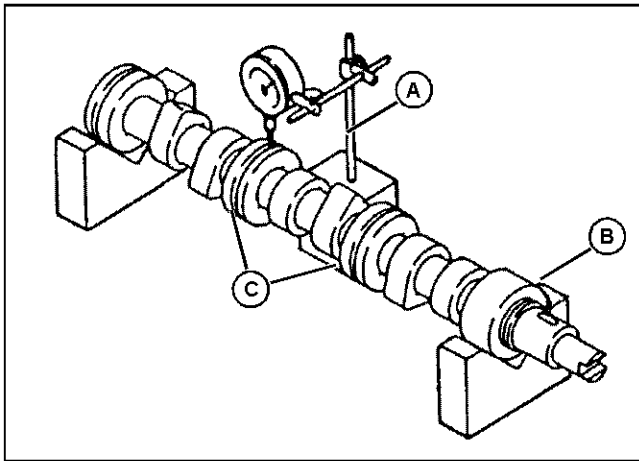


MX23959

8. Remove two thrust plate mounting cap screws (A) and remove the camshaft with the thrust plate.
9. Inspect all parts for wear or damage. (See "Camshaft Inspection" on page 93.)

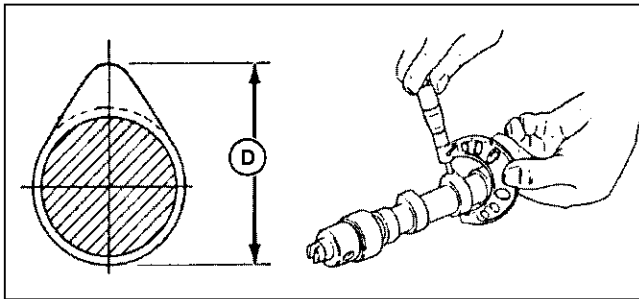
Camshaft Inspection

Important: Avoid Damage! Camshaft gear shown removed for clarity purposes. Camshaft gear is a shrink fit. Do not remove gear unless camshaft or gear are out of specification or damaged.



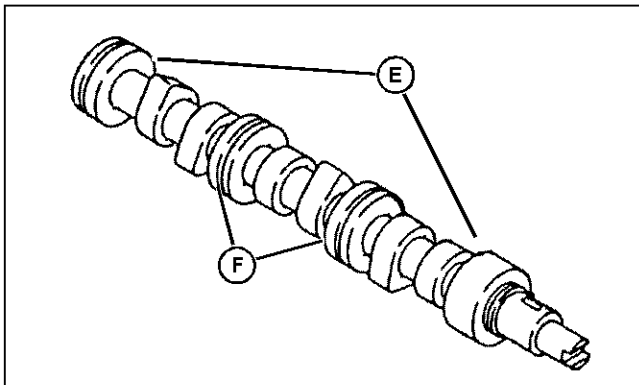
M82291A

1. Inspect camshaft for bend by using a pair of V-blocks (B) and a dial indicator (A). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.



M82070A

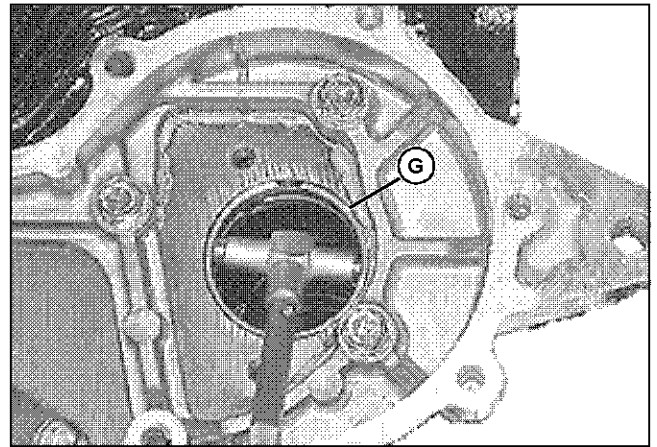
2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.



M82292A

3. Measure camshaft end journal (E) and intermediate journal (F) outside diameters. If journal diameters are less than wear limit, replace camshaft.

Important: Avoid Damage! Camshaft bearing journals must be measured and found to be within specifications before camshaft bushings can be determined serviceable or unserviceable.



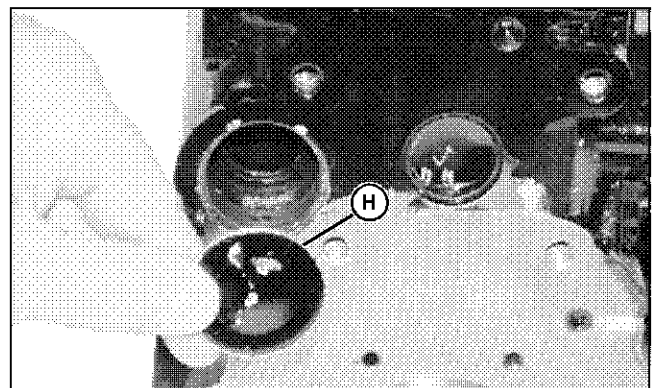
MX23953

4. Measure camshaft bushing (G) diameter at gear housing end. If bushing diameter exceeds wear limit, replace bushing using a driver set.

5. Subtract camshaft journal outside diameter from gear housing end bushing inside diameter to determine clearance. If clearance exceeds specifications, replace bushings.

6. Measure intermediate and flywheel end camshaft bearing diameter using the following steps.

7. Remove flywheel housing. (See "Remove and Install Flywheel Housing" on page 92.)



M98853

8. Remove rear plug (H) using a long wooden dowel. Insert wooden dowel through gear housing side.

9. Measure flywheel end and intermediate bearing inside diameters with telescoping gauge and micrometer.

10. Subtract camshaft journal outside diameter from intermediate clearance. If clearance exceeds specification, replace engine block.

11. Subtract camshaft journal outside diameter from

ENGINE - DIESEL REPAIR

flywheel end bushing inside diameter to determine clearance. If clearance exceeds specification, replace engine block.

12. Apply PM38655 John Deere High-Flex Form-in-Place Gasket, or equivalent, on outer edge of plug. Install plug until it bottoms in bore.

13. Install flywheel housing. (See "Remove and Install Flywheel Housing" on page 92.)

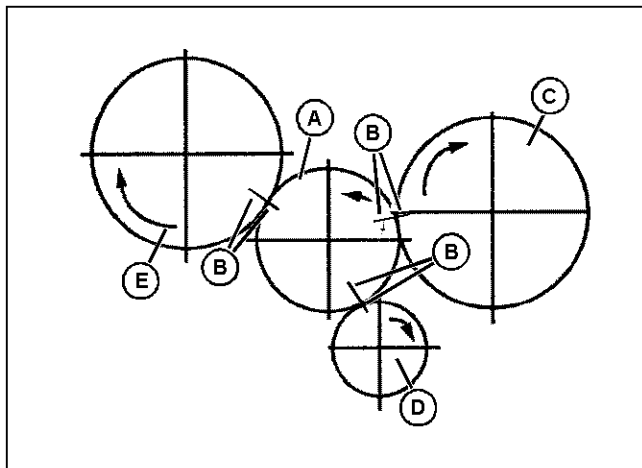
14. Install flywheel. (See "Remove and Install Flywheel" on page 92.)

Camshaft Installation

Important: Avoid Damage! Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

Note: Apply clean engine oil on all parts during installation.

The fuel injection drive gear, camshaft gear, and crankshaft gear all must be correctly timed to the idler gear. All three timing marks must line up at the same time. Due to the difference in gear sizes, it may take several revolutions to align timing marks.



MX23952

Arrows indicate direction of rotation (viewed from gear case).

- A- Idler Gear
- B- Timing Marks
- C- Camshaft Gear
- D- Crankshaft Gear
- E- Fuel Injection Drive Gear

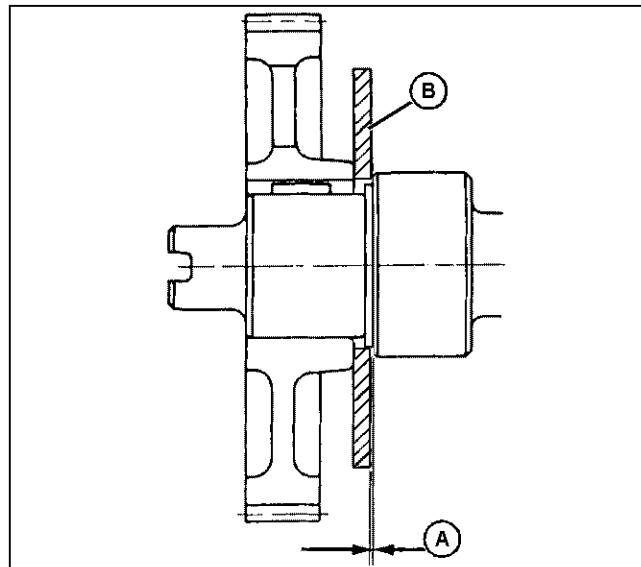
1. Rotate the crankshaft to align the timing marks.
2. Install the camshaft with thrust plate using two cap screws. Tighten cap screws.
3. Install timing gear cover. (See "Remove and Install

Timing Gear Cover" on page 98.)

4. If cam followers were removed, replace into same holes as removed.

5. Install push rods and rocker arm assembly. (See "Remove and Install Rocker Arm Assembly" on page 66.)

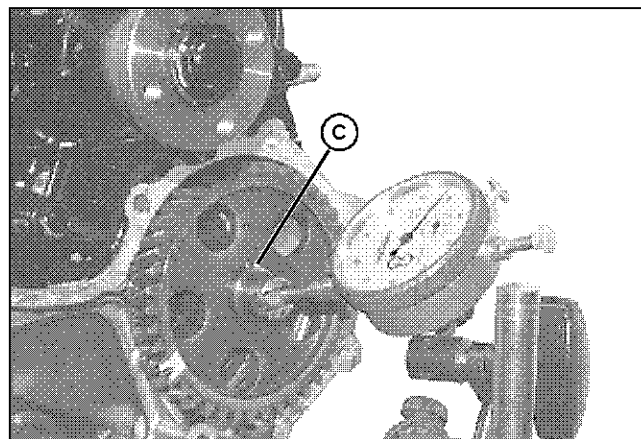
Camshaft End Play Check



M82067A

Note: Follow this procedure if camshaft is installed in cylinder block. If camshaft is removed from cylinder block, check end play (A) using a feeler gauge between camshaft thrust plate (B) and front side of first camshaft bearing journal.

1. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)
2. Remove idler gear. (See "Remove and Install Idler Gear" on page 99.)



M98825

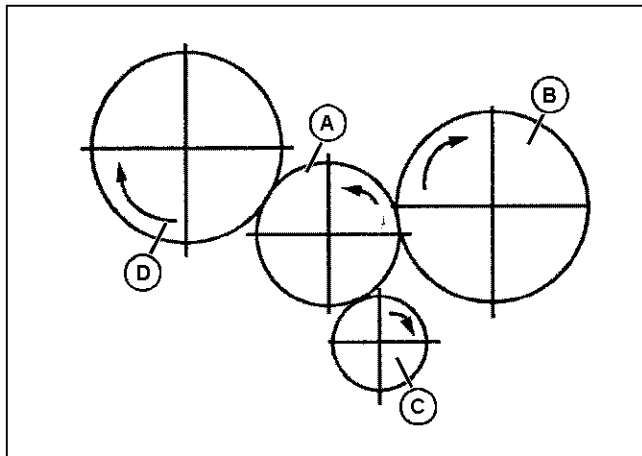
3. Fasten dial indicator base to cylinder block and position indicator tip on end of camshaft (C).

ENGINE - DIESEL REPAIR

4. Push camshaft toward the rear as far as possible.
5. Set the dial indicator to zero.
6. Pull camshaft forward as far as possible.
7. If camshaft end play exceeds specification, remove camshaft and inspect thrust plate, camshaft, and camshaft gear for wear. Replace parts as needed.

Timing Gear Backlash Check

1. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)



MX23952

Arrows indicate direction of rotation (viewed from gear case).

- A- Idler Gear
- B- Camshaft Gear
- C- Crankshaft Gear
- D- Fuel Injection Drive Gear

2. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.
3. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.
4. If backlash exceeds specifications, replace worn gears as a complete set: idler gear, camshaft gear, crankshaft gear, and fuel injection drive gear.

Camshaft Gear Removal

Important: Avoid Damage! Camshaft gear is a shrink fit. Do not remove gear unless camshaft or gear are out of specification or damaged.



Caution: Avoid Injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

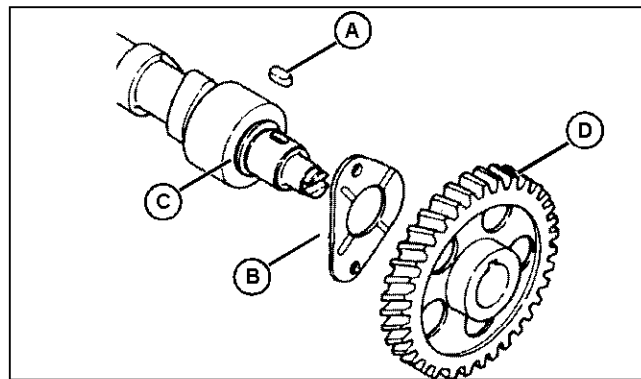
1. Heat gear to approximately 150°C (300°F).
2. Remove gear from camshaft using a knife-edge puller and an arbor press. Place flat side of puller against camshaft gear.
3. Inspect gear for chipped or broken teeth. Replace if necessary.

Camshaft Gear Installation



Caution: Avoid Injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).



M82068A

2. Install key (A) into slot of camshaft.
3. Install thrust plate (B) onto camshaft, centering onto stepped shoulder (C).

Important: Avoid Damage! Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.

4. Install heated camshaft gear (D) with longer hub of camshaft gear facing camshaft. Align slot in gear with key in shaft. Press gear onto camshaft until hub of gear is tight against camshaft shoulder. Thrust plate must spin freely on camshaft.

ENGINE - DIESEL REPAIR

Specifications

Camshaft Bend Wear Limit	0.05 mm (0.002 in.)
Camshaft Lobe Height	
Wear Limit	33.89 mm (1.334 in.)
Gear Housing and Flywheel End Journal	
OD Wear Limit	39.905 mm (1.571 in.)
Intermediate Journal	
OD Wear Limit	39.875 mm (1.570 in.)
Bearing-to-Camshaft Gear Housing End Journal	
Clearance (Wear Limit)	0.245 mm (0.010 in.)
Bearing-to-Camshaft Intermediate Journals	
Clearance (Wear Limit)	0.225 mm (0.009 in.)
Bearing-to-Camshaft Flywheel End Journal	
Journal Clearance (Wear Limit)	0.195 mm (0.008 in.)
Camshaft End Play	0.05-0.15 mm (0.002-0.006 in.)
Camshaft End Play (Wear Limit)	0.25 mm (0.010 in.)
Timing Gear Backlash Clearance	
(Wear Limit)	0.14 mm (0.0055 in.)
Camshaft Thrust Plate	
Cap Screw Torque	11 N•m (96 lb-in.)

Remove, Inspect, and Install Camshaft Follower

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Pickup Tool	N/A	Used to remove cam followers from cylinder block.

Removal

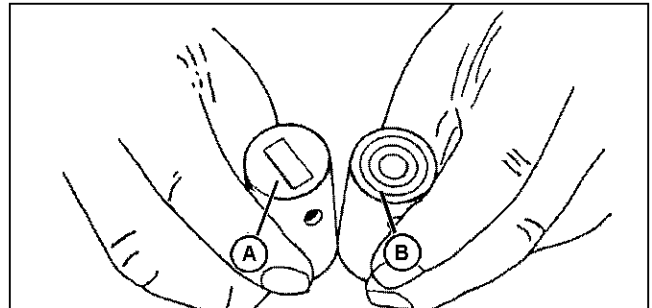
1. Remove cylinder head. (See "Remove and Install Cylinder Head" on page 69.)

Important: Avoid Damage! Cam followers must be installed in the same bores from which they were removed. Put a mark on each cam follower and cylinder block bore to aid in installation.

Always replace camshaft when replacing cam followers. Always replace cam followers when installing new camshaft. The components wear as a set and replacing only one will accelerate the wear of the other.

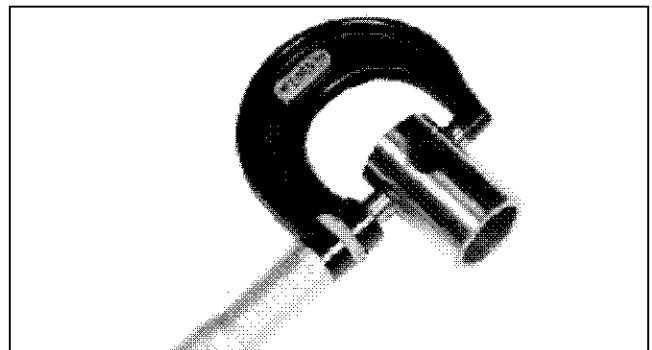
2. Remove cam followers from cylinder block with magnetic pickup tool.
3. Inspect all parts for wear or damage.

Inspection



M82293A

1. Inspect cam follower contact surface for abnormal wear (A). Normal wear (B) has light circular lines and flat surface.



M35268

2. Measure cam follower diameter. If outside diameter is less than wear limit, replace cam follower.
3. Use a straightedge and place it on the contact surface perpendicular to the wear mark across cam follower. Replace if surface appears to "valley" on wear mark.
4. Measure cam follower bore diameter in cylinder block. If cam follower bore diameter exceeds wear limit, replace cylinder block.
5. If tappet-to-bore oil clearance (bore ID minus follower OD) exceeds specification, replace cam follower, cylinder block, or both.

Installation

Installation is done in the reverse order of removal.

- Apply clean engine oil on all parts during installation.
- Install cam followers after camshaft is installed. Install followers with the flat contact surface toward the camshaft.

Specifications

Cam Follower OD Wear Limit	20.91 mm (0.823 in.)
Cam Follower Bore ID Wear Limit	21.04 mm (0.828 in.)
Tappet-to-Bore Oil Clearance	
Wear Limit	0.13 mm (0.005 in.)

ENGINE - DIESEL REPAIR

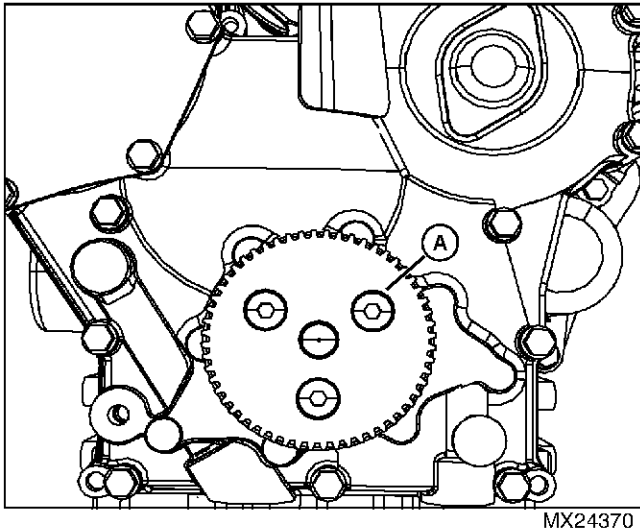
Remove and Install Timing Gear Cover

Other Material

Part No.	Part Name	Part Use
PM38655 (U.S.)/ PM38628 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to timing cover before installation.

Removal

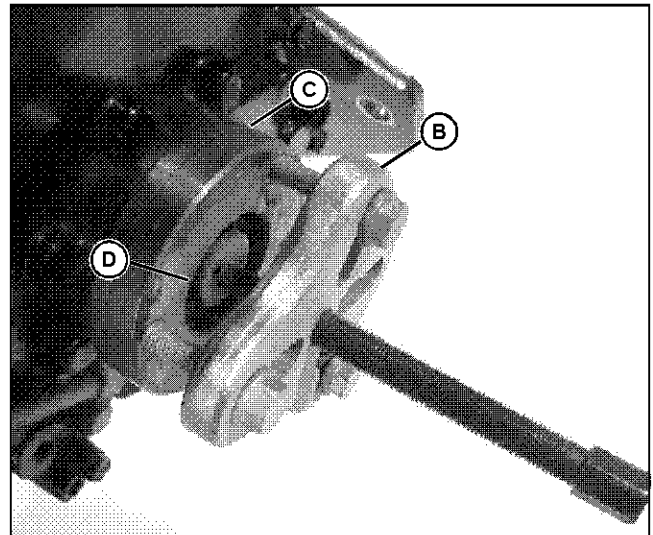
1. Remove engine. (See "Remove Engine" on page 62.)
2. Remove alternator. (See "Remove and Install 12V Alternator" on page 114.)



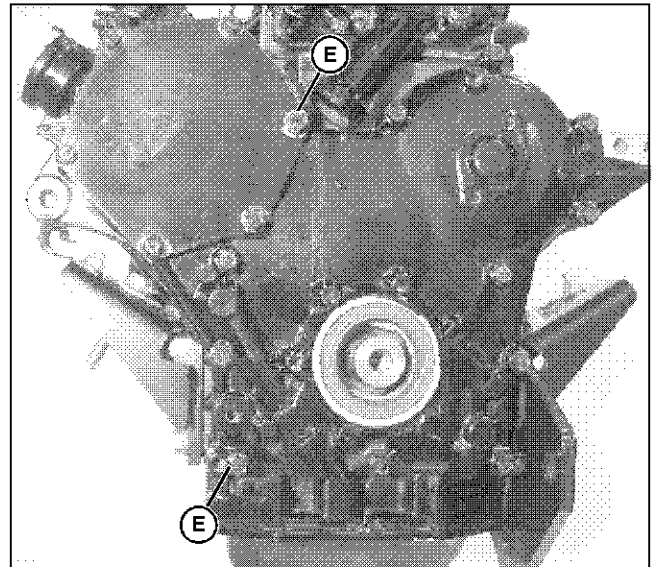
3. Remove three crankshaft sheave socket head cap screws (A) and remove sheave from crank hub.



Caution: Avoid Injury! Crank hub may suddenly release when removing. Injury can occur when crank hub releases. Keep the surrounding area of the crank hub clear of personnel.



4. Remove crank hub cap screw, washer and O-ring.
5. Install puller (B) to crank hub (C) using a thread protector (D) for the crankshaft end.
6. Remove crank hub.



7. Remove sixteen timing gear cover mounting cap screws (E).

Important: Avoid Damage! Use extreme care in removal of cover. Cover is aluminum and easily damaged, broken or bent by prying. DO NOT hammer on cover at any time.

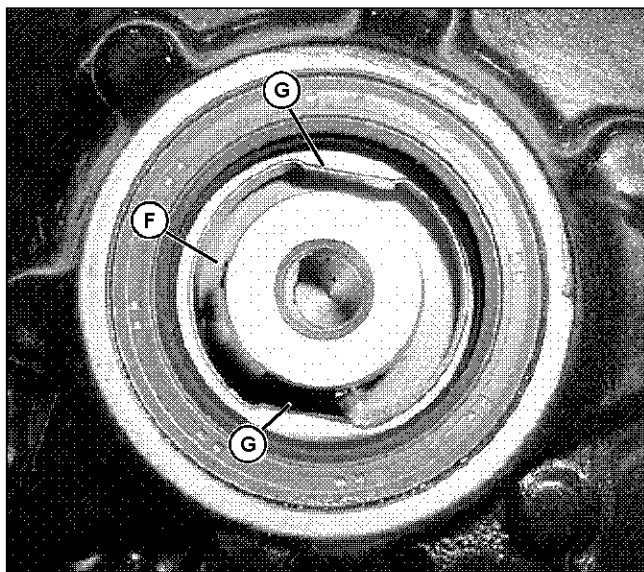
8. Remove timing gear cover.
9. Clean all old gasket material from timing gear cover and timing gear cover housing on block. Discard O-rings between cover and timing gear housing.

ENGINE - DIESEL REPAIR

Installation

Installation is done in the reverse order of removal.

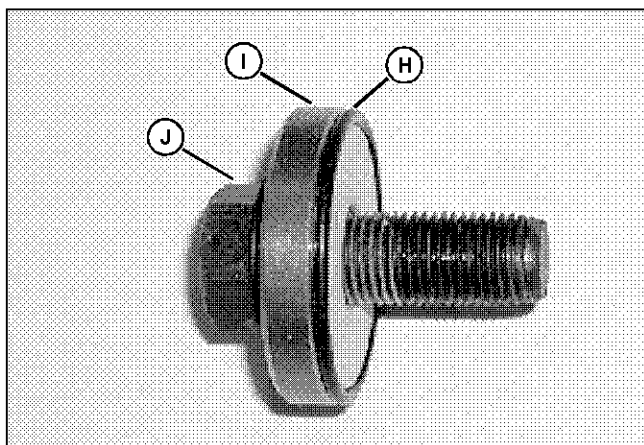
- Install new O-rings between cover and timing gear housing.
- Apply a thin bead of PM38655 John Deere High-Flex Form-in-Place Gasket to timing gear cover prior to installation.
- Tighten all timing gear cover mounting cap screws.
- Coat lip of crankshaft seal with clean engine oil.



MX23944

- Align keyway and flats on crank hub with key in crankshaft (F) and flats (G) of oil pump gear and install crank hub.

Note: Applying a small amount of petroleum jelly to the O-ring will hold it in position for assembly.

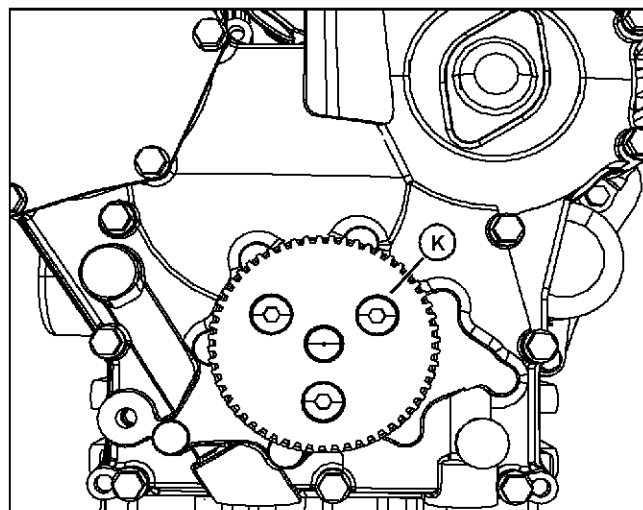


MX23937

- Install a new O-ring (H) to the shoulder of the crank hub washer (I).
- Assemble crank hub washer to cap screw (J) with O-ring

facing away from cap screw head.

- Install assembled cap screw, washer and O-ring to crank hub.
- Tighten crank hub cap screw to specification.



MX24370

- Install sheave to crank hub using three socket head cap screws (K).
- Adjust belt tension. (See "Check and Adjust Alternator Drive Belt Tension" on page 42.)

Specifications

Crank Hub

Cap Screw Torque 113-123 N•m (83-90 lb-ft)

Timing Gear Cover

Mounting Cap Screw Torque. 9 N•m (78 lb-in.)

Remove and Install Idler Gear

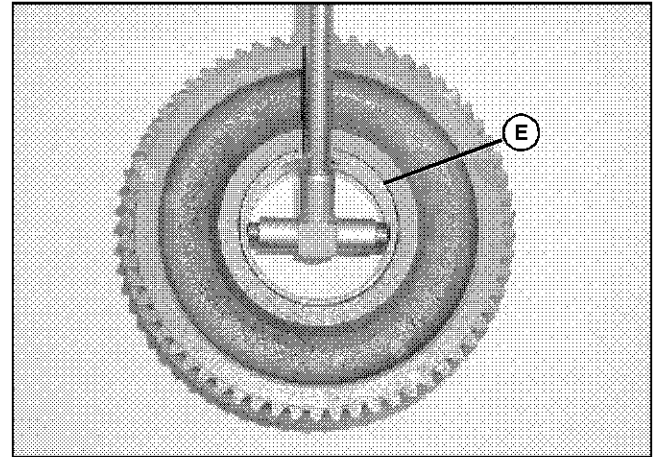
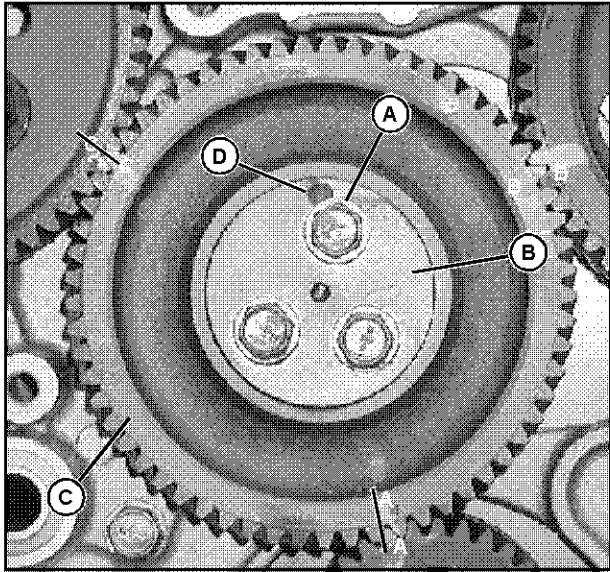
Special or Required Tools

Tool Name	Tool No.	Tool Use
Bushing Driver Set	N/A	Used to replace worn idler gear bushing.

Removal

1. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)
2. Check backlash of timing gears. (See "Timing Gear Backlash Check" on page 96.)

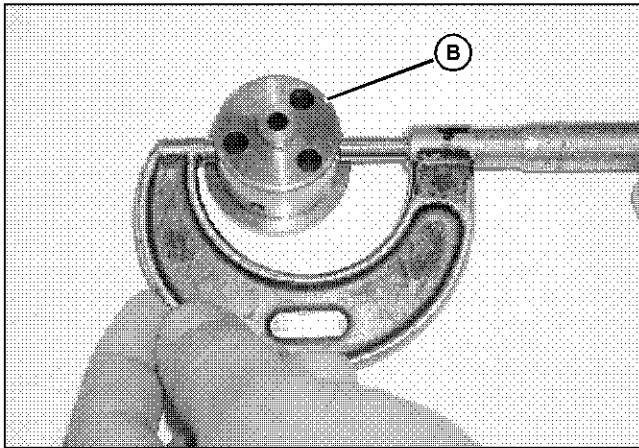
Note: All three timing marks must line up at the same time. Due to the difference in gear sizes, it may take several revolutions to align timing marks.



3. Rotate crankshaft and align timing marks.
4. Remove three cap screws (A), idler gear shaft (B), and idler gear (C). Note position of dimple (D).
5. Inspect all parts for wear or damage.

Inspection and Replacement

1. Inspect gear for chipped or broken teeth. Replace if necessary.



2. Measure idler gear shaft (B) diameter. If shaft diameter is less than wear limit, replace idler gear shaft.

3. Measure idler gear bushing (E) diameter using a telescoping gauge and a micrometer. If bushing diameter exceeds wear limit, replace bushing using a driver set.

- a. Align oil holes in bushing and idler gear.
- b. Install bushing flush with surface of idler gear.

4. If bushing oil clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft, or both.

Installation

Installation is done in the reverse order of removal.

- Install idler gear shaft with dimple (D) at top.
- Ensure that all timing marks align.
- Tighten idler gear shaft cap screws.

Specifications

Idler Gear Shaft

Standard OD 36.95-36.975 mm (1.455-1.456 in.)

Idler Gear Shaft OD

Wear Limit..... 36.90 mm (1.453 in.)

Idler Gear Bushing

Standard ID 37.00-37.025 mm (1.457-1.458 in.)

Idler Gear Bushing ID

Wear Limit..... 37.07 mm (1.4596 in.)

Oil Clearance 0.025-0.075 mm (0.001-0.003 in.)

Oil Clearance Wear Limit..... 0.175 mm (0.007 in.)

ENGINE - DIESEL REPAIR

Remove and Install Timing Gear Housing

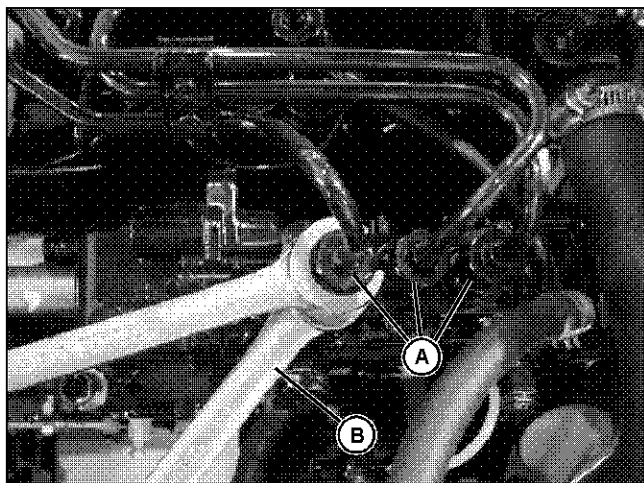
Other Material

Part No.	Part Name	Part Use
PM38655 (U.S.)/ PM38628 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to timing gear housing before installation.

Removal

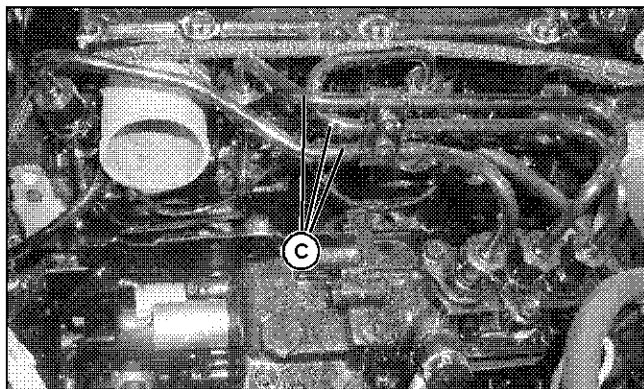
1. Remove engine. (See "Remove Engine" on page 62.)
2. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)

Note: Timing gear housing can be removed with fuel injection pump attached. Do not remove fuel injection pump from timing gear housing unless pump needs repair. If repair of fuel injection pump is required, see "Remove and Install Fuel Injection Pump" on page 107.



MX23676

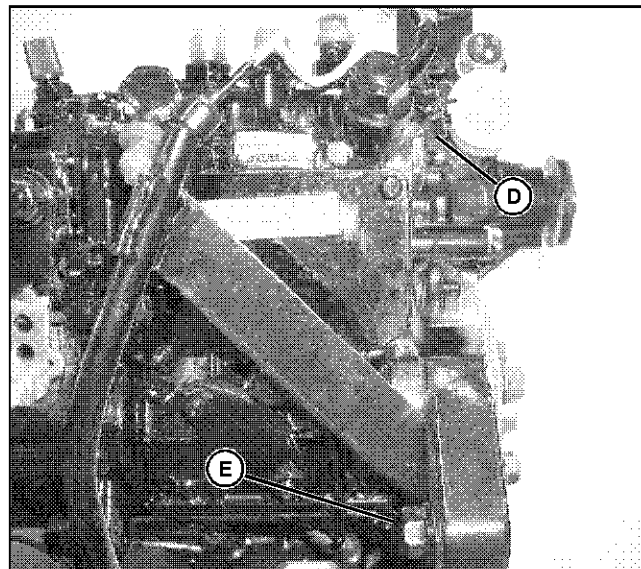
3. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.



MX23677

4. Remove fuel line nuts at injector nozzles and injection

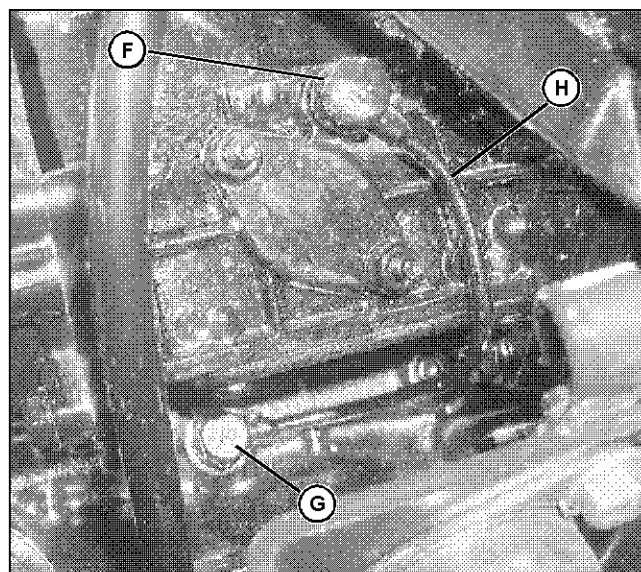
pump. When loosening line nuts, use a backup wrench to prevent fuel return line nuts from turning. Remove injector lines (C).



MX23960

5. Disconnect fuel injector return hose (D).
6. Remove dipstick support cap screw (E).

Note: Oil supply line has a bronze washer on each side. Do not lose washer when removing fittings.

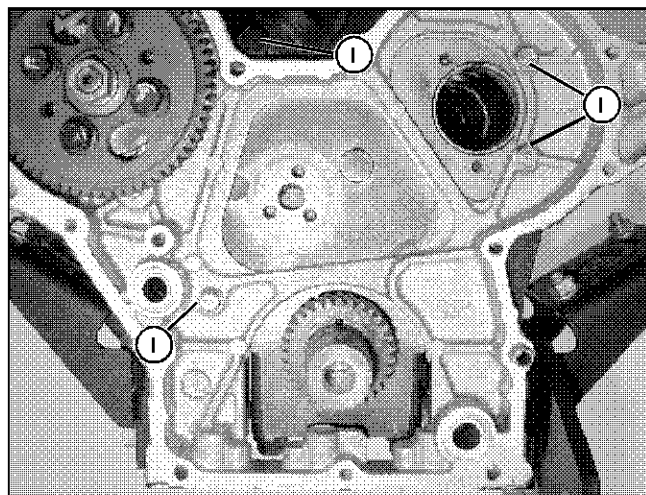


MX23961

7. Remove oil fitting (F) from injection pump.
8. Remove oil fitting (G) from side of engine.
9. Remove oil supply line (H).
10. Remove camshaft. (See "Remove, Inspect and Install Camshaft" on page 93.)
11. Remove idler gear. (See "Remove and Install Idler Gear" on page 99.)

ENGINE - DIESEL REPAIR

12.Remove oil pan and crankcase extension. (See "Remove and Install Oil Pan, Crankcase Extension and Pickup Tube" on page 102.)



MX23962

13.Remove timing gear housing mounting cap screws (I) and remove housing from cylinder block. Discard O-rings between housing and engine block.

14.If replacing timing housing, remove fuel injection pump. (See "Remove and Install Fuel Injection Pump" on page 107.)

15.Clean all old gasket material from timing gear cover housing and engine block. Discard O-rings between housing and engine block.

Installation

Installation is done in the reverse order of removal.

- Install alignment dowels in timing gear housing.
- Replace O-rings between housing and engine block.
- Apply PM38655 John Deere High-Flex Form-in-Place Gasket to timing gear housing when installing to cylinder block.
- Tighten mounting cap screws.

Specifications

Timing Gear Housing

Mounting Cap Screw Torque 11 N•m (96 lb-in.)

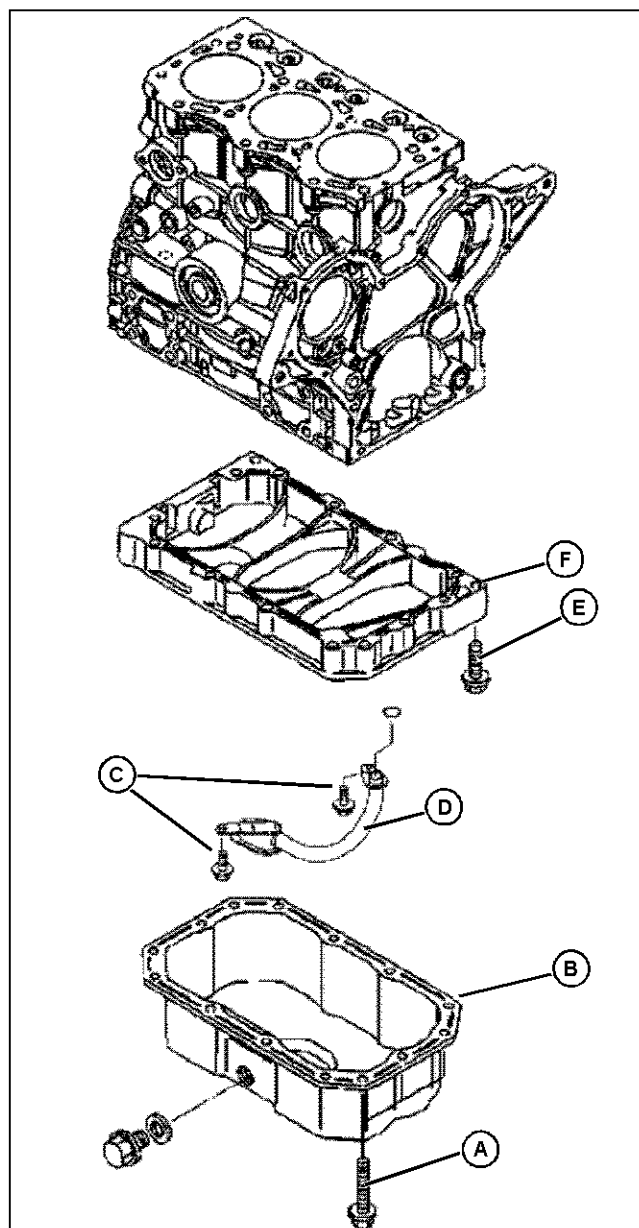
Remove and Install Oil Pan, Crankcase Extension and Pickup Tube

Other Material

Part No.	Part Name	Part Use
PM38655 (U.S.)/ PM38628 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to timing gear housing before installation.

Removal

1. Drain engine oil into a suitable container.



MX23627

2. Remove oil pan cap screws (A).

ENGINE - DIESEL REPAIR

Important: Avoid Damage! DO NOT use a screwdriver to pry oil pan from crankcase extension. Oil pan or crankcase extension may be damaged.

3. Carefully tap on oil pan (B) with a soft-faced mallet to loosen oil pan from engine block.
4. Remove cap screws (C) from pickup tube.
5. Remove oil pickup tube (D) and discard O-ring. Replace O-ring before installation.
6. Remove crankcase extension cap screws (E).

Important: Avoid Damage! DO NOT use a screwdriver to pry crankcase extension from engine block. Crankcase extension or engine block may be damaged.

7. Carefully tap on crankcase extension (F) with a soft-faced mallet to loosen crankcase extension from engine block.
8. Remove sealant and oil residue from oil pan, crankcase extension, and engine block mating surfaces.

Installation

Installation is done in reverse order of removal.

- Apply PM38655 John Deere High-Flex Form-in-Place Gasket to sealing surfaces.
- Replace pickup tube O-ring before installation.
- Securely tighten cap screws.
- Fill engine to proper level with oil of correct specifications. (See "4-Cycle Diesel Engine Oil - North America" on page 16.)

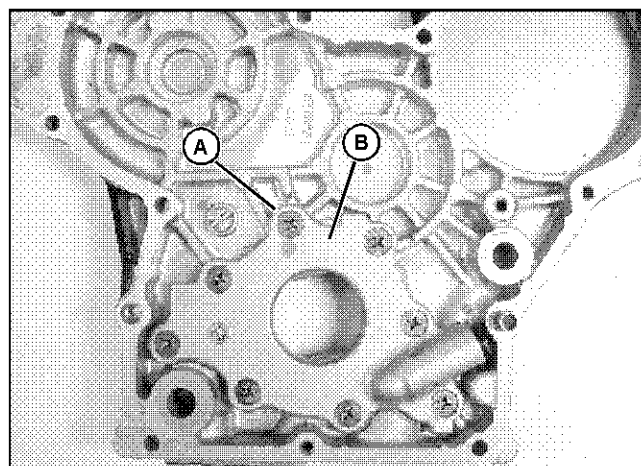
Remove, Inspect and Install Oil Pump

Other Material

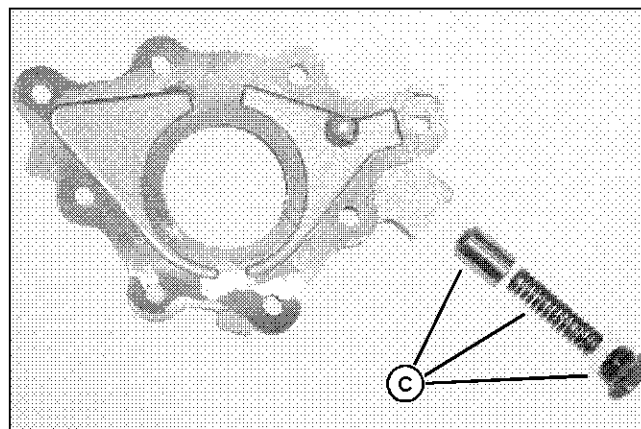
Part No.	Part Name	Part Use
PM37477 (U.S.)/ PM38621 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of oil pressure regulator cap and oil pump cover screws before installation.

Disassembly

1. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)

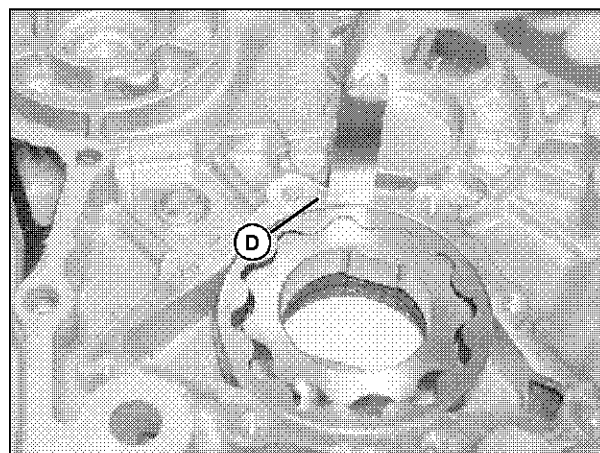


2. Remove eight mounting screws (A).
3. Remove oil pump cover (B).



4. Remove oil pressure regulator (C) from pump cover.
5. Inspect all pump parts for wear or damage. (See "Inspection" on page 103.)

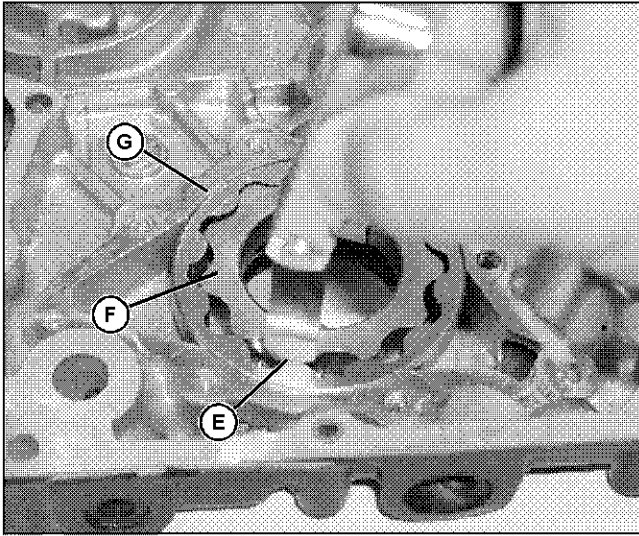
Inspection



1. Measure outer rotor-to-housing clearance (D) using a

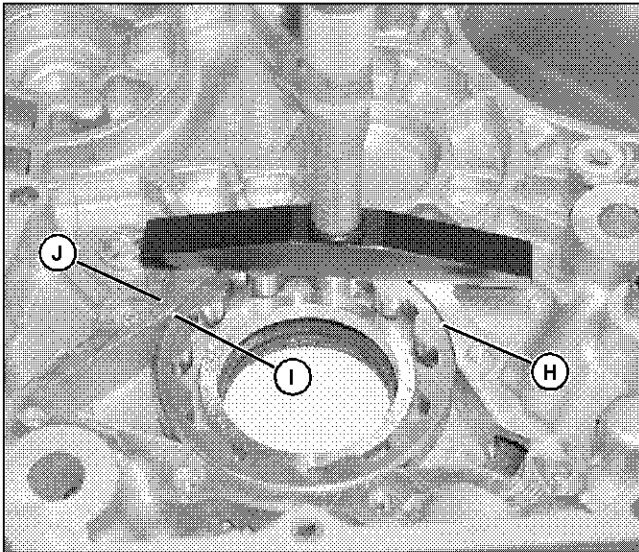
ENGINE - DIESEL REPAIR

feeler gauge. If the clearance is more than maximum limit, replace entire assembly.



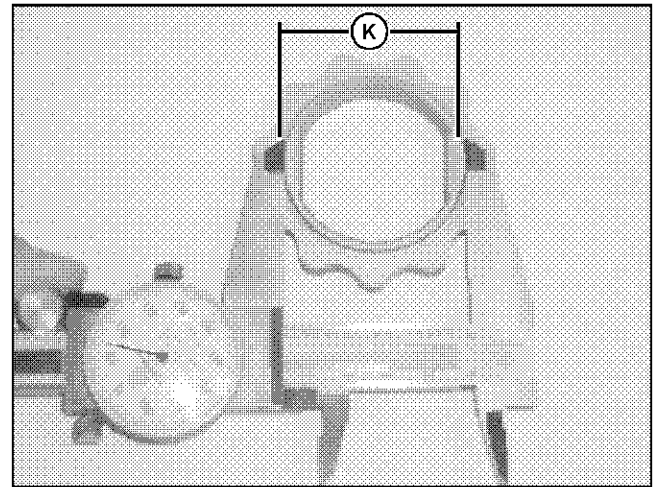
MX23966

2. Check clearance (E) between the tip of the inner rotor (F) and tip of the outer rotor (G). If the clearance is more than the wear limit, replace entire assembly.



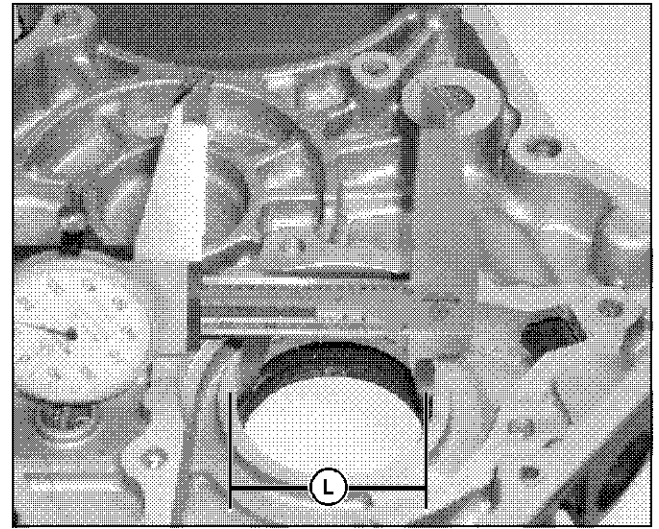
MX23967

3. Using a depth gauge, check side clearance (H) of outer rotor between top of rotor (I) and mounting surface of oil pump cover (J). If rotor side clearance is beyond wear limit, replace entire assembly.



MX23991

4. Measure and record inner rotor shoulder diameter (K). If shoulder diameter is less than specification, replace entire assembly.



MX23992

5. Measure and record inner rotor pilot hole diameter (L). If pilot hole diameter is more than specification, replace entire assembly.

6. If inner rotor-to-pilot hole oil clearance (pilot hole ID minus rotor shoulder OD) exceeds wear limit, replace entire assembly.

7. Inspect oil pump cavity for excessive wear or damage. Replace entire assembly if cavity is damaged.

Assembly

1. Coat all parts with clean engine oil.
2. Install outer rotor into housing assembly.
3. Install inner rotor into housing with shoulder seated into pilot hole of housing. Ensure that top surface of inner rotor is flush with top surface of outer rotor.

4. Apply medium strength thread lock to oil pressure regulator cap and install oil pressure regulator to pump cover.

5. Apply medium strength thread lock to oil pump cover screws and install oil pump cover. Tighten screws to specification.

6. Install timing gear cover. (See "Remove and Install Timing Gear Cover" on page 98.)

Specifications

Outer Rotor-to-Housing

Clearance Wear Limit 0.30 mm (0.012 in.)

Inner Rotor Tip-to-Outer Rotor Tip

Clearance (Maximum) 0.16 mm (0.006 in.)

Rotor-to-Pump Housing

Side Clearance Wear Limit 0.12 mm (0.005 in.)

Inner Rotor Shoulder

Diameter 45.98-46.00 mm (1.810-1.811 in.)

Inner Rotor Pilot Hole

Diameter 46.13-46.18 mm (1.816-1.818 in.)

Inner Rotor-to-Pilot Hole

Oil Clearance Wear Limit 0.25 mm (0.010 in.)

Remove and Install Coolant Pump (Thermostat Included)

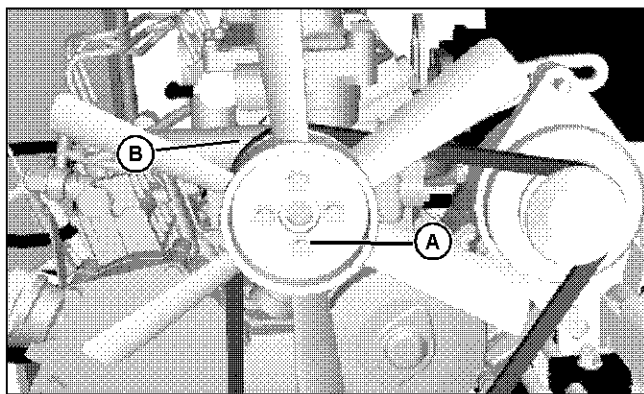
Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)

2. Allow engine to cool and pressure in cooling system to drop before working on coolant pump.

3. Remove radiator. (See "Remove, Inspect and Install Radiator" on page 57.)

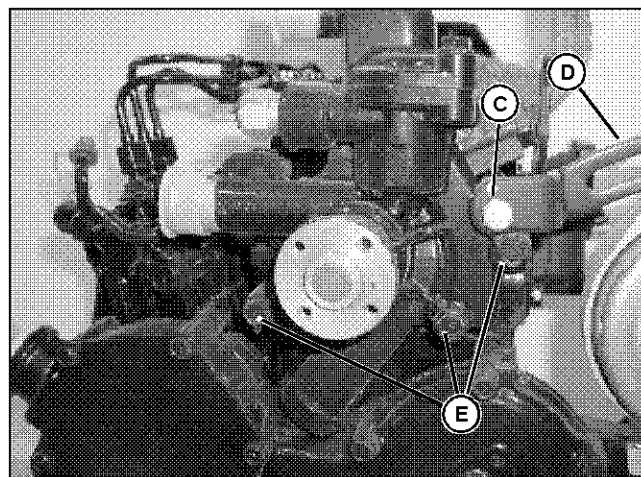
4. Loosen coolant pump/alternator drive belt. (See "Check and Adjust Alternator Drive Belt Tension" on page 42.)



5. Remove four fan mounting cap screws (A).

6. Remove fan and upper sheave (B).

Note: *It is not necessary to remove engine to remove coolant pump. Engine shown removed for picture clarity.*



7. Remove cap screw (C) and move alternator bracket (D) aside.

8. Remove coolant pump cap screws (E).

9. Remove coolant pump.

10. If the coolant pump is to be replaced, remove the coolant temperature switch and thermostat. (See "Remove and Install Coolant Temperature Switch" on page 60. See "Remove and Install Thermostat" on page 59.)

Installation

Installation is done in the reverse order of removal.

Note: *Replace O-ring on coolant pump before installing. Used O-rings will leak.*

- Remove gasket residue from mating surfaces of coolant pump and timing gear cover. Use a new gasket and O-ring for installation.

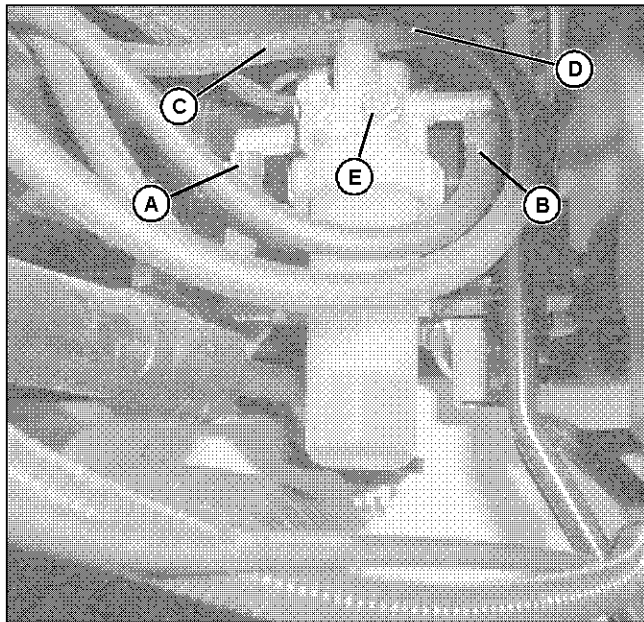
- Adjust coolant pump/alternator drive belt tension. (See "Check and Adjust Alternator Drive Belt Tension" on page 42.)

ENGINE - DIESEL REPAIR

Remove and Install Fuel Filter and Water Separator Assembly

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)



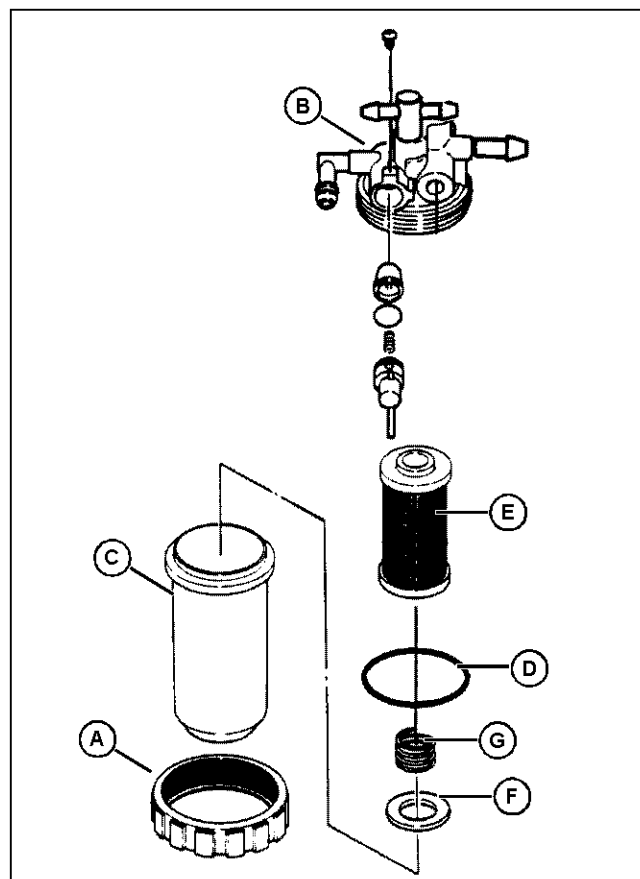
MX23397

2. Disconnect and plug fuel pump-to-fuel filter hose (A).
3. Disconnect and plug fuel filter-to-injection pump hose (B).
4. Disconnect and plug return-to-tank hose (C).
5. Disconnect and plug leak-off hose (D).
6. Remove mounting cap screw (E).
7. Remove fuel filter and water separator assembly.

Installation

Installation is done in the reverse order of removal.

Disassemble and Assemble Fuel Filter and Water Separator



M76799

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the filter cover (C).
2. Remove the filter cover from the mounting base.
3. Remove and replace O-ring (D) and filter element (E).
4. Be sure the ring (F) and spring (G) are in the filter cover.

Important: Avoid Damage! Tighten retaining nut only enough to keep the filter assembly from leaking. Overtightening the nut may damage the filter cover or retaining ring.

5. Place the filter element on mounting base.
6. Install the filter cover and retaining ring.

ENGINE - DIESEL REPAIR

Remove and Install Fuel Injection Pump

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Removal



Caution: Avoid Injury! Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- Search 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.

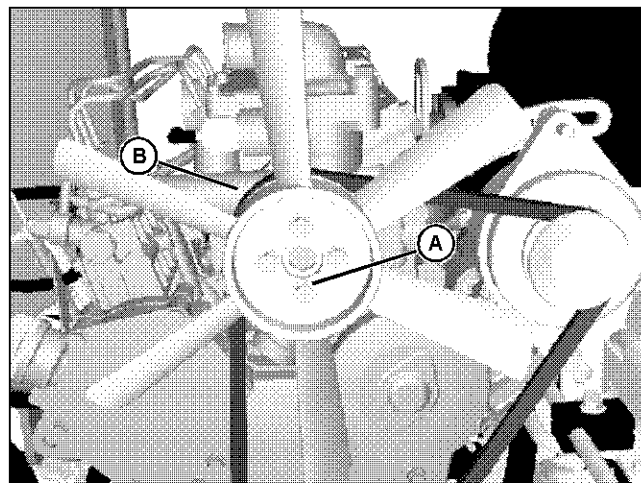


Caution: Avoid Injury! Do not attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

Important: Avoid Damage! Never steam clean or pour cold water on injection pump while pump is running or warm. Doing so can damage the pump.

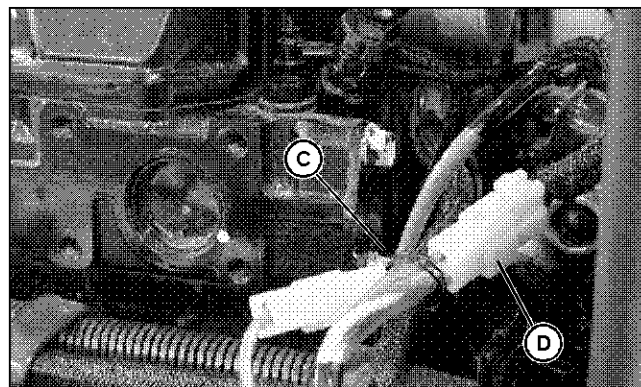
1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Turn the fuel shutoff valve on the fuel filter/water separator to the closed position.
3. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).
4. Remove radiator. (See "Remove, Inspect and Install Radiator" on page 57.)
5. Remove air cleaner assembly. (See "Remove and Install

Air Cleaner Assembly" on page 58.)



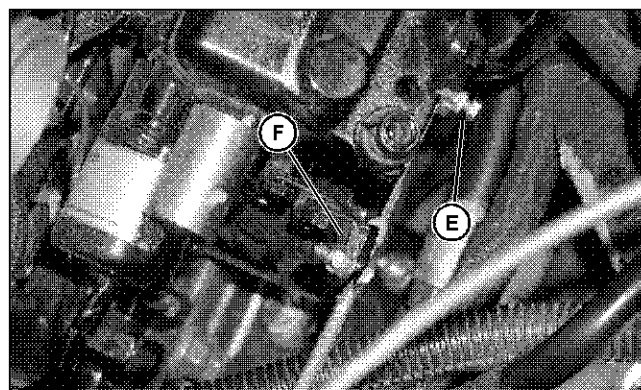
MX24371

6. Remove four fan mounting cap screws (A).
7. Remove fan and coolant pump sheave (B).



MX24340

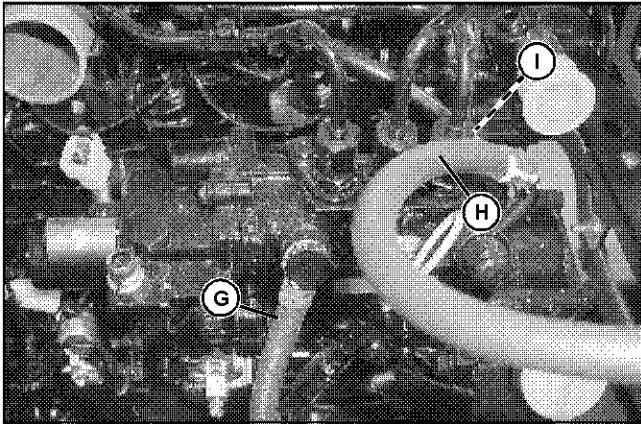
8. Remove tie strap (C) as needed.
9. Disconnect the electrical lead (D) to the fuel shutoff solenoid.



MX24341

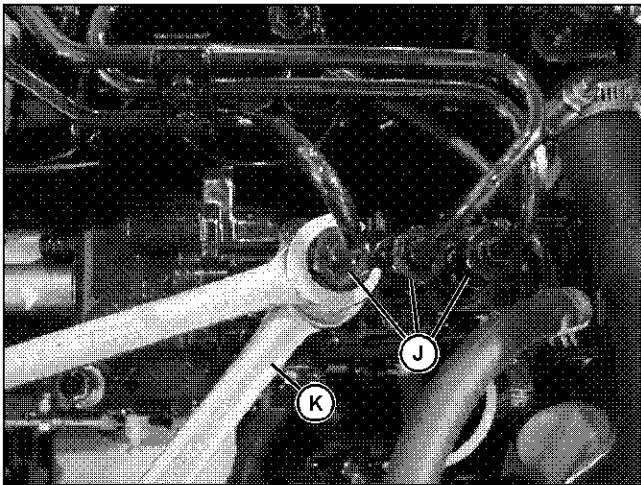
10. Loosen pump arm cable lock screw (E).
11. Loosen cable clamp (F) and remove throttle cable from injection pump.

ENGINE - DIESEL REPAIR



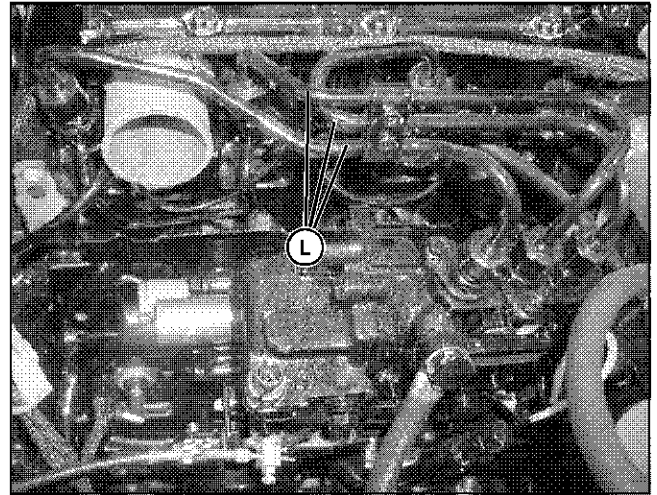
MX23683

12. Disconnect and plug injection pump supply line (G).
13. Disconnect and plug injection pump-to-fuel filter return line (H).
14. Disconnect and plug fuel injector-to-injection pump return line (I).



MX23676

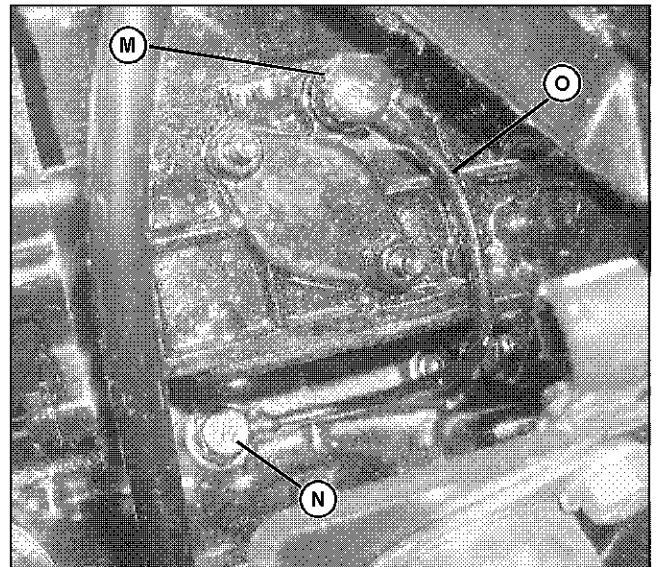
15. Loosen fuel line connectors (J) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (K) to prevent delivery valves from turning.



MX23677

16. Remove fuel line nuts at injection nozzles and injection pump. When loosening line nuts, use a backup wrench to prevent fuel return line nuts from turning. Remove injection lines (L).

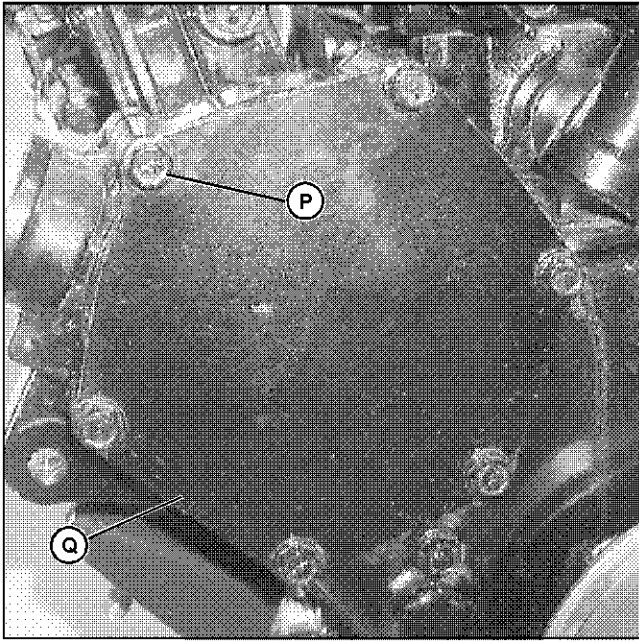
Note: Oil supply line has a bronze washer on each side. Do not lose washer when removing fittings.



MX23961

17. Remove oil fitting (M) from injection pump.
18. Remove oil fitting (N) from side of engine.
19. Remove oil supply line (O).

ENGINE - DIESEL REPAIR

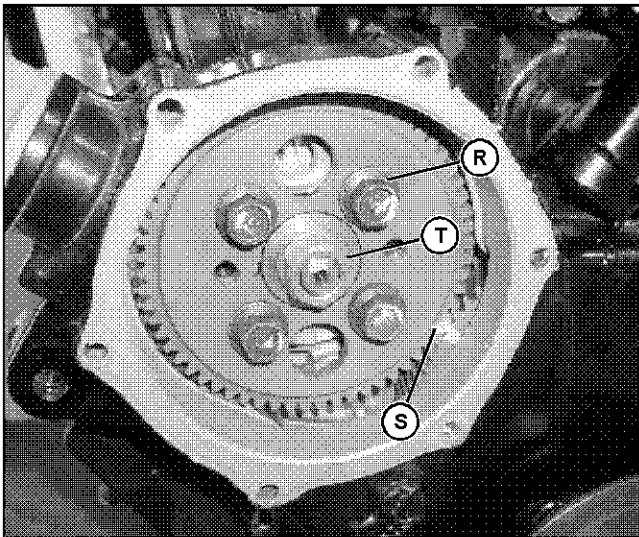


MX23928

20. Remove six cap screws (P) and injection pump drive cover (Q).

Important: Avoid Damage! Do not loosen or remove the four cap screws (R) that hold the drive gear to the drive hub. Injection pump timing will be changed.

Do not rotate engine, after marking timing gears.

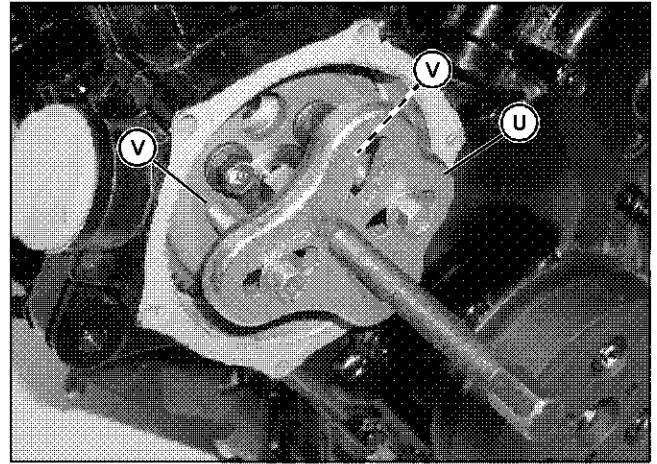


MX23931

21. Place alignment marks on gears (S) at the point that the gears mesh.

22. Without turning gears, remove drive gear retaining nut and lock washer (T).

23. Reinstall retaining nut, without lock washer, until nut is flush with end of drive shaft.



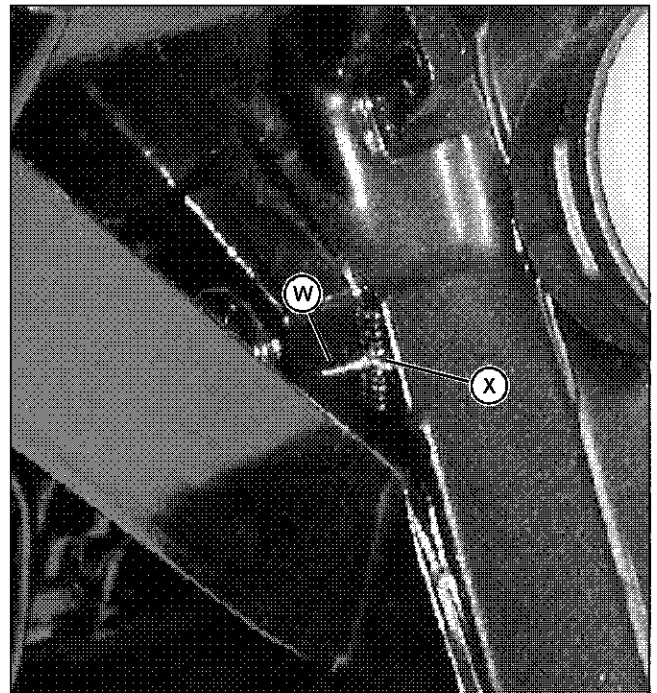
MX23932

24. Attach an appropriate puller (U) to the drive gear using the two threaded holes (V) in drive gear.

25. Pull drive gear until it "pops" loose from tapered drive shaft.

26. Remove puller and retaining nut. Ensure drive gear is loose on drive shaft but do not remove drive gear from gear case.

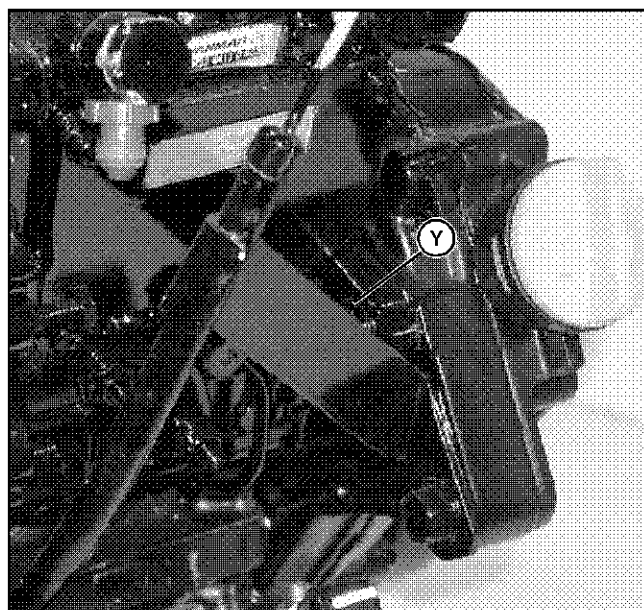
Important: Avoid Damage! Injection pump must be reinstalled with timing marks aligned exactly as it was removed.



MX23933

27. Note exact location of injection pump timing mark (W) in relation to gear case timing scale (X).

ENGINE - DIESEL REPAIR



MX23934

28. Remove three injection pump mounting nuts (Y) and remove injection pump.

Installation



Caution: Avoid Injury! Do not attempt to adjust the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

1. Install fuel injection pump. Installation is done in the reverse order of removal.

- Tighten injection pump mounting nuts to specification.
- Tighten drive gear nut to specification.
- Tighten high pressure fuel line nuts to specification.

2. If new injection pump is being installed, check and adjust injection pump timing. (See "Injection Pump Static Timing Check" on page 53.)

3. Bleed fuel system. (See "Bleed Fuel System" on page 47.)

Specifications

Injection Pump

Mounting Nut Torque 23-28 N•m (17-21 lb-ft)

Injection Pump Drive Gear

Nut Torque 59-69 N•m (44-51 lb-ft)

High-Pressure Line

Nut Torque 29-34 N•m (22-25 lb-ft)

Remove, Inspect, and Install Fuel Injection Nozzle

Special or Required Tools

Tool Name	Tool No.	Tool Use
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)



Caution: Avoid Injury! Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- Search 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.

Important: Avoid Damage! Never steam clean or pour cold water on injection pump while the pump is running, or engine is warm. Doing so can damage the pump.

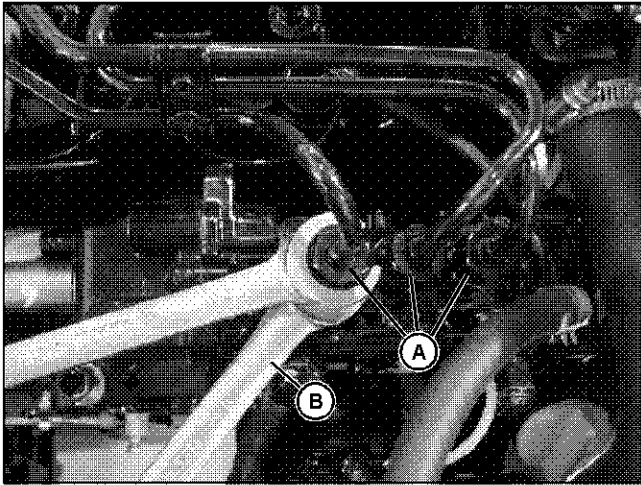
When removing injection lines, Do not turn pump delivery valve fittings or leak-off fitting nuts. Turning fittings may damage parts internally. Always use a backup wrench when removing lines.

2. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

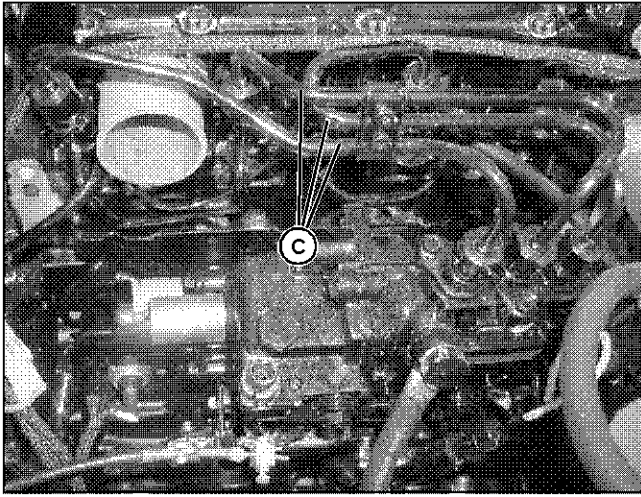
3. Remove air cleaner assembly. (See "Remove and Install Air Cleaner Assembly" on page 58.)

Note: Nozzles are matched to the cylinders. If removing more than one nozzle, tag each nozzle, according to the cylinder from which it was removed.

ENGINE - DIESEL REPAIR

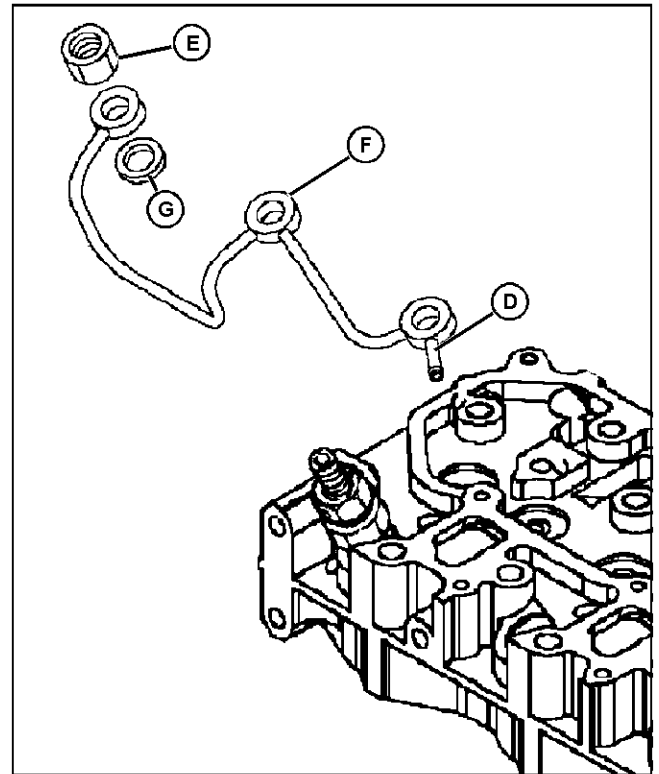


4. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.



5. Remove fuel line nuts at injection nozzles and remove injector lines (C). When loosening line nuts, use a backup wrench to prevent fuel return line nuts from turning.

Important: Avoid Damage! Leak-off lines are a one-piece assembly connected to all three fuel injectors. Use care not to bend or twist the leak-off lines when removing.

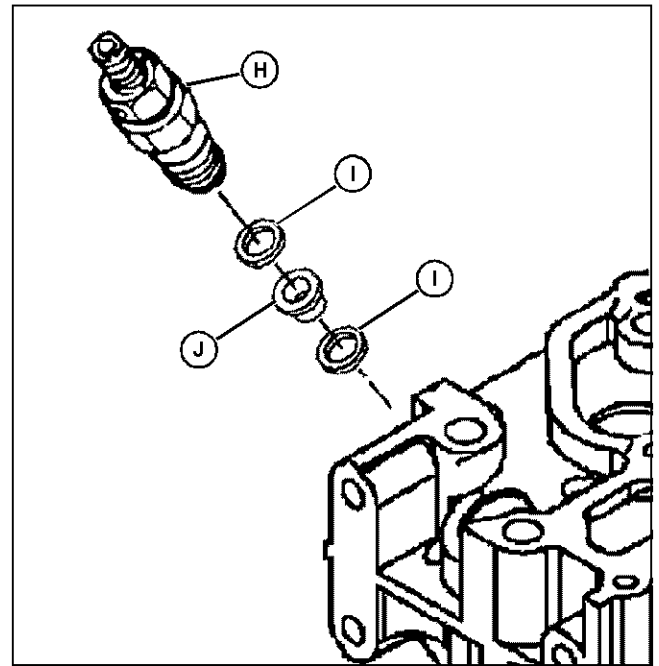


6. Disconnect and plug leak-off return hose from end of leak-off line assembly (D).

7. Remove nut (E) from each injector.

8. Remove leak-off line assembly (F).

9. Remove bronze washers (G).



10. Remove injection nozzle (H).

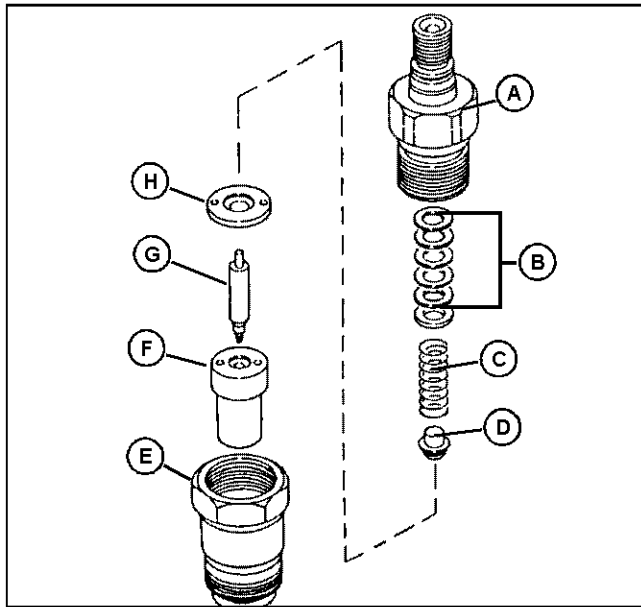
ENGINE - DIESEL REPAIR

11. Remove washers (I) and heat protector (J).
12. Test injection nozzles. (See "Test Fuel Injection Nozzle" on page 51.)

Repair

Important: Avoid Damage! If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.

Note: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

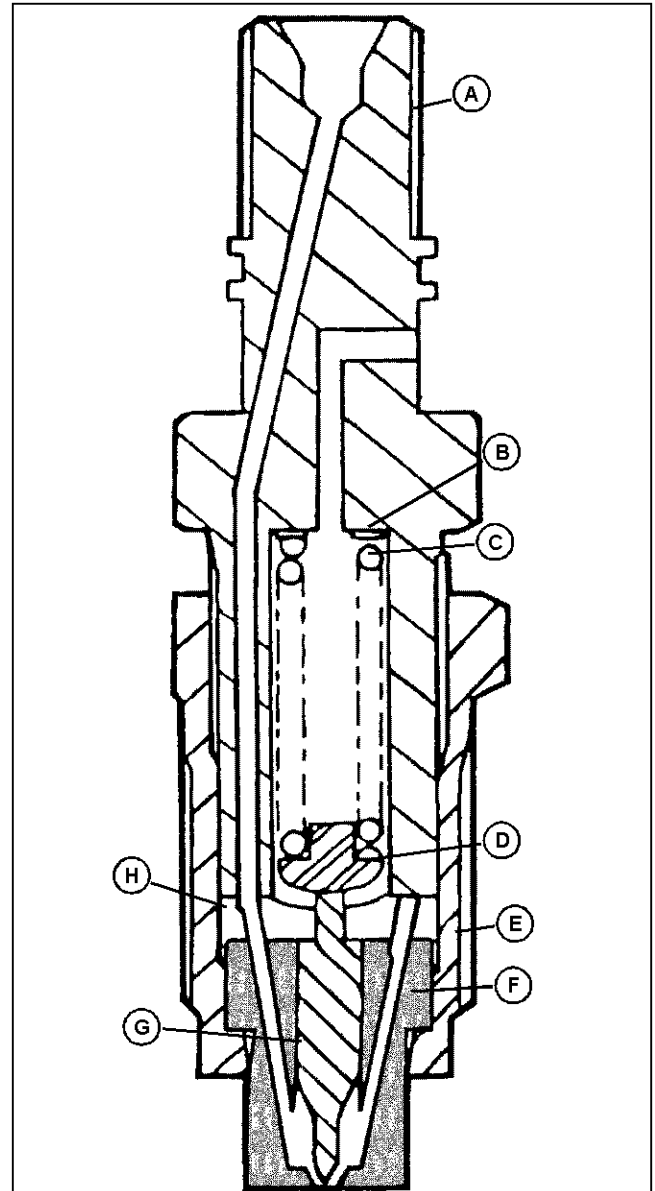


M82324A

- A- Injector Body
- B- Shims (as required)
- C- Spring
- D- Spring Seat
- E- Nozzle Fitting
- F- Nozzle Body
- G- Nozzle Valve
- H- Separator Plate

- Clean and inspect nozzle assembly. (See "Cleaning and Inspection" on page 112.)
- After assembly is complete, test injection nozzle. (See "Test Fuel Injection Nozzle" on page 51.)

Injection Nozzle Cross Section



M82325A

- A- Injector Body
- B- Shims (as required)
- C- Spring
- D- Spring Seat
- E- Nozzle Fitting
- F- Nozzle Body
- G- Nozzle Valve
- H- Separator Plate

Cleaning and Inspection

Note: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

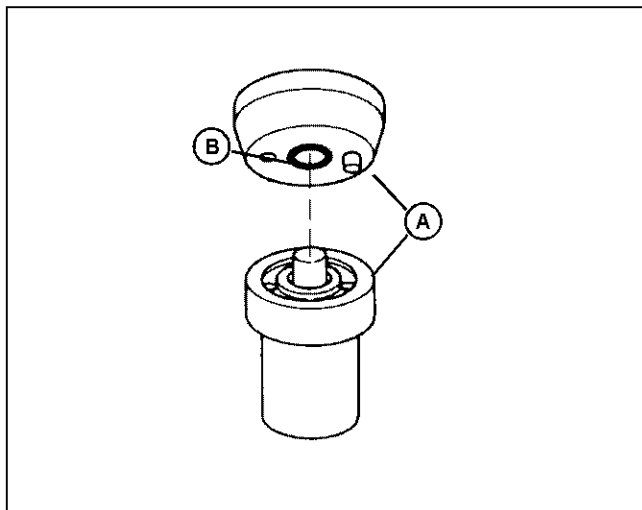
ENGINE - DIESEL REPAIR

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

Important: Avoid Damage! Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF13 Nozzle Cleaning Kit).

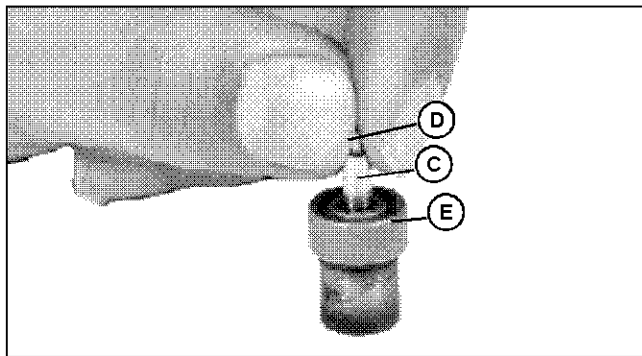
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.



M82326A

4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (A) (both parts) must not be scored or pitted. Use an inspection magnifier to aid in making the inspection.

5. Check nozzle contact surface (B) on separator plate for wear. If contact surface is more than the specified measurement, replace nozzle assembly.



M35919

6. Inspect the piston (C) (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present,

replace the nozzle assembly.

7. Further inspect the nozzle assembly by performing a slide test.

- Dip the nozzle valve (D) in clean diesel fuel. Insert valve in nozzle body (E).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat by its own weight.

Replace nozzle assembly if the valve does not slide freely to its seat.

Installation

Installation is done in the reverse order of removal.

- Replace all heat protectors and washers.
- Tighten injection nozzle to specification.
- Tighten leak-off fitting nut to specification.

Specifications

Separator Plate Contact Surface 0.10 mm (0.004 in.)

Specifications

Injection Nozzle Torque 49-59 N•m (36-43 lb-ft)

Leak-Off Fitting Nut Torque. 24-33 N•m (18-24 lb-ft)

Nozzle Fitting Torque. 29-49 N•m (21-36 lb-ft)

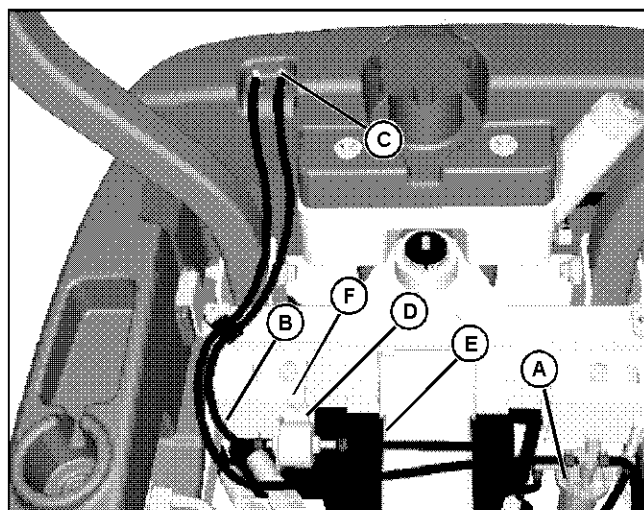
Remove and Install Fuel Pump

Other Material

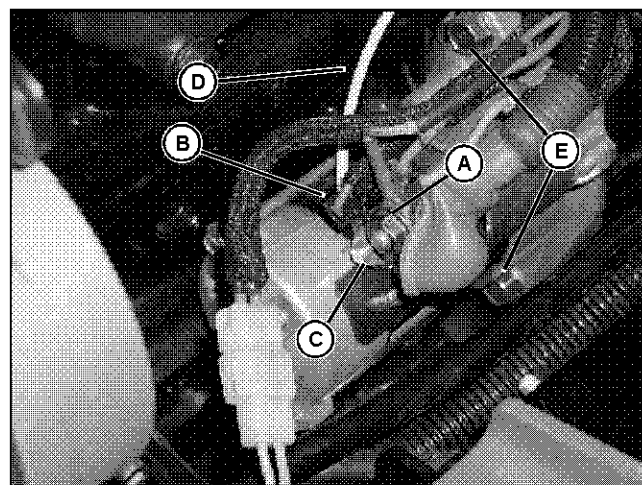
Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Remove seat base plate. (See "Remove and Install Seat Base Plate" on page 393.)
3. Disconnect fuel pump electrical connector.



MX24372



MX24343

4. Turn fuel shutoff valve (A) to the closed position.
5. Disconnect fuel tank-to-fuel pump hose (B) at fuel tank fitting (C) to prevent siphoning of fuel.
6. Disconnect fuel tank-to-fuel pump hose (B) at fuel pump (D).
7. Disconnect fuel pump-to-fuel filter hose (E) at fuel pump.
8. Remove two flange nuts and carriage bolts (F).
9. Remove fuel pump.

Installation

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

Installation is done in the reverse order of removal.

- Bleed air from fuel system. (See "Bleed Fuel System" on page 47.)

Remove and Install Starting Motor

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Raise hood.
3. Remove muffler. (See "Remove and Install Muffler" on page 58.)

4. Remove flange nut (A) and disconnect fusible links, positive (+) battery cable, and red wire from starting motor solenoid (battery terminal).
5. Disconnect brown wire (B) from starting motor solenoid.
6. Remove flange nut (C) and disconnect white wire (D) from starting motor solenoid output terminal.
7. Remove upper and lower cap screws (E).
8. Remove starting motor.

Installation

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

Installation is done in the reverse order of removal.

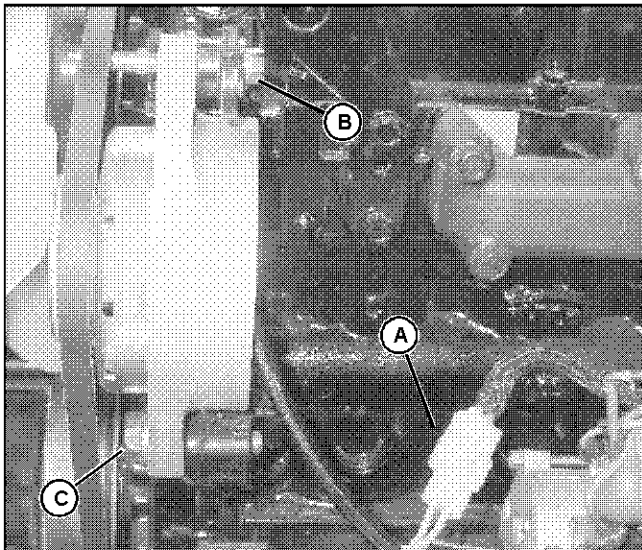
Remove and Install 12V Alternator

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Used to protect electrical terminals from corrosion.

Removal

1. Park machine safely. (See "Park Machine Safely" on page 3.)
2. Raise hood.



MX24285

3. Disconnect wire connector (A) from alternator.
4. Loosen top cap screw (B) and lower mounting bracket cap screw (C). Push alternator toward engine to loosen belt.
5. Remove drive belt from alternator sheave.
6. Remove lower mounting bracket cap screw.
7. Remove top cap screw.
8. Remove alternator.

Installation

Note: Use dielectric grease on all non-sealed electrical connections before connecting.

Installation is done in the reverse order of removal.

- Adjust belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 42.)



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ELECTRICAL SPECIFICATIONS

Specifications

General Specifications

Stator

Amperage, Unregulated	20 amps @ 3500 rpm
Voltage, Unregulated (minimum)	26 VAC @ 3400 rpm
Voltage, Regulated	14.3-14.7 VDC @ 3400 rpm
Stator Winding Resistance	0.11-0.18 ohm

Battery

Voltage	11.8-13.2 VDC
BCI Group	51
Cranking Amps @ 0°C (32°F)	522 amps
Reserve Capacity @ 25 Amps	70 min
Cold Cranking Amps @ -18°C (0°F)	435 amps
Specific Gravity	1.225-1.275 points
Load Test for 5 Seconds (Minimum)	480 amps

Starter

Minimum Brush Length	11.1 mm (0.44 in.)
Commutator Groove Depth	0.2 mm (0.008 in.)
Commutator Diameter	27 mm (1.063 in.)
Commutator Run-Out	0.05 mm (0.002 in.)
Maximum No-Load Starter Current Draw (11.5 Volts)	90 amps @ 3000 rpm
Starting Motor Cranking Current Draw	230 amps @ 1240 rpm
Solenoid Pull-In Amp Draw	55.5 amps (max)
Solenoid Hold Amp Draw	10.5 amps (max)

Sensor and Solenoid Specifications

Hydraulic Oil Temperature Sensor	89-98°C (193-208°F)
Engine Coolant Temperature Sensor Closing Temperature	107-113°C (225-235°F)
Engine Coolant Temperature Sensor Opening Temperature	97-103°C (207-217°F)
Engine Oil Pressure Switch Activation Pressure	98 ± 30 kPa (14.2 ± 4.3 psi)
Fuel Shutoff Solenoid Hold Coil Resistance	23.6 ohms
Fuel Shutoff Solenoid Pull-in Coil Resistance	0.4 ohms
Mow Solenoid Resistance	10 ± 2 ohms
Raise Solenoid Resistance	10 ± 2 ohms
Lower Solenoid Resistance	10 ± 2 ohms
Glow Plug Resistance	1.35-1.65 ohms

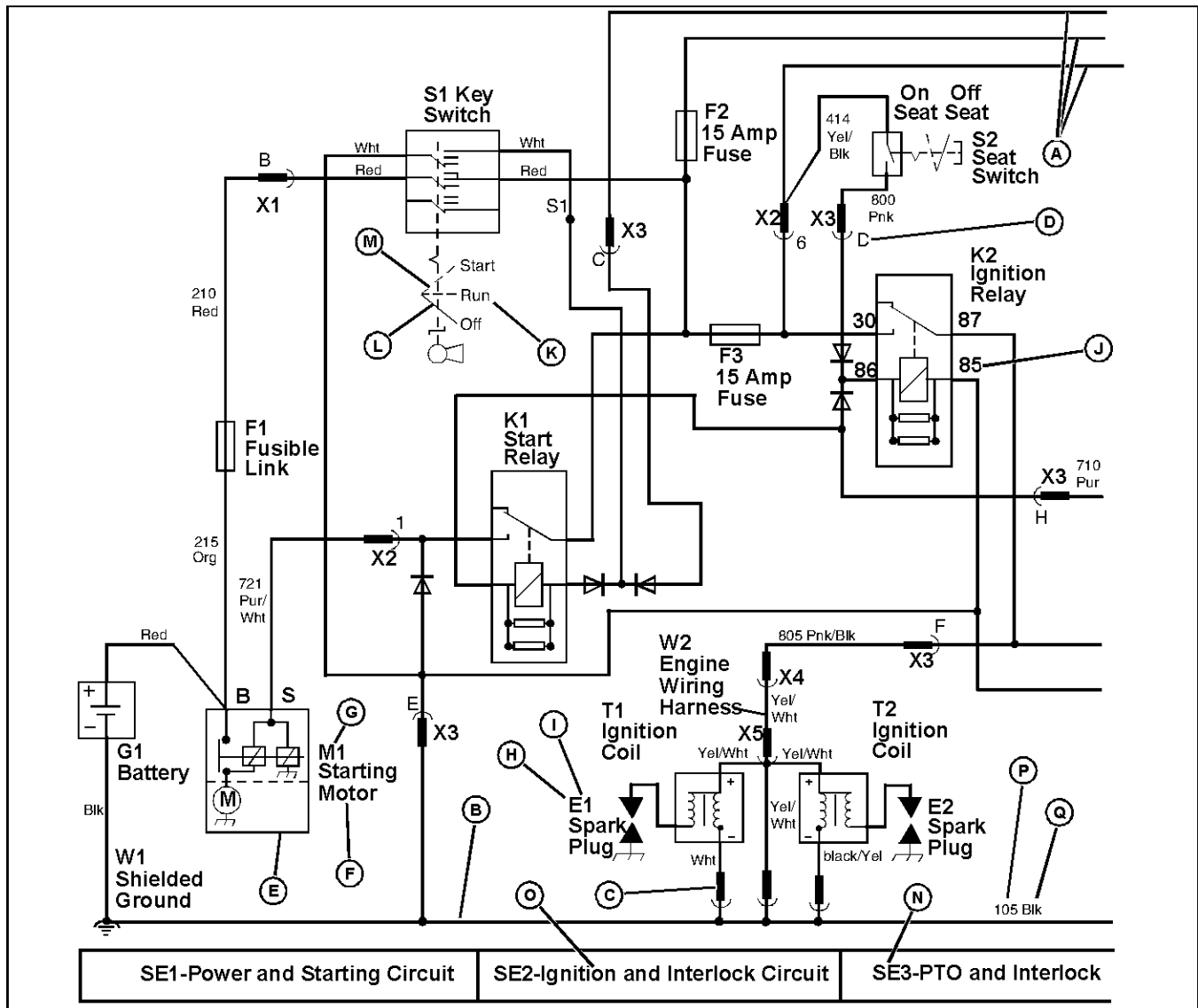
ELECTRICAL SPECIFICATIONS



ELECTRICAL GENERAL INFORMATION

General Information

Reading Electrical Schematics



The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to

the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Theory of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the

ELECTRICAL GENERAL INFORMATION

components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures are used to test the complete circuit regardless of the problem or complaint. Select a circuit or symptom from Circuit Operation and Diagnosis and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test location
- A question regarding the normal reading
- Check or test to perform based on the test results

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully.

The top frame of a step indicates the location of the test.

The middle frame gives the reading or condition that should be obtained when performing the test or check, posed in the form of a question.

The lower frame contains yes and no answers for the question posed in the middle frame.

Wire Color Abbreviation Chart

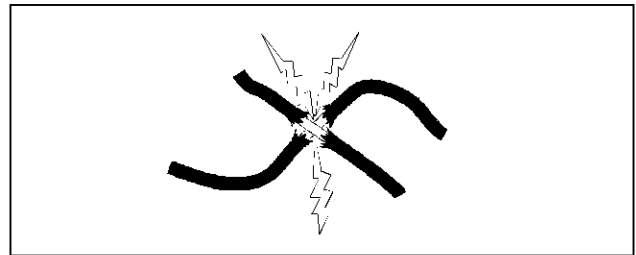
Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Red	Red
Tan	Tan
Wht.	White
Yel	Yellow

Common Circuit Tests

Shorted Circuit

A shorted circuit may result in the wrong component operating (i.e., improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.

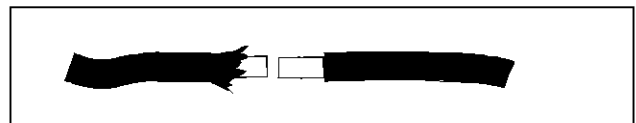


MIF (M85600)

High Resistance or Open Circuit

High resistance or open circuits usually result in slow, dim, or no component operation (i.e., poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

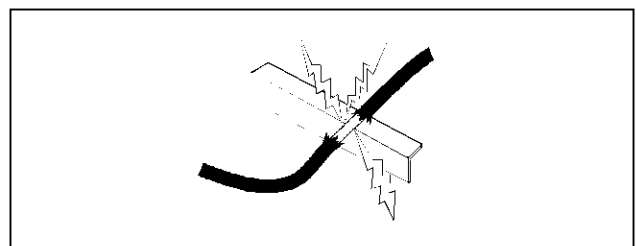
1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.



MIF (M85601)

Grounded Circuit

Grounded circuits usually result in no component operation or a blown fuse.



MIF (M85602)

ELECTRICAL TOOLS AND MATERIALS

Conductors for 12-Volt Circuits

Stranded Conductors for 12 Volt Circuits						
SAE Wire Size (Gauge)	20	18	16	14	12	10
Metric Wire Size (mm)	0.5	0.8	1.0	2.0	3.0	5.0
Typical Stranding	7 x 28	16 x 30	19 x 29	19 x 27	19 x 25	19 x 23
Minimum Conductor Area in Circular Mils	1072	1537	2336	3702	5833	9343

Tools and Materials

Special or Essential Tools

Note: Order tools according to information given in the **U.S. SERVICEGARD™ Catalog** or in the **European Microfiche Tool Catalog (MTC)**.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multi-meter	JT05791	Used for electrical tests.
Battery Tester	JT05685	Used to test battery condition.
Hydrometer	N/A	Used to check specific gravity of battery.
Current Clamp	JT02153	Used with multimeter to test current draw.
Jumper Wire	N/A	Used to jump starting motor solenoid terminal.
Terminal Removal Tool	JDG777	Used to remove terminal from connector body.
Extraction Tool	JDG364	Used to remove terminal from connector body.
Universal Electrical Pliers	JDG145	Used to strip insulation from wire.
Crimper	JDG865	Used to crimp terminals on wire.
Thermometer	N/A	Used to measure water temperature.

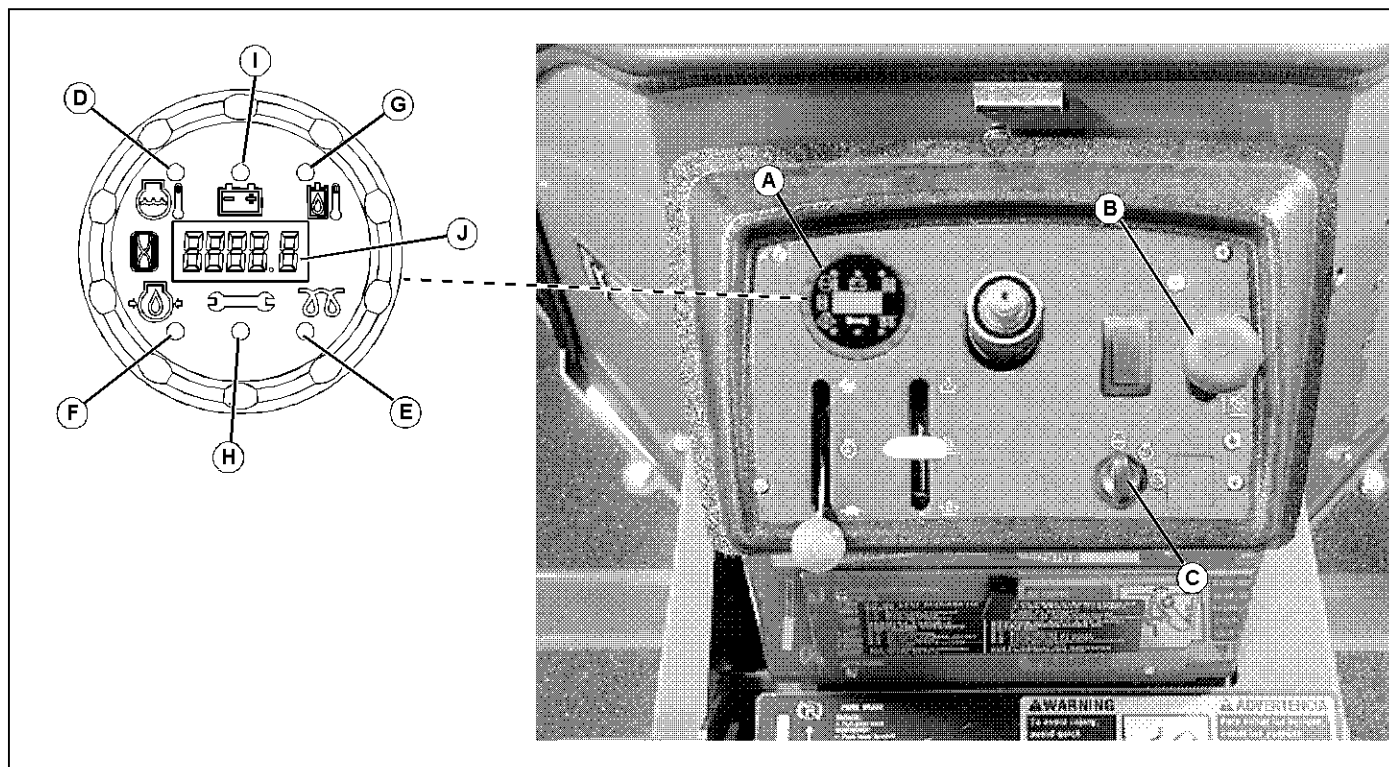
Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Seal connections.

ELECTRICAL COMPONENT LOCATION

Component Location

Electrical Components Instrument Cluster

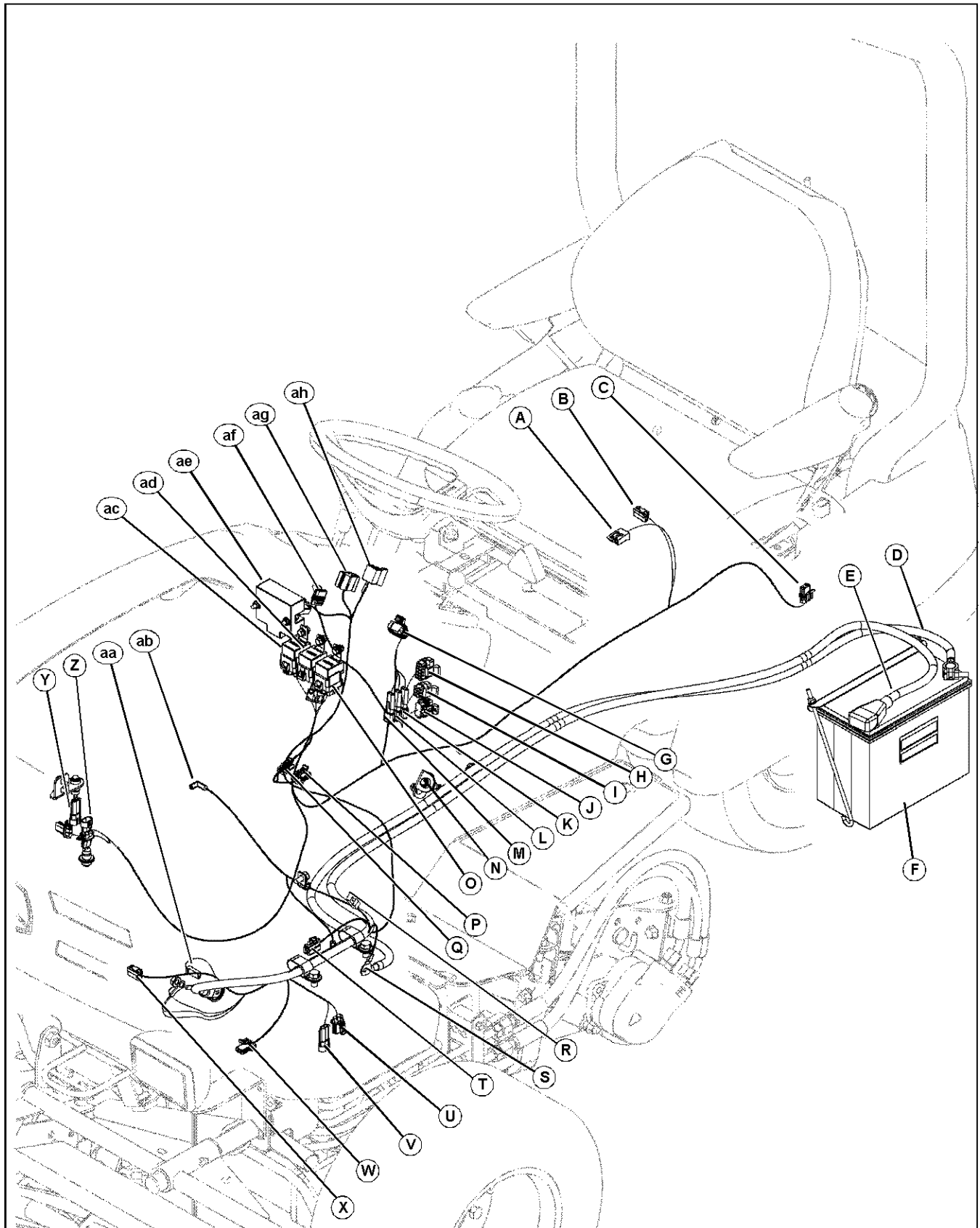


MIF, MX23511A

- A- Instrument Cluster (A2)
- B- Raise-Lower Switch (S7)
- C- Key Switch (S1)
- D- Engine Coolant Temperature LED (H2)
- E- Glow Plug LED (H5)
- F- Engine Oil Pressure LED (H1)
- G- Hydraulic Oil Temperature LED (H3)
- H- Diagnostic LED (H6) (Not Used)
- I- Battery Discharge LED (H4)
- J- Hour Meter (P1)

Note: *Steering wheel removed for clarity of photo.*

ELECTRICAL COMPONENT LOCATION



MX23577

A- Seat Switch (S4)

B- Fuel Pump (M2) Connector

C- Hydraulic Oil Temperature

ELECTRICAL COMPONENT LOCATION

D- Switch Connector (X12)
E- Battery Negative Cable (W2)
F- Battery Positive Cable (W1)
G- Battery (G1)
H- Instrument Cluster (A2)
I- Interlock Module 10-Pin Connector (X9)
J- Interlock Module 6-Pin Connector (X8)
K- Interlock Module 8-Pin Connector (X7)
L- Starting Motor Relay Diode (V1)
M- Pull-In Coil Relay Diode (V2)
N- Mow Resistor (R2)
O- Park Brake Switch (S3)
P- Fuel Pull-In Coil Relay (K3)
Q- Lift Valve Connector (X6)
R- Lower Valve Connector (X5)
S- Fuel Shutoff Solenoid (Y1)
T- Battery Frame Ground (X19)
U- Glow Plug Connector (X2)
V- Backlap Switch (S5)
W- Mow Valve Connector (X4)
X- Headlight Switch Connector (X14)
Y- Voltage Regulator-to-Alternator Connector (X3)
Z- Mow-Transport Switch Connector (X10)
AA- Neutral Switch (S2)
AB- Starting Motor Connector (M1)
AC- Engine Coolant Temperature Switch (B2)
AD- Starting Motor Relay (K1)
AE- Glow Plug Relay (K2)
AF- Voltage Regulator (N1)
AG- 15-amp Fuse (F4)
AH- Raise-Lower Switch 4-Pin Connector (X11)
AI- Key Switch Connector (X1)

ELECTRICAL SCHEMATICS AND HARNESSSES

Schematics and Harnesses

Schematic and Harness Legend

Components

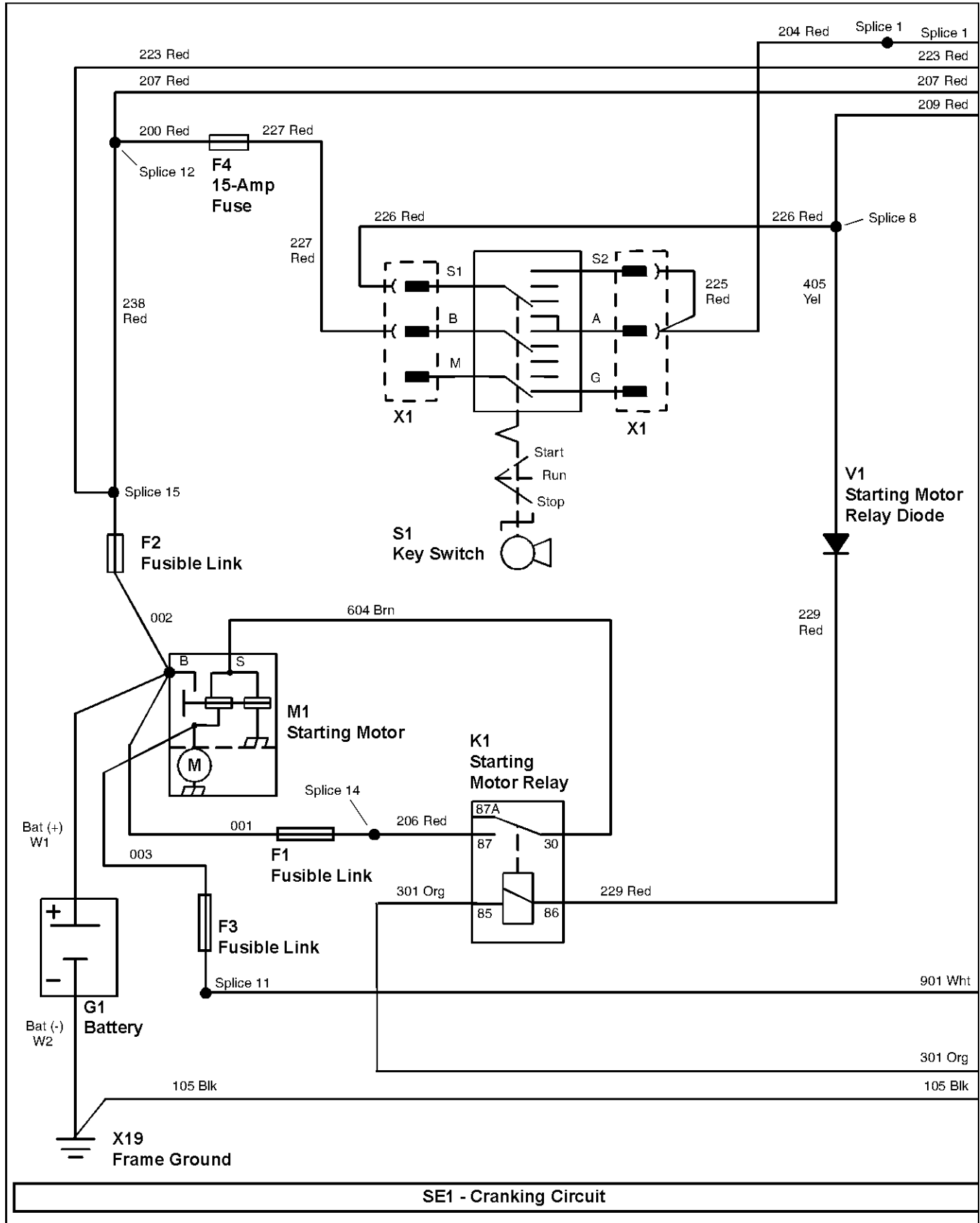
A1 - Interlock Module	R2 - Mow Resistor
A2 - Instrument Cluster	S1 - Key Switch
B1 - Engine Oil Pressure Switch	S3 - Park Brake Switch
B2 - Engine Coolant Temperature Switch	S4 - Seat Switch
B3 - Hydraulic Oil Temperature Switch	S5 - Backlap Switch
E1 - Right Headlight (Optional)	S6 - Mow-Transport Switch
E2 - Left Headlight (Optional)	S7 - Raise-Lower Switch
E3 - Rear Grass Catcher Light (Optional)	S8 - Headlight Switch
F1 - Fusible Link	V1 - Starting Motor Relay Diode
F2 - Fusible Link	V2 - Pull-in Coil Relay Diode
F3 - Fusible Link	V3 - Hydraulic Oil Temperature Diode
F4 - 15-Amp Fuse	V4 - Engine Coolant Temperature Diode
F5 - Fusible Link (Optional Lighting Wiring Harness)	W1 - Battery Positive Cable
G1 - Battery	W2 - Battery Frame Ground
G2 - 12V Alternator	W3 - Main Harness
H1 - Engine Oil Pressure LED	W4 - Lighting Wiring Harness (Optional)
H2 - Engine Coolant Temperature LED	X1 - Key Switch Connector
H3 - Hydraulic Oil Temperature LED	X2 - Glow Plug Connector
H4 - Battery Discharge LED	X3 - Voltage Regulator-to-Alternator Connector
H5 - Glow Plug LED	X4 - Mow Valve Connector
H6 - Diagnostic LED (Not Used)	X5 - Lower Valve Connector
K1 - Starting Motor Relay	X6 - Lift Valve Connector
K2 - Glow Plug Relay	X7 - Interlock Module 8-Pin Connector
K3 - Pull-In Coil Relay	X8 - Interlock Module 6-Pin Connector
K4 - Lighting Relay (Optional)	X9 - Interlock Module 10-Pin Connector
M1 - Starting Motor	X10 - Mow-Transport Switch Connector
M2 - Fuel Pump	X11 - Raise-Lower Switch 4-Pin Connector
N1 - Voltage Regulator	X12 - Hydraulic Oil Temperature Switch Connector
P1 - Hour Meter	X13 - Instrument Cluster 8-Pin Connector
R1 - Glow Plugs (3 Used)	X14 - Headlight Switch Connector
	X15 - Main Harness-to-Lighting Harness Connector
	X16 - Lighting Harness-to-Right Headlight (Optional)
	X17 - Lighting Harness-to-Left Headlight (Optional)

ELECTRICAL SCHEMATICS AND HARNESSSES

- X18 - Lighting Harness-to-Rear Grass Catcher Light
(Optional)
- X19 - Battery Frame Ground
- Y1 - Fuel Shutoff Solenoid
- Y2 - Mow Valve Solenoid
- Y3 - Raise Valve Solenoid
- Y4 - Lower Valve Solenoid

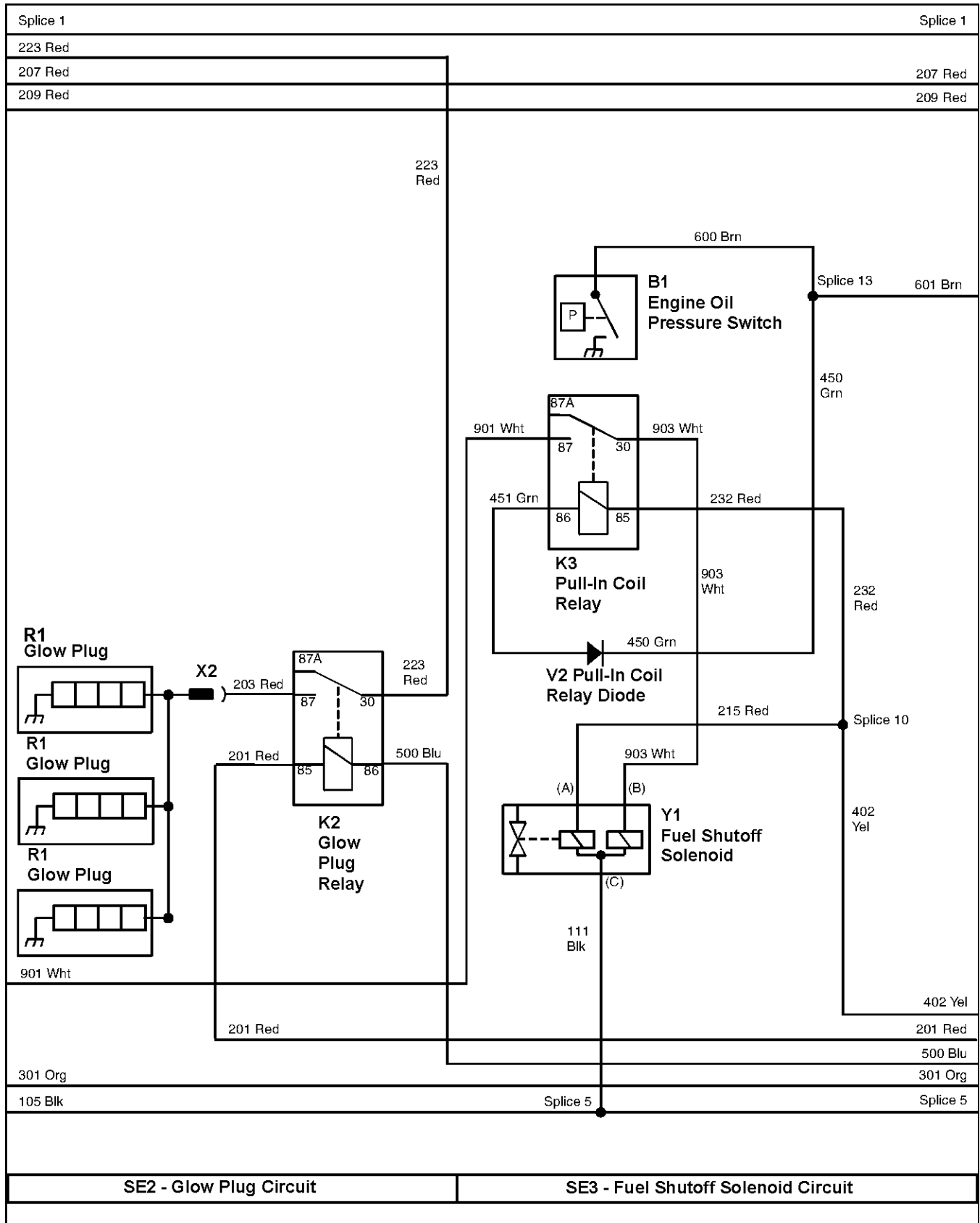
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Electrical Schematic (W3) (Sheet 1 of 8)



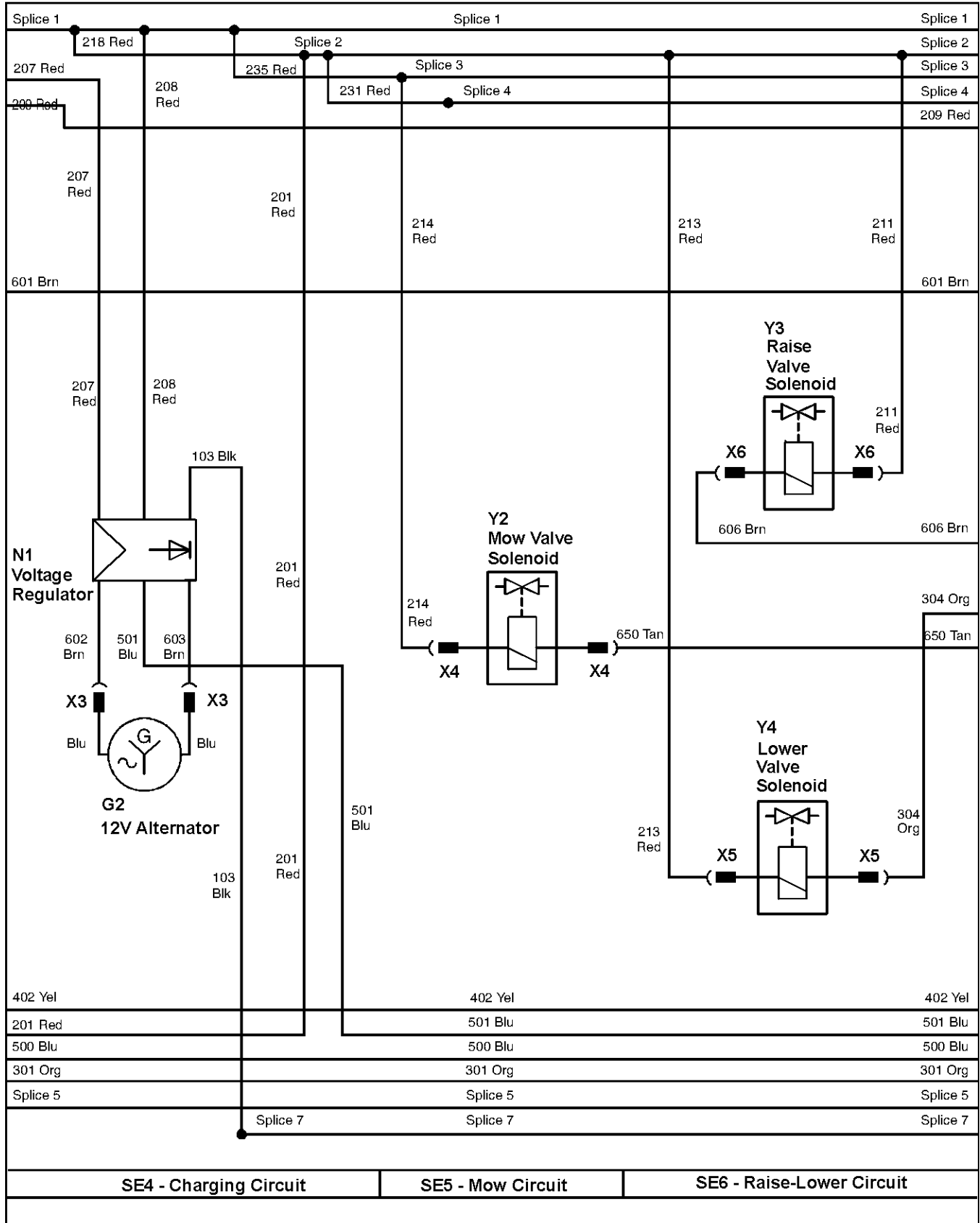
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Electrical Schematic (W3) (Sheet 2 of 8)



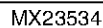
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Electrical Schematic (W3) (Sheet 3 of 8)



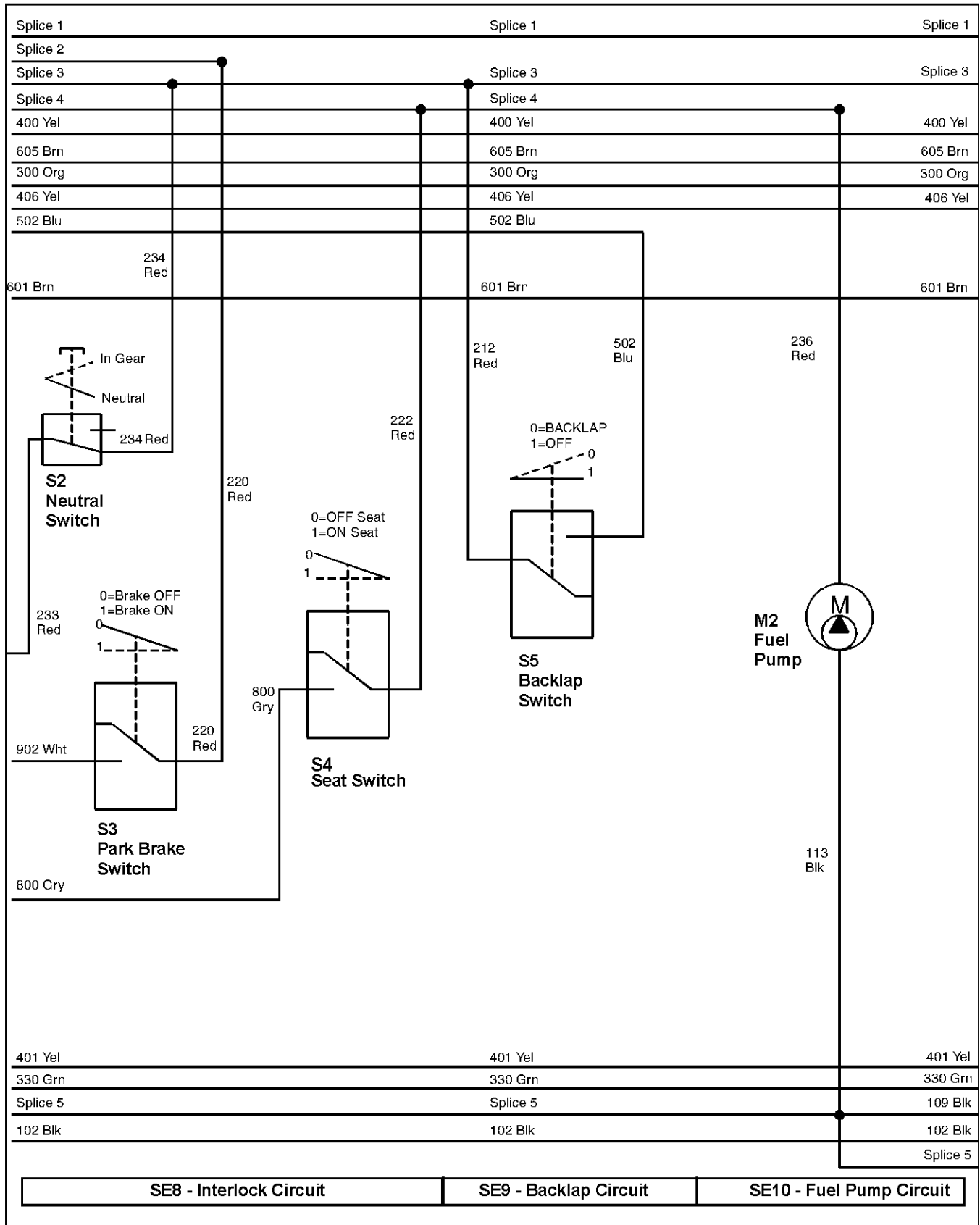
MX23533

Main Electrical Schematic (W3) (Sheet 4 of 8)



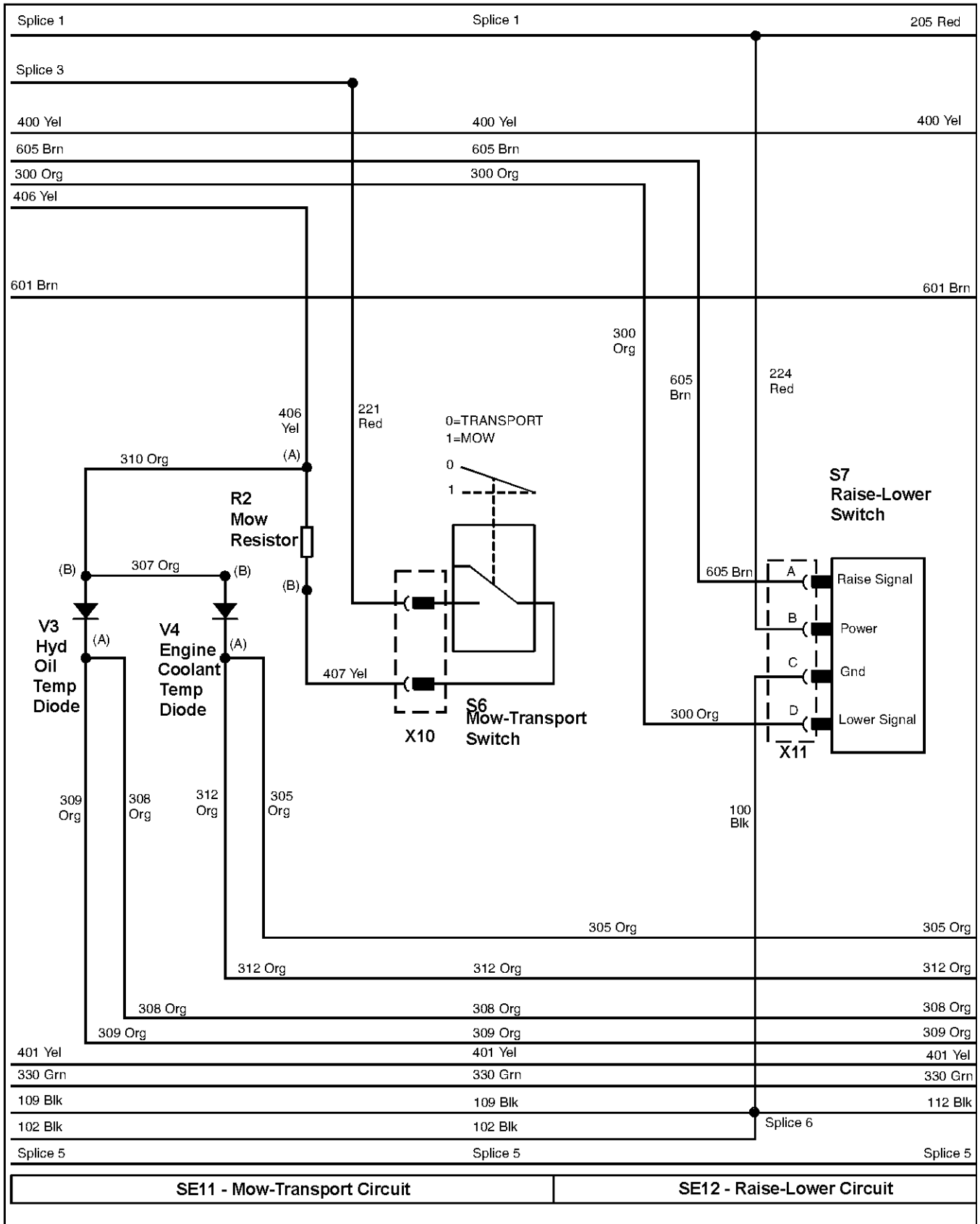
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Electrical Schematic (W3) (Sheet 5 of 8)



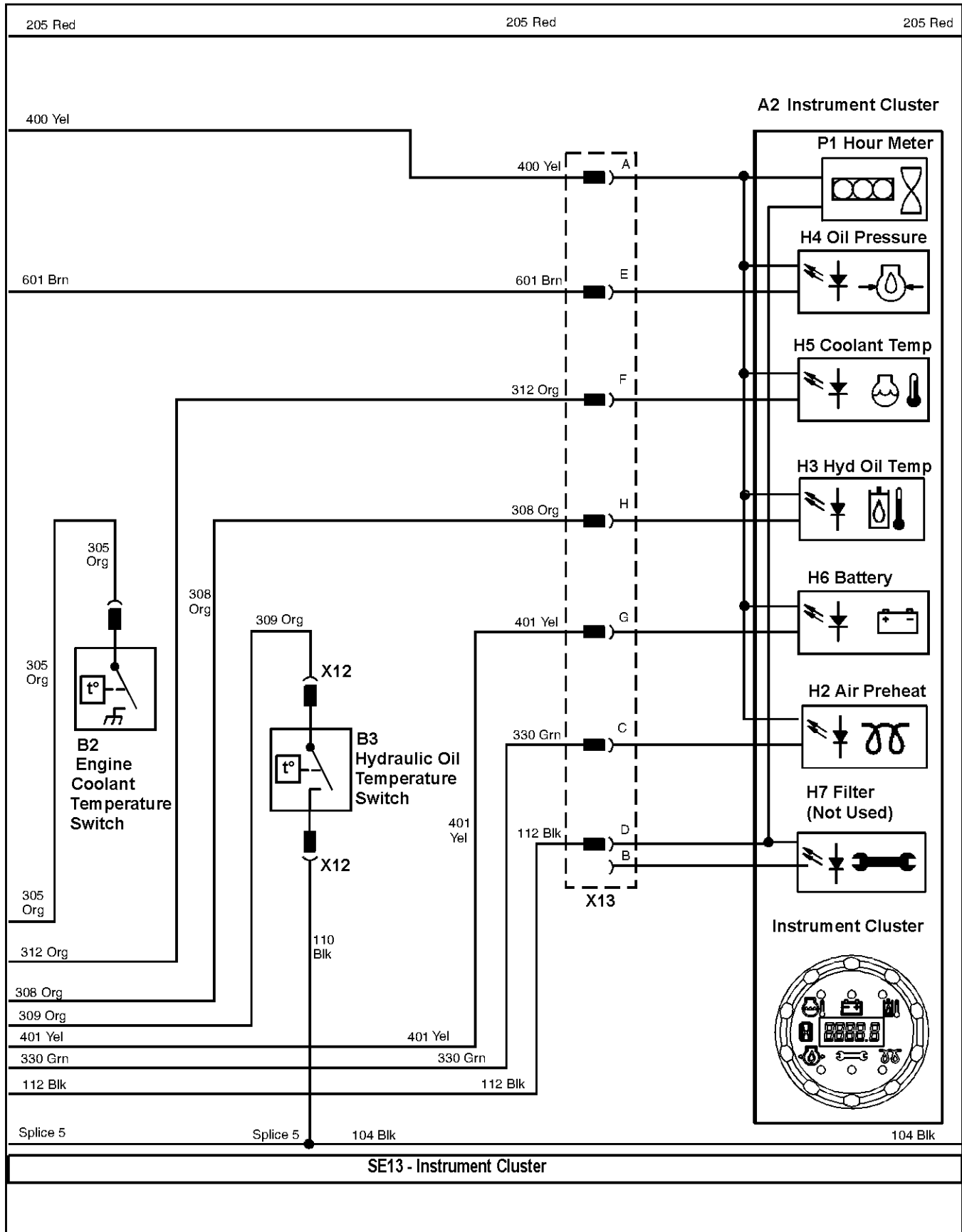
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Electrical Schematic (W3) (Sheet 6 of 8)



ELECTRICAL SCHEMATICS AND HARNESSSES

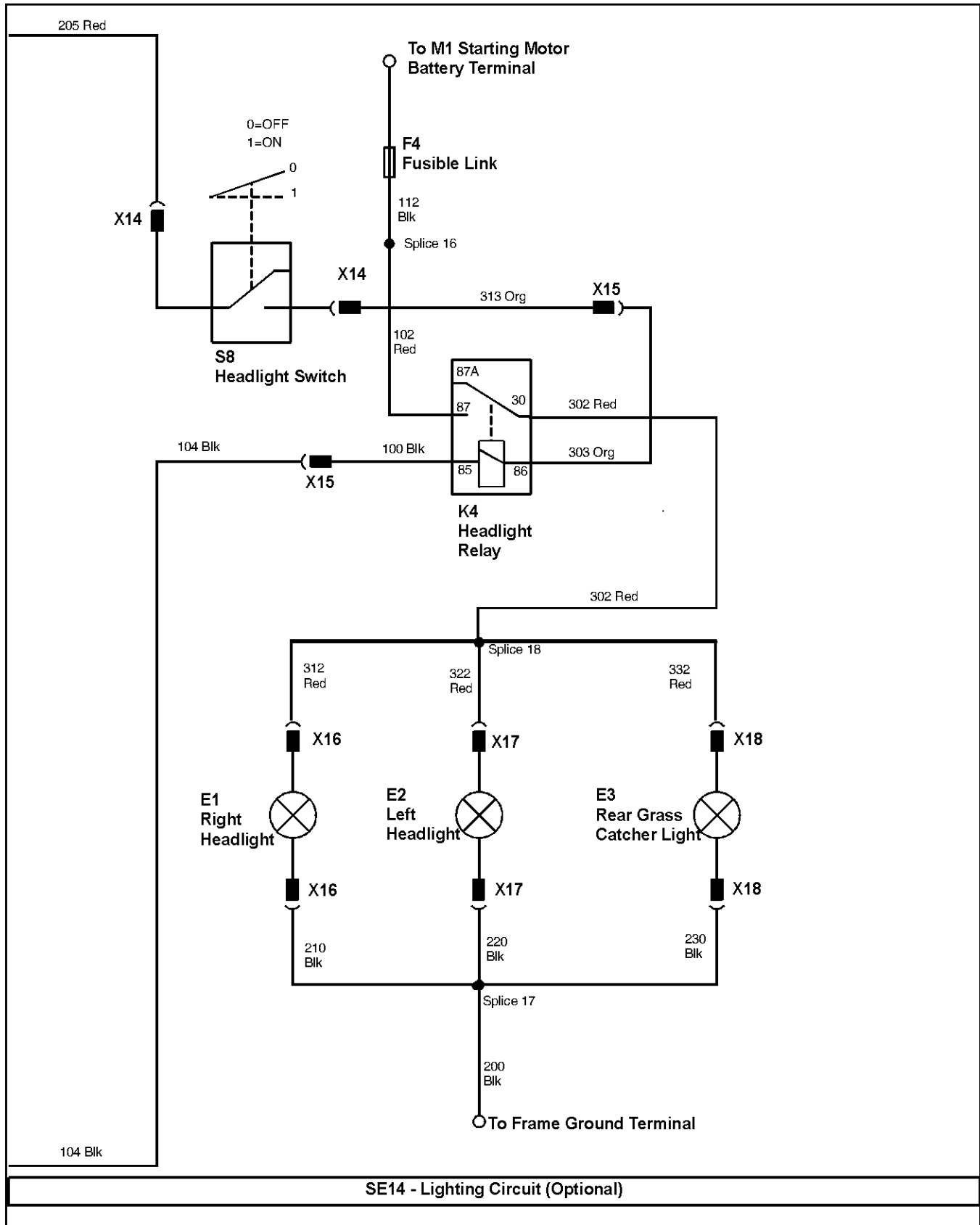
Main Electrical Schematic (W3) (Sheet 7 of 8)



MX23538

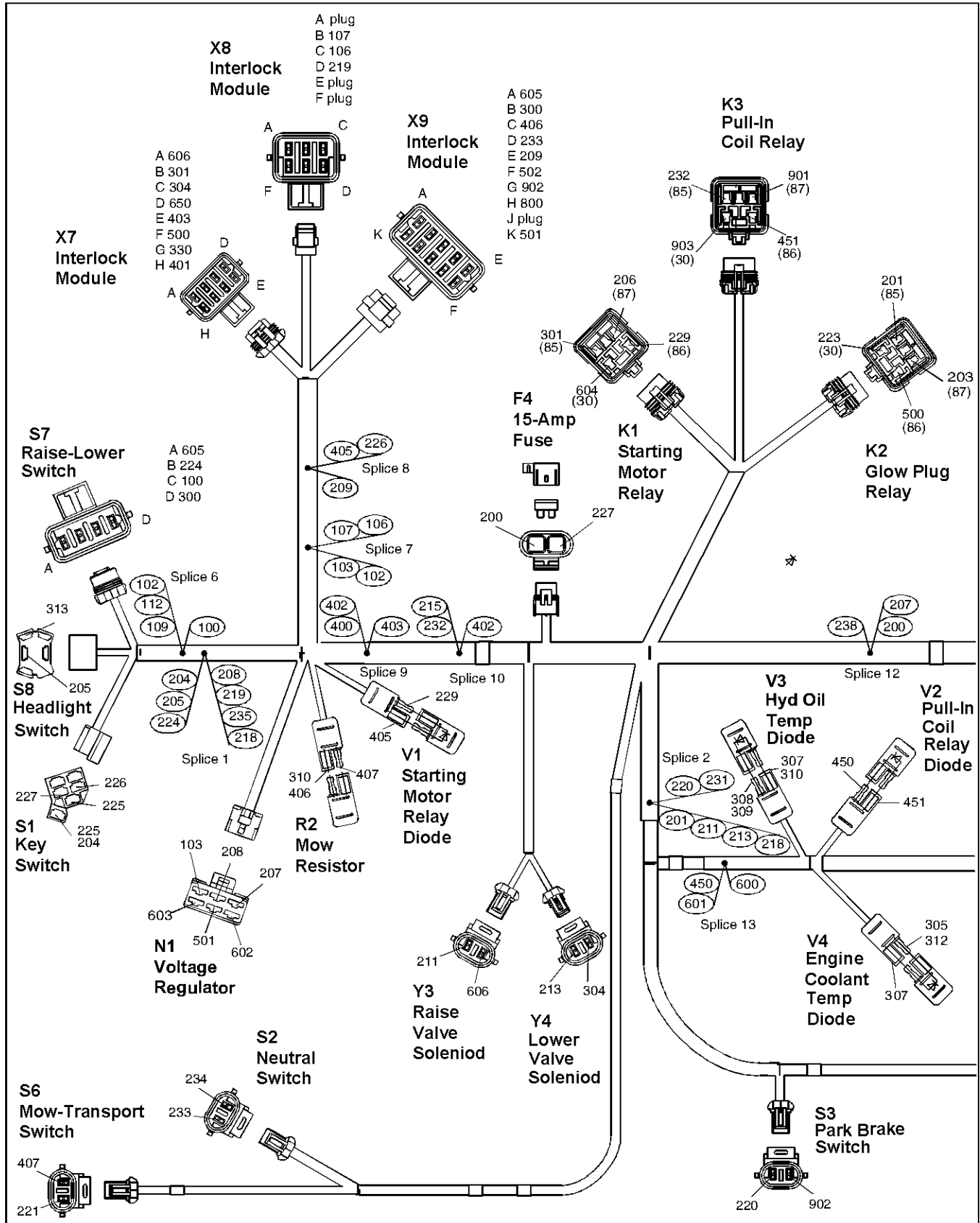
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Electrical Schematic (W3) (Sheet 8 of 8)



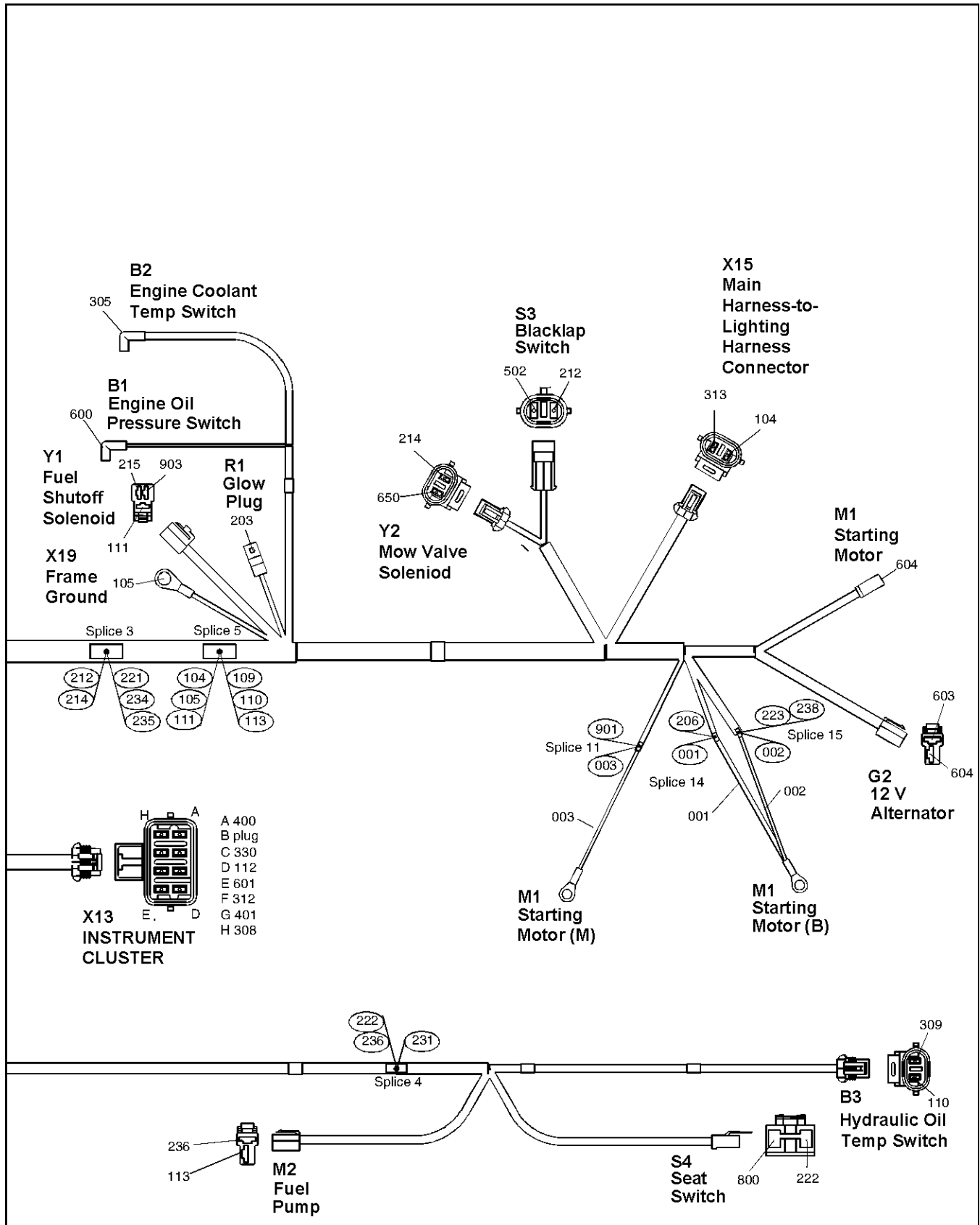
ELECTRICAL SCHEMATICS AND HARNESSSES

Main Wiring Harness (W3) (Sheet 1 of 2)



ELECTRICAL SCHEMATICS AND HARNESSSES

Main Wiring Harness (W3) (Sheet 2 of 2)



MX23548

ELECTRICAL SCHEMATICS AND HARNESSSES

Main Harness (W3) Wire Code Table

Circuit Number	Wire Size (mm ²)	Wire Color	Termination Points
001	0.8	Fusible link	M1 (B), Splice 14
002	1.0	Fusible link	M1 (B), Splice 15
003	1.0	Fusible link	M1, Splice 11
100	0.8	Blk	S7 (C), Splice 6
102	2.0	Blk	Splice 6, Splice 7
103	3.0	Blk	N1, Splice 7
104	1.0	Blk	X15, Splice 5
105	3.0	Blk	Frame Ground, Splice 5
106	1.0	Blk	X8 (C), Splice 7
107	1.0	Blk	X8 (B), Splice 7
109	2.0	Blk	Splice 5, Splice 6
110	0.8	Blk	X12, Splice 5
111	3.0	Blk	Y1 (C), Splice 5
112	0.8	Blk	X13 (D), Splice 6
113	1.0	Blk	M2, Splice 5
200	3.0	Red	F4, Splice 12
201	0.8	Red	K2 (85), Splice 2
203	3.0	Red	K2 (87), X2
204	2.0	Red	X1 (A), Splice 1
205	1.0	Red	X14, Splice 1
206	2.0	Red	K1 (87), Splice14
207	3.0	Red	N1, Splice 12
208	0.8	Red	N1, Splice 1
209	0.8	Red	X9 (E), Splice 8
211	0.8	Red	X6, Splice 2
212	0.8	Red	S5, Splice 3
213	0.8	Red	X5, Splice 2
214	0.8	Red	X4, Splice 3

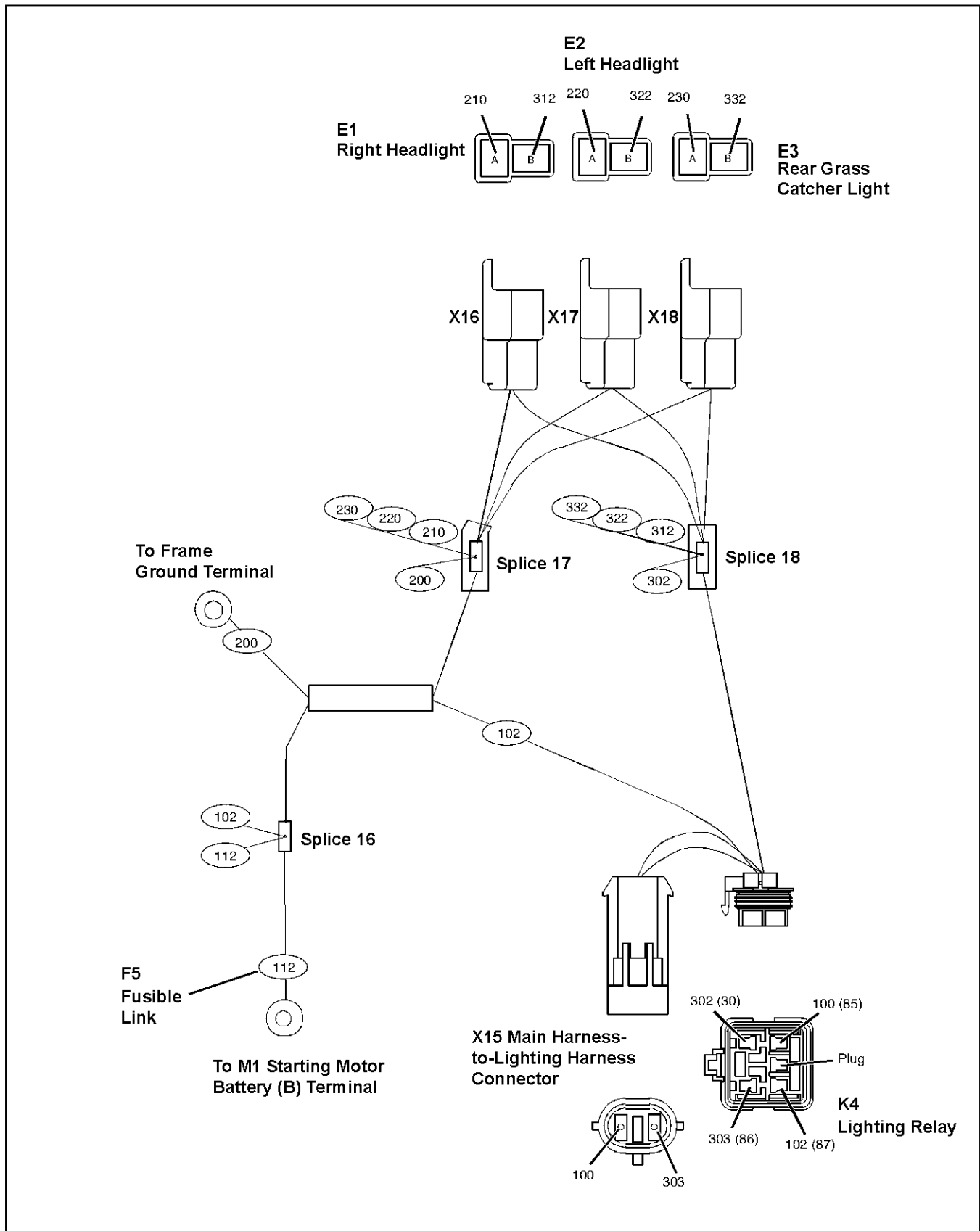
Circuit Number	Wire Size (mm ²)	Wire Color	Termination Points
215	1.0	Red	Y1 (A), Splice 10
218	2.0	Red	Splice 1, Splice 2
219	1.0	Red	X8 (D), Splice 1
220	1.0	Red	S3, Splice 2
221	0.8	Red	X10, Splice 3
222	0.8	Red	S4, Splice 4
223	3.0	Red	K2 (30), Splice 15
224	0.8	Red	S7 (B), Splice 1
225	2.0	Red	X1 (S2), X1 (A)
226	1.0	Red	X1 (S1), Splice 8
227	3.0	Red	X1 (B), F4
229	0.8	Red	K1 (86), V1
231	1.0	Red	Splice 2, Splice 4
232	0.8	Red	K3 (85), Splice 10
233	0.8	Red	S2, X9 (D)
234	0.8	Red	S2, Splice 3
235	1.0	Red	Splice 1, Splice 3
236	1.0	Red	M2, Splice 4
238	3.0	Red	Splice 12, Splice 15
300	0.8	Org	S7 (D), X9 (B)
301	0.8	Org	K1 (85), X7 (B)
304	0.8	Org	X5, X7 (C)
305	0.8	Org	B2, V4
307	0.8	Org	V3, V4
308	0.8	Org	X13 (H), V3
309	0.8	Org	X12, V3
310	0.8	Org	R2, V3
312	0.8	Org	X13 (F), V4
313	1.0	Org	X14, X15
330	0.8	Grn	X13 (C), X7 (G)
400	0.8	Yel	X13 (A), Splice 9

ELECTRICAL SCHEMATICS AND HARNESSSES

Circuit Number	Wire Size (mm ²)	Wire Color	Termination Points
401	0.8	Yel	X13 (G), X7 (H)
402	0.8	Yel	Splice 9, Splice 10
403	0.8	Yel	X7 (E), Splice 9
405	0.8	Yel	V1, Splice 8
406	0.8	Yel	R2, X9 (C)
407	0.8	Yel	R2, X10
450	0.8	Grn	V2, Splice 13
451	0.8	Grn	K3 (86), V2
500	0.8	Blu	K2 (86), X7 (F)
501	0.8	Blu	N1, X9 (K)
502	0.8	Blu	X9 (F), S5
600	0.8	Brn	B1, Splice 13
601	0.8	Brn	X13 (E), Splice 13
602	3.0	Brn	N1, X3
603	3.0	Brn	N1, X3
604	2.0	Brn	K1 (30), M1 (S)
605	0.8	Brn	X11 (A), X9 (A)
606	0.8	Brn	X6, X7 (A)
650	0.8	Tan	X4, X7 (D)
800	0.8	Gry	S4, X9 (H)
901	3.0	Wht	K3 (87), Splice 11
902	0.8	Wht	S3, X9 (G)
903	3.0	Wht	K3 (30), Y1 (B)

ELECTRICAL SCHEMATICS AND HARNESSSES

Lighting Wiring Harness (W4)



M98626 (MIF)

ELECTRICAL SCHEMATICS AND HARNESSSES

Lighting Wiring Harness (W4) Wire Code Table

Circuit Number	Wire Size (mm ²)	Wire Color	Termination Points
100	0.8	Blk	X15, K4 (85)
102	1.0	Red	K4 (87), Splice 16
112	0.5	Fuse Link	M1, Splice 16
200	0.8	Blk	Frame Ground, Splice 17
210	0.8	Blk	X16, Splice 17
220	0.8	Blk	X17, Splice 17
230	0.8	Blk	X18, Splice 17
302	1.0	Red	K4 (30), Splice 18
303	0.8	Org	K4 (86), X15
312	0.8	Red	X16, Splice 18
322	0.8	Red	X17, Splice 18
332	0.8	Red	X18, Splice 18

ELECTRICAL OPERATION AND DIAGNOSTICS

Operation and Diagnostics

Diagnostic Codes

Note: The code will cycle continuously with a two second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed for additional codes.

Code 1-2

One pulse followed by a short pause, followed by two pulses: Indicates that the park brake switch is not activated. Engage park brake and repeat check procedure.

If the code continues to flash after the brake has been set, Perform "Park Brake Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 1-3

One pulse followed by a short pause, followed by three pulses: Indicates that the mow switch is activated. Move mow-transport lever to TRANSPORT position and repeat check procedure.

If the code continues to flash after the mow-transport lever has been moved to the TRANSPORT position, perform "Mow-Transport Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 2-1

Two pulses followed by a short pause, followed by one pulse: Indicates that the neutral switch is not in the NEUTRAL position. Move travel pedals to the NEUTRAL position and repeat check procedure.

If the code continues to flash after the travel pedals have been moved to the NEUTRAL position: perform, "Neutral Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 2-2

Two pulses followed by a short pause, followed by two pulses: Indicates that the mow-backlap valve is in the BACKLAP position. Move mow-backlap valve to MOW position and repeat check procedure.

If the code continues to flash after the mow-backlap valve has been moved to the MOW position, Perform "Backlap Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 3-1

Three pulses followed by a short pause, followed by another pulse, indicates an over-voltage condition (voltage input to control box over 18 volts). (See "System: Charging

Circuit Diagnosis" on page 194.)

Note: When the following codes are displayed, no output LED indicators will be lit.

Circuit connected to the output connector of the interlock module operate by switching the ground side of the circuit.

Code 3-2

Three pulses followed by a short pause, followed by two pulses: Indicates a wiring harness failure. Proceed to (See "Interlock Module Check" on page 213.)

Code 3-3

Three pulses followed by a short pause, followed by three pulses: Indicates an output short to positive 12-volt failure. Proceed to test. (See "Interlock Module Check" on page 213.) Failure condition on a components (or more) of the following circuits:

- Raise-lower valve circuit
- Cranking circuit
- Discharge LED circuit
- Glow plug circuit
- Mow circuit

See individual circuit diagnosis for diagnostic procedures.

Code 3-4

Three pulses followed by a short pause, followed by four pulses: Indicates a fuel solenoid circuit failure.

Code 3-5

Three pulses followed by a short pause, followed by five pulses: Indicates fuel hold internal checking failure on circuit board or fuel hold output miswired to +12-volts.

Code 3-6

Three pulses followed by a short pause, followed by six pulses: Indicates a faulty power or ground connection to the control board.

Code 3-7

Three pulses followed by a short pause, followed by seven pulses: Indicates a faulty power or ground connection to the control board.

Code 3-8

Three pulses followed by a short pause, followed by eight pulses: Indicates a faulty power or ground connection to the control board.

- If there is no response to the key switch and no codes indicated as described above, proceed to the (See

“Interlock Module Check” on page 213.)

Cranking Circuit Operation

Function

The cranking circuit provides a signal to the interlock module to energize or de-energize the starting motor and fuel shutoff solenoid.

Operating Conditions

To crank the engine, the following conditions must be met:

- Park brake LOCKED.
- Travel pedals in NEUTRAL position.
- Mow-transport switch in TRANSPORT position.
- Backlap switch in MOW position.
- Key switch in START position.

Theory of Operation

The power circuit provides voltage to the key switch and protects the electrical system.

Voltage is available from the battery (G1) positive (+) terminal to the following circuits and components:

- 002 fusible link (F2).
- Splice 15.
- 238 Red wire.
- Splice 12.
- 200 Red wire.
- 15-amp fuse (F4).
- 227 Red wire.
- Key switch (S1), terminal B.
- Starting motor (M1), battery terminal.
- 001 fusible link (F1).
- Splice 14.
- 206 Red wire.
- Starting motor relay (K1), terminal 87.

When the key switch (S1) is in the RUN or START position, voltage is available from key switch, terminal A, to the following:

- Neutral switch (S2).
- Mow-transport switch (S6).
- Park brake switch (S3).
- Backlap switch (S5).
- Interlock module (A1) connector (X8), terminal D.

With voltage available to the interlock module, the interlock

module continues to operate until the key switch is turned to the OFF position. Ground is provided to interlock module connector (X8), terminals B and C, through the following circuits:

- 106 Blk wire.
- 107 Blk wire.
- Splice 7.
- 102 Blk wire.
- Splice 6.
- 109 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

Starting Motor Circuit

With the key switch in the START position and the operating conditions met, the interlock module provides a controlled ground to the starting motor relay (K1), energizing the relay. The controlled ground is provided from interlock module connector (X7), terminal B, to starting motor relay, terminal 85.

With starting motor relay energized, current flows between relay terminals 87 and 30, to the starting motor solenoid, engaging the starting motor.

With the key switch in the START position, current flows from key switch terminal (S1), to the following:

- 226 Red wire.
- Splice 8.
- 209 Red wire.
- Interlock module connector (X9), terminal E.
- Also at splice 8 connection, 405 Yel wire.
- Starting motor relay diode (V1).
- 229 Red wire.
- Starting motor relay (K1), terminal 86 and 85.
- 301 Org wire.
- Interlock module connector (X7), terminal B.

Fuel Shutoff Circuit

During engine starting the fuel shutoff pull-in coil is momentarily activated and the hold-in coil continues to operate when the key switch is turned from the START to RUN position. (See “Run Circuit Operation” on page 155.)

With key switch in the START position and the operating conditions met, the interlock module provides voltage to pull-in coil relay terminal 85. Initially during engine starting, engine oil pressure switch (B1) is in the CLOSED position,

ELECTRICAL OPERATION AND DIAGNOSTICS

allowing current to flow between pull-in coil relay terminals 85 and 86, energizing the relay. To energize pull-in coil relay (K3), current flows from interlock module connector (X7), terminal E, through the following circuits and components:

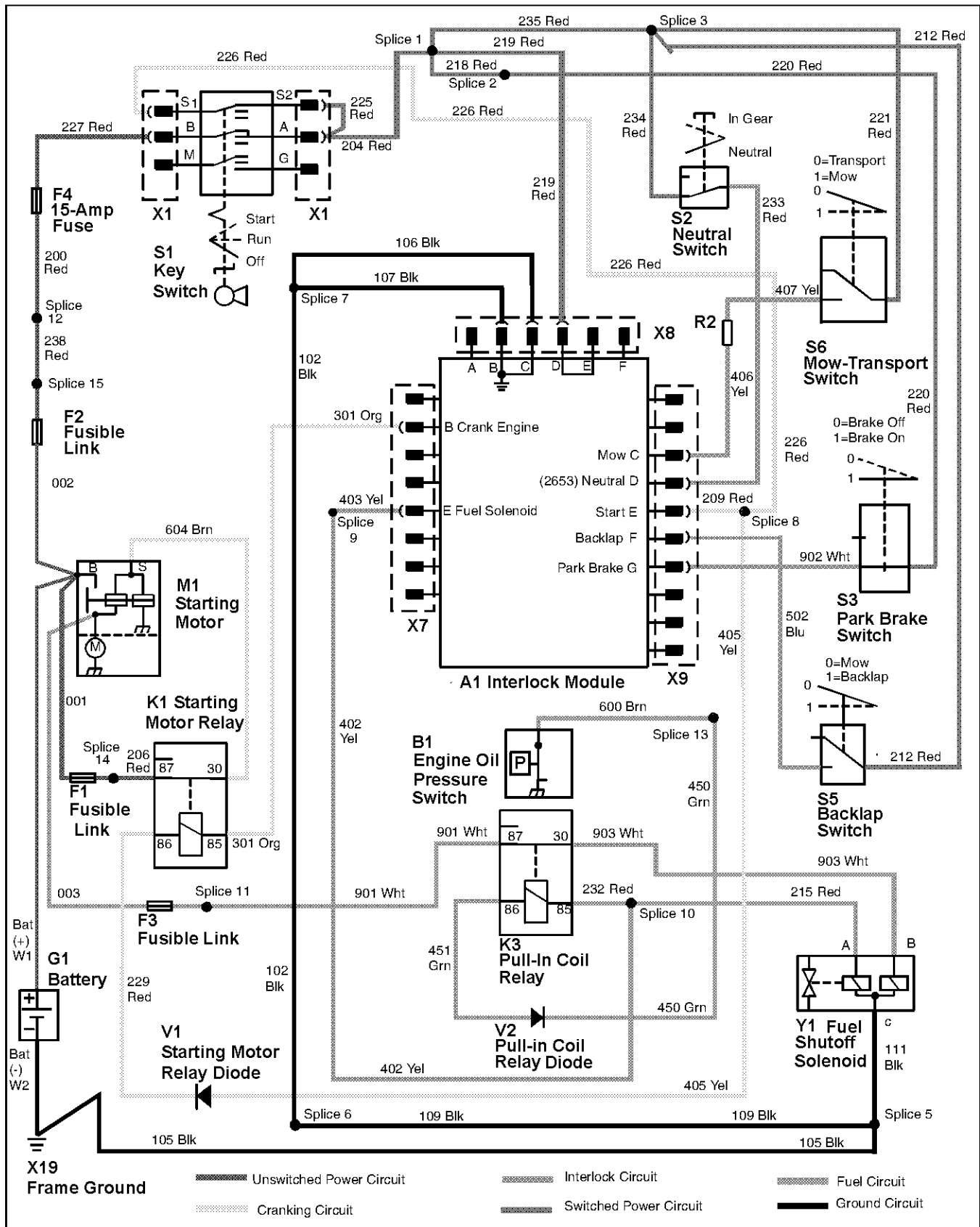
- 403 Yel wire.
- Splice 9.
- 402 Yel wire.
- Splice 10.
- 232 Red wire.
- Pull-in coil relay (K3), terminals 85 and 86.
- 451 Grn wire.
- Pull-in coil relay diode (V2).
- 450 Grn wire.
- Splice 13.
- 600 Brn.
- Engine oil pressure switch (B1).

With pull-in coil relay and starting motor solenoid energized, current flows to fuel shutoff solenoid pull-in coil, energizing the pull-in coil. Current flows through the following circuit and components to energize the pull-in coil:

- Starting motor solenoid terminal.
- 003 fusible link (F3).
- Splice 11.
- 901 Wht wire.
- Pull-in coil relay (K3), terminal 87 and 30.
- 903 Wht wire.
- Fuel shutoff solenoid (Y1), terminals B and C.
- 111 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

The fuel shutoff pull-in coil remains energized until the key switch is turned to the run position or the oil pressure switch contacts open.

Cranking Circuit Schematic



MX24022

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Cranking Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

Diagnostic Codes

Note: The code will cycle continuously with a 2 second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed for additional codes.

Code 1-2

One pulse followed by a short pause, followed by two pulses (Code 1-2): Indicates that the park brake switch is not activated. Engage park brake and repeat check procedure.

If the code continues to flash after the park brake has been set, perform "Park Brake Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 1-3

One pulse followed by a short pause, followed by three pulses (Code 1-3): Indicates that the mow switch is activated. Move mow-transport lever to TRANSPORT position and repeat check procedure.

If the code continues to flash after the mow-transport lever has been moved to the TRANSPORT position, perform "Mow-Transport Switch" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 2-1

Two pulses followed by a short pause, followed by one pulse: Indicates that the Neutral switch is not in the NEUTRAL position. Move travel pedals to the NEUTRAL position and repeat check procedure.

If the code continues to flash after the travel pedals have been moved to the NEUTRAL position, perform "Neutral Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

Code 2-2

Two pulses followed by a short pause, followed by two pulses (Code 2-2): Indicates that the mow-backlap valve is in BACKLAP position. Move mow-backlap valve to MOW position and repeat check procedure.

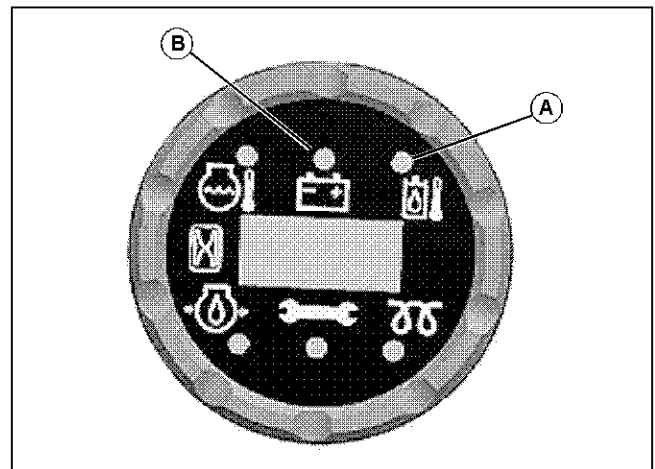
If the code continues to flash after the mow-backlap valve has been moved to the MOW position, perform "Backlap Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

- If there is no response to the key switch and no codes indicated as described above, test interlock module. (See "Interlock Module Check" on page 213.)

STEP 1: CRANKING CIRCUIT CHECK

Test Conditions

- Mow-transport lever in TRANSPORT position.
- Park brake LOCKED.
- Travel pedals in NEUTRAL position.
- Backlap switch in MOW position.

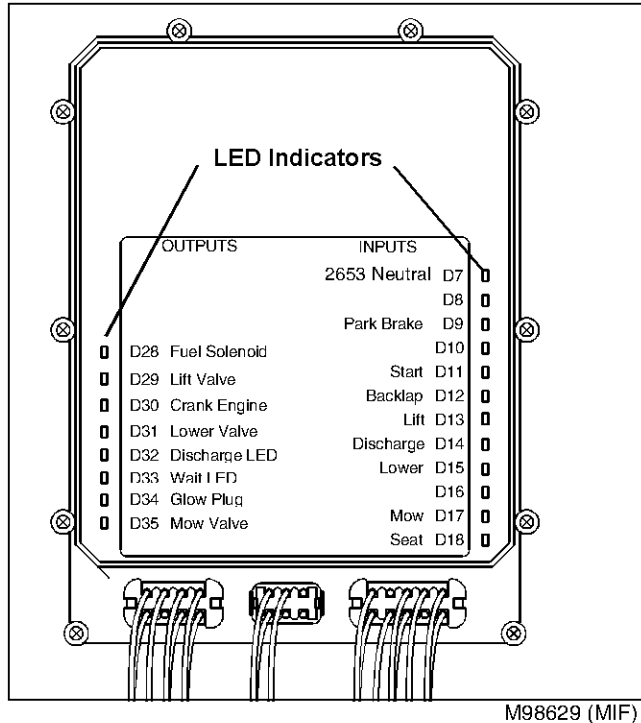


MX41835

- Turn key switch to START position.
- The engine should crank and start.
- If the engine does not crank, the oil pressure LED (A) and the battery discharge LED (B) will remain lit.
- If the engine does not crank, and the battery discharge LED does not come on, but the oil pressure LED does, check interlock module. (See "Interlock Module Check" on page 213.)
- If the engine does not crank, and the battery discharge and oil pressure LEDs do come on, but do not flash a code on the interlock module, perform "Key Switch Input" test. (See "STEP 2: INPUT CIRCUIT LED CHECK" on page 148.)

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STEP 2: INPUT CIRCUIT LED CHECK



Test Conditions

- Key switch in RUN position.

Key Switch Input

1. Open interlock module compartment panel.
2. Disable the starting motor by disconnecting the starting motor solenoid 604 Brn wire.
3. Move key switch to the START position and back to the RUN position.
4. Observe the Start input LED (D11). The LED should be ON when the key switch is in the START position, and OFF when the key switch is in the RUN position.

Seat Switch Input

1. Press down on the lower cushion of the seat to engage the seat switch.
2. Observe the Seat input LED (D18). The LED should be ON when the seat switch is engaged (operator on seat).
3. Release the seat switch.
4. Observe the Seat input LED (D18). The LED should be OFF when the seat switch is released (operator off seat).

If the LED does not come ON, test "Seat Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 149.)

Park Brake Switch Input

1. Park brake is LOCKED.

2. Observe the Park Brake input LED (D9). The LED should be ON when the park brake is LOCKED.

3. Release the park brake.

4. Observe the Park Brake input LED (D9). The LED should be OFF when the park brake is released.

If the LED does not come ON, first check park brake switch adjustment. (See "Adjust Park Brake Switch" on page 351.) If Park Brake LED does not come ON after adjustment, test "Brake Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 149.)

Mow-Transport Switch Input

1. Move mow-transport lever to MOW position.
2. Observe the MOW input LED (D17). The LED should be ON when the mow-transport lever is in the MOW position (mow-transport switch engaged).

If the LED does not come ON, test "Mow-Transport Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 149.)

Backlap Switch Input

1. Move the backlap valve to the MOW position.
2. Observe the BACKLAP input LED (D12). The LED should be ON when the backlap valve is in the BACKLAP position and OFF when the valve is in the MOW position.

If the LED does not function as described, test "Backlap Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 149.)

Neutral Switch Input

1. Move the travel pedals to the NEUTRAL position.
2. Observe the Neutral input LED (D7). The LED should be ON when the travel pedals are in the NEUTRAL position and OFF when the travel pedals are moved out of position.

If the LED does not function as described, test "Travel Pedals Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 149.)

ELECTRICAL OPERATION AND DIAGNOSTICS

STEP 3: CIRCUIT TESTS

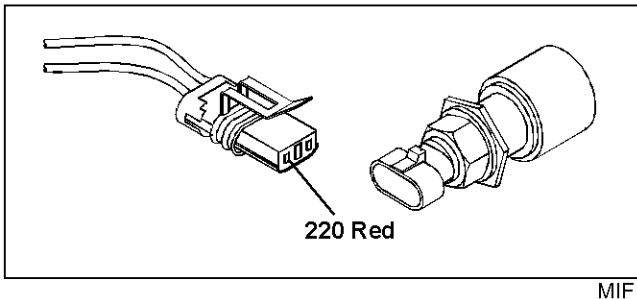
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Park Brake Switch Circuit Test

Test Conditions

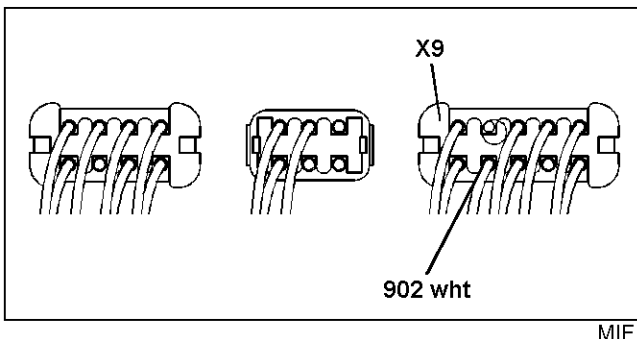
- Machine parked on a level surface
- Disable the starting motor by disconnecting the starting motor solenoid 604 Brn wire.
- Key switch in START position.
- Park brake LOCKED
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.



1. Measure voltage at park brake switch, 220 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 220, 218, and 204 Red wires and connections.



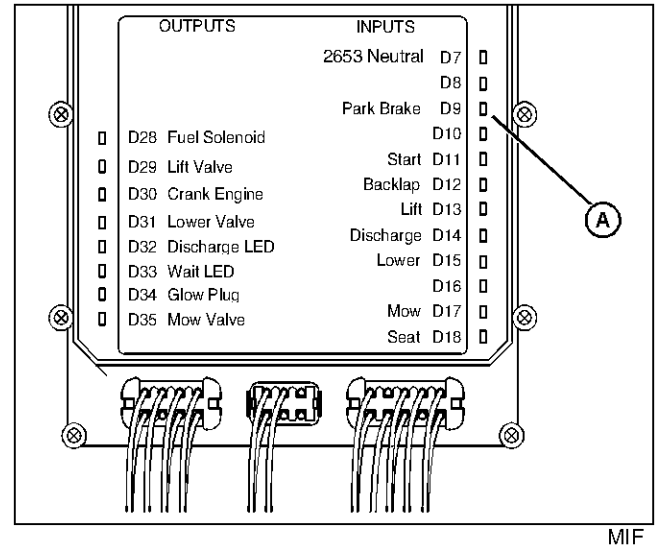
2. Park brake switch LOCKED position. Interlock module connector (X9), disconnected. Measure voltage at interlock module connector (X9), terminal G,

902 Wht wire. Is battery voltage present?

Yes: Go to next step.

No: Test 902 Wht wire and connections.

No: Test park brake switch. (See "Park Brake Switch Test" on page 222.)



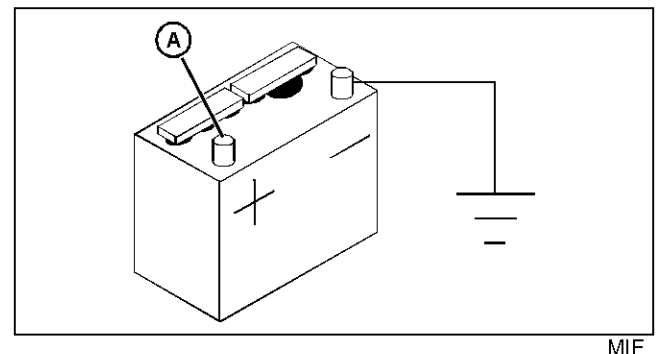
3. Interlock module LED Check. When the park brake is cycled between the LOCKED and UNLOCKED positions, does the park brake LED (A) turn ON and OFF?

No: Test interlock module. (See "Interlock Module Check" on page 213.)

Cranking Circuit Test

Test Conditions

- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

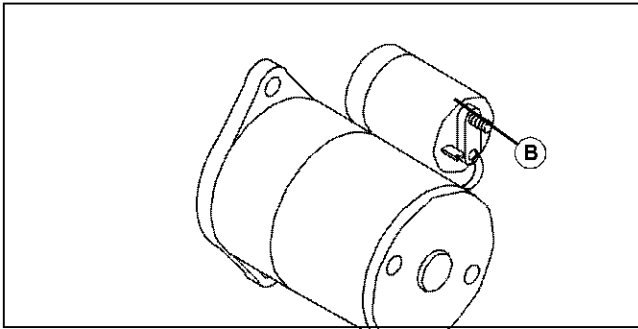


1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

ELECTRICAL OPERATION AND DIAGNOSTICS

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

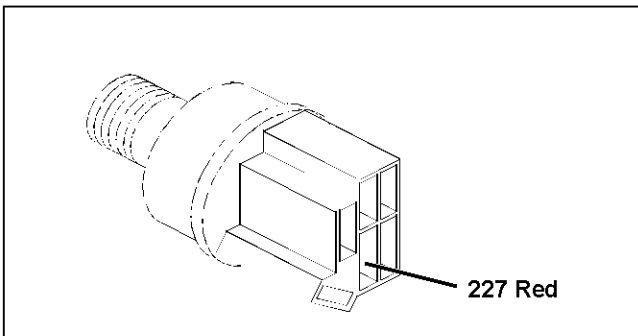


MIF

2. Measure voltage at starting motor solenoid battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

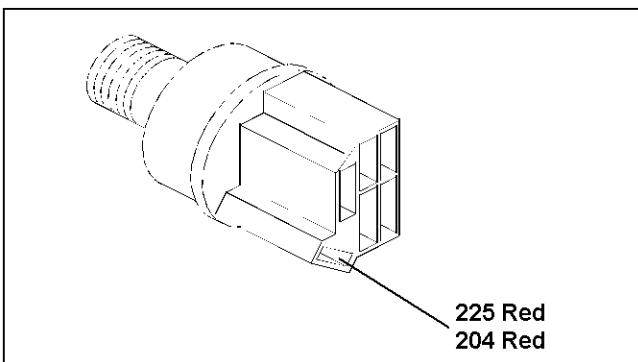
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.

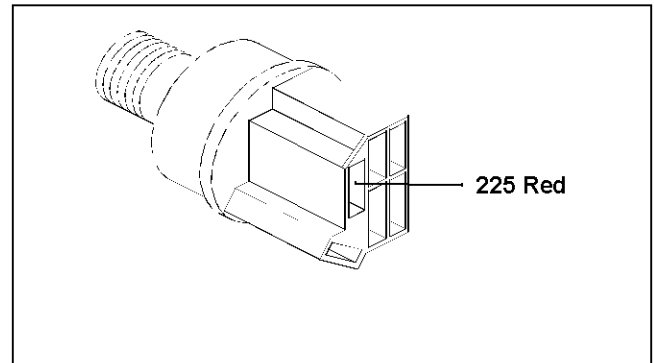


MIF

4. Measure voltage at key switch connector, terminal A, 204, and 225 Red wires. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See "Key Switch Test" on page 222.)

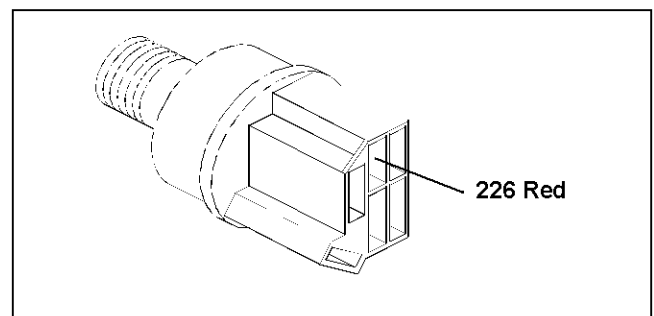


MIF

5. Measure voltage at key switch connector, terminal S2, 225 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 225 Red wire and connections.

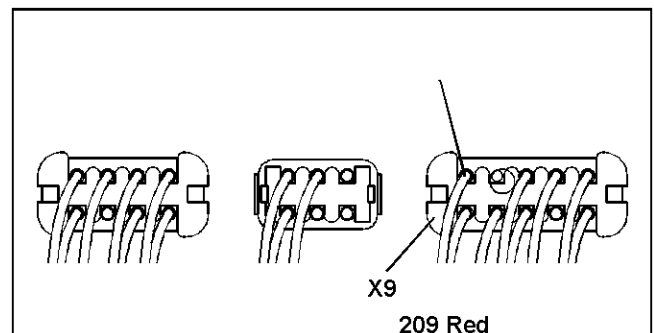


MIF

6. Measure voltage at key switch connector, terminal S1, 226 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See "Key Switch Test" on page 222.)



MIF

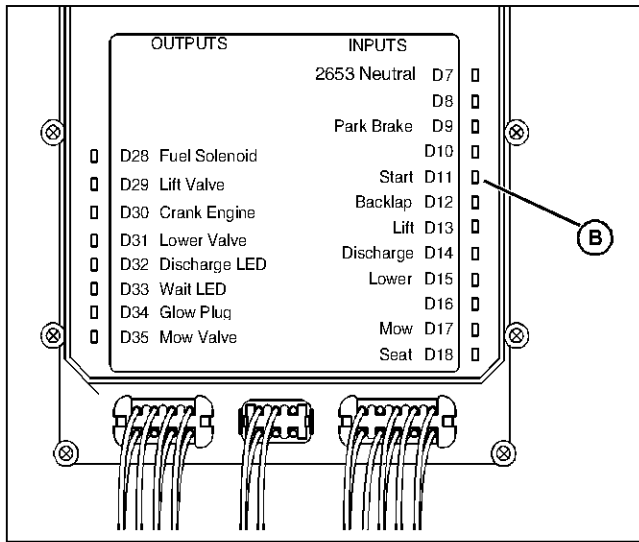
7. Measure voltage at interlock module (A1) connector (X9), terminal E, 209 Red wire. Is battery voltage

ELECTRICAL OPERATION AND DIAGNOSTICS

present?

Yes: Go to next step.

No: Test 209 Red wire and connections.

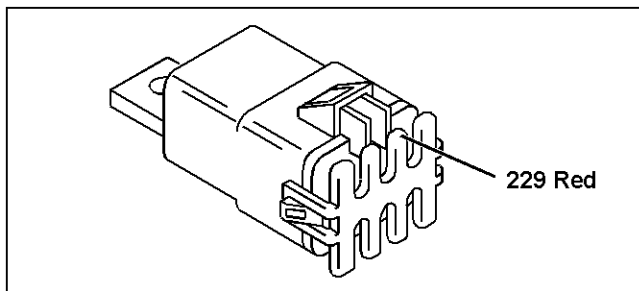


MIF

8. Interlock module LED Check. When the key switch is cycled between the START and RUN positions, does the start LED (B) turn ON and OFF?

Yes: Go to next step.

No: Test interlock module. (See "Interlock Module Check" on page 213.)



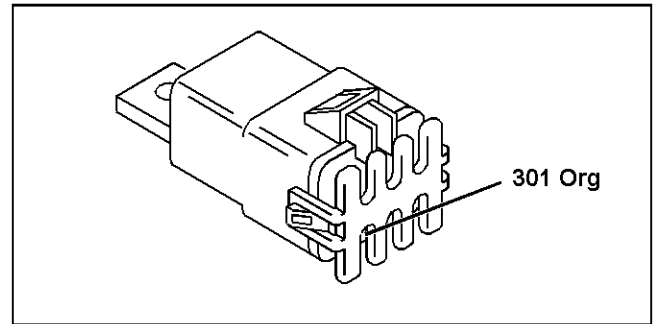
MIF

9. Measure voltage at starting motor relay (K1) terminal 86, 229 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 229 and 226 Red wires, and 405 Yel wire and connections.

No: Test starting motor relay diode (V1). (See "Diode Test" on page 220.)

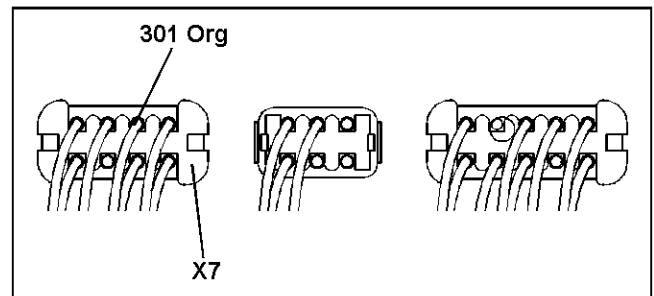


MIF

10. Interlock module connector (X7) disconnected. Measure voltage at starting motor relay (K1) terminal 85, 301 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test Relay. (See "Electrical Relays Test" on page 221.)

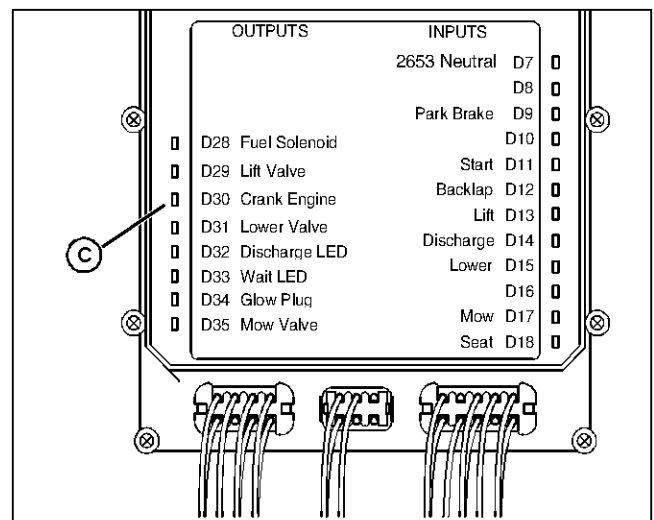


MIF

11. With interlock module connector (X7), disconnected, measure voltage at terminal B, 301 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 301 Org wire and connections.



MIF

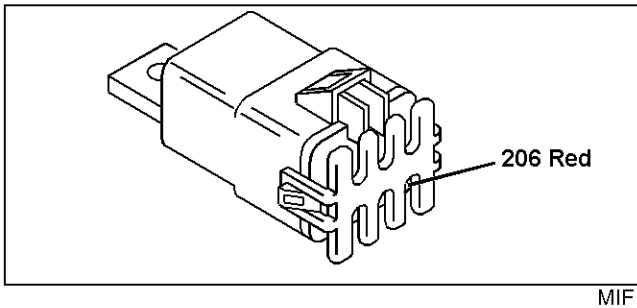
12. Interlock module connector (X7) connected. Interlock module LED Check. When the key switch is

ELECTRICAL OPERATION AND DIAGNOSTICS

cycled between the START and RUN positions, does crank engine LED (C) turn ON and OFF?

Yes: Go to next step.

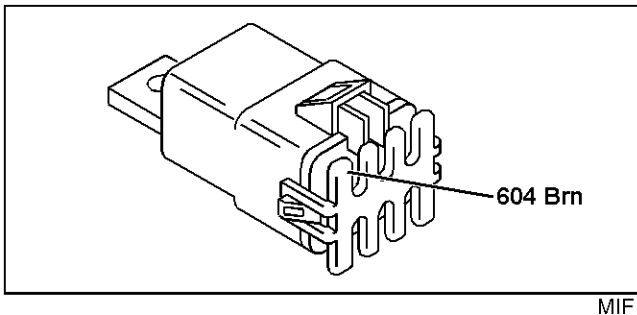
No: Test interlock module. (See "Interlock Module Check" on page 213.)



13. With interlock module connector (X7) connected. Measure voltage at starting motor relay (K1) terminal 87, 206 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 206 Red wire, fusible link (F1) and connections.



14. Key switch in the START position. Measure voltage at starting motor relay (K1) terminal 30, 604 Brn wire. Is battery voltage present?

Yes: Go to next step.

No: Test Relay. (See "Electrical Relays Test" on page 221.)

15. With the key switch in the START position, measure voltage at starting motor solenoid terminal, 604 Brn wire. Is battery voltage present?

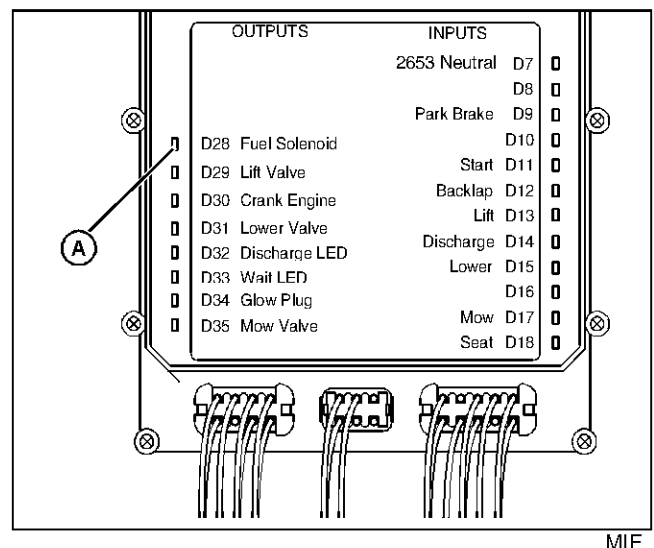
Yes: Test starting motor solenoid test. (See "Starting Motor Solenoid Test" on page 219.)

No: Test 604 Brn wire and connections.

Fuel Shutoff Solenoid Circuit Test

Test Conditions

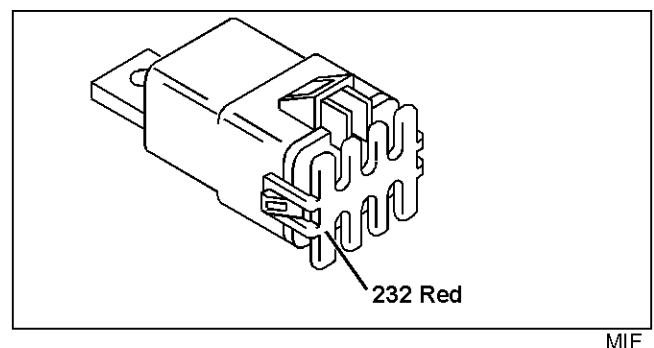
- Key switch in STOP position.
- Park brake LOCKED.
- Fuel shutoff solenoid (Y1) connector disconnected.
- Engine oil pressure switch (B1) connector disconnected.
- Interlock module connector (X9), connected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.



1. Interlock module LED Check. Is fuel solenoid LED (A) ON?

Yes: Go to next step.

No: Test interlock module. (See "Interlock Module Check" on page 213.)

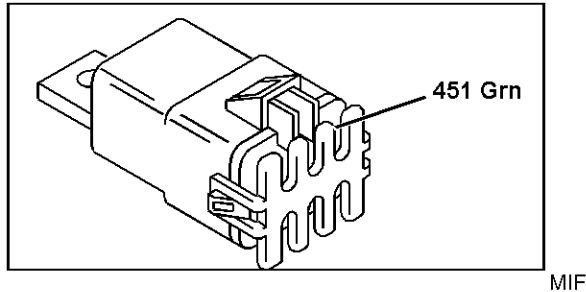


2. Measure voltage at pull-in coil relay (K3), terminal 85, 232 Red wire. Is battery voltage present?

Yes: Go to next step.

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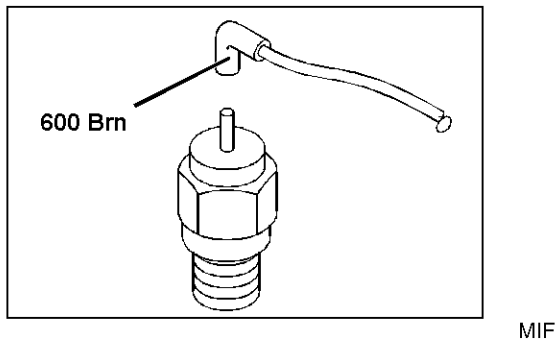
No: Test 232 Red wire and connections.



3. Disconnect engine oil pressure switch connector. Measure voltage at pull-in coil relay (K3), terminal 86, 451 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test relay. (See "Electrical Relays Test" on page 221.)

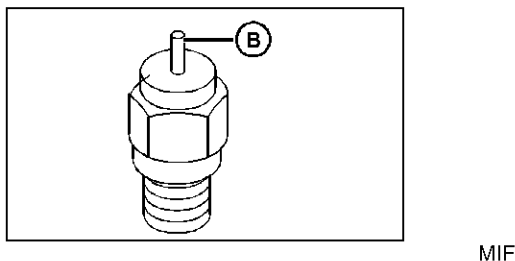


4. Measure voltage at engine oil pressure switch connector, 600 Brn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 600 Brn wire, and 450 and 451 Grn wires and connections.

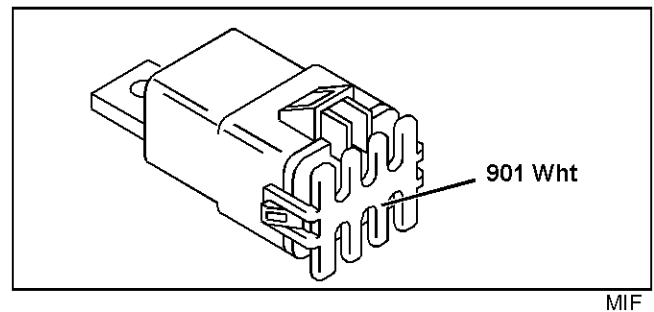
No: Test pull-in coil relay diode (V2). (See "Diode Test" on page 220.)



5. Measure resistance between engine oil pressure switch terminal (B) and ground. Is resistance less than 0.1 ohm?

Yes: Go to next step.

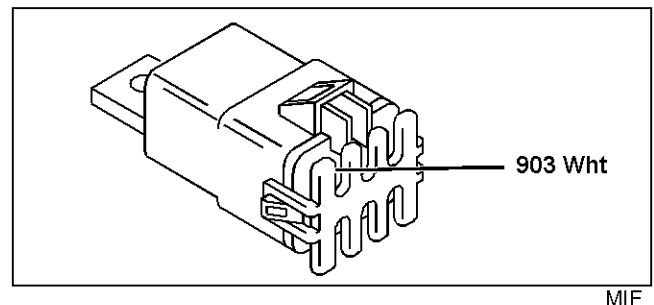
No: Test engine oil pressure switch. (See "Engine Oil Pressure Switch Test" on page 227.)



6. With the key switch in the START position, measure voltage at pull-in coil relay (K3), terminal 87, 901 Wht wire. Is battery voltage present?

Yes: Go to next step.

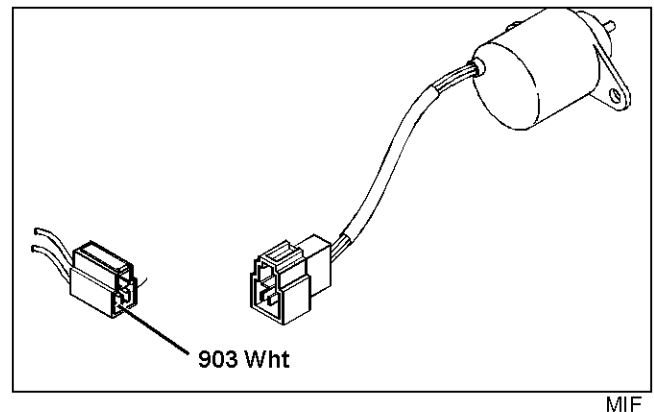
No: Test 901 Wht wire, fusible link (F3) and connections.



7. With the key switch in the START position, measure voltage at pull-in coil relay (K3), terminal 30, 903 Wht wire. Is battery voltage present?

Yes: Go to next step.

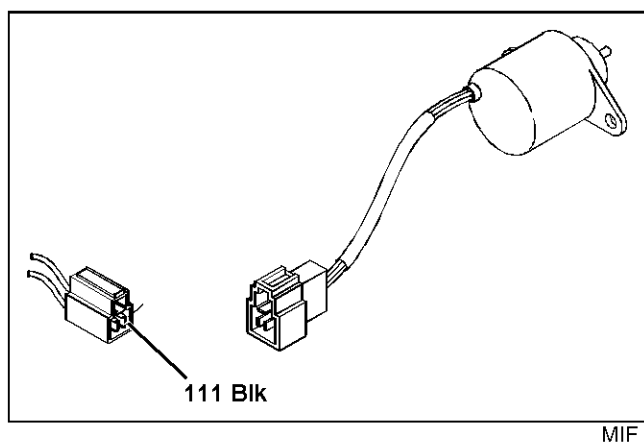
No: Test relay. (See "Electrical Relays Test" on page 221.)



8. With the key switch in the START position, measure voltage at fuel shutoff solenoid terminal, 903 Wht wire. Is battery voltage present?

Yes: Go to next step.

No: Test 903 Wht wire and connections.



9. Measure resistance between fuel shutoff solenoid connector terminal 111 Blk wire, and ground. Is resistance less than 0.1 ohm?

Yes: Test fuel shutoff solenoid. (See "Fuel Shutoff Solenoid Test" on page 226.)

No: Test 111 and 105 Blk wires and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS

Run Circuit Operation

Function

The run circuit provides voltage to switches and components to allow the engine to run when the operator is ON the seat or OFF the seat.

Operating Conditions:

- Key switch in RUN position - engine operating.
- Operator ON seat.
- Park brake UNLOCKED.

Theory of Operation

The power circuit provides voltage to the key switch and protects the electrical system.

Voltage is available from the battery (G1) positive (+) terminal to the following circuits and components:

- 002 fusible link (F2).
 - Splice 15.
 - 238 Red wire.
 - Splice 12.
 - 200 Red wire.
 - 15-amp fuse (F4).
 - 227 Red wire.
 - Key switch (S1), terminal B.
- When the key switch (S1) is in the RUN position, voltage is available from key switch, terminal A, to the following:
- Fuel pump (M2).
 - Park brake switch (S3).
 - Seat switch (S4).
 - Interlock module (A1) connector (X8), terminal D.

With voltage available to the interlock module, the interlock module continues to operate until the key switch is turned to the OFF position. Ground is provided to interlock module connector (X8), terminals B and C, through the following circuits:

- 106 Blk wire.
- 107 Blk wire.
- Splice 7.
- 102 Blk wire.
- Splice 6.
- 109 Blk wire.
- Splice 5.
- 105 Blk wire.

- Frame ground (X19).

Operator ON Seat

When the operator is ON the seat, the seat switch is engaged, allowing current to flow from the seat switch to the interlock module seat input, activating the input. To activate the seat input, current flows from the switch through 800 Gry wire to the interlock module connector (X9), terminal H.

With the seat input activated, current flows from the interlock module to fuel shutoff solenoid (Y1) hold-in coil, energizing the coil. To energize the hold-in coil, current flows from interlock module connector (X9) terminal E, through the following circuits and components:

- 403 Yel wire.
- Splice 9.
- 402 Yel wire.
- Splice 10.
- 215 Red wire.
- Fuel shutoff solenoid (Y1) terminals A and C.
- 111 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

The fuel shutoff hold-in coil will keep the fuel shutoff solenoid energized, allowing fuel to be supplied to the engine until one of the following conditions should occur:

- Operator OFF the seat without the park brake LOCKED.
- Key switch turned to the OFF position.

Operator OFF Seat

To allow the engine to run with the operator off the seat, the park brake must be LOCKED. With the park brake locked, the park brake linkage places park brake switch (S3) in the ON position.

With the park brake switch in the ON position, current flows from the switch to interlock module park brake input, activating the input. When activating the park brake input, current flows from the park brake switch through 902 Wht wire to interlock module connector (X9), terminal G.

With the park brake input active, current flows from the interlock module to the fuel shutoff solenoid (Y1) hold-in coil, energizing the coil. To energize the hold-in coil, current flows from interlock module (X9), terminal E, through the following circuits and components:

- 403 Yel wire.
- Splice 9.

ELECTRICAL OPERATION AND DIAGNOSTICS

- 402 Yel wire.
- Splice 10.
- 215 Red wire.
- Fuel shutoff solenoid (Y1) terminals A and C.
- 111 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

The fuel shutoff hold-in coil will keep the fuel shutoff solenoid energized, allowing fuel to be supplied to the engine until the key switch is turned to the OFF position.

Fuel Pump Circuit

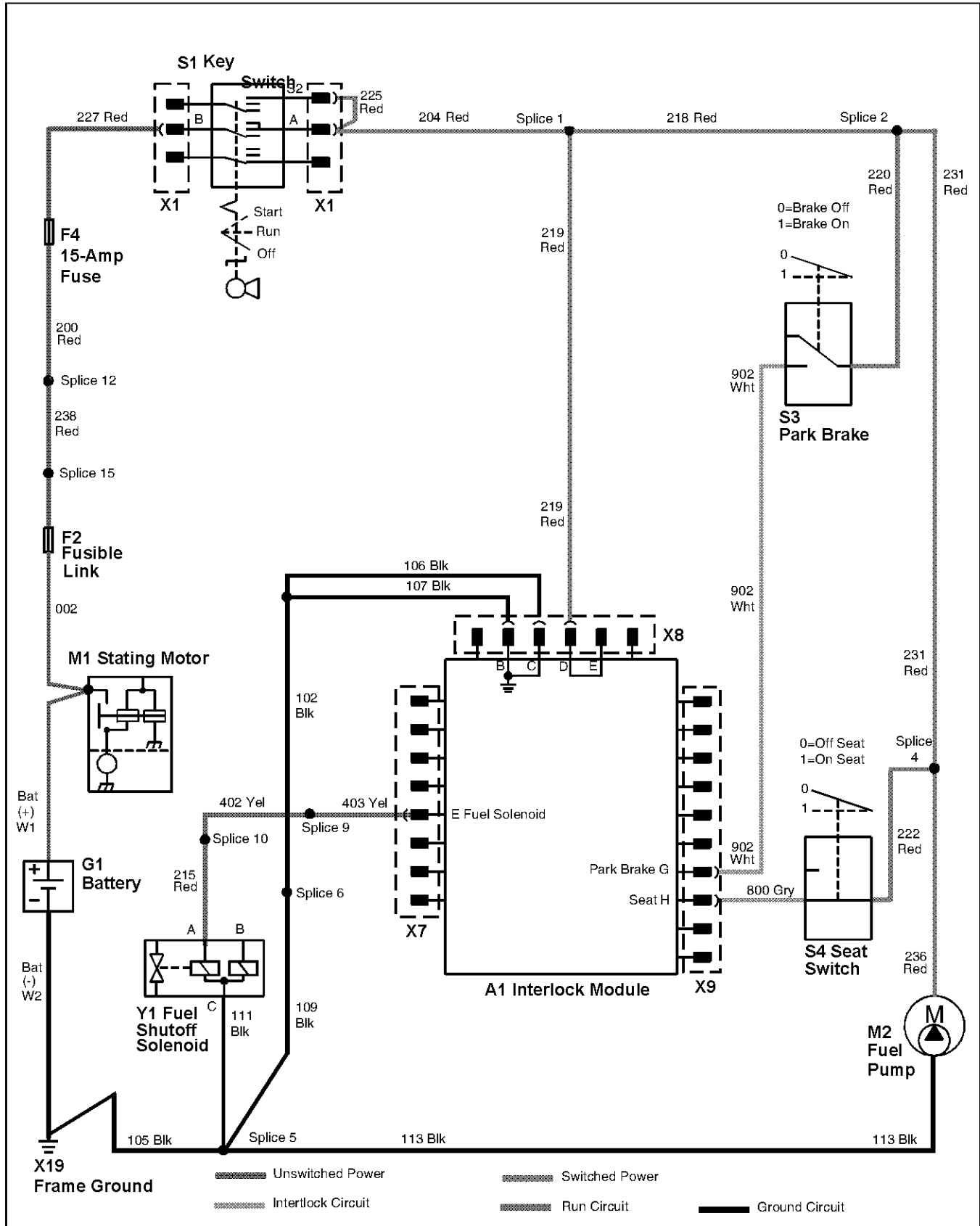
With the key switch (S1) is in the RUN position, current flows from the key switch to the fuel pump (M2), operating the fuel pump. To operate the fuel pump, current flows from key switch terminal A through the following circuits and components:

- 204 Red wire.
- Splice 1.
- 218 Red wire.
- Splice 2.
- 231 Red wire.
- Splice 4.
- 236 Red wire.
- Fuel pump (M2).
- 113 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

The fuel pump operates continuously when the key switch is in the RUN position.

ELECTRICAL OPERATION AND DIAGNOSTICS

Run Circuit Schematic



ELECTRICAL OPERATION AND DIAGNOSTICS

System: Run Circuit Diagnosis

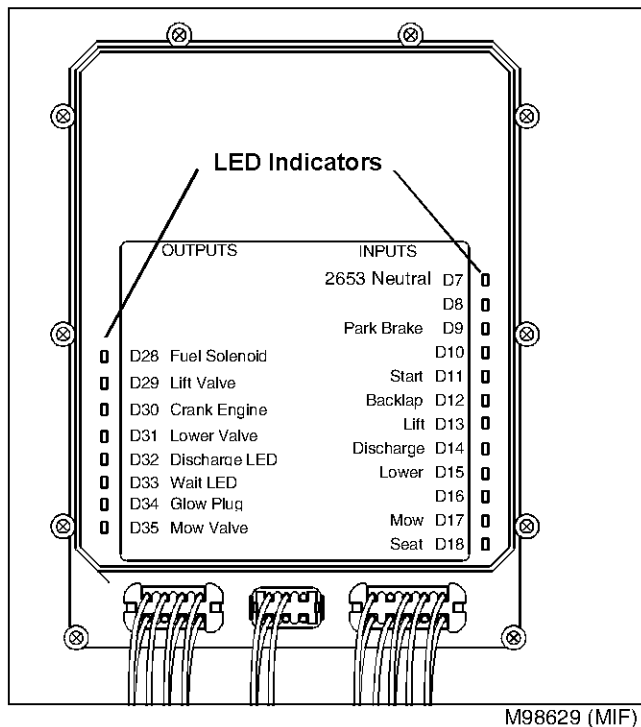
The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module test. (See "Interlock Module Check" on page 213.)

STEP 2: INPUT CIRCUIT LED CHECK



Test Conditions

- Key switch in RUN position.

Seat Switch Input

1. Press down on the lower cushion of the seat to engage the seat switch.
2. Observe the Seat input LED (D18). The LED should be ON when the seat switch is engaged (operator on seat).
3. Release the seat switch
4. Observe the Seat input LED (D18). The LED should be OFF when the seat switch is released (operator off seat).

If the LED does not come ON, perform "Seat Switch

Circuit" test. (See "Seat Switch Test" on page 223.)

Park Brake Switch Input

1. Engage the park brake.
2. Observe the Park Brake input LED (D9). The LED should be ON when the park brake is set (park brake switch LOCKED).
3. Release the park brake.
4. Observe the Park Brake input LED (D9). The LED should be OFF when the park brake is released (park brake switch is UNLOCKED).

If the LED does not come ON, first check park brake switch adjustment. (See "Adjust Park Brake Switch" on page 351.) If park brake LED does not come ON after adjustment, perform "Park Brake Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 159.)

Fuel Solenoid Output

1. Release park brake.
 2. Press down on the lower cushion of the seat to engage the seat switch.
 3. Observe the Fuel Solenoid output LED (D28). The LED should be ON when the seat switch is engaged (operator on seat).
 4. Release the seat switch.
 5. Observe the Fuel Solenoid output LED (D28). The LED should be OFF when the seat switch is released (operator off seat).
- If the LED does not come ON, perform "Seat Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 159.)
6. LOCK the park brake.
 7. Observe the Fuel Solenoid output LED (D28). The LED should be ON when the park brake is LOCKED (park brake switch LOCKED).

8. Release the park brake.
9. Observe the Fuel Solenoid output LED (D28). The LED should be OFF when the park brake is UNLOCKED (park brake switch is released).

If the LED does not come ON, first check brake switch adjustment. (See "Adjust Park Brake Switch" on page 351.) If fuel solenoid LED does not come ON after adjustment, perform "Park Brake Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 159.)

If the fuel solenoid output LED functions as described, but the fuel shutoff solenoid does not engage (engine does not run), perform "Fuel Shutoff Solenoid Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 159.)

ELECTRICAL OPERATION AND DIAGNOSTICS

STEP 3: CIRCUIT TESTS

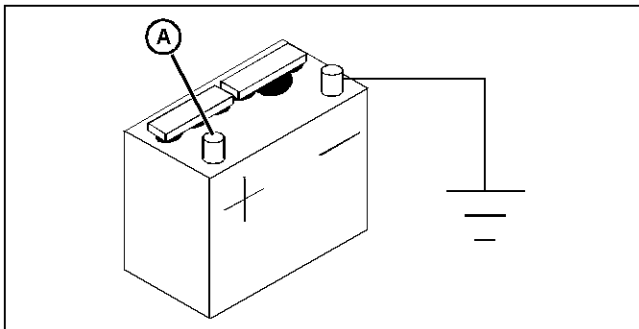
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Seat Switch Circuit Test

Test Conditions

- Machine parked on a level surface.
- Park brake in LOCKED position.
- Key switch in RUN position.
- Travel pedals to NEUTRAL position.
- Seat Switch ENGAGED.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.

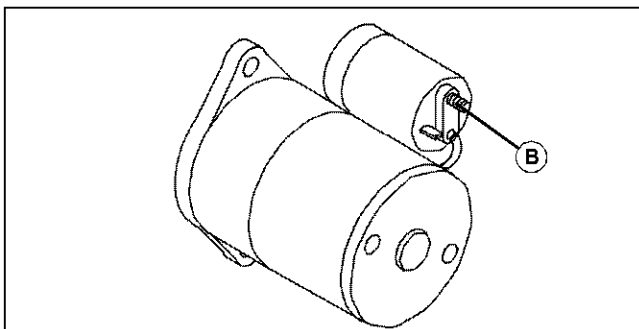


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)



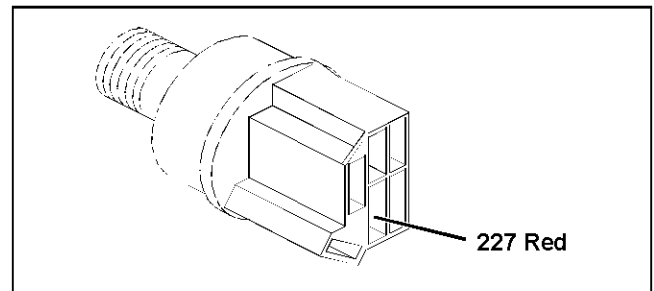
MIF

2. Measure voltage at starting motor solenoid, battery

terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

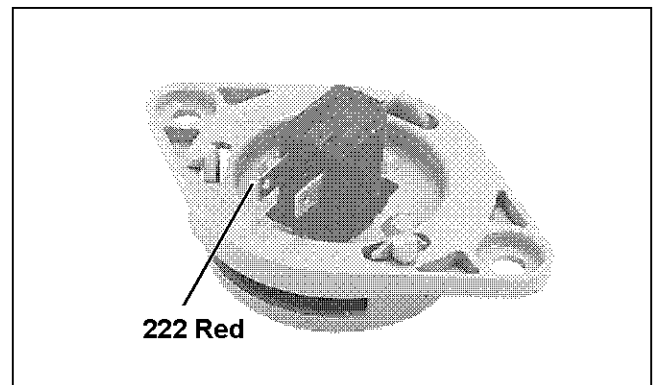
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.



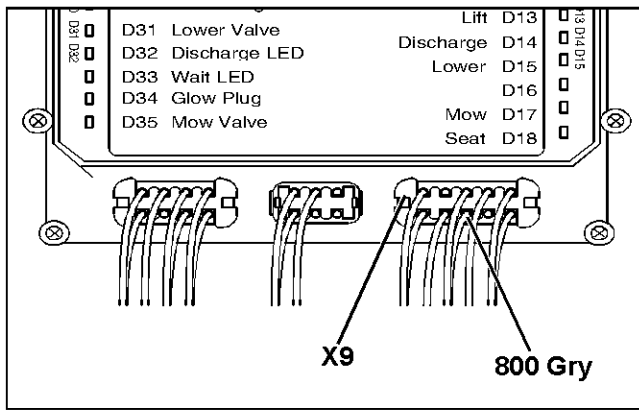
MIF

4. Measure voltage at seat terminal 222 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 222, 231, 218, and 204 Red wires and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS



M98629

5. Seat switch connector connected. Seat switch engaged. Interlock module connector (X9), disconnected. Measure voltage at interlock module connector (X9), terminal H, 800 Gry wire. Is battery voltage present?

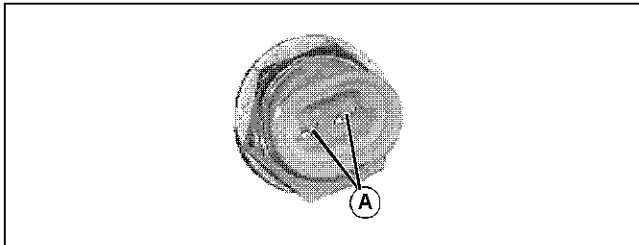
No: Test 800 Gry wire and connections.

No: Test seat switch. (See "Seat Switch Test" on page 223.)

Park Brake Switch Circuit Test

Test Conditions

- Park machine on level surface.
- Lower cutting units to the ground.
- Turn key switch to OFF position.
- Park brake UNLOCKED.
- Disconnect brake switch connector.

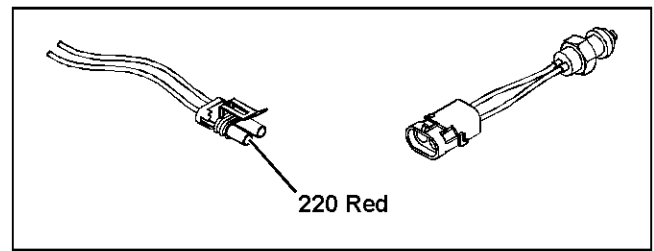


M98551

1. Check continuity across switch terminals (A). There should be NO continuity.

Yes: Go to next step.

No: Is voltage on connector terminal 220 Red wire?

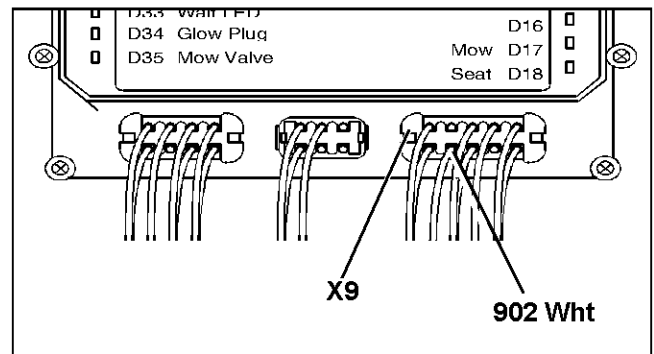


MIF

2. If continuity is across switch. (See "Park Brake Switch Test" on page 222.)

Yes: Go to next step.

No: Test 220, 218, and 204 Red wires and connections.



MIF

3. Interlock module connector (X9) disconnected. Park brake connector, connected. Check voltage on interlock module connector (X9), terminal G, 902 Wht wire with park brake LOCKED. Is battery voltage present?

Yes: Go to next step.

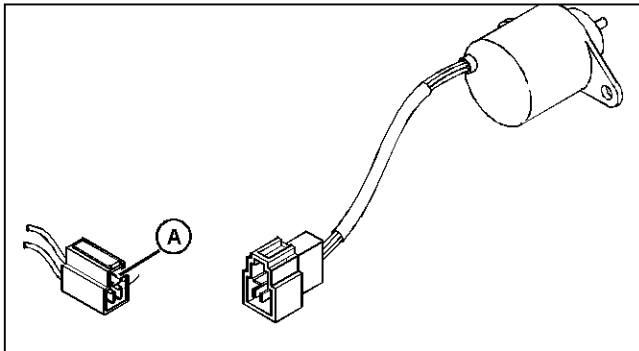
No: Check interlock module. (See "Interlock Module Check" on page 213.)

ELECTRICAL OPERATION AND DIAGNOSTICS

Fuel Shutoff Solenoid Circuit Test

Test Conditions

- Key switch in STOP position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Fuel shutoff solenoid connector disconnected.
- Engine oil pressure switch connector disconnected.

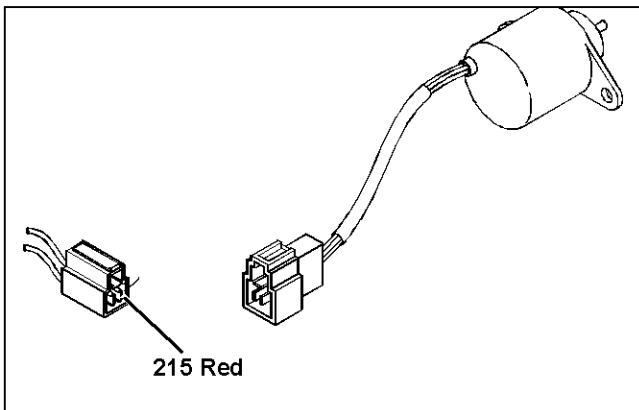


MIF

1. Check continuity from fuel shutoff solenoid (Y1) connector position (A) to ground. Is resistance less than 0.1 ohm?¹

Yes: Go to next step.

No: Test 111 and 105 Blk wires and test fuel solenoid. (See "Fuel Shutoff Solenoid Test" on page 226.)



MIF

2. Key switch in RUN position; engine not running. Measure voltage at fuel shutoff solenoid connector, 215 Red wire. Is voltage present?

No: Test 215 Red wire, 402 and 403 Yel wires and connections.

¹ Some ohmmeters may not provide an accurate reading at a very low resistance. Touch meter probe leads together and subtract shorted probe reading from the measured resistance reading.

ELECTRICAL OPERATION AND DIAGNOSTICS

Raise-Lower Circuit Operation

Function

The raise-lower switch provides a signal to the interlock module to raise and lower the cutting units.

Operating Conditions

- Key switch in the RUN position - engine operating.
- Operator ON seat or park brake LOCKED.

Theory of Operation

The power circuit provides voltage to the key switch and protects the electrical system.

Voltage is available from the battery (G1) positive (+) terminal to the following circuits and components:

- 002 fusible link (F2).
- Splice 15.
- 238 Red wire.
- Splice 12.
- 200 Red wire.
- 15-amp fuse (F4).
- 227 Red wire.
- Key switch (S1), terminal B.

When the key switch (S1) is in the RUN position, voltage is available from key switch, terminal A, to the following:

- Raise-lower switch (S7).
- Raise valve solenoid (Y3).
- Lower valve solenoid (Y4).
- Interlock module (A1) connector (X8) terminal D.

With voltage available to the interlock module, the interlock module continues to operate until the key switch is turned to the OFF position. Ground is provided to interlock module connector (X8), terminals B and C, through the following circuits:

- 106 Blk wire.
- 107 Blk wire.
- Splice 7.
- 102 Blk wire.
- Splice 6.
- 109 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

Raise Circuit

When the operating conditions are met and when the raise-lower switch is placed in the RAISE position, a signal is provided from the raise-lower switch to the interlock module lift input, activating the lift input. With the lift input active, the interlock module provides the controlled ground to raise valve solenoid (Y3) energizing the solenoid. With the solenoid energized, the cutting units are raised.

To activate the lift input, current flows through the following circuit and components:

- Raise-lower switch (S7).
- 605 Brn wire.
- Interlock module connector (X9), terminal A.

With the lift input activated, the interlock module supplies a controlled ground to the raise valve solenoid through the following circuit and components:

- Interlock module connector (X7), terminal A.
- 606 Brn wire.
- Raise valve solenoid (Y3).

Lower Circuit

When the operating conditions are met and when the raise-lower switch is placed in the LOWER position, a signal is provided from the raise-lower switch to the interlock module lower input, activating the lower input. With the lower input active, the interlock module provides the controlled ground to lower valve solenoid (Y4) energizing the solenoid. With the solenoid energized, the cutting units are lowered.

To activate the lower input, current flows through the following circuit and components:

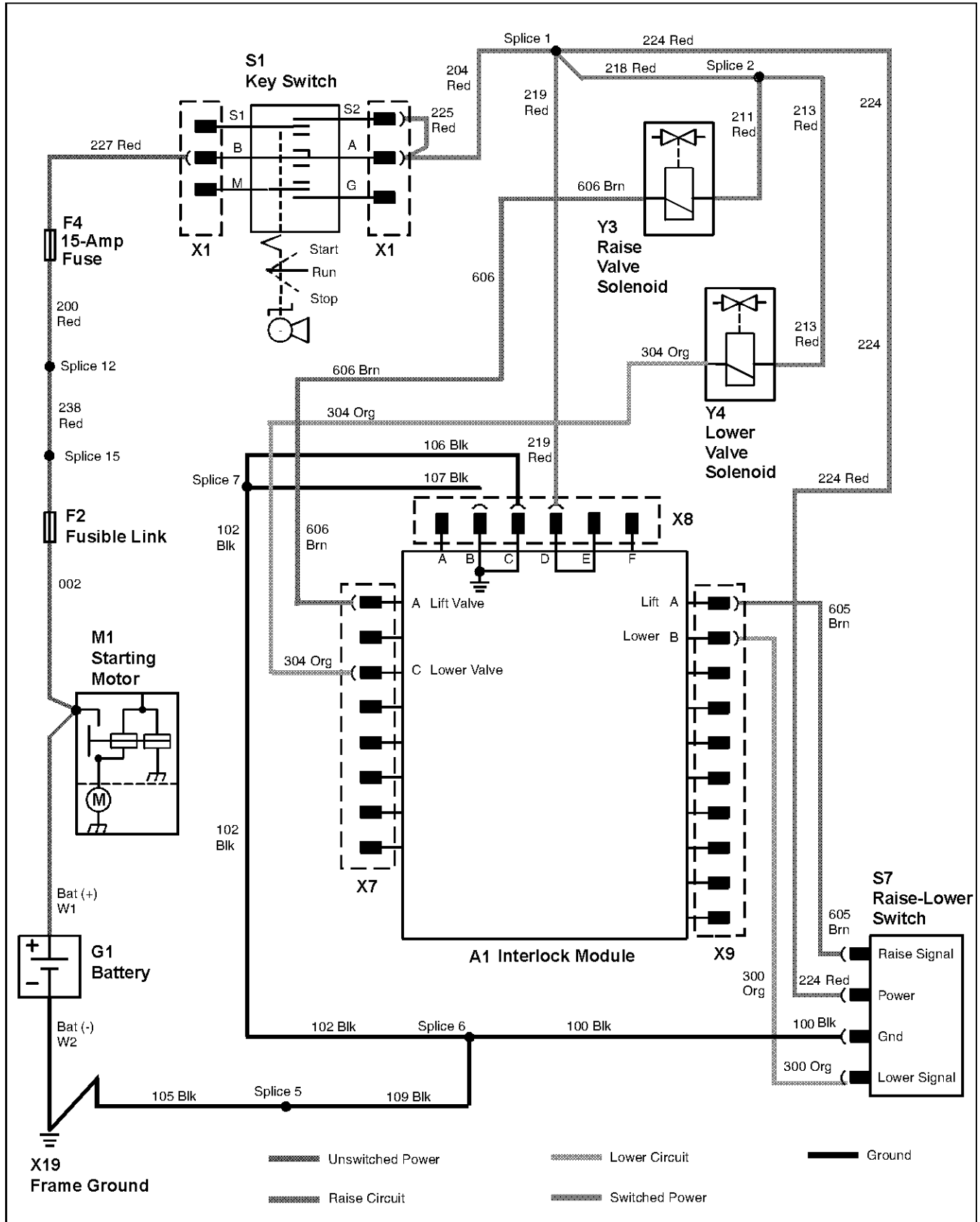
- Raise-lower switch (S7).
- 300 Org wire.
- Interlock module connector (X9), terminal B.

With the lower input activated, the interlock module supplies a continuously controlled ground to the lower valve solenoid through the following circuit and components:

- Interlock module connector (X7) terminal C.
- 304 Org wire.
- Lower valve solenoid (Y4).

ELECTRICAL OPERATION AND DIAGNOSTICS

Raise-Lower Circuit Schematic



ELECTRICAL OPERATION AND DIAGNOSTICS

System: Raise-Lower Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks. It is important that all steps be performed in sequence.

Step 1: INTERLOCK MODULE CHECK

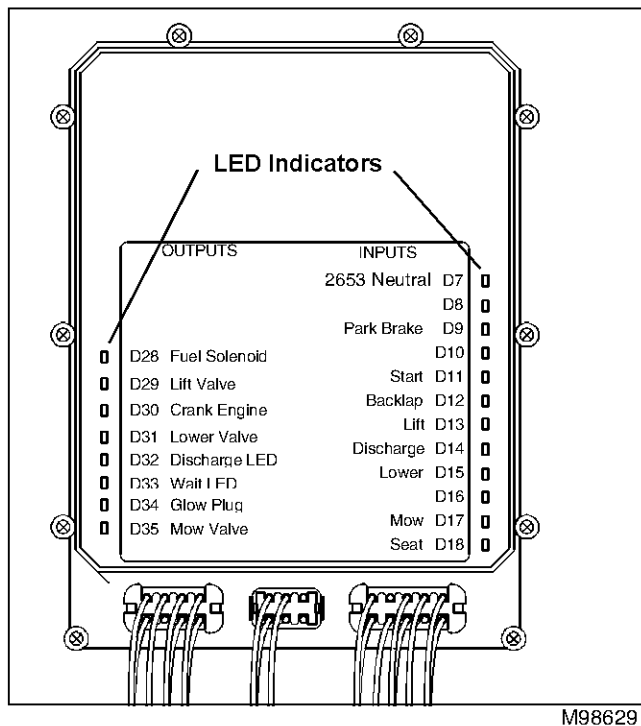
Perform interlock module check. (See “Interlock Module Check” on page 213.)

STEP 2: INPUT CIRCUIT LED CHECK

Test Conditions

- Key switch in RUN position.
- Open interlock module (A1) compartment panel.

Procedure



Lower Switch Input and Lower Valve Output

1. Move key switch to RUN position.
2. Move raise-lower switch to LOWER position.
3. Observe the Lower input LED (D15). The LED should be ON when switch is activated, and OFF when the switch is released.

If the LED does not come ON when the raise-lower switch is activated, perform “Raise-Lower Switch Circuit” test.

(See “Raise-Lower Switch Test” on page 223).

4. Observe the Lower Valve output LED (D31). The LED should be ON when lower switch is activated and should remain ON.

If the LED does not come ON when the lower switch is activated; (See “Interlock Module Test” on page 214.)

If the LED operates correctly, but lower solenoid does not energize, test lower solenoid circuit. (See “System: Raise-Lower Circuit Diagnosis” on page 164.)

Raise Switch Input and Raise Valve Output

1. Move key switch to RUN position.
2. Move raise-lower switch to RAISE position.
3. Observe the Lift input LED (D13). The LED should be ON when raise switch is activated, and OFF when the switch is released.

If the LED does not come ON when the raise-lower switch is activated, perform “Raise-Lower Switch Circuit” test. (See “System: Raise-Lower Circuit Diagnosis” on page 164.)

4. Observe the Lift Valve output LED (D29). The LED should be ON when the switch is activated and should remain ON for approximately four seconds.

If the LED does not come ON when the switch is activated; Test interlock module (See “Interlock Module Check” on page 213.)

If the LED operates correctly, but raise solenoid does not energize, perform “Raise Solenoid Circuit” test. (See “System: Raise-Lower Circuit Diagnosis” on page 164.)

Step 3: CIRCUIT TESTS

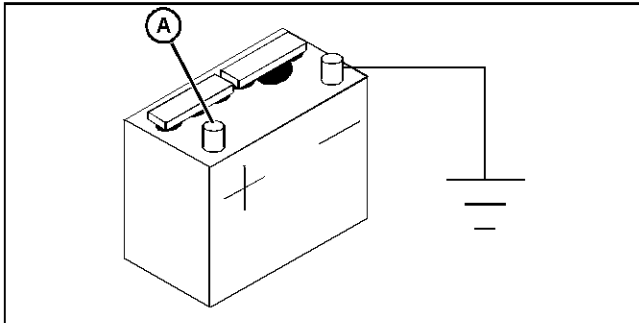
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

ELECTRICAL OPERATION AND DIAGNOSTICS

Raise-Lower Circuit Test

Test Conditions

- Park machine on level surface.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.

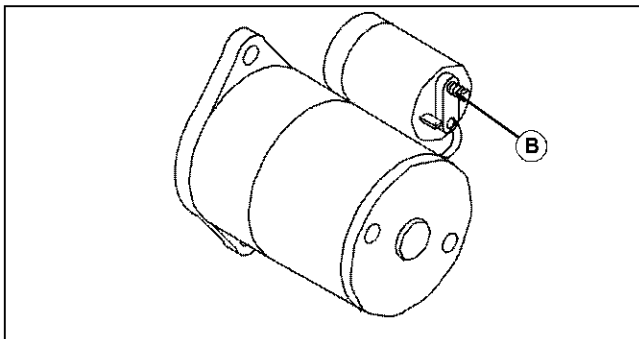


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

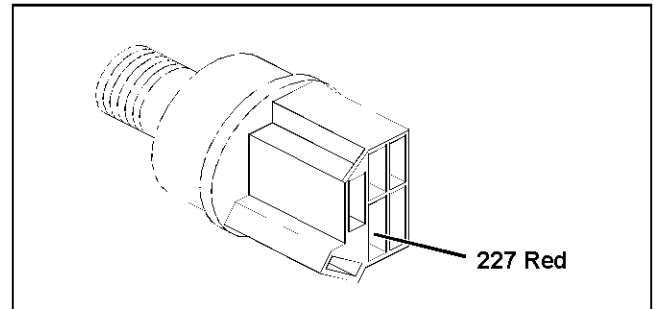


MIF

2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch connector (X1), terminal B, 227 Red wire. Is battery voltage present?

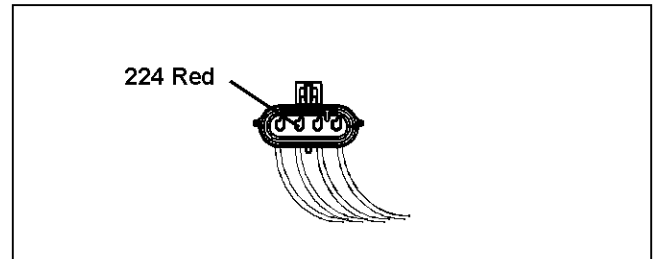
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.

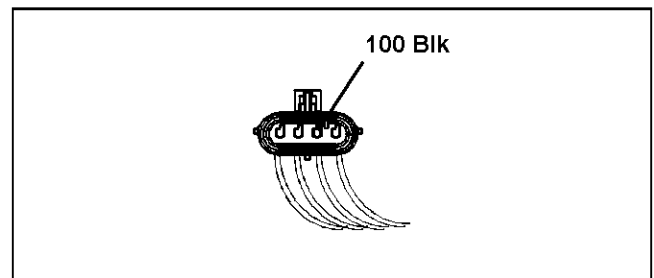


MIF

4. Disconnect raise-lower switch (S7) connector. Measure voltage at raise-lower switch connector, 224 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 224 and 204 Red wires and connections between raise-lower switch connector and key switch connector.



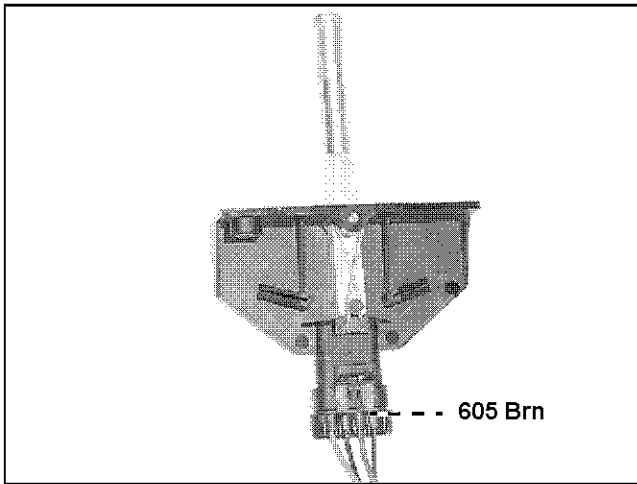
MIF

5. Measure ground circuit resistance at raise-lower switch connector (X11), 100 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 100, 109, and 105 Blk wires and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS

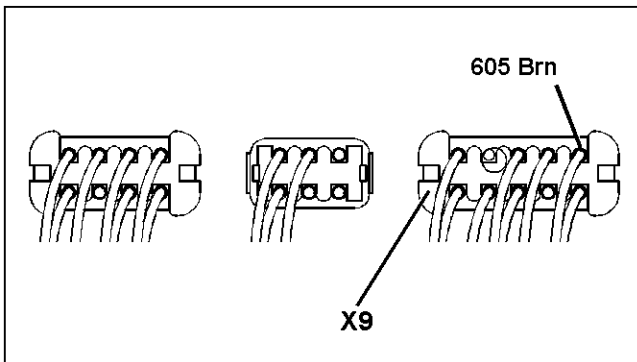


MIF

6. Raise-lower switch connector connected. Raise-lower switch in the RAISE position. With a small diameter probe, measure voltage at raise-lower switch connector (X11), 605 Brn wire. Is there voltage when the switch is in the RAISE position and NO voltage in the RELEASED position?

Yes: Go to next step.

No: Test raise-lower switch. (See "Raise-Lower Switch Test" on page 223.)

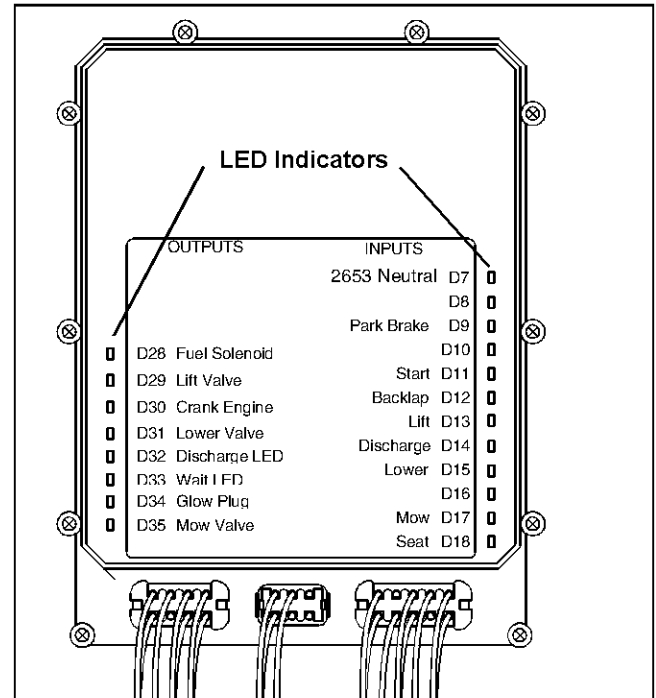


MIF

7. With raise-lower switch in the RAISE position, measure voltage at interlock module connector (X9), terminal A, 605 Brn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 605 Brn wire and connections between raise-lower switch and interlock module.

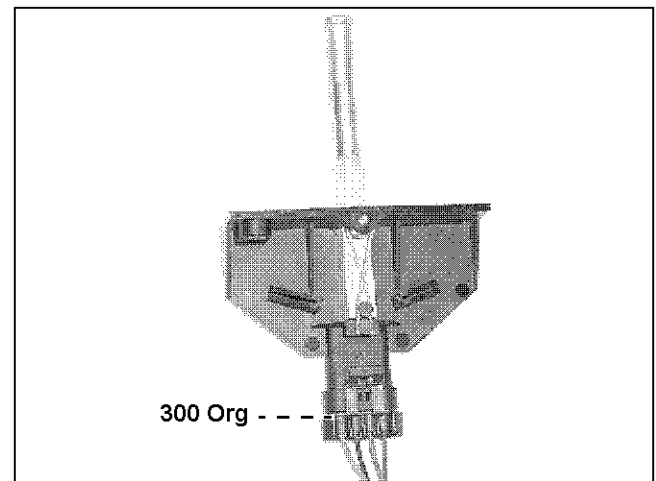


M98629

8. With the raise-lower switch in the RAISE position, perform interlock module input LED check. Is the Raise input LED (D13) ON?

Yes: Go to next step.

No: Test interlock module. (See "Interlock Module Check" on page 213.)



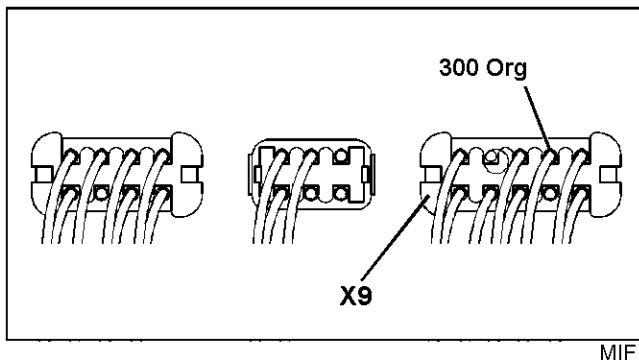
MIF

9. With the raise-lower switch in the LOWER position. With a small diameter probe, measure voltage at raise-lower switch connector (X11), 300 Org wire. Is there voltage when the switch is in the LOWER position and NO voltage in the RELEASED position?

Yes: Go to next step.

No: Test raise-lower switch. (See "Raise-Lower Switch Test" on page 223.)

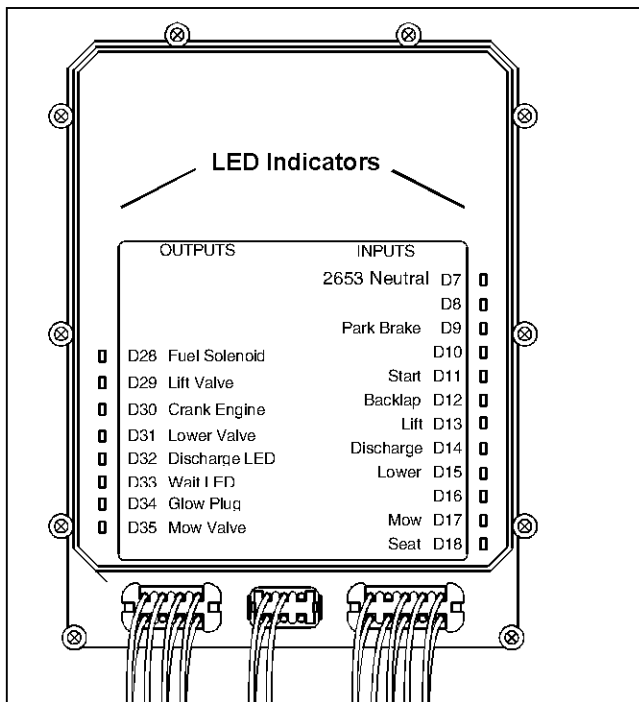
ELECTRICAL OPERATION AND DIAGNOSTICS



10. With raise-lower switch in the LOWER position, measure voltage at interlock module connector (X9), terminal B, 300 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300 Org wire and connections between raise-lower switch and interlock module.



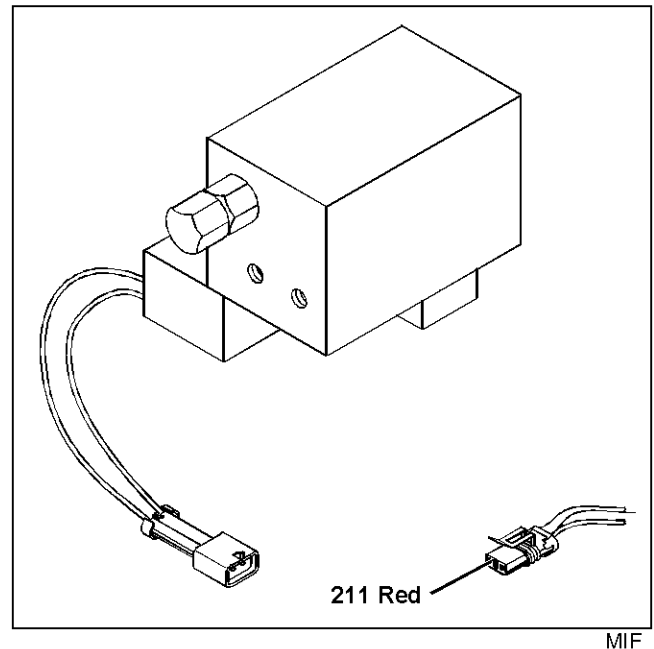
11. Raise-lower switch in the LOWER position. Perform interlock module input LED check. Is lower input LED ON?

No: Test interlock module. (See "Interlock Module Check" on page 213.)

Raise Valve Solenoid Circuit Test

Test Conditions

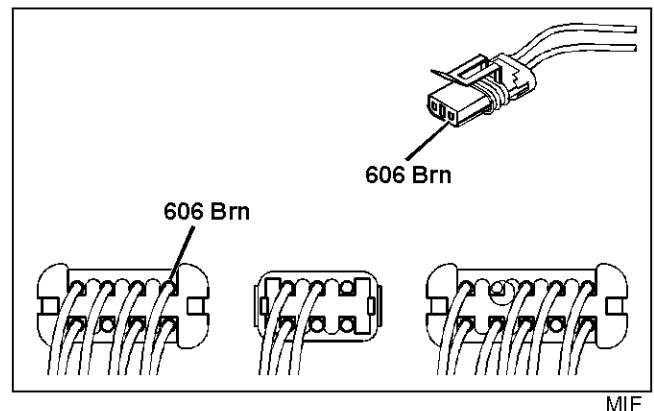
- Park machine on level surface.
- Key switch in RUN position.
- Raise valve solenoid connector (X6) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.



1. Measure voltage at raise valve solenoid (Y3), connector (X6), 211 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Check 211, 218, and 204 Red wires and connections.



2. Measure resistance between interlock module

ELECTRICAL OPERATION AND DIAGNOSTICS

connector (X7) terminal (A), 606 Brn wire, and raise valve solenoid connector, 606 Brn wire. Is resistance less than 0.1 ohm?

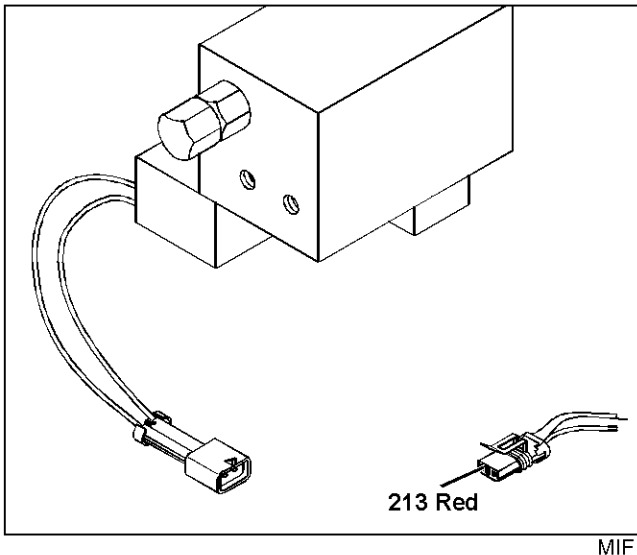
Yes: Test raise valve solenoid. (See "Raise or Lower Solenoid Test" on page 225.)

No: Check 606 Brn wire and connections.

Lower Solenoid Circuit Test

Test Conditions

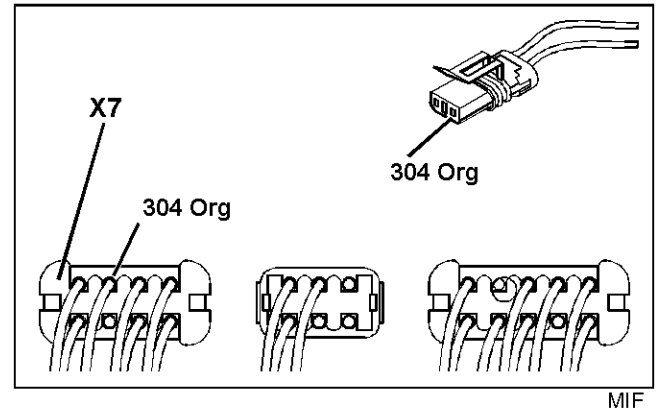
- Machine parked on a level surface.
- Key switch in RUN position.
- Lower valve solenoid connector (X5) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.



1. Measure voltage at lower valve solenoid (Y4), connector, 213 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Check 213, 218, and 204 Red wires and connections.



2. Measure resistance between interlock module connector (X7), 304 Org wire, and lower valve solenoid connector, 304 Org wire. Is resistance less than 0.1 ohm?

Yes: Test lower valve solenoid. (See "Raise or Lower Solenoid Test" on page 225.)

No: Check 304 Org wire and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS

Mow Circuit Operation

Function

The mow-transport switch provides a signal to the interlock module to energize or de-energize the mow valve solenoid.

Operating Conditions

- Key switch in the RUN position - engine operating.
- Mow-transport switch in MOW position.
- Operator ON seat (seat switch engaged).
- Park brake UNLOCKED.

Theory of Operation

The power circuit provides voltage to the key switch and protects the electrical system.

Voltage is available from the battery (G1) positive (+) terminal to the following circuits and components:

- 002 fusible link (F2).
- Splice 15.
- 238 Red wire.
- Splice 12.
- 200 Red wire.
- 15-amp fuse (F4).
- 227 Red wire.
- Key switch (S1), terminal B.

When the key switch (S1) is in the RUN position, voltage is available from key switch, terminal A, to the following:

- Seat switch (S4).
- Raise-lower switch (S7).
- Mow-transport switch (S6).
- Lower valve solenoid (Y4).
- Mow valve solenoid (Y2).
- Interlock module (A1) connector (X8), terminal D.

With voltage available to the interlock module, the interlock module continues to operate until the key switch is turned to the OFF position. Ground is provided to interlock module connector (X8), terminals B and C, through the following circuits:

- 106 Blk wire.
- 107 Blk wire.
- Splice 7.
- 102 Blk wire.
- Splice 6.
- 109 Blk wire.

- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

Mow Circuit

With the operating conditions met and when the raise-lower switch is placed in the LOWER position, a signal is provided from the raise-lower switch to the interlock module lower input, activating the lower input. With the lower input active, the interlock module provides a controlled ground to lower valve solenoid (Y4) and mow valve solenoid (Y2), energizing the solenoids. With the solenoids energized, the cutting units are lowered and the cutting motors start operating.

To activate the lower input, current flows through the following circuits and components:

- Raise-lower switch (S7).
- 300 Org wire.
- Interlock module connector (X9), terminal B.

To activate the mow input, current flows through the following circuit and components:

- Mow-transport switch (S6).
- 407 Yel wire.
- Mow resistor (R2).
- 406 Yel wire.
- Interlock module connector (X9), terminal C.

With lower input activated, the interlock module supplies a continuously controlled ground to the lower valve solenoid through the following circuit and components:

- Interlock module connector (X7) terminal C.
- 304 Org wire.
- Lower valve solenoid (Y4).

To energize the mow valve solenoid, the interlock module supplies a controlled ground to the mow valve solenoid through the following circuit and components:

- Interlock module connector (X7), terminal D.
- 650 Tan wire.
- Mow valve solenoid (Y2).

Mow Shutdown Circuits

When the mow-transport switch is in the MOW position, current flows to the interlock module mow input terminal through mow resistor (R2), activating the mow input. When either the hydraulic oil temperature or engine coolant temperature switch is closed, current flows through the mow resistor to ground instead of to the mow input terminal, deactivating the mow input.

ELECTRICAL OPERATION AND DIAGNOSTICS

When the mow-transport switch is in the MOW position and the hydraulic oil temperature switch is in the CLOSED (over temperature) position, current flows through the following circuit and components:

- Mow-transport switch (S6).
- 407 Yel wire.
- Mow resistor (R2).
- 310 Org wire.
- Hydraulic oil temperature diode (V3).
- 309 Org wire.
- Hydraulic oil temperature switch (B3) (closed position).
- 110 Blk wire.
- Splice 5.
- 105 Blk wires.
- Frame ground (X19).

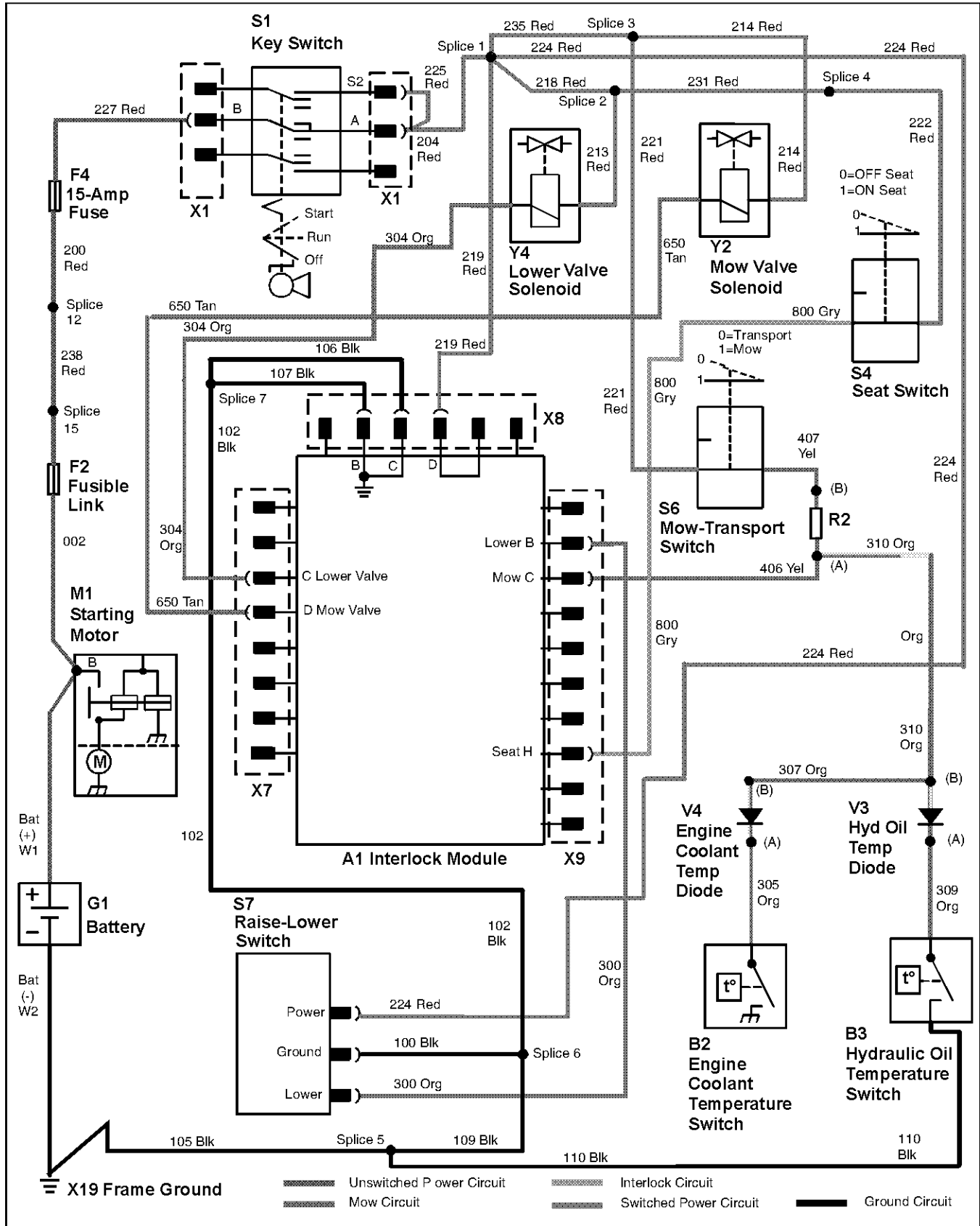
When the mow-transport switch is in the mow position and the engine coolant temperature switch is in the closed (over temperature) position, current flows through the following circuit and components:

- Mow-transport switch (S6).
- 407 Yel wire.
- Mow resistor (R2).
- 310 Org wire.
- 307 Org wire.
- Engine coolant temperature diode (V4).
- 305 Org wire.
- Engine coolant temperature switch (B2) (closed position).
- The engine coolant temperature switch is grounded through the engine.

The diodes (V3 and V4) prevent the hydraulic oil temperature LED (H3) and the engine coolant temperature LED (H2) from both illuminating when only one temperature switch is closed.

ELECTRICAL OPERATION AND DIAGNOSTICS

Mow Circuit Schematic



MX24015

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Mow Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks. It is important that all steps be performed in sequence.

Step 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

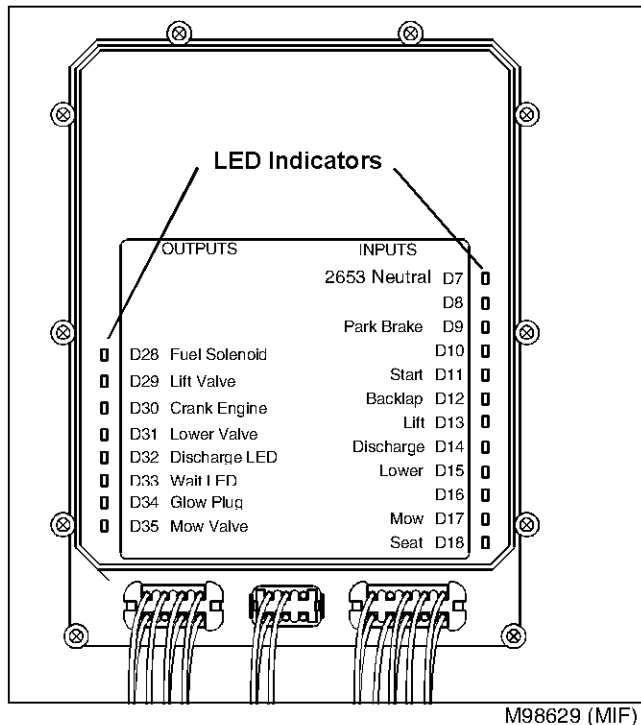
STEP 2: INPUT CIRCUIT LED CHECK

Test Conditions

- Machine parked on a level surface.
- Key switch in RUN position.
- Backlap valve in MOW position.

Procedure

1. Open interlock module (A1) compartment panel.



Seat Switch Input

1. Move key switch to RUN position.
2. Press down on the lower cushion of the seat to engage the seat switch.
3. Observe the Seat input LED (D18). The LED should be

ON when the seat switch is engaged (operator on seat).

4. Release the seat switch.

5. Observe the Seat input LED (D18). The LED should be OFF when the seat switch is released (operator off seat).

If the LED does not come ON, perform "Seat Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 173.)

Mow-Transport Switch Input

1. Move key switch to RUN position.
2. Move mow-transport lever to MOW position.
3. Observe the Mow input LED (D17). The LED should be ON when the mow-transport lever is in the MOW position (mow-transport switch engaged).

If the LED does not come ON, perform "Mow Transport Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 173.)

Lower Switch Input and Lower Valve Output

1. Move key switch to RUN position.
2. Move raise-lower switch to LOWER position.
3. Observe the Lower input LED (D15). The LED should be ON when the switch is activated, and OFF when the switch is released.

If the LED does not come ON when the raise-lower switch is activated, perform "Raise-Lower Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 173.)

4. Observe the Lower valve output LED (D31). The LED should be ON when the lower switch is activated and should remain ON.

If the LED does not come ON when the lower switch is activated, Test interlock module, (See "Interlock Module Check" on page 213.)

If the LED operates correctly, but lower solenoid does not energize, perform "Lower Solenoid Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 173.)

Mow Valve Output

1. Move key switch to RUN position.
2. Operator ON the seat.
3. Mow-Transport switch in the MOW position.
4. Move raise-lower switch to LOWER position.
5. Mow valve LEDs should be ON.

If the LED do not come ON when the lower switch is activated, Test interlock module, (See "Interlock Module Check" on page 213.)

If the mow valve output LED is ON but the mow valve solenoid does not energize, perform "Mow Valve Solenoid

ELECTRICAL OPERATION AND DIAGNOSTICS

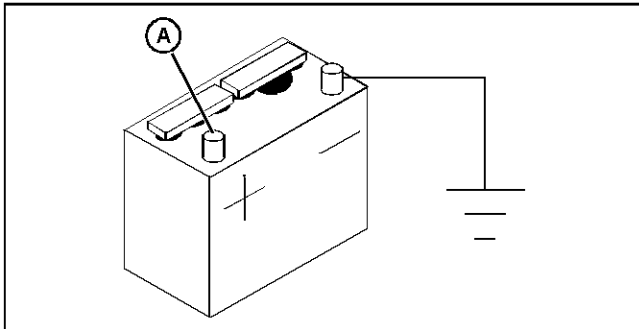
Circuit Test". (See "STEP 3: CIRCUIT TESTS" on page 173.)

STEP 3: CIRCUIT TESTS

Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Seat Switch Circuit Test

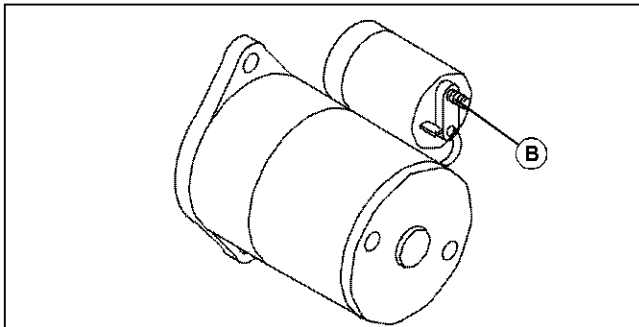


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

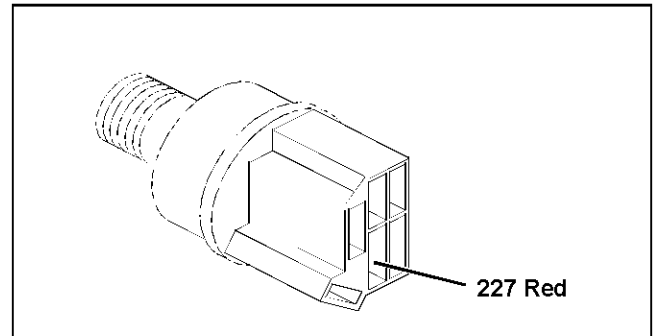


MIF

2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch connector (X1), terminal B, 227 Red wire. Is battery voltage present?

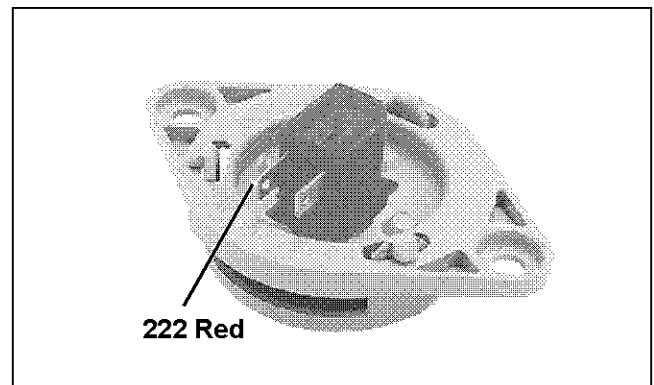
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.

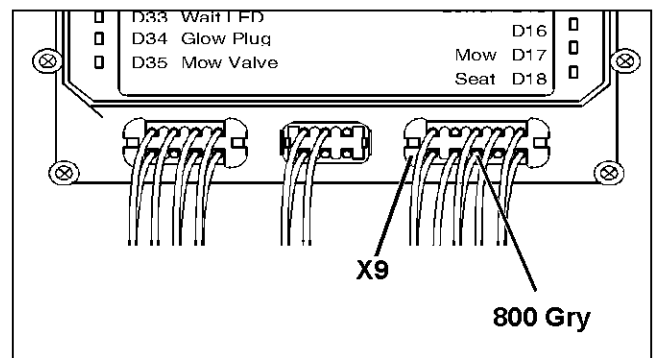


MIF

4. Measure voltage at seat terminal 222 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 222, 231, 218, and 204 Red wires and connections.



M98629

5. Seat switch connector connected. Seat switch engaged. interlock module connector (X9)

ELECTRICAL OPERATION AND DIAGNOSTICS

disconnected. Measure voltage at interlock module connector (X9), terminal H, 800 Gry wire. Is battery voltage present?

Yes: Go to next step.

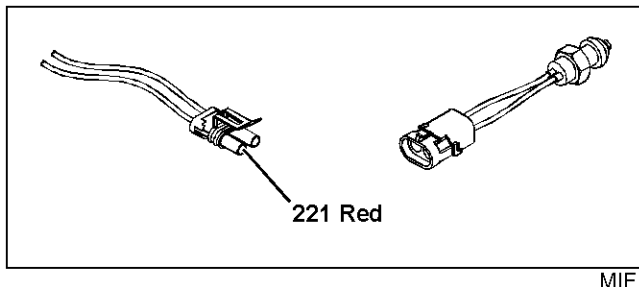
No: Test 800 Gry wire and connections.

No: Test seat switch. (See "Seat Switch Test" on page 223.)

Mow-Transport Switch Circuit Test

Test Conditions

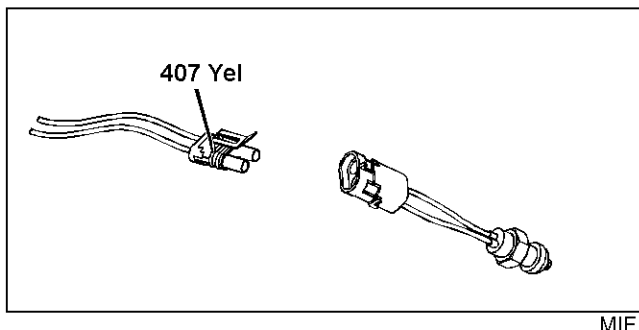
- Machine parked on a level surface.
- Key switch in RUN position.
- Move travel pedals to NEUTRAL position.
- Seat switch ENGAGED.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.



1. Mow-transport switch connector disconnected. Measure voltage at mow-transport switch connector, 221 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 221, 235, and 204 Red wires and connections.

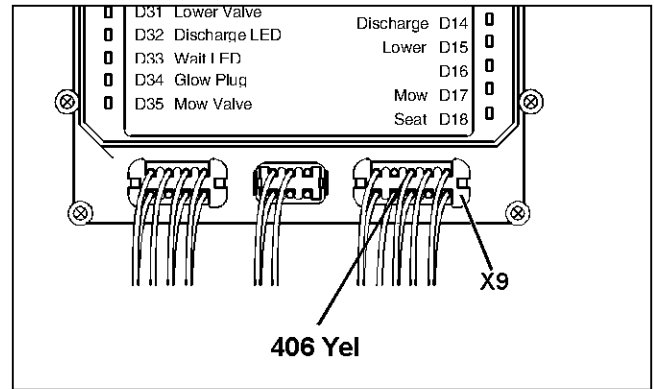


2. Mow-transport switch connector (X10) connected. Measure voltage at mow-transport switch connector, 407 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test switch. (See "Mow-Transport Switch Test" on

page 224.)



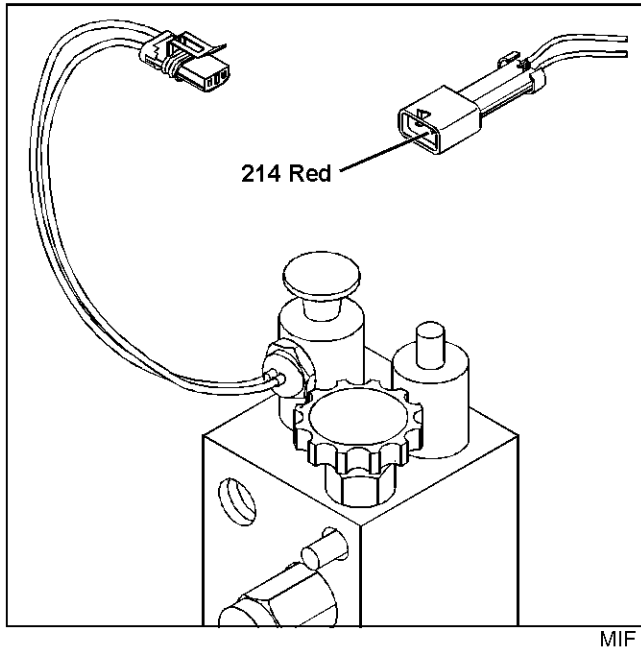
3. Measure voltage at interlock module connector (X9), terminal C, 406 Yel wire. Is battery voltage present?

No: Test 406 and 407 Yel wires and connections.

No: Test mow resistor (R2). (See "Mow Resistor Test" on page 220.)

ELECTRICAL OPERATION AND DIAGNOSTICS

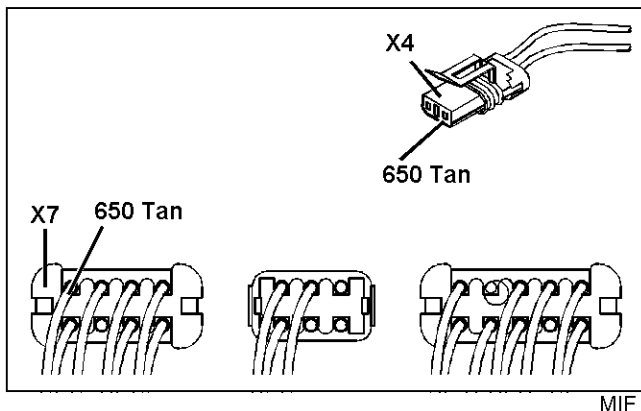
Mow Valve Solenoid Circuit Test



1. Measure voltage at Mow Valve (Y2) connector, 214 red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 214, 235, and 204 Red wires and connections.



2. Mow-transport switch in MOW position. interlock module connector (X7), disconnected. Measure resistance between interlock module connector (X7), terminal D, 650 Tan wire and mow valve solenoid connector. Is resistance less than 0.1 ohm?

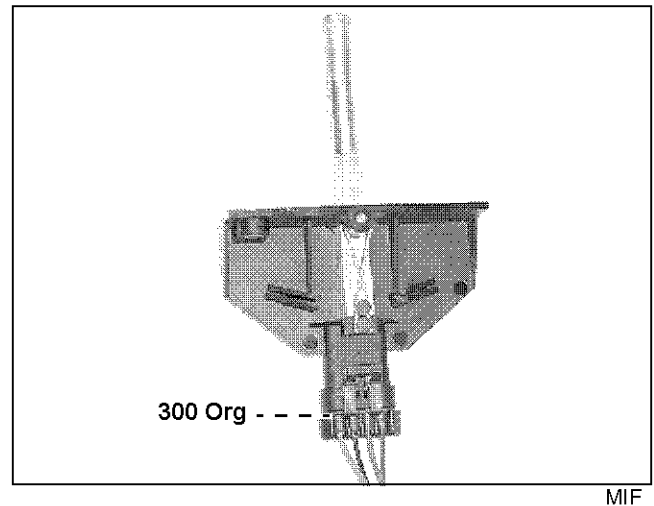
Yes: Test mow valve solenoid. (See "Mow Solenoid Test" on page 224.)

No: Test 650 Tan wire and connections.

Lower Circuit Test

Test Conditions

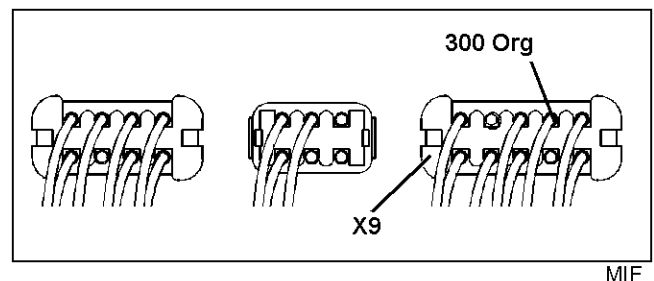
- Machine parked on a level surface.
- Key switch in RUN position.
- Mow-transport switch connector, disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.



1. Raise-lower switch in the LOWER position. With a small diameter probe, measure voltage at raise-lower switch connector, 300 Org wire. Is there voltage when the switch is in the LOWER position and NO voltage in the RELEASED position?

Yes: Go to next step.

No: Test raise-lower switch. (See "Raise-Lower Switch Test" on page 223.)

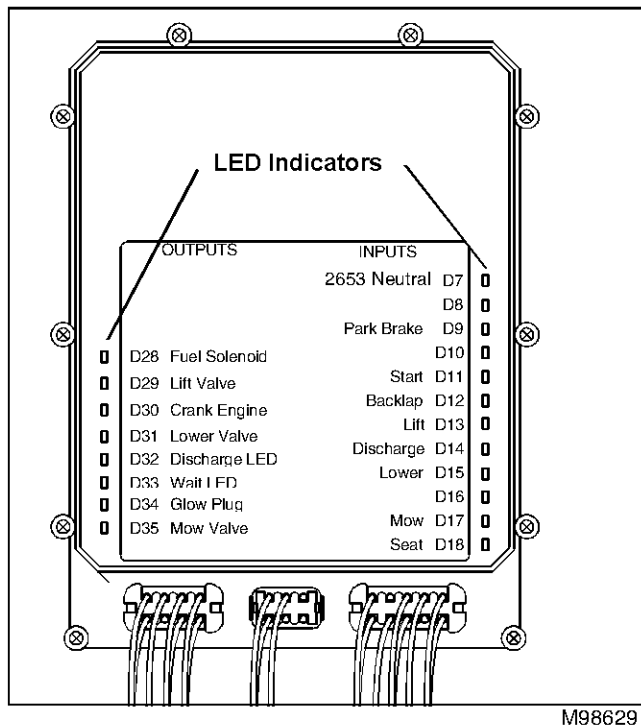


2. With raise-lower switch in the LOWER position, measure voltage at interlock module connector (X9) terminal (B) 300 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300 Org wire and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS



3. With the raise-lower switch in the LOWER position, perform interlock module input LED check. Is lower input LED ON?

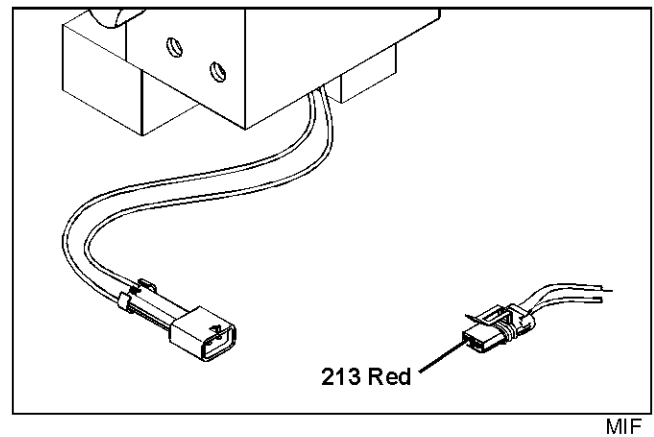
Yes: Go to next step.

No: Test interlock module. (See "Interlock Module Check" on page 213.)

Lower Valve Solenoid Circuit

Test Conditions

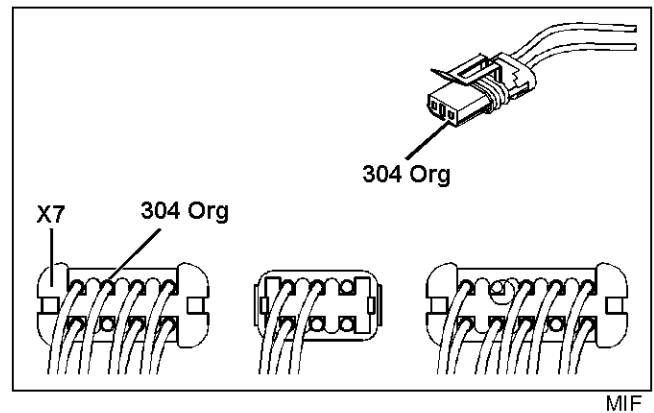
- Machine parked on a level surface.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Lower valve solenoid connector disconnected.
- Check connections for corrosion and looseness when checking and testing.



1. Check voltage at lower valve solenoid (Y4) connector, 213 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 213, 218, and 204 Red wires and connections.



2. Interlock module connector (X7), disconnected. Check resistance at lower valve solenoid (Y4) connector to interlock module connector (X7), terminal C. Is resistance less than 0.1 ohm?²

Yes: Test lower solenoid. (See "Raise or Lower Solenoid Test" on page 225.)

No: Test 304 Org wire.

2. Some ohmmeters may not provide an accurate reading at a very low resistance. Touch meter probe leads together and subtract shorted probe reading from the measured resistance reading.

ELECTRICAL OPERATION AND DIAGNOSTICS

Backlap Circuit Operation

Function

To engage the cutting units when the backlap switch is in the BACKLAP position.

Operating Conditions

- Key switch in the RUN position - engine operating.
- Park brake LOCKED.
- Operator OFF the seat.
- Raise-lower switch in the LOWER position.
- Backlap switch in BACKLAP position.
- Mow-transport switch in the MOW position.

Theory of Operation

The power circuit provides voltage to the key switch and protects the electrical system.

Voltage is available from the battery (G1) positive (+) terminal to the following circuits and components:

- 002 fusible link (F2).
- Splice 15.
- 238 Red wire.
- Splice 12.
- 200 Red wire.
- 15-amp fuse (F4).
- 227 Red wire.
- Key switch (S1), terminal B.

When the key switch (S1) is in the RUN position, voltage is available from key switch, terminal A, to the following:

- Park brake switch (S3).
- Neutral switch (S2).
- Backlap switch (S5).
- Mow-transport switch (S6).
- Raise-lower switch (S7).
- Mow valve solenoid (Y2).
- Lower valve solenoid (Y4).
- Interlock module (A1) connector (X8), terminal D.

With voltage available to the interlock module, the interlock module continues to operate until the key switch is turned to the OFF position. Ground is provided to interlock module connector (X8), terminals B and C, through the following circuits:

- 106 Blk wire.
- 107 Blk wire.

- Splice 7.
- 102 Blk wire.
- Splice 6.
- 109 Blk wire.
- Splice 5.
- 105 Blk wire.
- Frame ground (X19).

Backlap Circuit

The interlock module backlap input allows the mow circuit to operate with the park brake LOCKED and the operator OFF the seat.

With the operating conditions met and when the raise-lower switch is placed in the LOWER position, a signal is provided from the raise-lower switch to the interlock module lower input, activating the lower input. With the lower input active, the interlock module provides the controlled ground to lower valve solenoid (Y4), and mow valve solenoid (Y2), energizing the solenoids. With the solenoids energized, the cutting units are lowered and the cutting motors start operating in the reverse direction.

To activate the backlap input, current flows through the following circuits and components:

- Backlap switch (S5).
- 502 Blu wire.
- Interlock module connector (X9), terminal F.

To energize the mow valve solenoid, the interlock module supplies a controlled ground to the mow valve solenoid through the following circuits and components:

- Interlock module connector (X7), terminal D.
- 650 Tan wire.
- Mow valve solenoid (Y2).

To activate the lower input, current flows through the following circuits and components:

- Raise-lower switch (S7).
- 300 Org wire.
- Interlock module connector (X9), terminal B.

To activate the mow input, current flows through the following circuit and components:

- Mow-transport switch (S6).
- 407 Yel wire.
- Mow resistor (R2).
- 406 Yel wire.
- Interlock module connector (X9), terminal C.

With lower input activated, the interlock module supplies a

ELECTRICAL OPERATION AND DIAGNOSTICS

continuously controlled ground to the lower valve solenoid through the following circuit and components:

- Interlock module connector (X7), terminal C.
- 304 Org wire.
- Lower valve solenoid (Y4).

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Backlap Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks. It is important that all steps be performed in sequence.

Step 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

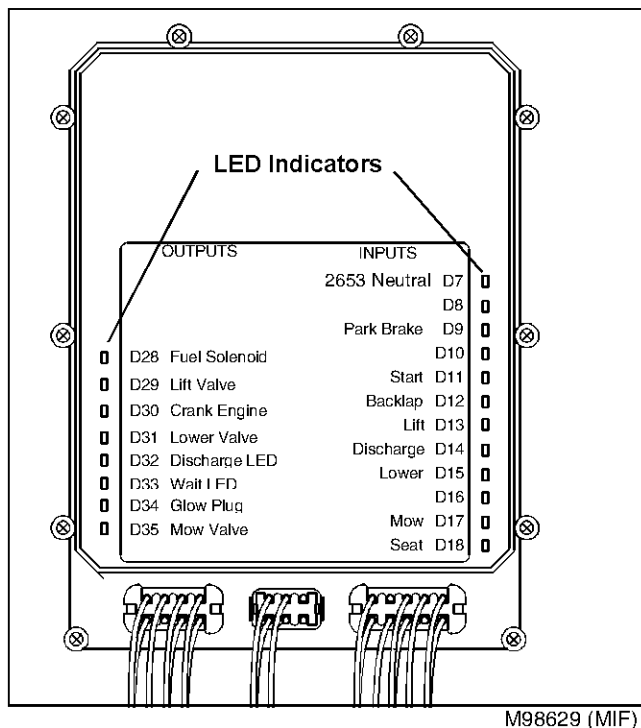
STEP 2: INPUT CIRCUIT LED CHECK

Test Conditions

- Park brake in LOCKED position.
- Operator OFF the seat.
- Key switch in RUN position.
- Raise-lower switch in the LOWER position.
- Backlap valve in BACKLAP position.
- Mow-transport switch in the MOW position.

Procedure

1. Open interlock module (A1) compartment panel.



Neutral Switch Input

1. Move the travel pedals to the NEUTRAL position.
2. Observe the Neutral input LED (D7). The LED should be ON when the travel pedals are in the NEUTRAL position and OFF when the travel pedals are moved out of position.

If the LED does not function as described, test "Travel Pedals Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 181.)

Park Brake Switch Input

1. Park brake is LOCKED.
2. Observe the Park Brake input LED (D9). The LED should be ON when the park brake is LOCKED.
3. Release the park brake.
4. Observe the Park Brake input LED (D9). The LED should be OFF when the park brake is released.

If the LED does not come ON, first check park brake switch adjustment. (See "Adjust Park Brake Switch" on page 351.) If Park Brake LED does not come ON after adjustment, test "Brake Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 181.)

Lower Switch Input and Lower Valve Output

1. Move raise-lower switch to LOWER position.
2. Observe the Lower input LED (D15). The LED should be ON when the switch is activated, and OFF when the switch is released.

If the LED does not come ON when the raise-lower switch is activated, perform "Raise-Lower Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 173.)

3. Observe the Lower valve output LED (D31). The LED should be ON when the lower switch is activated and should remain ON.

If the LED does not come ON when the lower switch is activated, Test interlock module, (See "Interlock Module Check" on page 213.)

If the LED operates correctly, but lower solenoid does not energize, perform "Lower Solenoid Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 181.)

Mow-Transport Switch Input

1. Move mow-transport lever to MOW position.
2. Observe the MOW input LED (D17). The LED should be ON when the mow-transport lever is in the MOW position (mow-transport switch engaged).

If the LED does not come ON, perform "Mow Transport Switch Circuit" test. (See "STEP 3: CIRCUIT TESTS" on page 181.)

ELECTRICAL OPERATION AND DIAGNOSTICS

Mow Valve Output

1. Mow-Transport switch in the MOW position.
2. Move raise-lower switch to LOWER position.
3. Mow valve LEDs should be ON.

If the LED do not come ON when the lower switch is activated, Test interlock module, (See "Interlock Module Check" on page 213.)

If the mow valve output LED is ON but the mow valve solenoid does not energize, perform "Mow Valve Solenoid Circuit Test". (See "STEP 3: CIRCUIT TESTS" on page 181.)

Backlap Switch Input

1. Move the backlap valve to the MOW position.
2. Observe the BACKLAP input LED (D12). The LED should be ON when the backlap valve is in the BACKLAP position and OFF when the valve is in the MOW position.

If the LED does not function as described, test "Backlap Switch Circuit". (See "STEP 3: CIRCUIT TESTS" on page 181.)

STEP 3: CIRCUIT TESTS

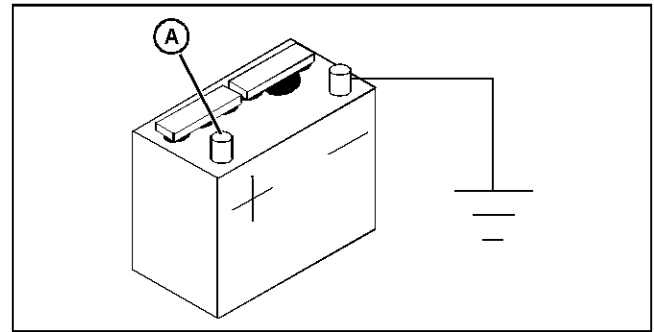
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Backlap Switch Circuit Test

Test Conditions

- Machine parked on a level surface.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Lower valve solenoid connector disconnected.
- Check connections for corrosion and looseness when checking and testing.

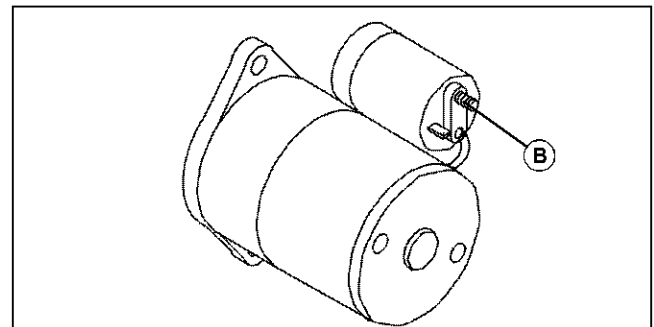


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

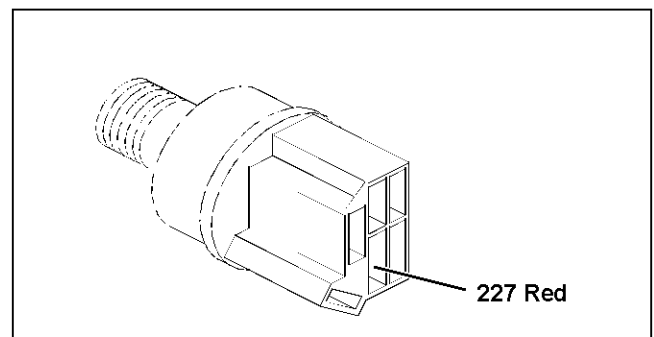


MIF

2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch connector (X1), terminal B, 227 Red wire. Is battery voltage present?

Yes: Go to next step.

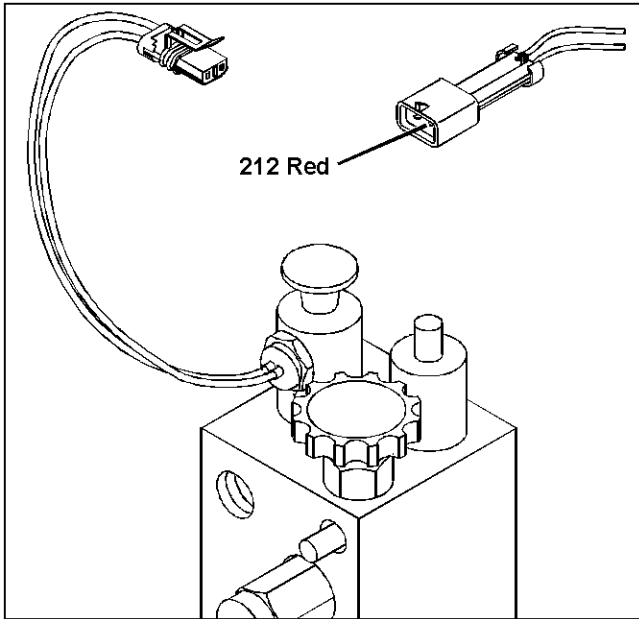
No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS

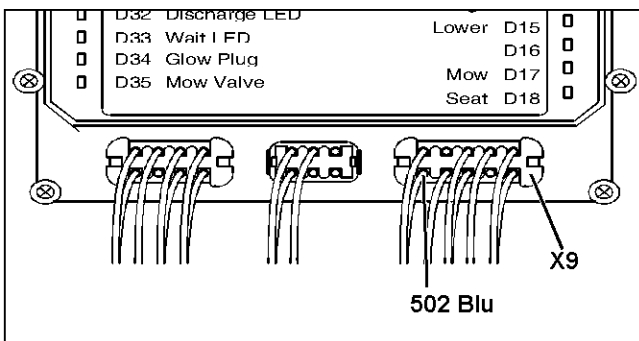
No: Test fusible link (F2) and connections.



4. Measure voltage at backlap switch (S5) connector, 212 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 212, 235, and 204 Red wire and connections.



5. Backlap switch in BACKLAP position. Backlap switch connector connected. Interlock module connector (X9) disconnected. Measure voltage at interlock module connector (X9), terminal F, 502 Blu wire. Is battery voltage present?

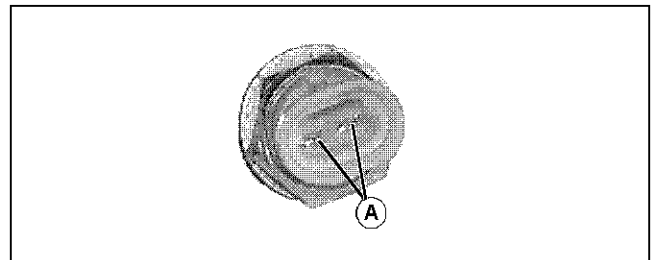
No: Test 502 Blu wire and connections.

No: Test backlap switch. (See "Backlap Switch Test" on page 225.)

Park Brake Switch Circuit

Test Conditions

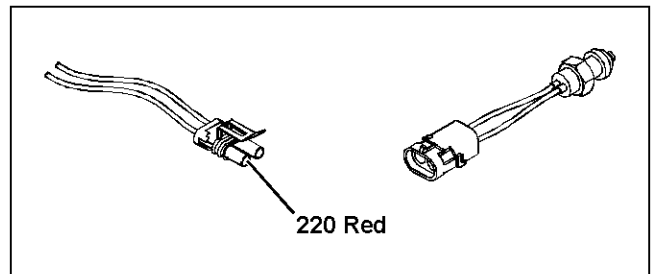
- Park machine on level surface.
- Lower cutting units to the ground.
- Turn key switch to OFF position.
- Park brake UNLOCKED.
- Disconnect brake switch connector.



1. Check continuity across switch terminals (A). There should be NO continuity.

Yes: If continuity is across switch (See "Park Brake Switch Test" on page 222.)

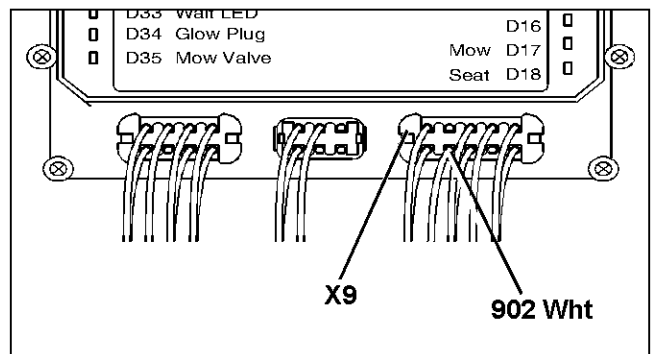
No: Go to next step.



2. Is voltage on connector terminal 220 Red wire?

Yes: Go to next step.

No: Test 220, 218, and 204 Red wires and connections.



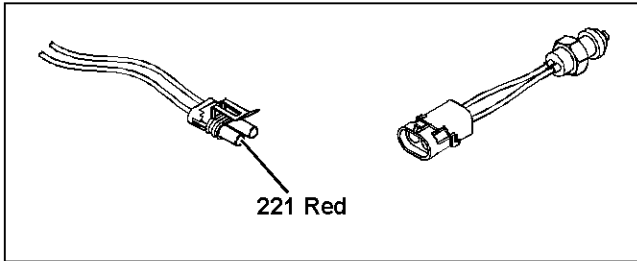
3. Interlock module connector (X9) disconnected. With the park brake connector connected, check voltage on

ELECTRICAL OPERATION AND DIAGNOSTICS

interlock module connector (X9), terminal G, 902 Wht wire, with park brake LOCKED. Is battery voltage present?

Yes: If voltage is present. (See "STEP 1: INTERLOCK MODULE CHECK" on page 158.)

Mow-Transport Switch Circuit

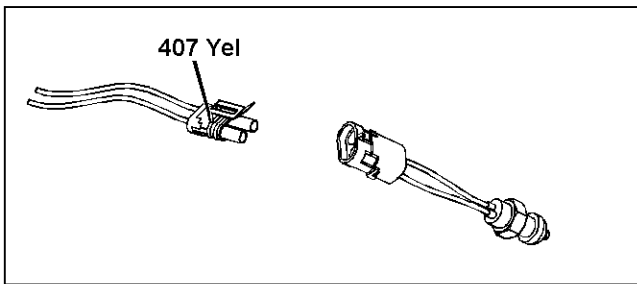


MIF

1. Mow-transport switch connector disconnected. Measure voltage at mow-transport switch connector, 221 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 221, 235, and 204 Red wires and connections.

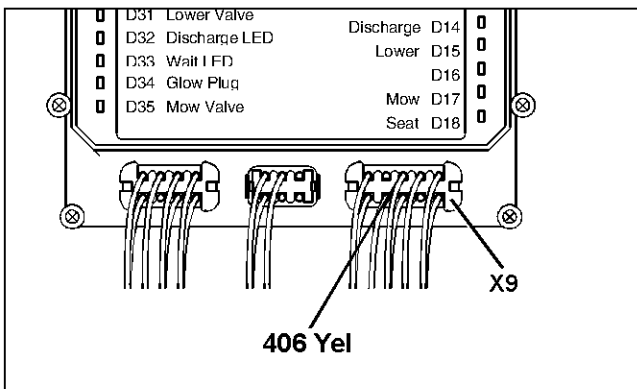


MIF

2. Mow-transport switch connector connected. Measure voltage at mow-transport switch connector, 407 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test switch. (See "Mow-Transport Switch Test" on page 224.)



M89629

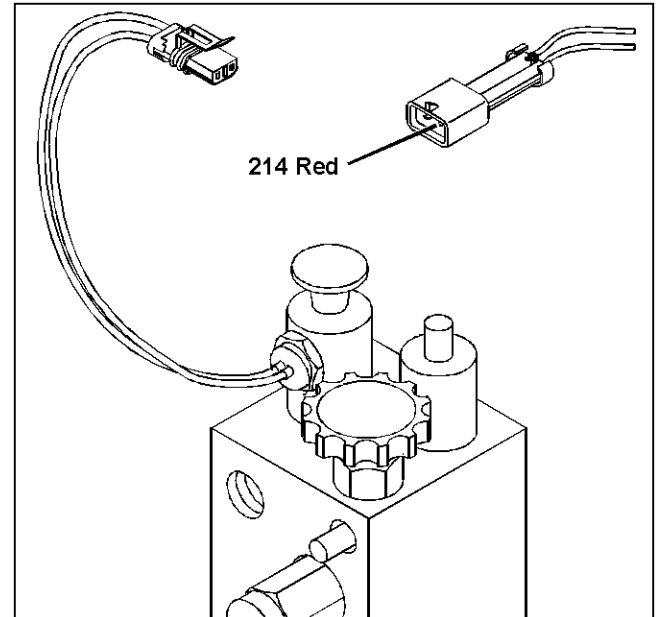
3. Measure voltage at interlock module connector (X9) terminal C, 406 Yel wire. Is battery voltage present?

No: Test 406 and 407 Yel wires and connections.

No: Test mow resistor (R2). (See "Mow Resistor Test" on page 220.)

No: Test switch. (See "Mow-Transport Switch Test" on page 224.)

Mow Valve Solenoid Circuit Test

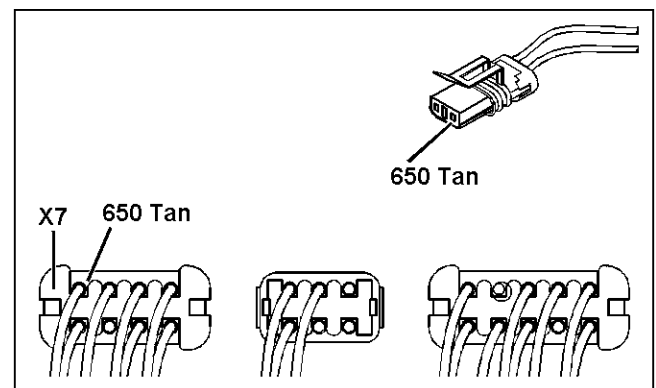


MIF

1. Measure voltage at mow valve (Y2) connector, 214 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 214, 235, and 204 Red wires and connections.



MIF

2. Mow-transport switch in MOW position. interlock module connector (X7) disconnected. Measure resistance between interlock module connector (X7), terminal D, wire 650 Tan and mow valve solenoid connector. Is resistance less than 0.1 ohm?

Yes: Test mow valve solenoid. (See "Mow Solenoid Test" on page 224.)

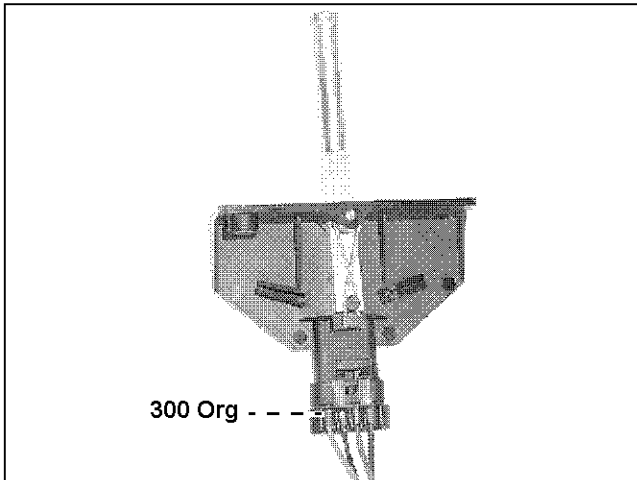
ELECTRICAL OPERATION AND DIAGNOSTICS

No: Test 650 Tan wire and connections.

Lower Switch Circuit

Test Conditions

- Machine parked on a level surface.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking and testing.

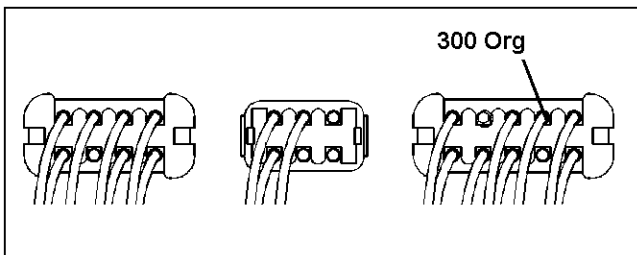


MIF

1. Raise-lower switch in the LOWER position.
With a small diameter probe, measure voltage at raise-lower switch connector, 300 Org wire. Is there voltage when the switch is in the LOWER position and NO voltage in the RELEASED Position?

Yes: Go to next step.

No: Test raise-lower switch. (See "Raise-Lower Switch Test" on page 223.)

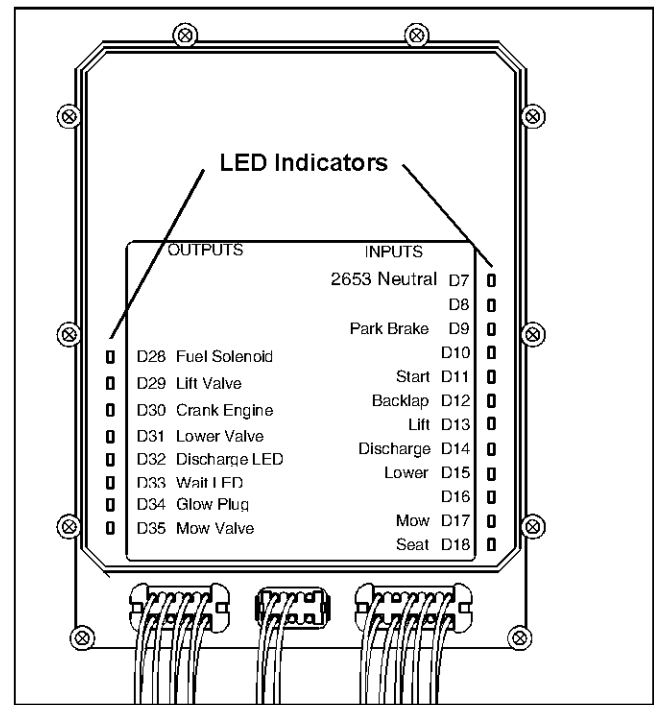


MIF

2. With raise-lower switch in the LOWER position, measure voltage at interlock module connector (X9), terminal (B), 300 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300 Org wire and connections.



M98629

3. Raise-lower switch in the LOWER position, perform interlock module input LED check. Is lower input LED ON?

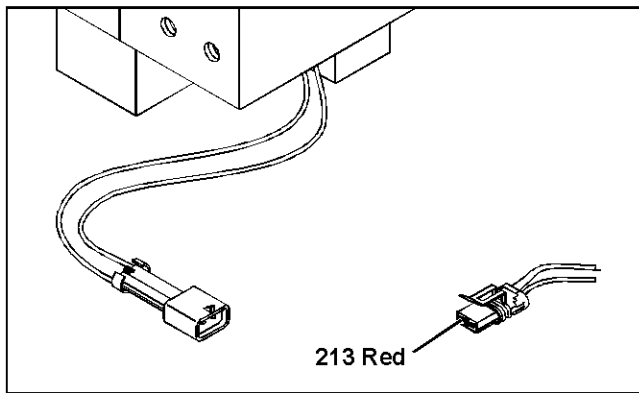
No: Test interlock module. (See "Interlock Module Check" on page 213.)

ELECTRICAL OPERATION AND DIAGNOSTICS

Lower Valve Solenoid Circuit Test

Test Conditions

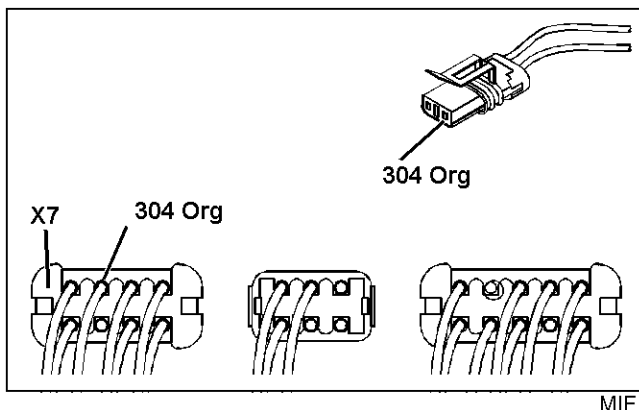
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Lower valve solenoid connector disconnected.
- Check connections for corrosion and looseness when checking and testing.



1. Check voltage at lower valve solenoid (Y4) connector, 213 Red wire. Is battery voltage present?

Yes: Go to next step.

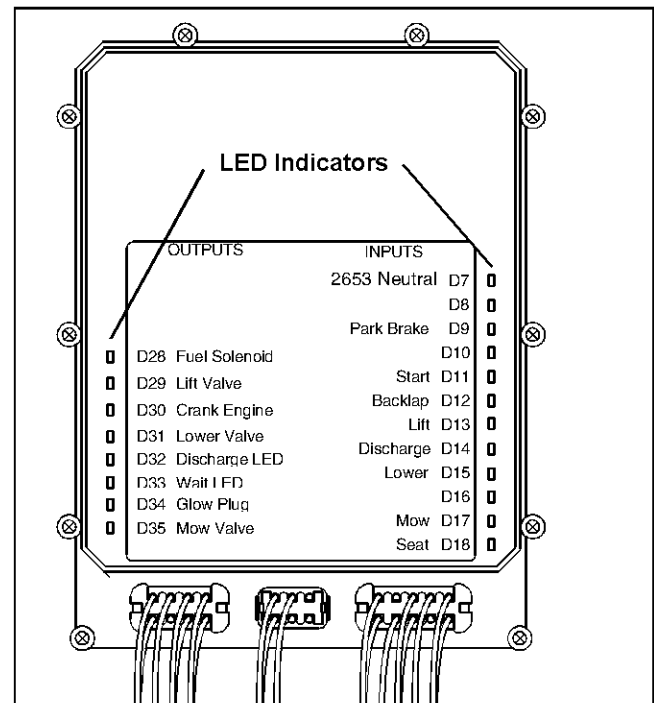
No: Test 213, 218, and 204 Red wires and connections.



2. Interlock module connector (X7), disconnected. Check resistance at lower valve solenoid (Y4) connector, to interlock module connector (X7), terminal C. Is resistance less than 0.1 ohm?³

Yes: Test lower solenoid. (See "Raise or Lower Solenoid Test" on page 225.)

No: Test 304 Org wire.



3. Raise-lower switch in the LOWER position, perform interlock module input LED check. Is lower input LED ON?

No: Test interlock module. (See "Interlock Module Check" on page 213.)

3. Some ohmmeters may not provide an accurate reading at a very low resistance. Touch meter probe leads together, and subtract shorted probe reading from the measured resistance reading.

ELECTRICAL OPERATION AND DIAGNOSTICS

Glow Plug Circuit Operation

Function

To provide power to the glow plugs to preheat the engine for better starting performance.

Operating Conditions

- Key switch in the RUN position.
- Park brake LOCKED or operator on seat.

Theory of Operation

The power circuit provides voltage to the key switch and protects the electrical system.

Voltage is available from the battery (G1) positive (+) terminal to the following circuits and components:

- 002 fuse link (F2).
- Splice 15.
- 238 Red wire.
- Splice 12.
- 200 Red wire.
- 15-Amp fuse (F4).
- 227 Red wire.
- Key switch (S1), terminal B.
- Glow plug relay (K2), terminal 30.

When the key switch (S1) is in the RUN position, voltage is available from key switch, terminal A, to the following:

- Park brake switch (S2).
- Glow plug relay (K2), terminal 85.
- Neutral input switch (S2).
- Interlock module connector (X8), terminal D.

Switched power is provided to terminal D of interlock module connector X8 through 219 Red wire; powering up the interlock module if the park brake is LOCKED or the operator on the seat. The interlock module continues to operate until the key switch is turned to the OFF position. Ground is provided to terminals B and C of interlock module connector X8 through the following:

- 107 Blk wire.
- 106 Blk wire.
- Splice 7.
- 102 Blk wire.
- Splice 6.
- 109 Blk wire.
- Splice 5.
- 105 Blk wire.

When the interlock module is powered up, it activates the glow plug circuit for approximately 10 seconds and the glow plug LED for approximately 4 seconds.

The interlock module glow plug output terminal provides a ground to glow plug relay terminal 86, energizing the relay. To energize the glow plug relay, current flows through the following circuits and components:

- Key switch (S1), terminal A.
- 204 Red wire.
- Splice 1.
- 218 Red wire.
- Splice 2.
- 201 Red wire.
- Glow plug relay (K2), terminals (85 and 86).
- 500 Blu wire.
- Interlock module (A3), connector (X7), terminal F.

With the glow plug relay energized, current flows between the relay terminals to the glow plugs, warming the cylinders. Current flows to the glow plugs through the following circuits:

- 002 fusible link (F2).
- Splice 15.
- 223 Red wire.
- Glow plug relay (K2), terminals (30 and 87).
- 203 Red wire.
- Glow plug connector (X2).
- Glow plugs (R1) time 3.

Instrument cluster power is provided from the interlock module fuel solenoid output terminal. To turn on glow plug LED (H5), the interlock module wait light output terminal provides a ground to the LED. Current flows from interlock module connector (X7), terminal E to the following components and circuits to turn ON the LED:

- 403 Yel wire.
- Splice 9.
- 400 Yel wire.
- Instrument cluster (A2), connector (X13), terminal A.
- Glow plug LED (H5).
- Instrument cluster (A2), connector (X13), terminal C.
- 330 Grn wire.
- Interlock module connector (X7), terminal G.

When the following conditions occur:

- Operator is OFF the seat.

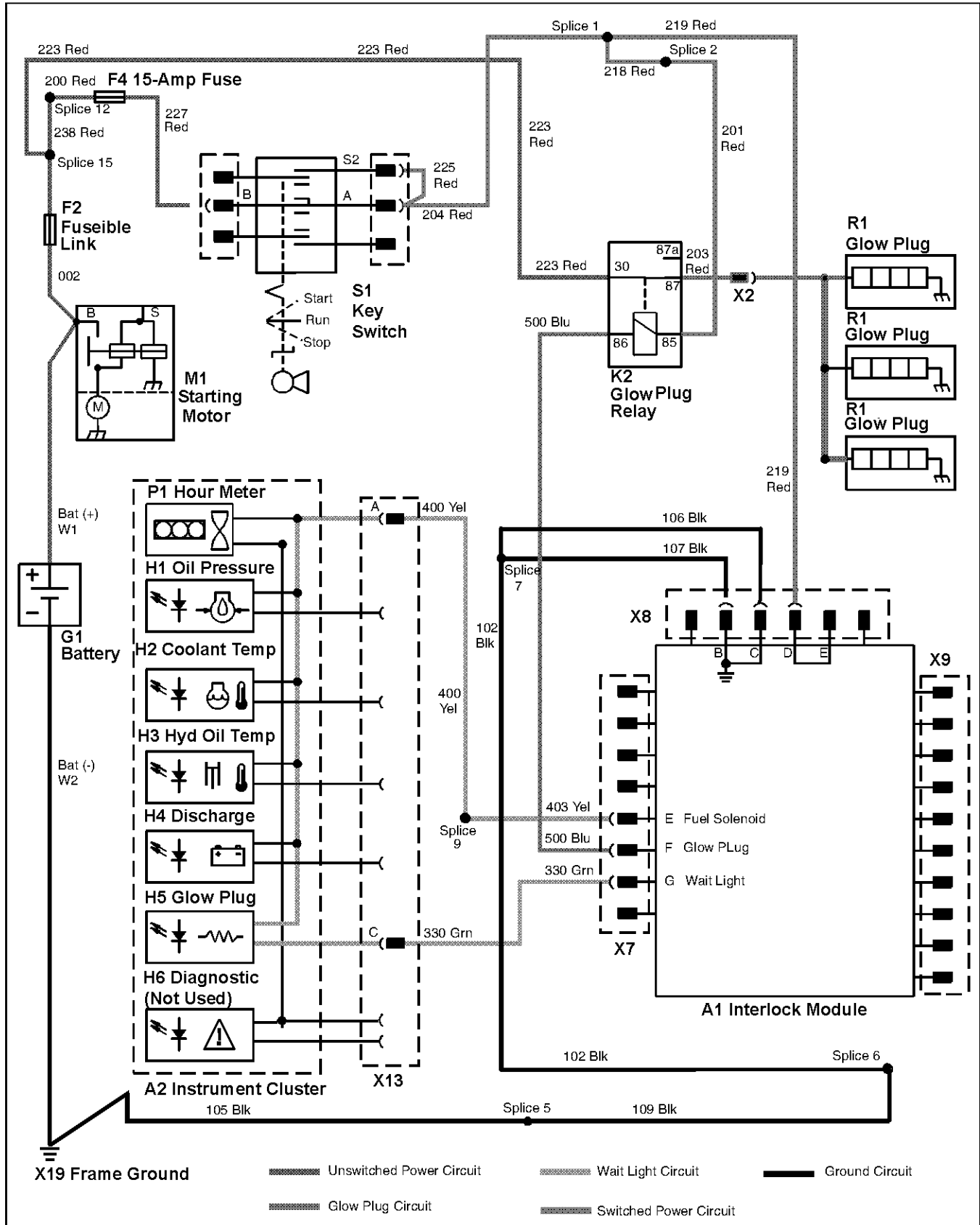
ELECTRICAL OPERATION AND DIAGNOSTICS

- Park brake UNLOCKED.
- Key switch (S1) in the RUN position.

The interlock module will still power up and activate the glow plug circuit, but the instrument cluster LED indicators will not turn on because the interlock module has deactivated the fuel solenoid output terminal.

ELECTRICAL OPERATION AND DIAGNOSTICS

Glow Plug Circuit Schematic



ELECTRICAL OPERATION AND DIAGNOSTICS

System: Glow Plug Circuit Diagnosis

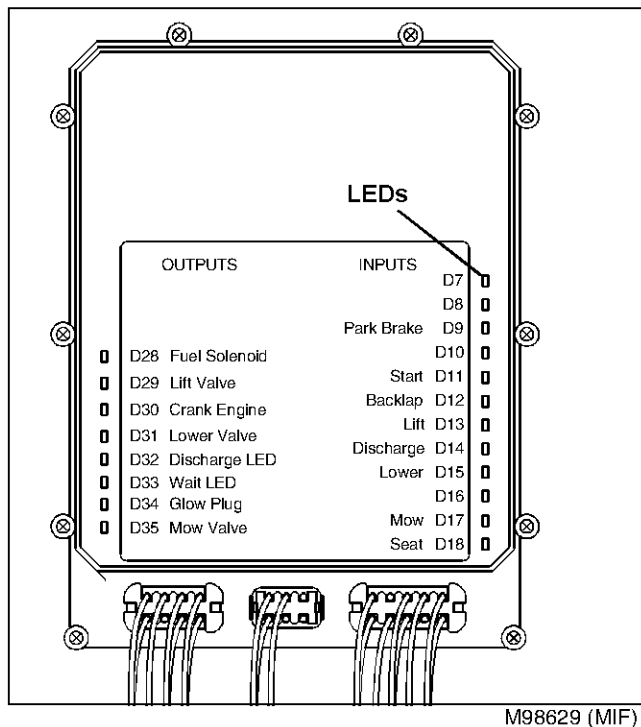
The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

STEP 2: INPUT CIRCUIT LED CHECK



Test Conditions

- Key switch in RUN position.

Glow Plug-Wait LED Output

- Open interlock module compartment panel.
- Observe the wait LED (D33) and glow plug LED (D34). The wait LEDs on the interlock module and on the console should be on for approximately four seconds. The glow plug LED should remain on for approximately ten seconds.

STEP 3: CIRCUIT TESTS

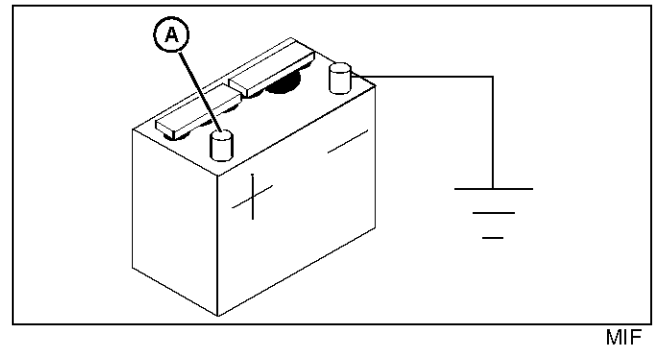
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Glow Plug Circuit Test

Test Conditions

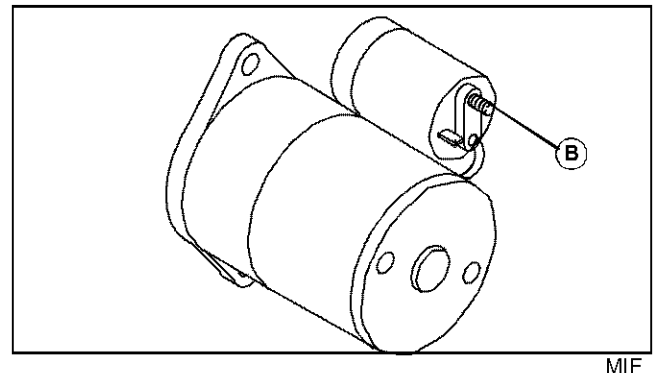
- Key switch in STOP position.
- Park brake LOCKED or operator on seat.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.



1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

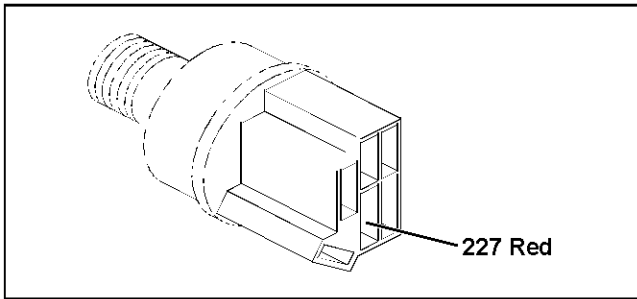


2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.

ELECTRICAL OPERATION AND DIAGNOSTICS



MIF

3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

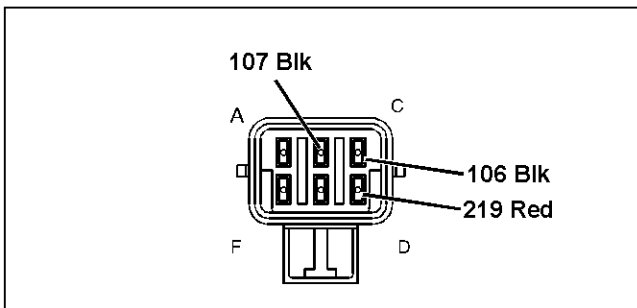
No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.

4. Key switch in RUN position - engine not running. Interlock module (A1) connector (X8) disconnected. Measure voltage at key switch (S1) connector (X1), terminal A, 204 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See "Key Switch Test" on page 222.)



MIF

Interlock module harness connector (X8) shown.

5. Measure voltage at interlock module (A1) connector (X8), terminal D, 219 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 219 and 204 Red wires and connections.

6. Measure ground circuit resistance at interlock module (A1) connector (X8), terminal B, 107 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

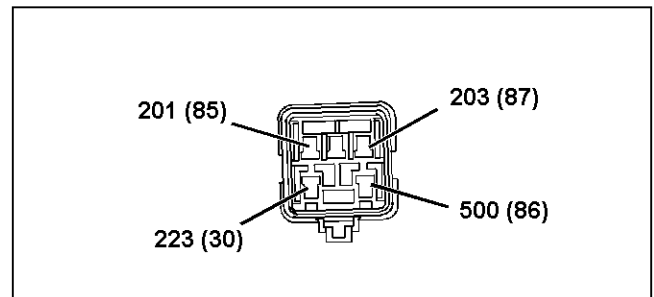
No: Test 107, 102, 109, and 105 Blk wires and connections.

7. Measure ground circuit resistance at interlock

module (A1) connector (X8), terminal C, 106 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 106, 107, 102, 109, and 105 Blk wires and connections.



MIF

Glow plug harness connector shown.

8. Connect interlock module (A1) connector (X8). Remove glow plug relay (K2). Measure voltage at glow plug relay (K2), terminal 85, 201 Red wire. Is battery voltage present?

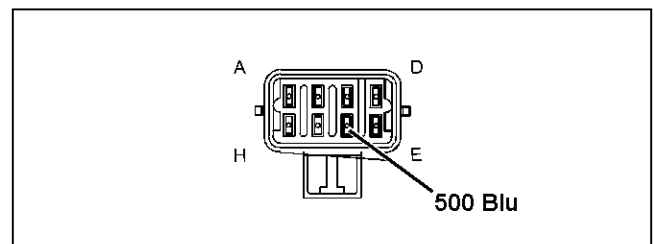
Yes: Go to next step.

No: Test 201, 218, and 204 Red wires and connections.

9. Measure voltage at glow plug relay (K2), terminal 30, 223 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 223 Red wire and connections.



MIF

Interlock module harness connector (X7) shown.

10. Disconnect interlock module (A1) connector (X7). Measure 500 Blu wire resistance between glow plug relay (K2), terminal 86 and interlock module connector (X7), terminal F. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Repair or replace 500 Blu wire.

11. Connect interlock module connector (X7). Install glow plug relay (K2). Cycle key switch (S1) to STOP position and then to RUN position. Within 10 seconds, measure voltage at glow plug relay (K2), terminal 87, 203 Red wire. Is battery voltage present?

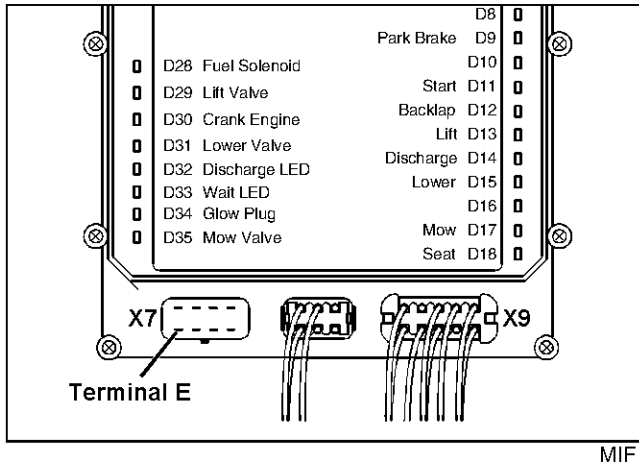
Yes: See "Glow Plug Test" on page 219.

ELECTRICAL OPERATION AND DIAGNOSTICS

Yes: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, Test interlock module (See "Interlock Module Check" on page 213.)

No: Test glow plug relay. (See "Electrical Relays Test" on page 221.)

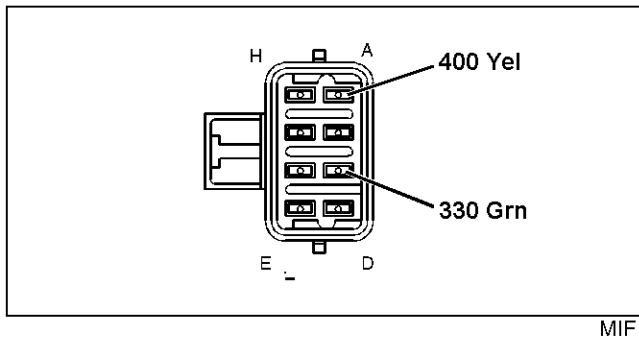
Glow Plug Indicator LED Circuit Test



1. Key switch in STOP position. Disconnect interlock module connector (X7). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X7), terminal E. Is battery voltage present?

Yes: Go to next step.

No: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, Test interlock module. (See "Interlock Module Check" on page 213.)

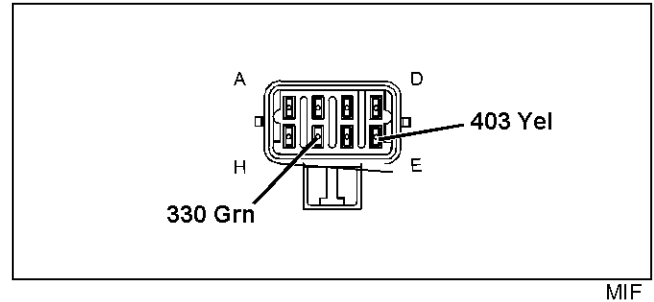


Instrument cluster (A2) harness connector (X13) shown.

2. Key switch to STOP position. Connect interlock module connector (X7). Disconnect instrument cluster (A2) connector (X13). Place key switch in RUN position - engine off. Measure voltage at instrument cluster (A2) connector (X13), terminal A, 400 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 400 and 403 Yel wires and connections.



Interlock module harness connector (X7) shown.

3. Disconnect interlock module connector (X7). Measure 330 Grn wire resistance between instrument cluster (A2) connector (X13), terminal C and interlock module connector (X7), terminal G. Is resistance less than 0.1 ohm?

Yes: If wait LED on interlock module illuminates for approximately four seconds, but the glow plug LED on the instrument cluster (A2) does not illuminate, replace instrument cluster (A2).

Yes: If neither LED illuminates, make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock module. (See "Interlock Module Check" on page 213.)

No: Repair or replace 330 Grn wire and connections.

Charging Circuit Operation

Function

To maintain voltage between 11.8 and 13.2 volts DC.

Operating Conditions

- Key switch in the RUN position.
- Engine running.

Theory of Operation

The power circuit provides voltage to the key switch (S1) and protects the charging circuit with a fusible link (F2) and 15-amp fuse (F4). Current flows from the battery (G1) positive (+) terminal through the fusible link (F2), 238 and 200 Red wires, 15-amp fuse (F4), and 227 Red wire to the key switch (S1), terminal B.

The power circuit also provides voltage and a direct connection to the voltage regulator (N1). Current flows from the battery (G1) positive (+) terminal through the fusible link (F2), 238, and 207 Red wire to the voltage regulator (N1).

With the key switch in the RUN position, current flows to the interlock module (A1) connector (X8), terminal D, through 219 Red wire. When the park brake is LOCKED or the operator is on the seat, current flows out the interlock module connector (X7), terminal E, and through 403 and 400 Yel wires to the instrument cluster (A2) connector (X13), terminal A. The ground side of the discharge LED is connected to the interlock module connector (X7), terminal H.

Voltage is also supplied to the voltage regulator through 208 Red wire.

A ground circuit provides a path to ground for the voltage regulator through 103 Blk wire.

The engine turns the alternator (G2) producing alternating current (AC). The alternating current flows from the alternator (G2) to the voltage regulator (N1) through 602 and 603 Brn wires. The voltage regulator converts the AC voltage to the DC voltage required to charge the battery.

When battery voltage is low, the voltage regulator turns on and charges the battery. When the battery is fully charged, the voltage regulator turns off, which stops current flow to the battery.

When the alternator output to the voltage regulator becomes too low or stops, the voltage regulator allows voltage to flow to the interlock module connector (X9), terminal K, through 501 Blu wire. The interlock module will then complete a path to ground and illuminate the discharge warning LED on the instrument cluster (A2).

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Charging Circuit Diagnosis

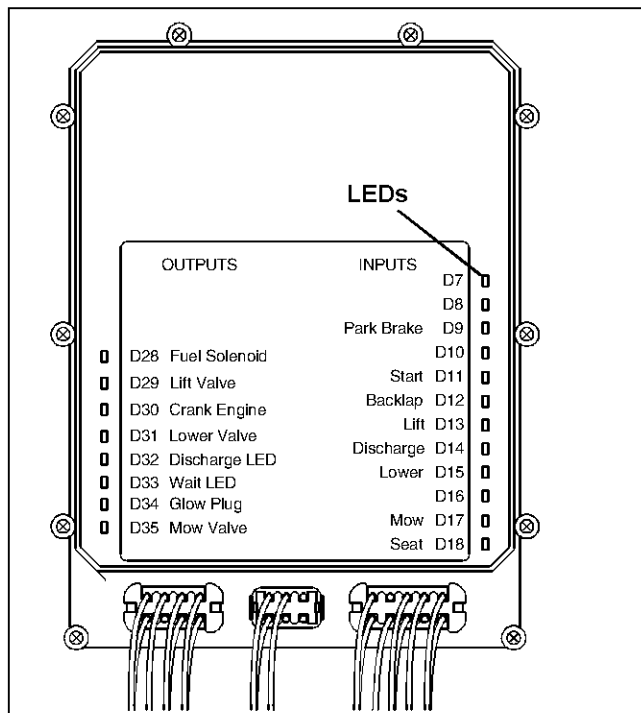
The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

STEP 2: INPUT CIRCUIT LED CHECK



Test Conditions

- Key switch in RUN position.

Voltage Regulator Input Circuit

1. Open interlock module panel.
2. Observe the inputs discharge LED (D14). The LED should be on when the key switch is in the RUN position with the engine not running. The LED should be off when the engine is running.

If the LED does not come on when the engine is not running, test the discharge LED circuit. (See "STEP 3: CIRCUIT TESTS" on page 194.)

Discharge LED Output Circuit

1. Observe the outputs discharge LED (D32) and discharge LED on the instrument cluster (A2). Both LEDs should be on when the key switch is in the RUN position with the engine not running. The LEDs should be off when the engine is running.

If the outputs discharge LED (D32) from the interlock module does come on, but the discharge warning LED on the instrument cluster (A2) does not come on when the engine is not running, test the discharge warning LED circuit. (See "STEP 3: CIRCUIT TESTS" on page 194.)

STEP 3: CIRCUIT TESTS

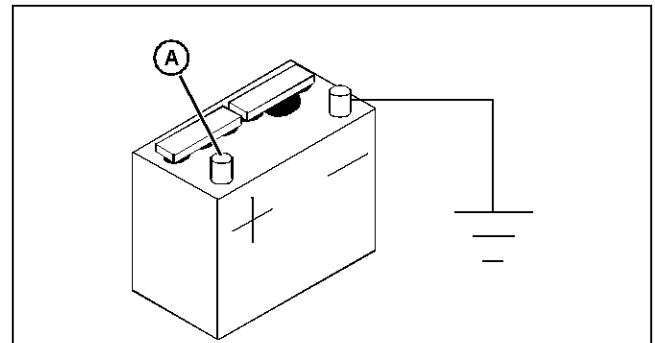
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Voltage Regulator Input Circuit

Test Conditions

- Key switch in STOP position.
- Park brake LOCKED or operator on seat.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

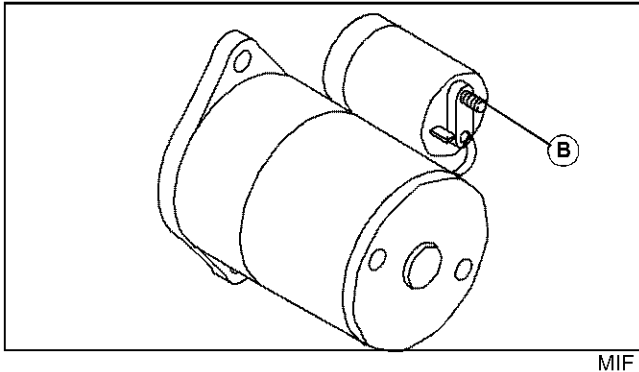


1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

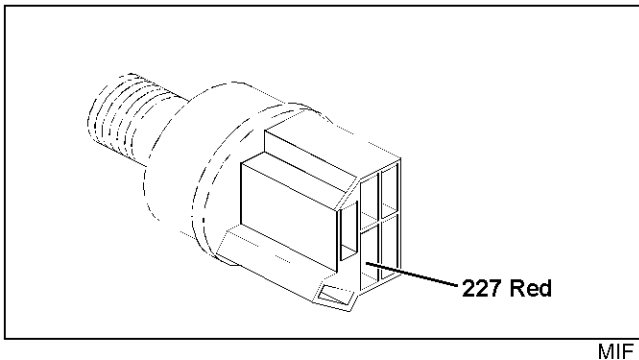
ELECTRICAL OPERATION AND DIAGNOSTICS



2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

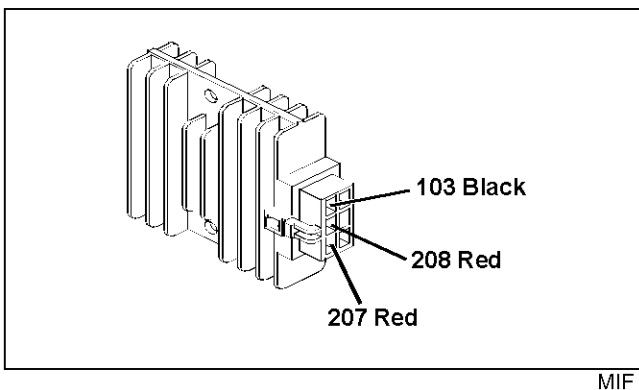
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.



4. Measure voltage at voltage regulator (N1), 207 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 207 and 238 Red wires and connections.

5. Measure resistance at voltage regulator (N1), 103 Blk wire. Is resistance less than 0.1 ohm?

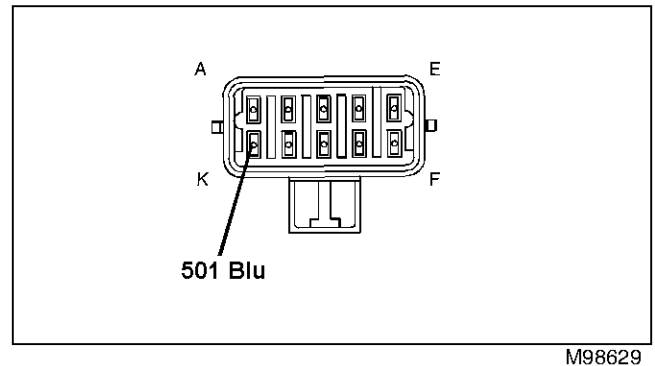
Yes: Go to next step.

No: Test 103, 102, 109, and 105 Blk wires and connections.

6. Key switch in RUN position - engine not running. Measure voltage at voltage regulator (N1), 208 Red wire. Is battery voltage present?

Yes: Go to next step.

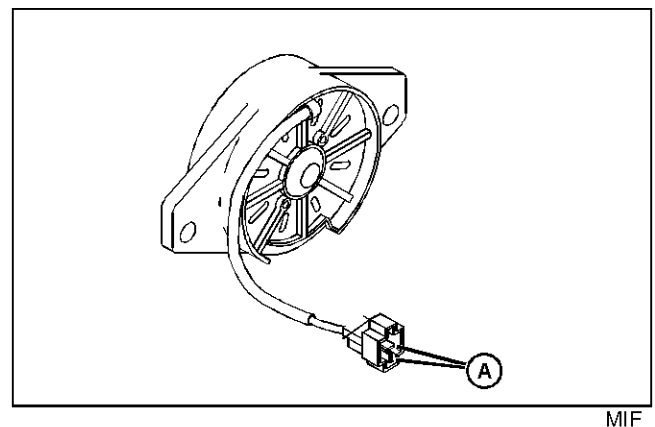
No: Test 208 and 204 Red wires and connections.



7. Turn key switch to STOP position. Disconnect interlock module connector (X9). Move key switch to RUN position - engine off. Measure voltage at interlock module connector (X9), terminal K, 501 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 501 Blu wire and connections.



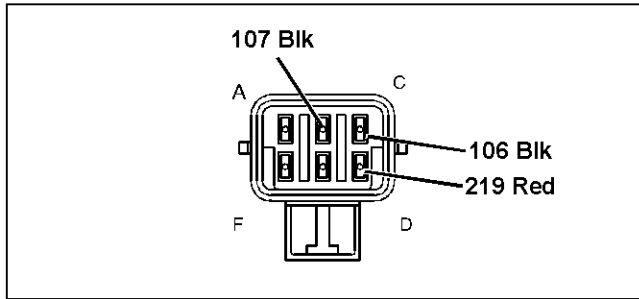
8. Key switch in STOP position. Connect interlock module connector (X9). Disconnect alternator connector. Place key switch in RUN position with engine running at fast idle. Measure voltage across alternator connector (A) (alternator output is AC voltage). Is output to specification?

ELECTRICAL OPERATION AND DIAGNOSTICS

Yes: Go to next step.

No: Repair or replace alternator.

Discharge Circuit Test



MIF

1. Place key switch in STOP position. Connect alternator connector. Disconnect interlock module (A1) connector (X8). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X8), terminal D, 219 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 219 and 204 Red wires and connections.

2. Measure ground circuit resistance at interlock module connector (X8), terminal B, 107 Blk wire. Is there less than 0.1 ohm of resistance?

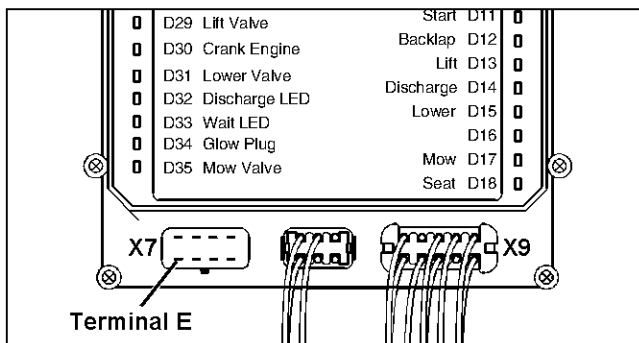
Yes: Go to next step.

No: Test 107, 102, 109, and 105 Blk wires and connections.

3. Measure ground circuit resistance at interlock module connector (X8), terminal C, 106 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 106, 102, 109, and 105 Blk wires and connections.

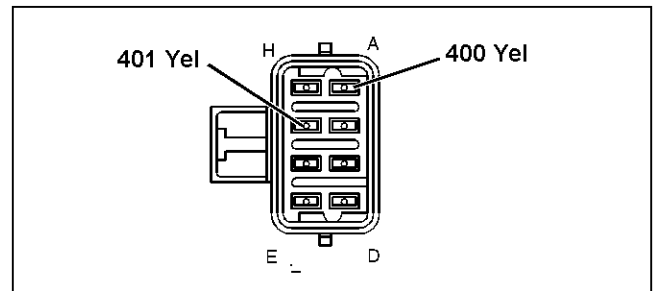


MIF

4. Place key switch in STOP position. Connect interlock module connector (X8). Disconnect interlock module connector (X7). Place key switch in RUN position - engine off. Measure voltage at interlock module (A1) connector (X7), terminal E. Is battery voltage present?

Yes: Go to next step.

No: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock module. (See "Interlock Module Check" on page 213.)

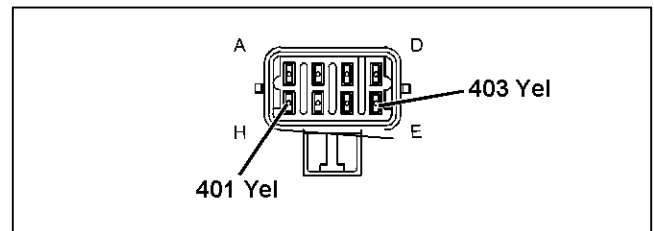


MIF

5. Key switch to STOP position. Connect interlock module connector (X7). Disconnect instrument cluster (A2) connector (X13). Place key switch in RUN position - engine off. Measure voltage at instrument cluster (A2) connector (X13), terminal A, 400 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 400 and 403 Yel wires and connections.



MIF

6. Disconnect interlock module connector (X7). Check resistance of 401 Yel wire between instrument cluster (A2) connector (X13), terminal G and interlock module (A1) connector (X7), terminal H. Is resistance less than 0.1 ohm?

Yes: If outputs discharge LED on interlock module (A1) illuminates with key switch in RUN position - engine off, but the discharge LED on the instrument cluster (A2) does not illuminate, replace instrument cluster (A2).

Yes: If neither LED illuminates, make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock. (See "Interlock Module Test" on page 214.)

No: Repair or replace 401 Yel wire and connections.

Engine Oil Pressure Circuit Operation

Function

To warn the operator if the engine oil pressure drops below the safe operating level.

Operating Conditions

- Key switch in the RUN position.
- Engine running.

Theory of Operation

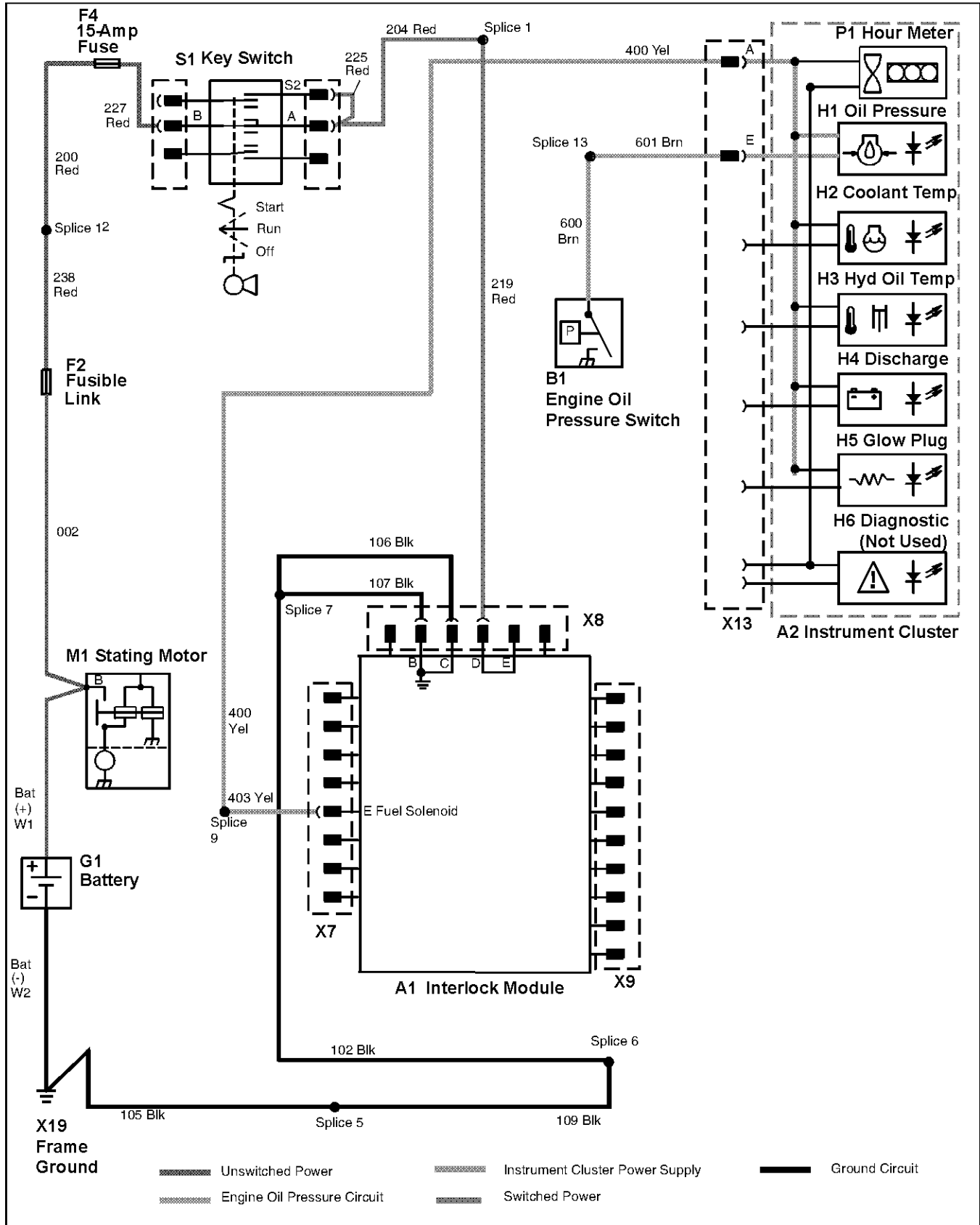
The power circuit provides voltage to the key switch (S1) and protects the oil pressure warning LED circuit with a fusible link (F2) and 15-amp fuse (F4). Current flows from the battery (G1) positive (+) terminal through the fusible link (F2), 238 and 200 Red wires, 15-amp fuse (F4), and 227 Red wire to the key switch (S1), terminal B.

With the key switch in the RUN position, current flows to the interlock module connector (X8), terminal D, through 219 Red wire. When the park brake is LOCKED or the operator is on the seat, current flows out the interlock module connector (X7), terminal E, and through 403 and 400 Yel wires to the instrument cluster (A2) connector (X13), terminal A. Current flows through the oil pressure LED and out terminal E, through 601 Brn wire and to the oil pressure switch (B1).

When the engine oil pressure drops below the safe operating level, the oil pressure switch (B1) closes and supplies a path to ground for 601 Brn wire, causing the oil pressure LED to illuminate.

ELECTRICAL OPERATION AND DIAGNOSTICS

Engine Oil Pressure Circuit Schematic



MX24282

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Engine Oil Pressure Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and/or continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

STEP 2: CIRCUIT TESTS

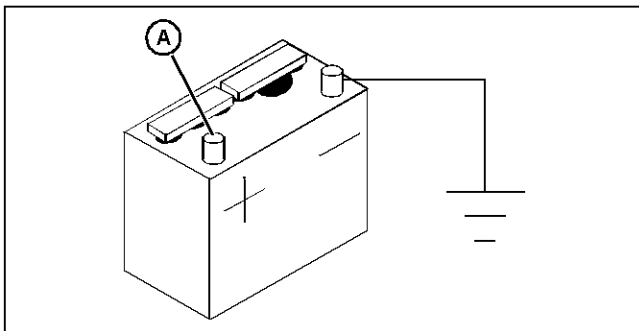
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Engine Oil Pressure Circuit Test

Test Conditions

- Key switch in STOP position.
- Park brake LOCKED or operator on seat.
- Engine oil pressure switch - connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

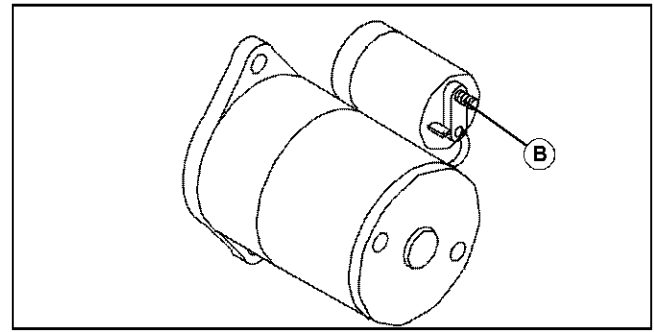


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

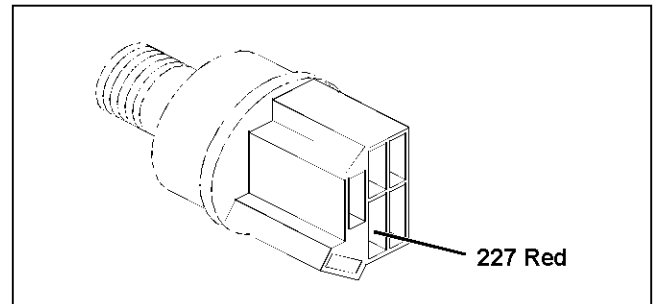


MIF

2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

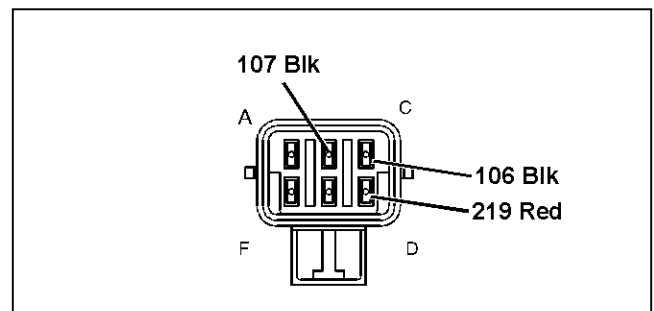
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.



MIF

4. Disconnect interlock module (A1) connector (X8). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X8), terminal D, 219 Red wire. Is battery voltage present?

Yes: Go to next step.

ELECTRICAL OPERATION AND DIAGNOSTICS

No: Test 219 and 204 Red wires and connections.

5. Measure ground circuit resistance at interlock module connector (X8), terminal B, 107 Blk wire. Is there less than 0.1 ohm of resistance?

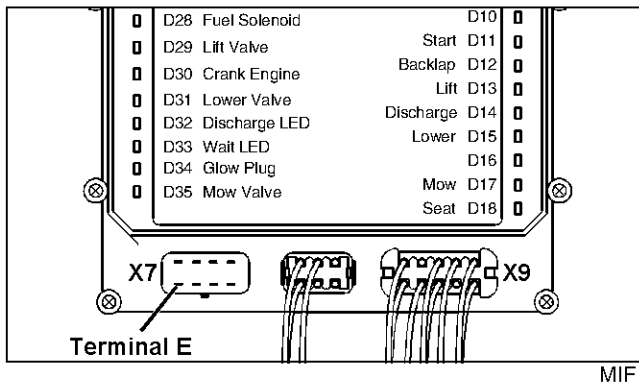
Yes: Go to next step.

No: Test 107, 102, 109, and 105 Blk wires and connections.

6. Measure ground circuit resistance at interlock module connector (X8), terminal C, 106 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

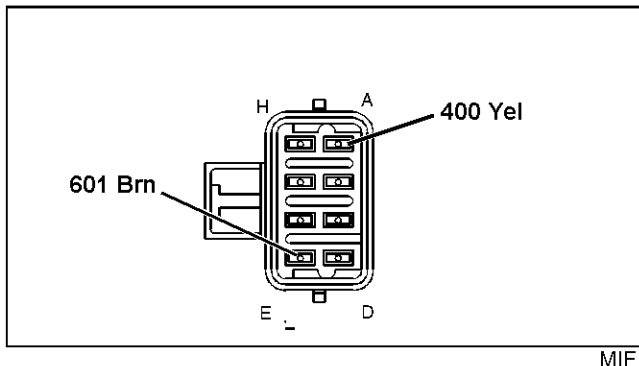
No: Test 106, 102, 109, and 105 Blk wires and connections.



7. Key switch to STOP position. Connect interlock module connector (X8). Disconnect interlock module connector (X7). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X7), terminal E. Is battery voltage present?

Yes: Go to next step.

No: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock module. (See "Interlock Module Check" on page 213.)

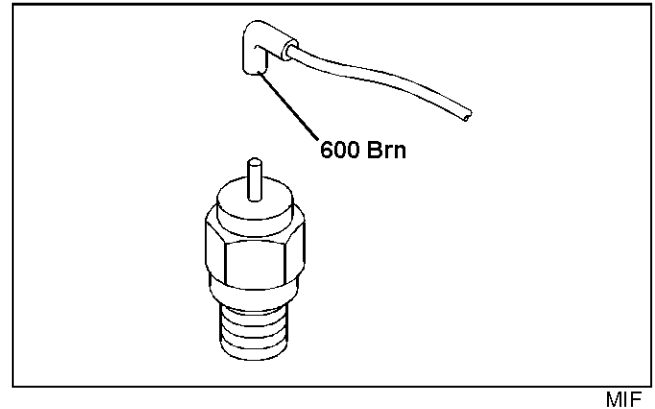


8. Key switch to STOP position. Connect interlock module connector (X7). Disconnect instrument cluster (A2) connector (X13). Place key switch in RUN position - engine off. Measure voltage at instrument cluster (A2)

connector (X13), terminal A, 400 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 400 and 403 Yel wires and connections.



9. Connect instrument cluster (A2) connector (X13). Measure voltage at oil pressure switch (B1) connector, 600 Brn wire. Are between 7.0-10.0 volts present?

Yes: Test oil pressure switch (B1). (See "Engine Oil Pressure Switch Test" on page 227.)

No: Test 600 and 601 Brn wires and connections. If OK, replace instrument cluster (A2).

Engine Coolant Circuit Operation

Function

To warn the operator if the engine coolant temperature exceeds the safe operating limit.

Operating Conditions

- Key switch in the RUN position.
- Engine running.

Theory of Operation

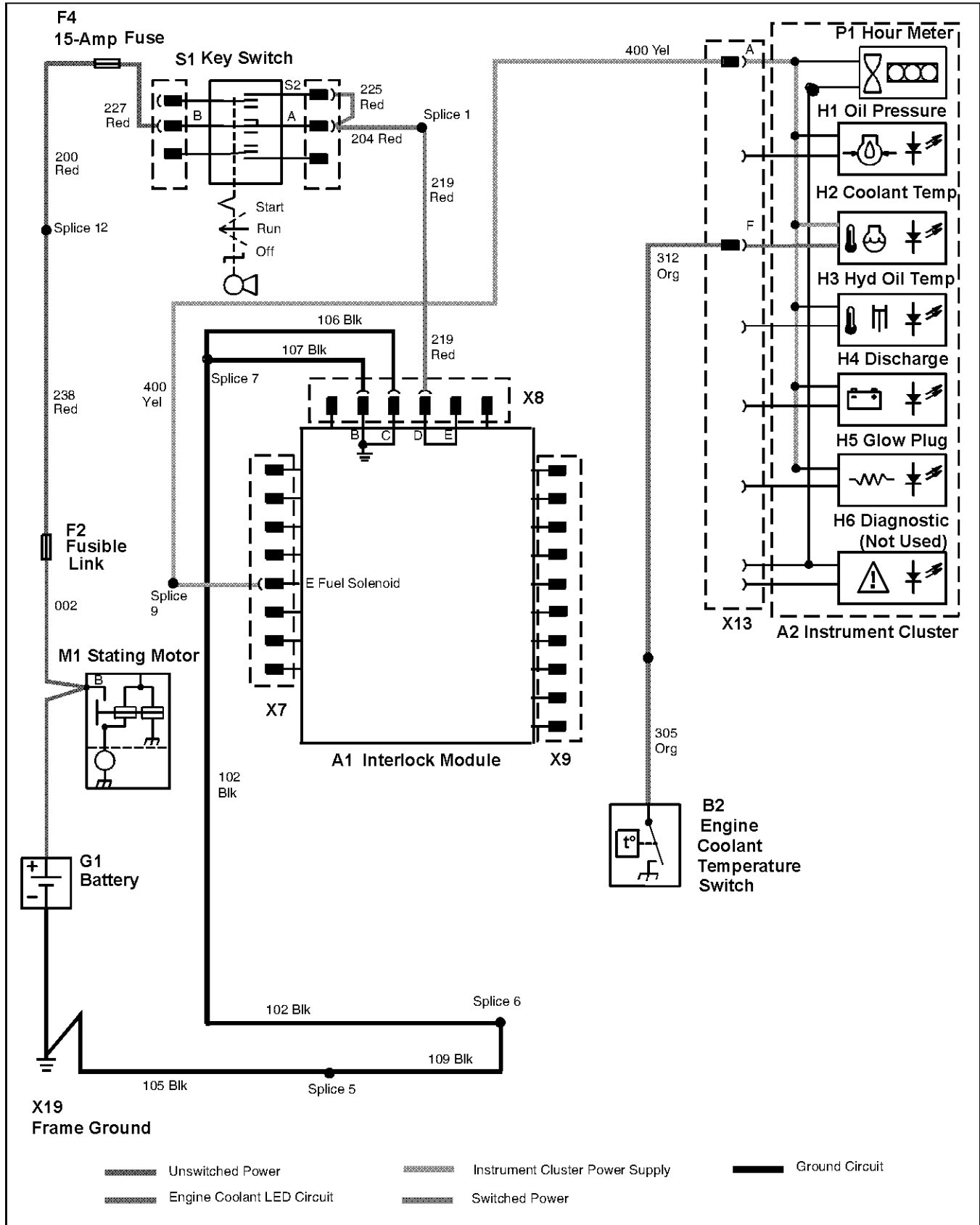
The power circuit provides voltage to the key switch (S1) and protects the coolant temperature warning LED circuit with a fusible link (F2) and 15-amp fuse (F4). Current flows from the battery (G1) positive (+) terminal through the fusible link (F2), 238 and 200 Red wires, 15-amp fuse (F4), and 227 Red wire to the key switch (S1), terminal B.

With the key switch in the RUN position, current flows to the interlock module (A1) connector (X8), terminal D, through 219 Red wire. When the park brake is LOCKED or the operator is on the seat, current flows out the interlock module connector (X7), terminal E and through 403 and 400 Yel wires to the instrument cluster (A2) connector (X13), terminal A. Current flows through the coolant temperature LED and out terminal F, through 312 and 305 Org wires and to the coolant switch (B2).

When the engine coolant temperature rises above the safe operating level, the coolant temperature switch (B2) closes and completes the path to ground, causing the coolant temperature LED to illuminate.

ELECTRICAL OPERATION AND DIAGNOSTICS

Engine Coolant Circuit Schematic



MX24283

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Engine Coolant Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and/or continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

STEP 2: CIRCUIT TESTS

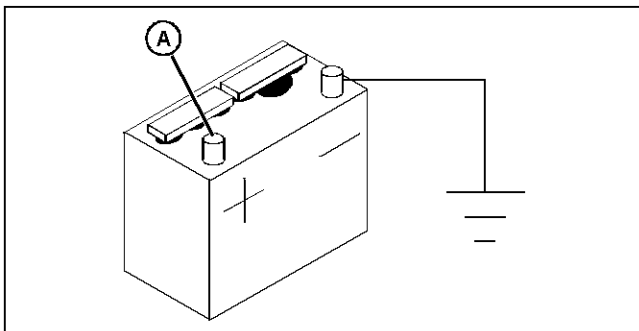
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Engine Coolant Circuit Test

Test Conditions

- Key switch in STOP position.
- Park brake LOCKED or operator on seat.
- Engine coolant temperature switch connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

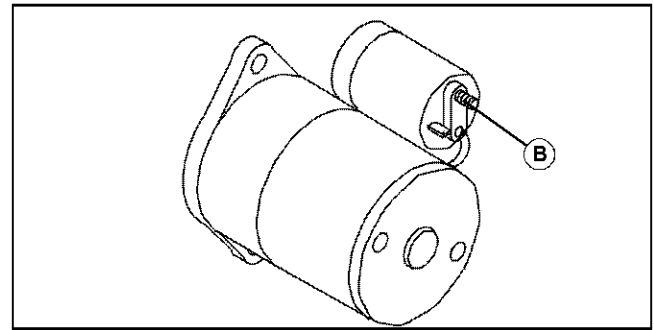


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

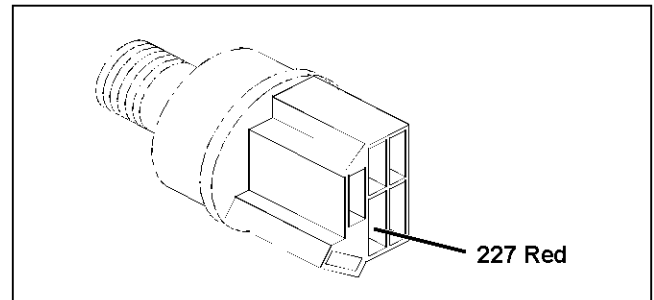


MIF

2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

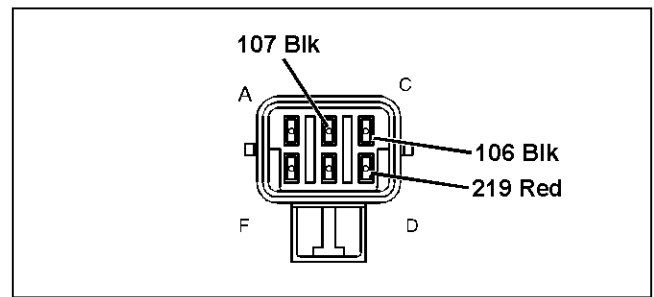
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.



MIF

4. Disconnect interlock module connector (X8). Place key switch in RUN position - engine off.

Measure voltage at interlock module connector (X8), terminal D, 219 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 219 and 204 Red wires and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS

5. Measure ground circuit resistance at interlock module connector (X8), terminal B, 107 Blk wire. Is there less than 0.1 ohm of resistance?

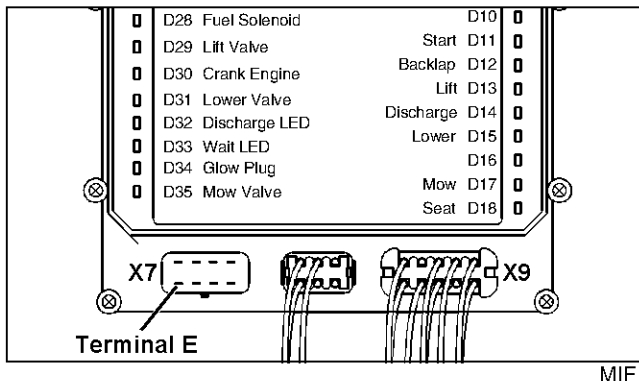
Yes: Go to next step.

No: Test 107, 102, 109, and 105 Blk wires and connections.

6. Measure ground circuit resistance at interlock module connector (X8), terminal C, 106 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

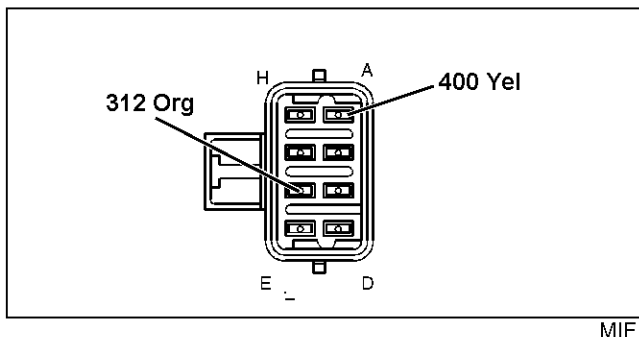
No: Test 106, 102, 109, and 105 Blk wires and connections.



7. Key switch to STOP position. Connect interlock module connector (X8). Disconnect interlock module connector (X7). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X7), terminal E. Is battery voltage present?

Yes: Go to next step.

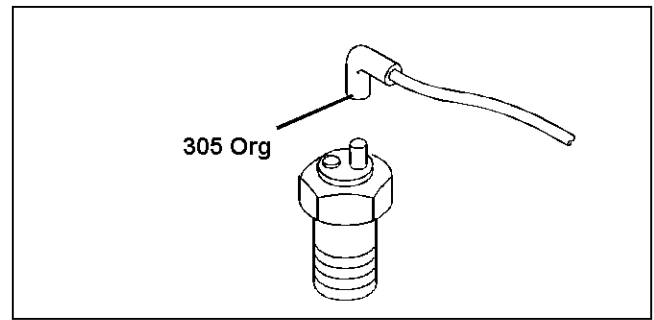
No: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock module. (See "Interlock Module Check" on page 213.)



8. Key switch to STOP position. Connect interlock module connector (X7). Disconnect instrument cluster (A2) connector (X13). Place key switch in RUN position - engine off. Measure voltage at instrument cluster (A2) connector (X13), terminal A, 400 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 400 and 403 Yel wires and connections.



9. Connect instrument cluster (A2) connector (X13). Measure voltage at engine coolant temperature switch (B2) connector, 305 Org wire. Are between 7.0-10.0 volts present?

Yes: Test coolant temperature switch. (See "Engine Coolant Temperature Switch Test" on page 228.)

No: Test wires 305 and 312 Org, and connections. If OK, replace instrument cluster (A2)

Hydraulic Oil Temperature Circuit Operation

Function

To warn the operator if the hydraulic oil temperature exceeds the safe operating limit.

Operating Conditions

- Key switch in the RUN position.
- Engine running.

Theory of Operation

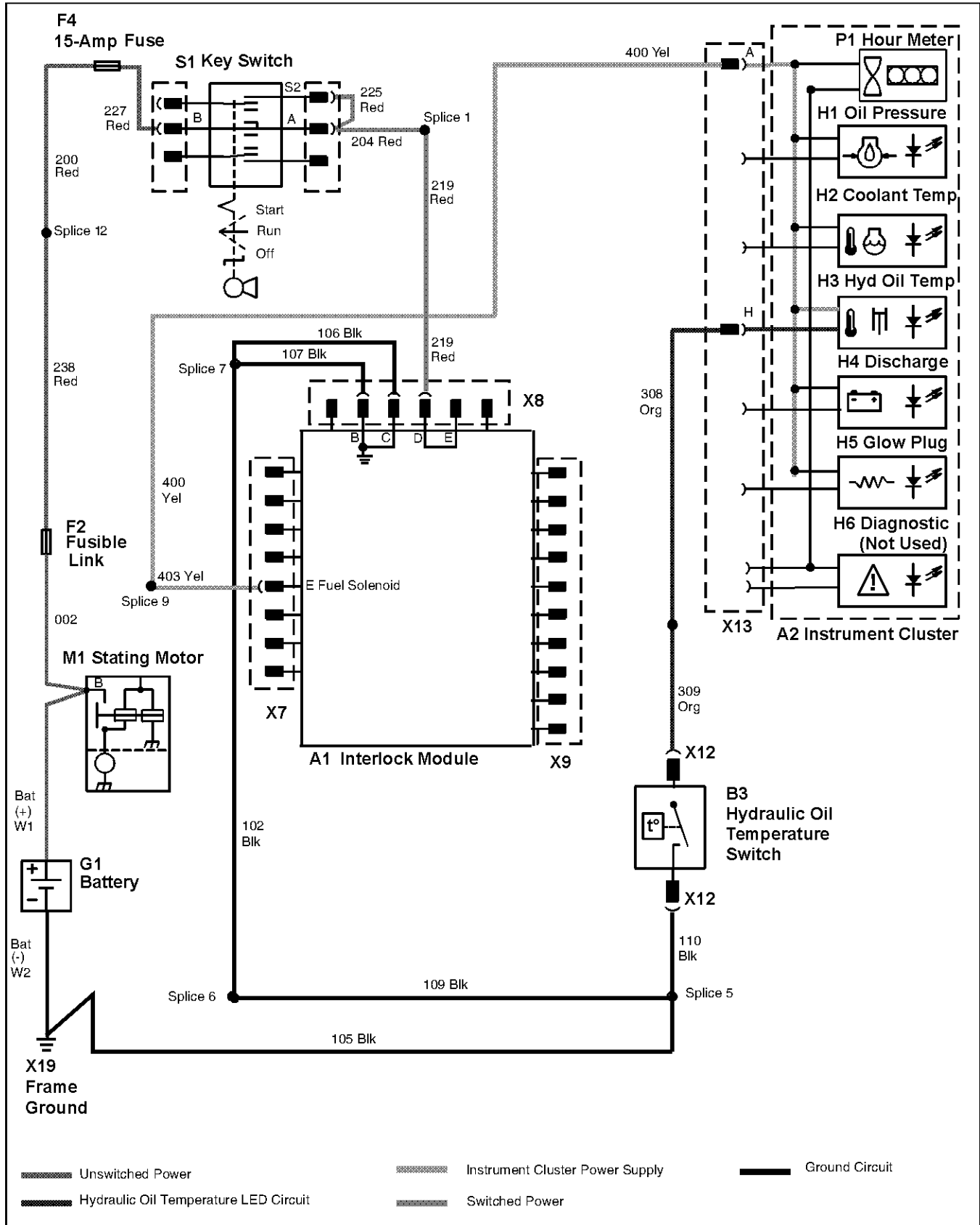
The power circuit provides voltage to the key switch (S1) and protects the hydraulic oil temperature warning LED circuit with a fusible link (F2) and 15-amp fuse (F4). Current flows from the battery (G1) positive (+) terminal through the fusible link (F2), 238 and 200 Red wires, 15-amp fuse (F4), and 227 Red wire to the key switch (S1), terminal B.

With the key switch in the RUN position, current flows to the interlock module (A1) connector (X8), terminal D, through 219 Red wire. When the park brake is LOCKED or the operator is on the seat, current flows out the interlock module connector (X7), terminal E, and through 403 and 400 Yel wires to the instrument cluster (A2) connector (X13), terminal A. Current flows through the hydraulic oil temperature LED and out terminal H, through 308 and 309 Org wires to the hydraulic oil temperature switch (B3).

At room temperature, the switch is open (infinite resistance). If the hydraulic oil temperature rises above the safe operating level of 96C° (200F°), the switch closes, completing the circuit to ground, causing the hydraulic oil temperature LED to illuminate.

ELECTRICAL OPERATION AND DIAGNOSTICS

Hydraulic Oil Temperature Circuit Schematic



MX24284

ELECTRICAL OPERATION AND DIAGNOSTICS

System: Hydraulic Oil Temperature Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

STEP 2: CIRCUIT TESTS

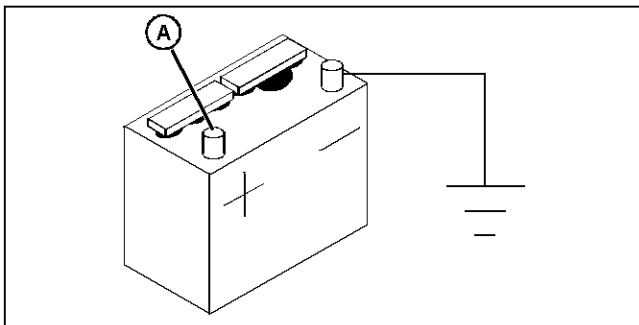
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Hydraulic Oil Temperature Circuit Test

Test Conditions

- Key switch in STOP position.
- Park brake LOCKED or operator on seat.
- Hydraulic temperature switch connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

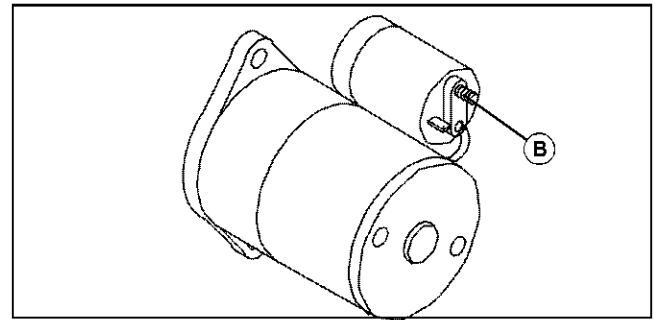


MIF

1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See "Battery Test" on page 215.)

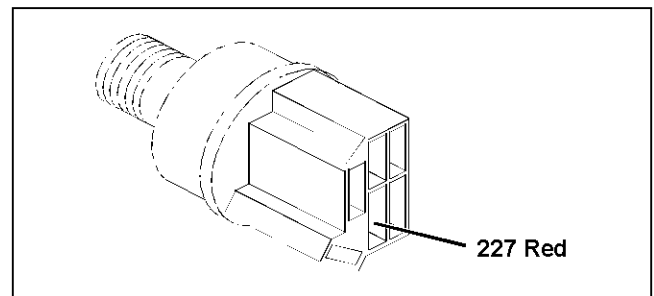


MIF

2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



MIF

3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

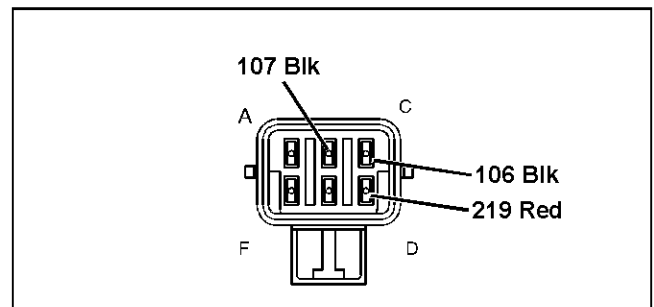
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.



MIF

4. Disconnect interlock module connector (X8). Place key switch in RUN position - engine off. Measure voltage at interlock module (A1) connector (X8), terminal D, 219 Red wire. Is battery voltage present?

Yes: Go to next step.

ELECTRICAL OPERATION AND DIAGNOSTICS

No: Test 219 and 204 Red wires and connections.

5. Measure ground circuit resistance at interlock module connector (X8), terminal B, 107 Blk wire. Is there less than 0.1 ohm of resistance?

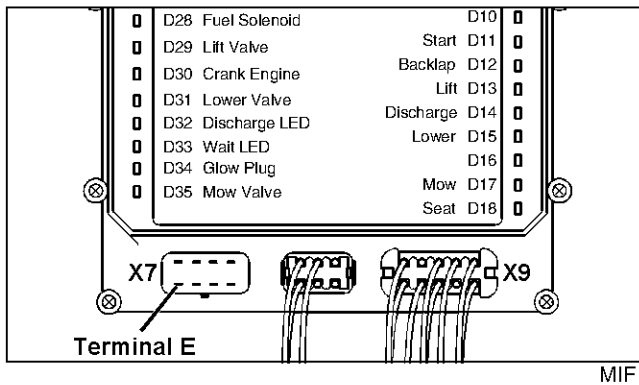
Yes: Go to next step.

No: Test 107, 102, 109, and 105 Blk wires and connections.

6. Measure ground circuit resistance at interlock module connector (X8), terminal C, 106 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

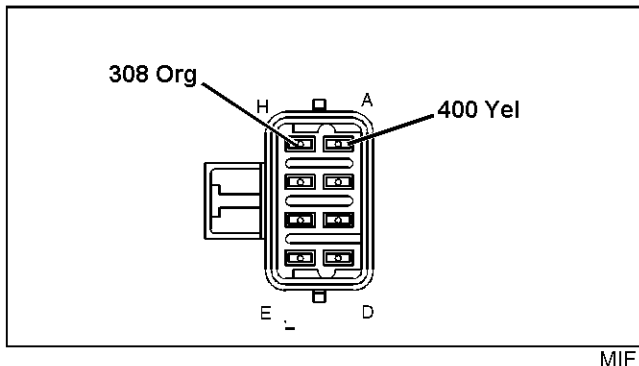
No: Test 106, 102, 109, and 105 Blk wires and connections.



7. Key switch to STOP position. Connect interlock module connector (X8). Disconnect interlock module connector (X7). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X7), terminal E. Is battery voltage present?

Yes: Go to next step.

No: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock module (See "Interlock Module Check" on page 213.)

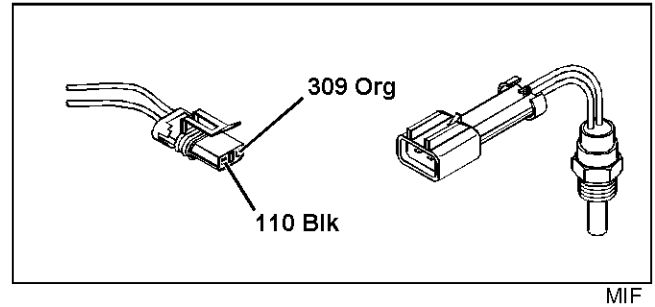


8. Key switch to STOP position. Connect interlock module connector (X7). Disconnect instrument cluster (A2) connector (X13). Place key switch in RUN position - engine off. Measure voltage at instrument cluster (A2)

connector (X13), terminal A, 400 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 400 and 403 Yel wires and connections.



9. Connect instrument cluster (A2) connector (X13). Measure circuit resistance at hydraulic oil temperature switch (B3) connector, 110 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110 and 105 Blk wires and connections. If OK, replace instrument cluster (A2).

10. Measure voltage at hydraulic oil temperature switch (B3) connector, 309 Org wire. Is voltage between 7.0-10.0 volts?

Yes: Test hydraulic oil temperature switch. (See "Hydraulic Temperature Switch Test" on page 226.)

No: Test wires 309 and 308 Org and connections. If OK, replace instrument cluster (A2).

Hour Meter Circuit Operation

Function

To record the number of hours in 1/10 hour increments when the key switch is in the RUN position.

Operating Conditions

- Key switch in the RUN position.
- Park brake LOCKED or operator on seat.

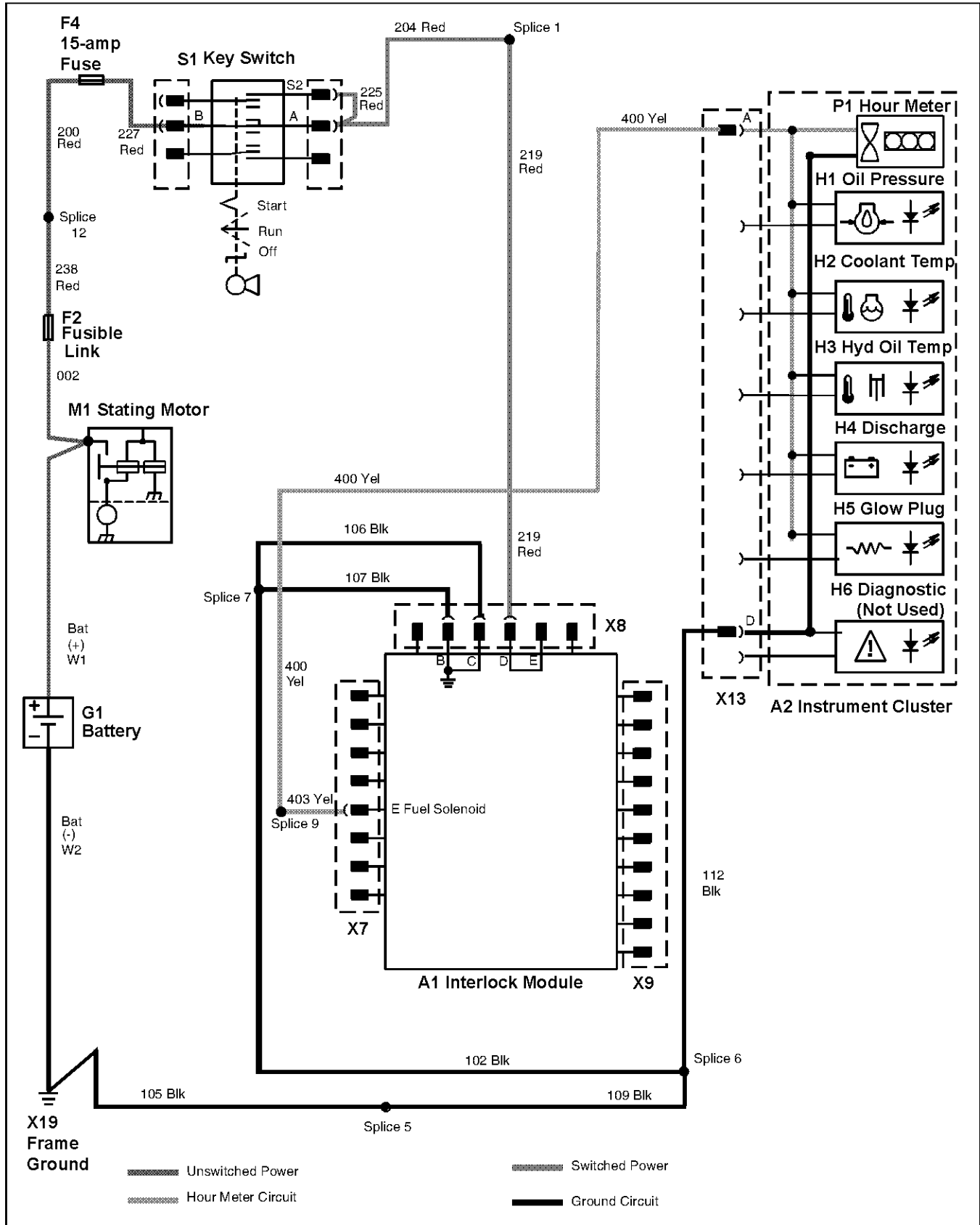
Theory of Operation

The power circuit provides voltage to the key switch (S1) and protects the hour meter circuit with a fusible link (F2) and 15-amp fuse (F4). Current flows from the battery (G1) positive (+) terminal through the fusible link (F2), 238 and 200 Red wires, 15-amp fuse (F4), and 227 Red wire to the key switch (S1), terminal B.

With the key switch in the RUN position, current flows to the interlock module (A1) connector (X8), terminal D, through 219 Red wire. When the park brake is LOCKED or the operator is on the seat, current flows out the interlock module connector (X7), terminal E, and through 403 and 400 Yel wires to the instrument cluster (A2) connector (X13), terminal A. Current flows through the hour meter, which records in 1/10 hour increments, and a ground is provided out terminal D, through 112, 109, and 105 Blk wires.

ELECTRICAL OPERATION AND DIAGNOSTICS

Hour Meter Circuit Schematic



ELECTRICAL OPERATION AND DIAGNOSTICS

System: Hour Meter Circuit Diagnosis

The electrical diagnosis for circuits that include the interlock module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the interlock module and to minimize the need to perform voltage and/or continuity checks.

Important: Avoid Damage! Steps must be performed in sequence.

STEP 1: INTERLOCK MODULE CHECK

Perform interlock module check. (See "Interlock Module Check" on page 213.)

STEP 2: CIRCUIT TESTS

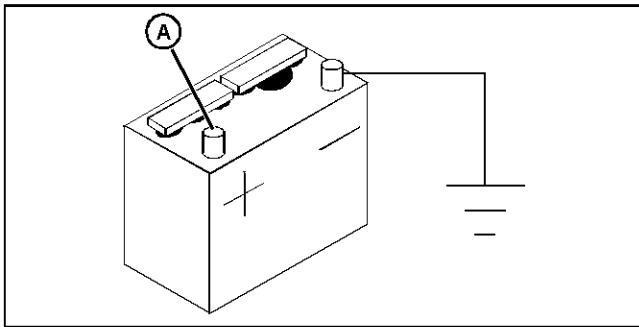
Important: Avoid Damage! DO NOT force meter probes into female terminals of METRI-PACK™ connectors. Excess force can damage terminals. Touch the probes lightly to terminals when testing.

Note: Check connections for corrosion and looseness when checking and testing.

Hour Meter Circuit Test

Test Conditions

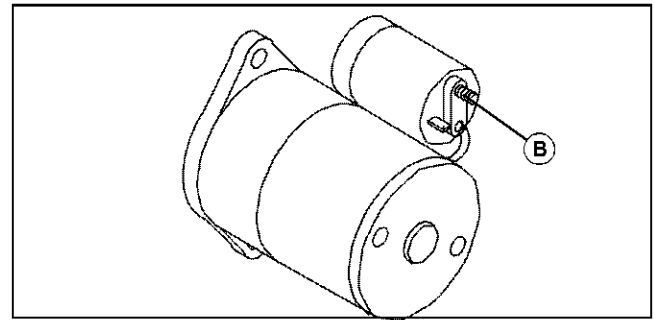
- Key switch in RUN position.
- Park brake LOCKED or operator on seat.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.



1. Measure voltage at battery positive (+) post (A). Is voltage between 11.8-13.2 volts?

Yes: Go to next step.

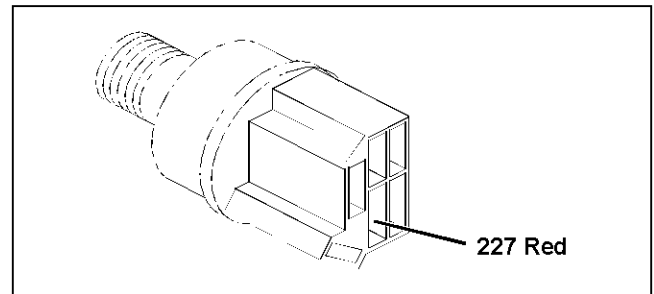
No: Check battery condition. (See "Battery Test" on page 215.)



2. Measure voltage at starting motor solenoid, battery terminal (B). Is battery voltage present?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



3. Measure voltage at key switch (S1) connector (X1), terminal B, 227 Red wire. Is battery voltage present?

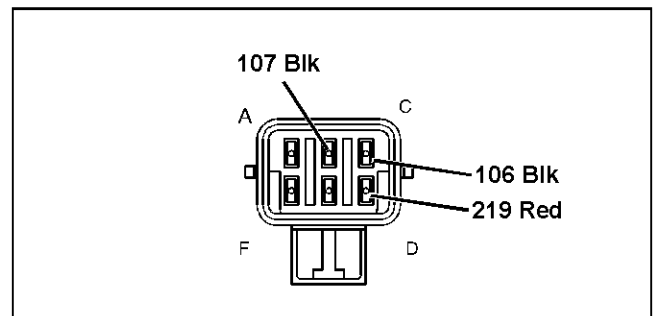
Yes: Go to next step.

No: Test 227 Red wire and connections.

No: Test fuse (F4). (See "Fuse Test" on page 220.)

No: Test 200 and 238 Red wires and connections.

No: Test fusible link (F2) and connections.



4. Disconnect interlock module connector (X8). Place key switch in RUN position - engine off.

Measure voltage at interlock module connector (X8), terminal D, 219 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 219 and 204 Red wires and connections.

ELECTRICAL OPERATION AND DIAGNOSTICS

5. Measure ground circuit resistance at interlock module connector (X8), terminal B, 107 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 107, 102, 109, and 105 Blk wires and connections.

6. Measure ground circuit resistance at interlock module connector (X8), terminal C, 106 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 106, 102, 109, and 105 Blk wires and connections.

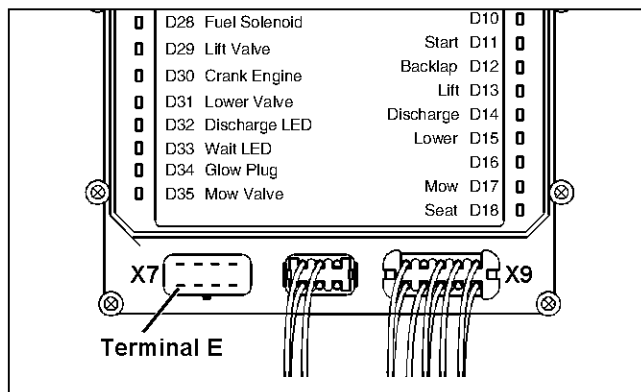
Yes: Go to next step.

No: Test 400 and 403 Yel wires and connections.

9. Measure resistance at instrument cluster (A2) connector (X13), terminal D, 112 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Replace instrument cluster (A2).

No: Test 112, 109, and 105 Blk wires and connections.

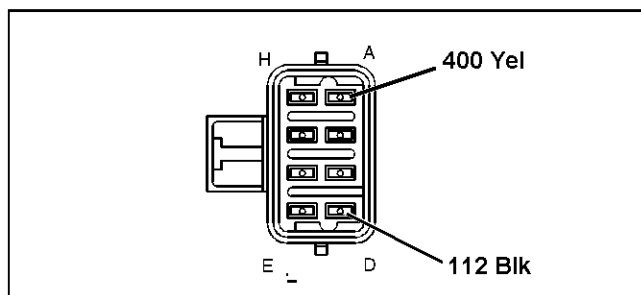


MIF

7. Key switch to STOP position. Connect interlock module connector (X8). Disconnect interlock module connector (X7). Place key switch in RUN position - engine off. Measure voltage at interlock module connector (X7), terminal E. Is battery voltage present?

Yes: Go to next step.

No: Make sure interlock module pins are clean and making good contact with the connectors (X7, X8, and X9). If OK and no service codes occur, test interlock. (See "Interlock Module Check" on page 213.)



MIF

8. Key switch to STOP position. Connect interlock module connector (X7). Disconnect instrument cluster (A2) connector (X13). Place key switch in RUN position - engine off. Measure voltage at instrument cluster (A2) connector (X13), terminal A, 400 Yel wire. Is battery voltage present?

ELECTRICAL TESTS AND ADJUSTMENTS

Tests and Adjustments

Ground Circuit Test

Reason

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

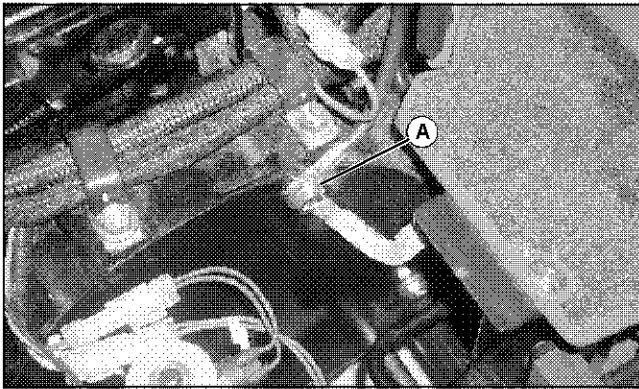
Note: In a “switched ground” system, not all components are grounded directly to the battery. Most circuit components are grounded through the interlock module (A1).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure resistance.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Connect ohmmeter negative (black) lead to negative (-) terminal of battery.



MX24382

6. Connect ohmmeter red lead to ground terminal of circuit (A) or component to be tested that is closest to the battery negative terminal. Resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohm⁴. Check both sides of the connectors closely, as disconnecting and connecting may temporarily solve problem.

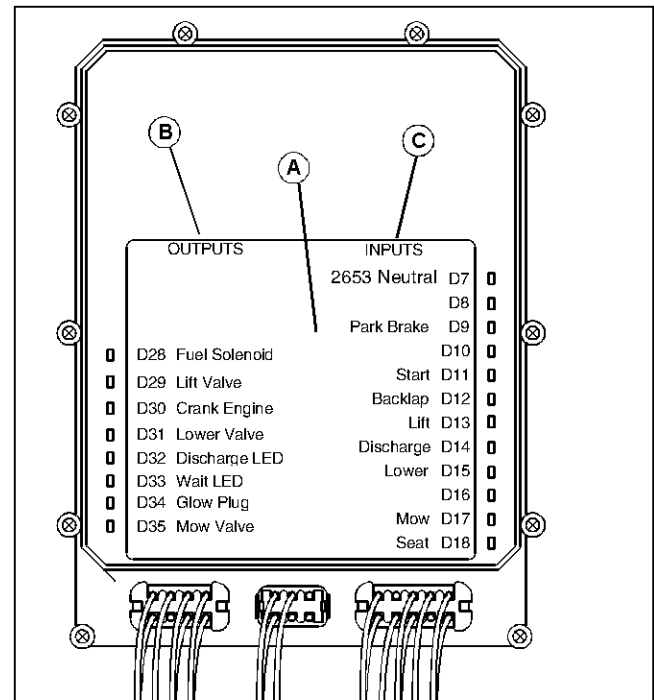
Interlock Module Check

Reason

To determine the operating condition of the interlock module. The interlock module includes several self-protection features and is designed to last the life of the machine. Most electrical problems are caused by harness or component failures, and are rarely a result of an interlock module failure.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Open interlock module compartment panel.
6. Move key switch to RUN position.



M98629 (MIF)

7. Check “Heartbeat” (A), input (C), and output (B) LED Indicators.

Results

Normal

- “Heartbeat” LED flashes in a regular, even rate.
- Input LEDs correspond to activated switches.

4. Some ohmmeters may not provide an accurate reading at a very low resistance. Touch meter probe leads together, and subtract shorted probe reading from the measured resistance reading.

ELECTRICAL TESTS AND ADJUSTMENTS

Battery Test



Caution: Avoid Injury! Battery electrolyte contains sulfuric acid. It is poisonous and can cause serious burns:

- Wear eye protection and gloves.
- Keep skin protected.
- If electrolyte is swallowed, get medical attention immediately.
- If electrolyte is splashed into eyes, flush immediately with water for 15-30 minutes and get medical attention.
- If electrolyte is splashed onto skin, flush immediately with water and get medical attention if necessary.

Note: The original battery supplied with this machine is a sealed battery and is not serviceable. This procedure is for a serviceable battery that has replaced the original sealed battery.

Do not attempt to open, add fluid, or service a sealed battery.

To test a sealed battery, perform a battery load test. (See "Load Battery Test" on page 217.)

Reason

To check condition of battery and determine voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	N/A	Used to check specific gravity.
Digital Multi-meter	JT05791	Used to check battery voltage.
Battery Tester	JT05685 or equivalent	Used to check battery voltage.

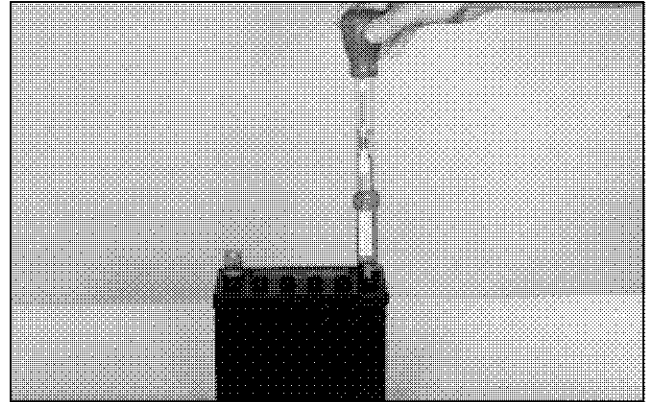
Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Clean cable ends, battery terminals and top of battery. (See "Clean Battery" on page 229.)
6. Remove battery. (See "Battery Removal and Installation" on page 228.)
7. Inspect battery terminals and case for breakage or

cracks.

8. Check electrolyte level in each battery cell. Add clean, distilled water as needed. If water is added, charge battery for 20 minutes at 10 amps.

9. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

10. Use a hydrometer to check for a minimum specific gravity of 1.225 with less than a 50-point variation in each cell. If specific gravity is not within range perform one of the following:

- If all cells are less than 1.175, charge battery at 10-amp rate.
- If all cells are less than 1.225 with less than 50-point variation, charge battery at 10 amps.
- If all cells are more than 1.225 with less than 50-point variation, load test battery.
- If more than 50-point variation, replace battery.

11. Use a voltmeter or JT05685 Battery Tester to check for a minimum battery voltage of 12.4 volts. One of the following may result:

- If battery voltage is less than 12.4 VDC, charge battery.
- If battery voltage is more than 12.4 VDC, test specific gravity. (See step 10.)

12. Install battery. (See "Battery Removal and Installation" on page 228.)

ELECTRICAL TESTS AND ADJUSTMENTS

Charge Battery



Caution: Avoid Injury! The battery produces a flammable and explosive gas. The battery may explode:

- Do not smoke near battery.
- Wear eye protection and gloves.
- Do not allow direct metal contact across battery posts.
- Remove negative cable first when disconnecting.
- Install negative cable last when connecting.

Reason

To increase battery charge after the battery has been discharged.

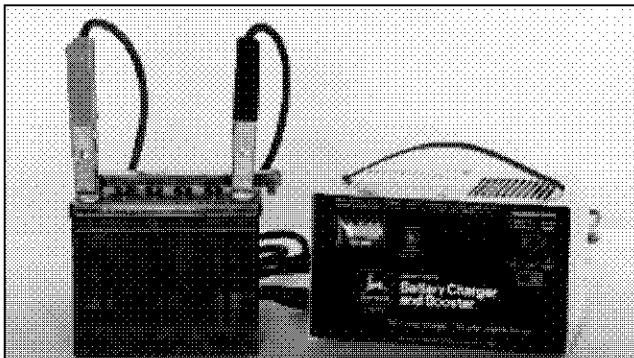
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (Variable Rate)	N/A	Used to charge battery.

Procedure

Note: Before charging serviceable battery, check electrolyte level. (See "Battery Test" on page 215.)

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Clean cable ends, battery terminals and top of battery.
6. Remove battery. (See "Battery Removal and Installation" on page 228.)



M49598

7. Connect variable rate charger to battery.
8. Start charger at SLOW rate. Increase charge rate ONE setting at a time. Check charger ammeter after 1 minute at

each setting. Maintain 10-amp charge rate. Use boost setting as necessary.

9. Check if battery is accepting 10-amp charge rate after 10 minutes at boost setting. One of the following may result:

- If battery WILL NOT accept 10-amp charge after 10 minutes at boost setting, replace battery.
- **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 12 and 13.
- **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, but battery DID need water or all cells were BELOW 1.175, go to steps 11 and 12.

10. Set charger at 15-25 amps.

Important: Avoid Damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

11. **Serviceable batteries only:** Check specific gravity after 30 minutes. One of the following problems may result:

- If MORE THAN 50-point variation between cells, replace battery.
- If LESS THAN 50-point variation between cells, go to steps 13 and 14.

Note: Serviceable batteries: If battery was discharged at slow or unknown rate, charge battery at 10-15 amps for 6-12 hours.

Maintenance-free batteries: Follow battery charger manufacturer's recommendations.

12. Load test battery.

13. Install battery. (See "Battery Removal and Installation" on page 228.)

Specifications

Battery Specific Gravity. 1.225-1.275 points

ELECTRICAL TESTS AND ADJUSTMENTS

Load Battery Test

Reason

To check condition of battery under load.

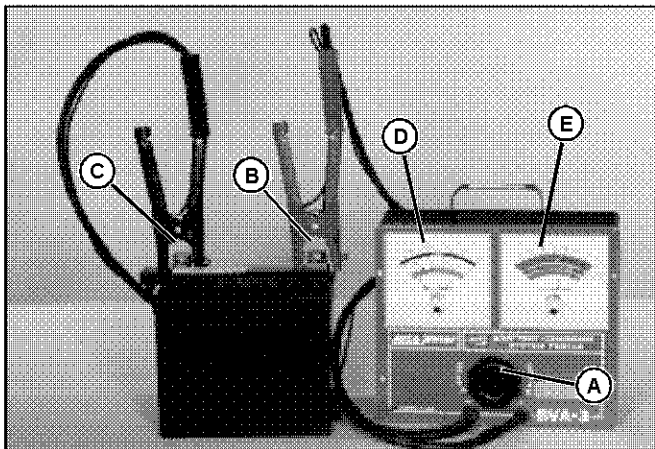
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester (use according to manufacturer's instructions)	JT05685 or equivalent	Used to test battery.

Procedure

1. Park machine on level surface.
2. Turn key switch to STOP position and LOCK park brake.
3. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
4. Remove battery from machine.
5. Clean battery terminals and case.

Important: Avoid Damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.



M49597

6. Connect tester positive cable (red) to battery positive (+) terminal (B).
7. Connect tester negative cable (black) to battery negative (-) terminal (C).

Important: Avoid Damage! Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5-10 seconds.

8. Turn load knob (A) of tester clockwise until amperage reading (D) is equal to:

- cold cranking amperage rating of battery (use blue scale).
- or-
- three times ampere hour rating (use black scale).

9. Hold for 15 seconds and turn load knob (A) of tester counterclockwise to OFF position.

10. Repeat steps 9 and 10 above and read condition of battery at DC volts scale (E).

11. If battery DOES NOT pass test and HAS NOT been charged, charge battery and retest. (See "Charge Battery" on page 216.)

12. If battery DOES NOT pass test and HAS been charged, replace the battery.

Regulated Voltage Output Test

Reason

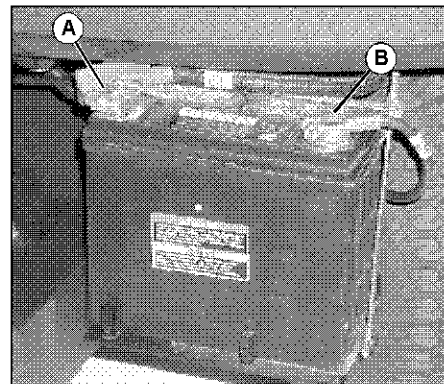
To check the regulated voltage (charging) output of the voltage regulator.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure voltage.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Remove surface charge from battery by cranking the engine for 15 seconds.
6. Set multimeter to measure voltage.



MX24384

7. Connect meter red lead to battery positive (+) terminal (A).
8. Connect meter black lead to battery negative (-) terminal

ELECTRICAL TESTS AND ADJUSTMENTS

(B).

9. Start and run engine at FAST idle - (3400 ± 50 rpm).
10. Read meter several times during 5 minutes of running time. Voltage should remain at specifications.

Results

- If the DC voltage remains below the minimum specification, perform unregulated voltage output tests. (See "Unregulated Voltage Output Test" on page 218.)
- If the DC voltage goes above the maximum specification, replace the voltage regulator.

Specifications

Regulated Voltage. 14.3-14.7 volts

Unregulated Voltage Output Test

Reason

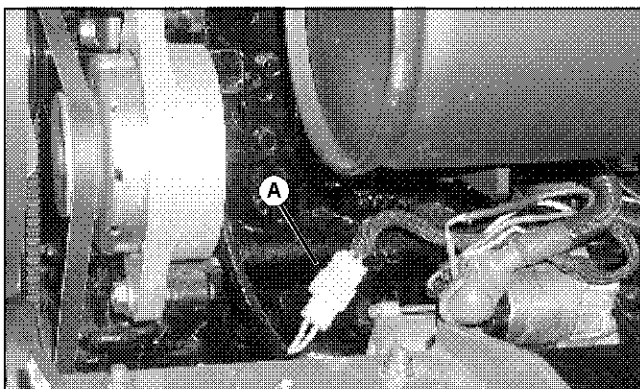
To check the stator output voltage to determine the stator condition.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure voltage.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.



MX24385

5. Disconnect the alternator wiring connector (A).
6. Set multimeter to measure AC voltage.
7. Connect multimeter leads across stator leads.
8. Start and run engine at FAST idle.
9. Read and record stator output voltage.

Results

If reading is less than specifications, repair or replace alternator.

Specifications

Unregulated Voltage (Minimum) 26 volts AC

Starting Motor Cranking Amperage Draw Test

Reason

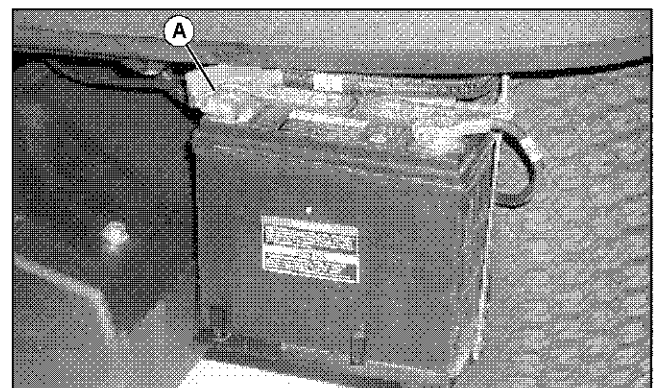
To determine the amperage required to crank the engine and check starter motor operation under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Clamp	JT02153	Used to measure starting motor current.
Digital Multimeter	JT05791	Used with current clamp.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Test system ground circuit connections. (See "Ground Circuit Test" on page 213.)
6. Test battery. (See "Battery Test" on page 215.)



MX24384

7. Connect JT02153 Current Clamp around battery positive (+) cable (A).
8. Set multimeter to measure DC amperage.
9. Connect multimeter to current clamp.
10. Disconnect the oil pressure switch 600 Brn wire.

ELECTRICAL TESTS AND ADJUSTMENTS

Important: Avoid Damage! Perform the following procedure within 15 seconds to prevent damage to electrical components.

11. Crank engine and read amperage on DC amp scale of multimeter.

12. Turn key switch to STOP position.

Results

- If amperage is above specifications, or rpm is low, check starter for binding or damage.
- If starter is good, check engine for internal binding or damage.

Specifications

Starting Motor Cranking Amperage Draw (Maximum) at 1240 engine RPM 230 Amps

Starting Motor Solenoid Test

Reason

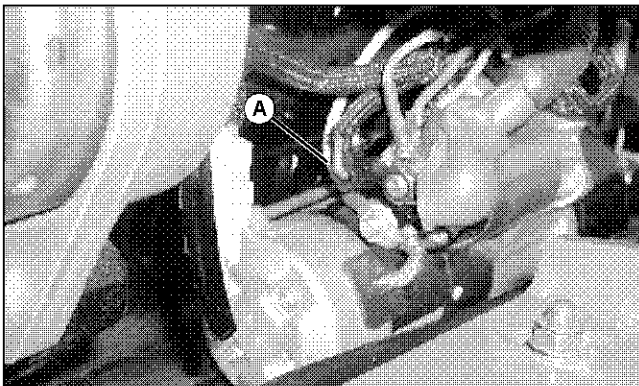
To determine if the starter solenoid or starting motor is defective.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Clamp	JT02153	Used to measure starting motor current.
Jumper Wire	N/A	Used to test starting motor solenoid.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Disconnect fuel shutoff solenoid wiring connector.



MX24386

6. Disconnect 604 Brn wire (A) from starter solenoid.

Note: All solenoid terminals must be clean and free of corrosion.

7. Connect jumper wire to positive (+) battery terminal and briefly jump to starting motor solenoid terminal (S).

- Starter runs: Solenoid is good, check circuit wiring (See "System: Cranking Circuit Diagnosis" on page 147.)
- Starter does not run: Go to step 8.

8. Briefly connect jumper wire between starter solenoid large terminals.

- Starter runs: Replace solenoid.
- Starter does not run: Check battery cables, replace starter.

Glow Plug Test

Reason

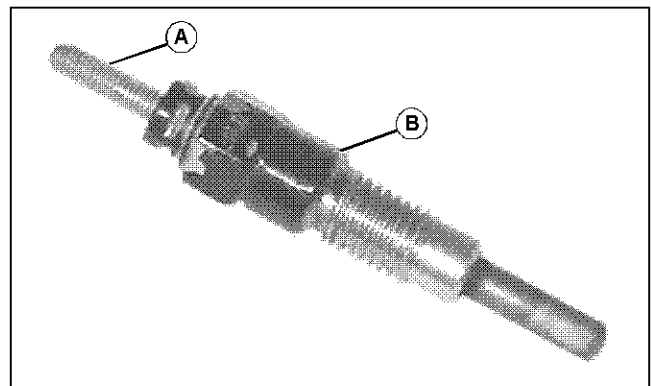
To test the condition of the glow plug.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure glow plug resistance.

Procedure

1. Remove glow plug(s).



M98190

2. Check resistance across terminal (A) and glow plug body (B).

Results

If the glow plug does not have the correct resistance, replace the glow plug.

Specifications

Glow Plug Resistance 1.35-1.65 ohms

ELECTRICAL TESTS AND ADJUSTMENTS

Fuse Test

Reason

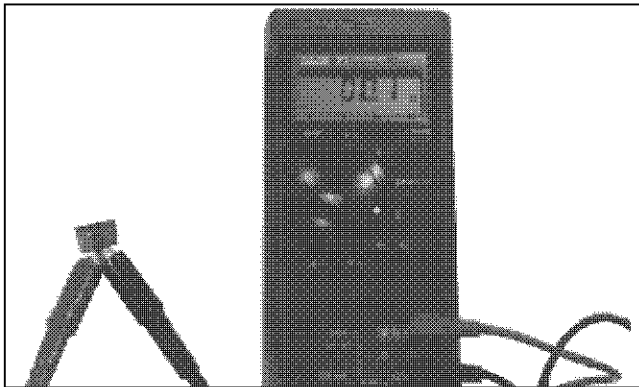
To determine if fuse has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure glow plug resistance.

Procedure

1. Remove fuse to be tested.
2. Set ohmmeter to ohms function.



3. Connect one meter lead to one post of fuse. Connect other meter lead to other post of fuse.
4. Measure continuity between fuse terminals.

Results

If there is no continuity between fuse terminals, replace fuse.

Diode Test

Reason

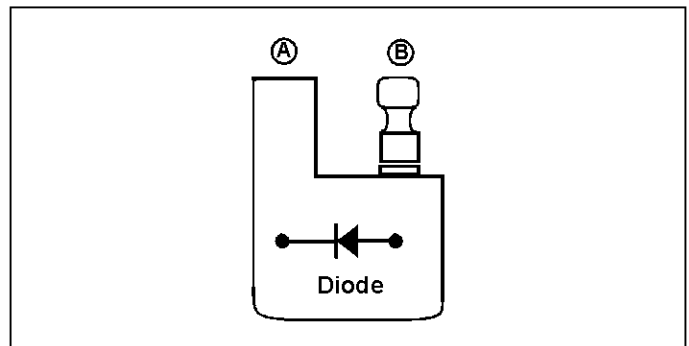
To determine if diode has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure glow plug resistance.

Procedure

1. Remove diode from connector.
2. Set meter to diode test.



3. Connect meter test leads between terminals (A) and (B). Check for continuity.
4. Reverse test leads. Check for continuity.

Results

Diode must have a low resistance reading in one direction only. Replace defective diode.

Mow Resistor Test

Reason

To determine if resistor has failed.

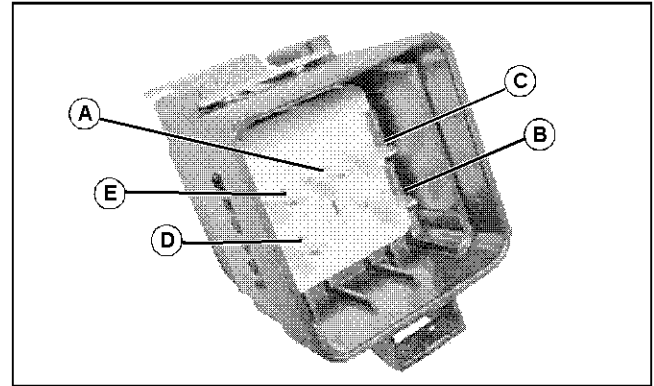
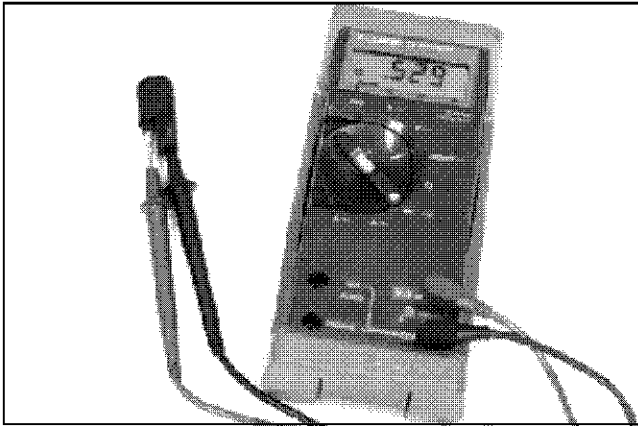
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure glow plug resistance.

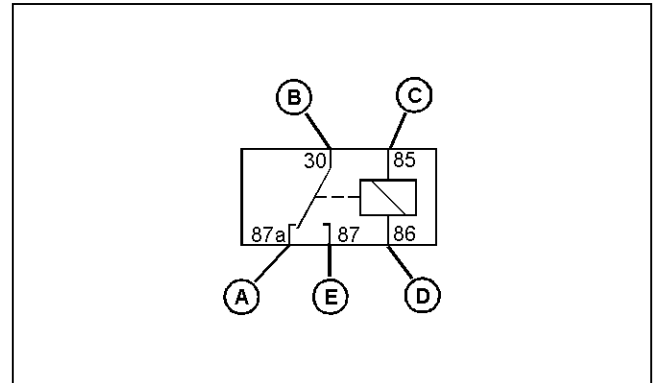
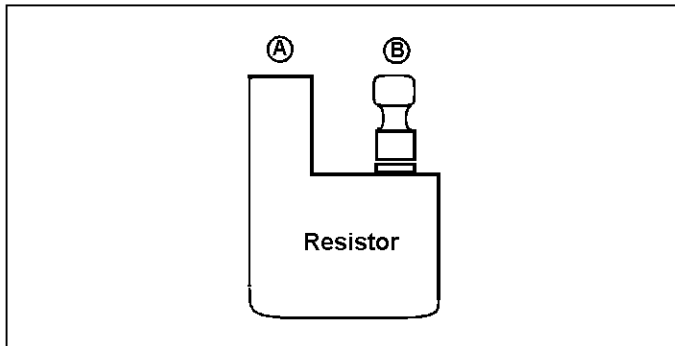
Procedure

1. Remove resistor from connector.
2. Set meter to measure resistance.

ELECTRICAL TESTS AND ADJUSTMENTS



MX14471



MIF

3. Measure the resistance between terminals (A) and (B).

Results

If resistance reading is not in the range of 900-1100 ohms replace resistor.

Electrical Relays Test

Reason

To determine if electrical relay coils are actuating correctly and resistance of relay contact points is correct.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure glow plug resistance.
Jumper Wires (2)	N/A	Used to test relays.
12V Battery	N/A	Used to test relays.

Procedure

Note: All relays function the same. The relay schematic below reflects the operation of the relays.

1. Check terminal continuity using an ohmmeter.

- Continuity should exist between relay terminals 87a and 30 (A and B) and between 85 and 86 (C and D).
- No continuity between relay terminals 30 and 87 (B and E).

2. Connect jumper wire from battery positive (+) terminal to relay terminal 85 (C). Connect another jumper wire from relay terminal 86 (D) to battery negative (-) terminal.

- Continuity should exist between relay terminals 30 and 87 (B and E).
- No continuity between relay terminals 30 and 87a (B and A).

Results

If continuity is not correct, replace relay.

ELECTRICAL TESTS AND ADJUSTMENTS

Key Switch Test

Reason

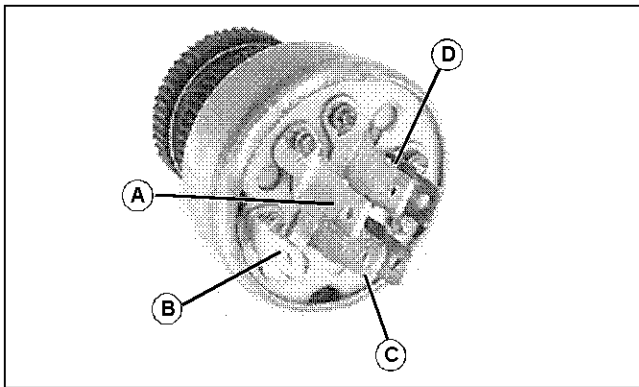
To verify that the key switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure glow plug resistance.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Disconnect key switch connector.



6. Measure for continuity between switch terminals with switch in STOP, RUN and START positions.

Note: DO NOT refer to markings stamped on terminals. Identify by art keys ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity	
Switch Position	Terminal Continuity
STOP	NONE
RUN	B and C
START	B and C A and D

Results

If any continuity is NOT correct, replace the switch.

Park Brake Switch Test

Reason

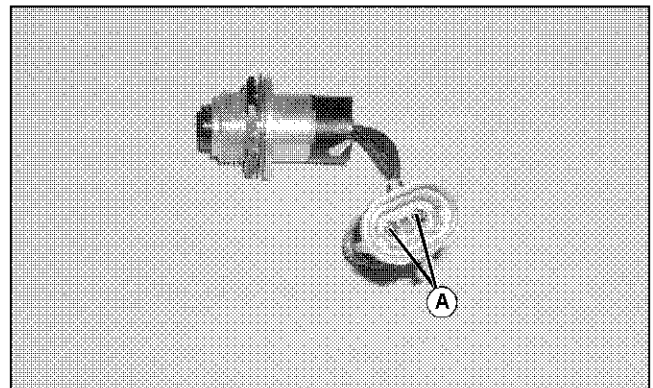
To verify continuity between the switch terminals when the park brake switch has been activated.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake RELEASED.
5. Disconnect brake switch connector.



6. Check continuity across switch terminals (A). There should be no continuity.
7. Depress plunger.
8. Check continuity across terminals. There should be continuity.

Results

If continuity is not correct in either position, replace switch.

ELECTRICAL TESTS AND ADJUSTMENTS

Raise-Lower Switch Test

Reason

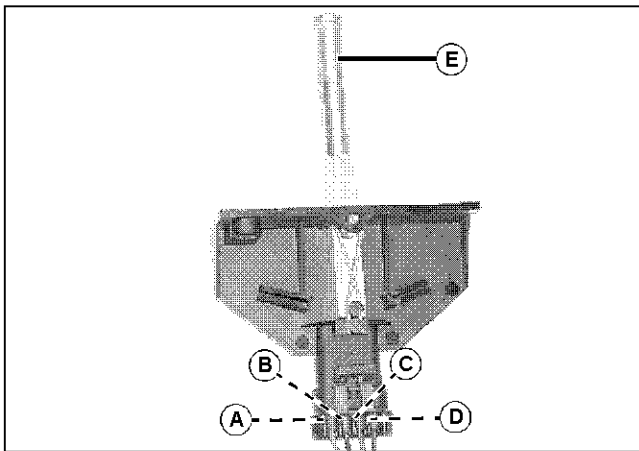
To determine if raise-lower switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test raise-lower switch.

Procedure

1. Turn key switch to RUN position.



2. With a small diameter probe connect meter negative (-) lead to raise-lower switch connector terminal (B) 100 Blk wire. With a small diameter probe connect meter positive (+) lead to raise-lower switch connector terminal (C) 224 Red wire. Is there voltage? If there is NO voltage, test raise-lower circuit.

3. Leave meter negative (-) lead connected to raise-lower switch connector terminal (B) 100 Blk wire for remainder of procedure.

4. With a small diameter probe connect meter positive (+) lead to raise-lower switch connector terminal (D) 605 Brn wire. Move raise-lower switch lever (E) to RAISE position. Is there voltage?

Move lever to the LOWER position. Voltage should go to 0.

5. With a small diameter probe connect meter positive (+) lead to raise-lower switch connector terminal (A) 300 Org wire. Move raise-lower switch lever (E) to LOWER position. Is there voltage?

Move lever to the RAISE position. Voltage should go to 0.

Results

If voltage is not as specified, replace raise-lower switch.

Seat Switch Test

Reason

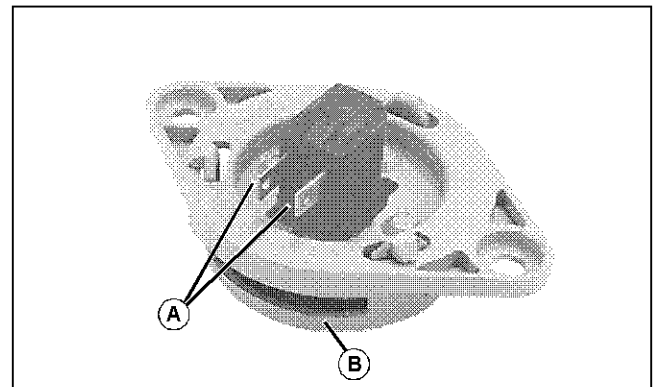
To verify continuity between the seat switch terminals when the operator is on the seat.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Remove seat from platform.
6. Disconnect seat switch connector.



7. Check continuity across switch terminals. There should be no continuity.

8. Depress plunger (B).

9. Check continuity across switch terminals (A). Continuity should exist between terminals.

Results

If continuity is not correct, replace the switch.

ELECTRICAL TESTS AND ADJUSTMENTS

Mow-Transport Switch Test

Reason

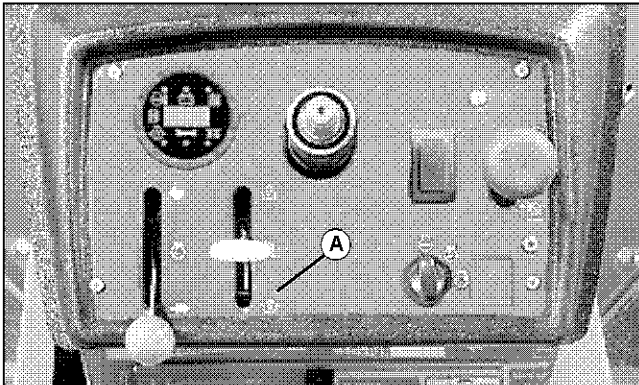
To verify continuity between the switch terminals when the machine is in the MOW and TRANSPORT modes.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

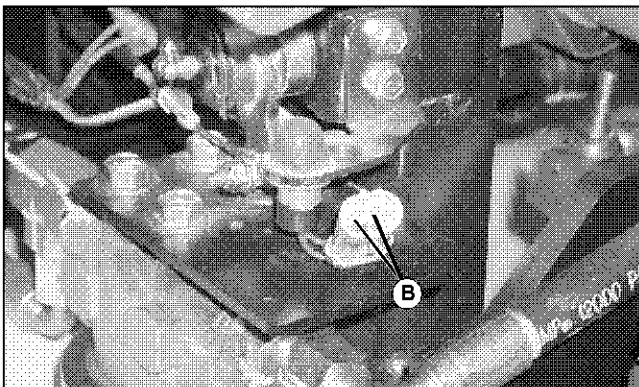
Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Disconnect mow-transport switch connector.



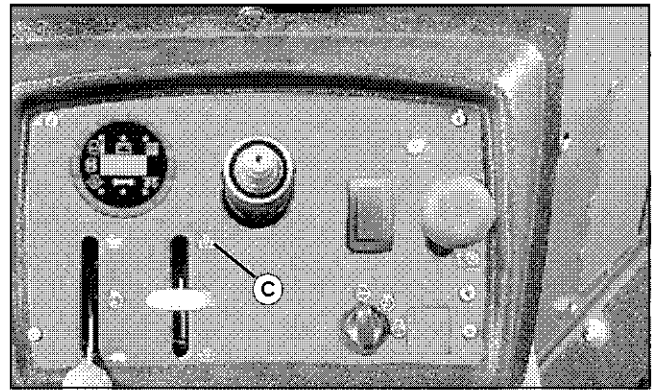
MX23511A

6. Move mow-transport lever to MOW position (A).



M24388

7. Check continuity across switch terminals (B). There should be no continuity.



MX23511A

8. Move mow-transport lever to TRANSPORT position (C).
9. Check continuity across switch terminals. There should be continuity.

Results

If continuity is not correct, replace the switch.

Mow Solenoid Test

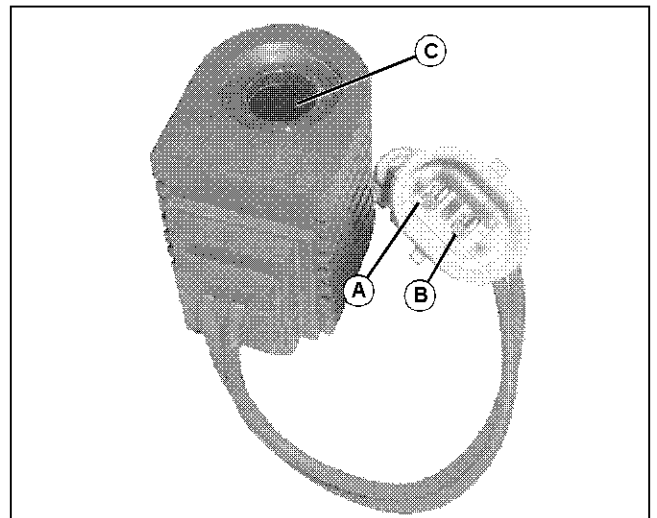
Reason

To determine condition of mow valve solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test mow solenoid.

Procedure



MX20164

1. Measure resistance between mow solenoid connector terminals (A and B). Resistance must be within specification.
2. Check for grounds or shorts between solenoid terminals

ELECTRICAL TESTS AND ADJUSTMENTS

(A and B) and bare metal of the coil core (C). There must be NO continuity between terminal (A or B) and core.

Results

- If resistance between terminals is not within specification, replace solenoid.
- If continuity exists between terminal and core, replace solenoid.

Specifications

Mow Solenoid Resistance 10 ± 2 ohms

Raise or Lower Solenoid Test

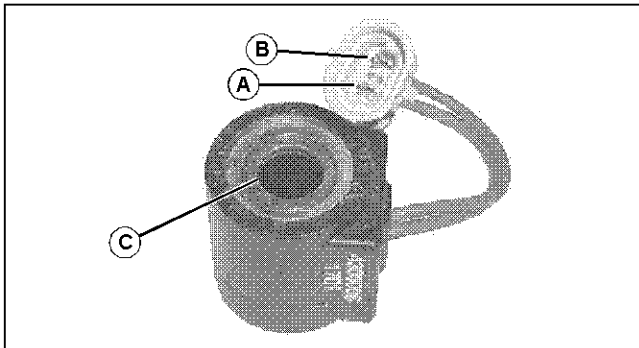
Reason

To determine condition of the raise or lower solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test solenoid.

Procedure



1. Measure resistance between solenoid connector terminals (A and B). Resistance must be within specification.
2. Check for grounds or shorts between solenoid terminals (A and B) and bare metal of the solenoid core (C). There must be NO continuity between terminal (A or B) and core.

Results

- If resistance between terminals is not within specification, replace solenoid.
- If continuity exists between terminal and core, replace solenoid.

Specifications

Raise Solenoid Resistance 10 ± 2 ohms

Lower Solenoid Resistance..... 10 ± 2 ohms

Backlap Switch Test

Reason

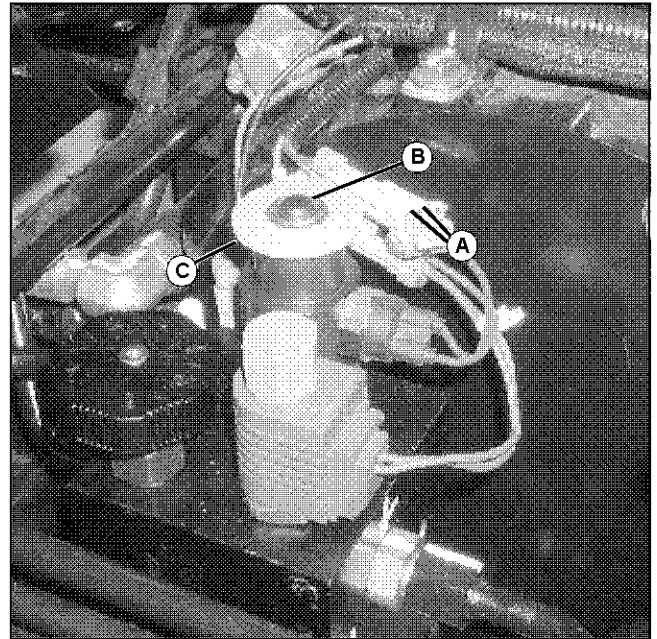
To verify continuity between the switch terminals when the machine is in the MOW and BACKLAP modes.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Disconnect backlap switch wiring connector.



6. Backlap valve in MOW position (DOWN).
7. Check continuity across connector terminals (A). There should be no continuity.
8. Press down on button (B) and lift up on backlap valve (C) to BACKLAP position (UP).
9. Check continuity across connector terminals. There should be continuity.

Results

If continuity is not correct, replace the switch.

ELECTRICAL TESTS AND ADJUSTMENTS

Hydraulic Temperature Switch Test

Reason

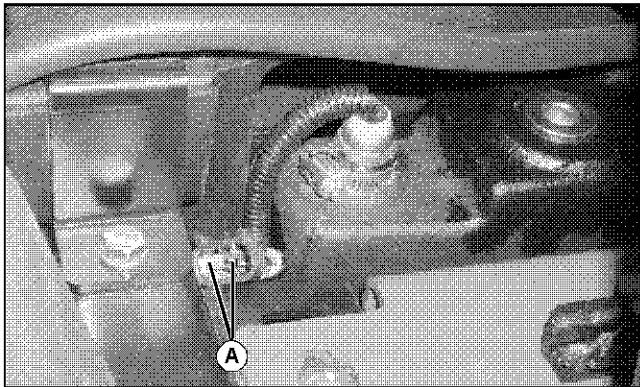
To verify the hydraulic oil temperature switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position and allow the hydraulic oil to cool to room temperature.
4. Park brake LOCKED
5. Disconnect wiring connector.



MX24389

6. Measure resistance across switch terminals (A). There should be no continuity across the terminals at room temperature.

Results

Replace the switch if there is continuity at room temperature.

Fuel Shutoff Solenoid Test

Reason

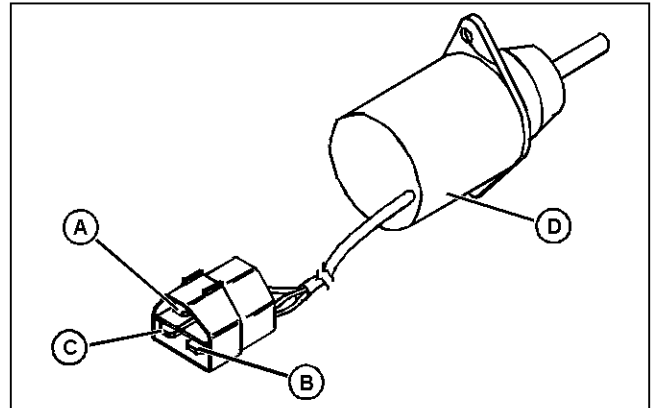
To determine if the fuel shutoff solenoid is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test fuel shutoff solenoid.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Open engine hood.
6. Disconnect fuel shutoff solenoid connector.



MIF (M87349)

7. Check pull-in coil resistance, terminals (A and B). Resistance must be to specification.
8. Check hold coil resistance, terminals (A and C). Resistance must be to specification.
9. Check resistance of both coils (combined), terminals (A and C). Resistance must be to specification.
10. Check for grounds or shorts between solenoid terminals (A, B and C) and solenoid housing (D). There must be NO continuity between terminal (A, B or C) and solenoid housing.

Results

- If resistance does not meet specifications, replace fuel shutoff solenoid.
- If continuity exists between connector terminals and solenoid housing, replace fuel shutoff solenoid.

Specifications

Fuel Shutoff Solenoid Resistance

Terminals A and B	0.4 ohm
Terminals A and C	23.6 ohms
Terminals B and C	24 ohms

ELECTRICAL TESTS AND ADJUSTMENTS

Engine Oil Pressure Switch Test

Reason

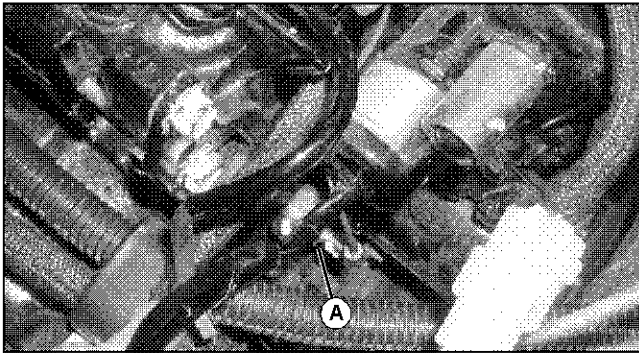
To determine if the engine oil pressure switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Park brake LOCKED.
5. Disconnect 600 Brn wire from oil pressure switch.



MX24390

6. Connect black lead of ohmmeter to engine block and red lead of ohmmeter to terminal of switch (A).
7. Measure resistance between the switch terminal and engine block. There should be continuity between switch terminal and ground.
8. Start and run engine at FAST idle.
9. Measure resistance between the switch terminal and engine block. There should be no continuity between switch terminal and ground.

Results

Note: Apply pipe sealant with TEFLON® to threads of switch any time it is installed.

- If there is NO continuity between switch terminal and engine block (ground) with engine NOT running, replace the oil pressure switch.
- If the switch DOES have continuity between switch terminal and engine block (ground) with engine running, check oil pressure. If oil pressure is to specification, replace the oil pressure switch.

Headlight Switch Test (Optional)

Reason

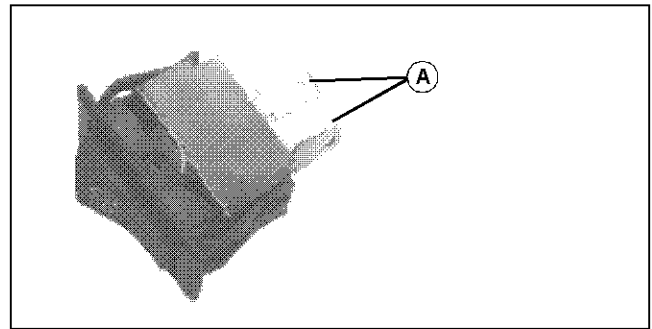
To verify that the headlight switch terminals have continuity when the headlight switch is ON.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Park brake LOCKED.
3. Turn key switch to STOP position.
4. Disconnect headlight switch connector.



M48378

5. Check continuity between switch terminals (A) with the switch in the ON and OFF positions.

Results

- If there is NO continuity with the switch in the ON position, replace the switch.
- If continuity exists with the switch in the OFF position, replace the switch.

ELECTRICAL REPAIR

Engine Coolant Temperature Switch Test

Reason

To determine the operating temperature of the switch.

Special or Required Tools

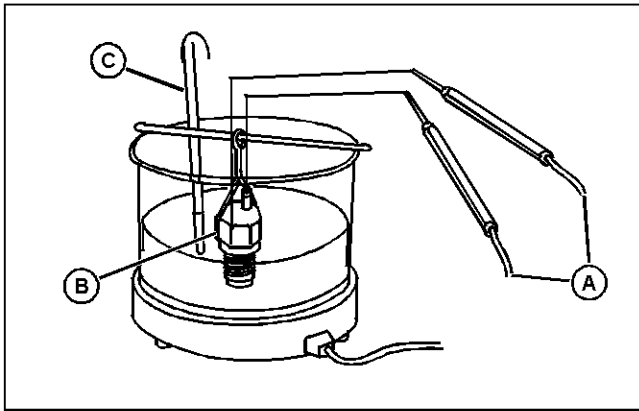
Tool Name	Tool No.	Tool Use
Thermometer	N/A	Used to measure water temperature.
Glass Container	N/A	Used to contain water in test.
Heating Unit	N/A	Used to heat water.
Ohmmeter	N/A	Used to measure continuity.

Procedure

1. Park machine on level surface.
2. Remove coolant temperature switch.



Caution: Avoid Injury! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



MIF (M91295)

3. Connect lead wires from ohmmeter probes (A) to switch terminal and body.
4. Suspend switch (B) and a thermometer (C) in a container of water and coolant mixture.
5. Heat and stir the mixture. Observe temperature, when continuity occurs. Temperature must be to specification.
6. Install temperature switch using pipe sealant with TEFLON in the threads. Tighten to specification.

Results

If continuity does not occur within specification, replace switch.

Specifications

Engine Coolant Temperature Switch

Operating Temperature 107-113°C (225-235°F)

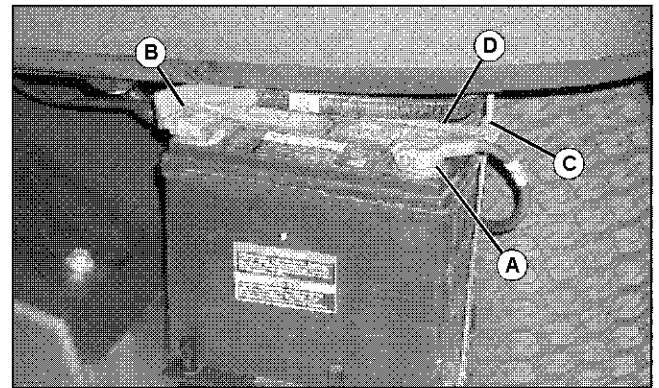
Repair

Battery Removal and Installation



Caution: Avoid Injury! Battery electrolyte contains sulfuric acid. It is poisonous and can cause serious burns:

- Wear eye protection and gloves.
- Keep skin protected.
- If electrolyte is swallowed, get medical attention immediately.
- If electrolyte is splashed into eyes, flush immediately with water for 15-30 minutes and get medical attention.
- If electrolyte is splashed onto skin, flush immediately with water and get medical attention if necessary.



MX24384

1. Disconnect negative (-) cable (A) first, then positive (+) cable (B).
2. Remove nut (C) on each side of battery and bracket (D).
3. Remove battery.

Installation

Installation is done in the reverse order of removal.

- Clean battery if dirty. (See "Clean Battery" on page 229).
- Inspect battery terminals and case for breakage or cracks. Replace if needed.
- Test battery condition. (See "Battery Test" on page 215).
- Connect negative (-) cable last.

ELECTRICAL REPAIR

Clean Battery

1. Remove battery from machine. (See "Battery Removal and Installation" on page 228).

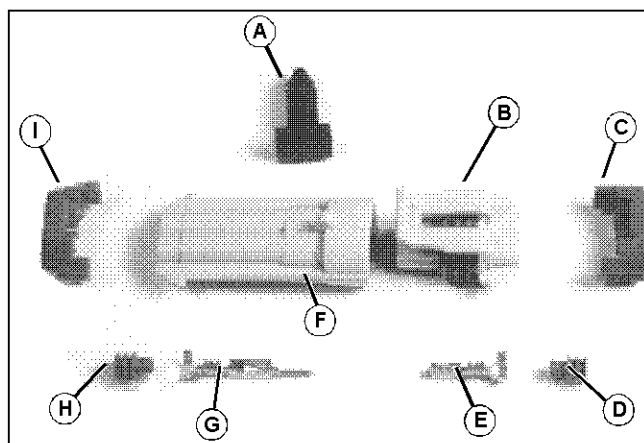
Note: Keep cleaning solution out of battery cells.

2. Clean battery case, battery terminals, cable ends, bracket and battery box with a solution of one part baking soda and four parts water.
3. Rinse all parts with clean water. Let dry thoroughly.
4. Apply petroleum jelly to battery terminals to prevent corrosion.

METRI-PACK™ Connector Removal

Special or Required Tools

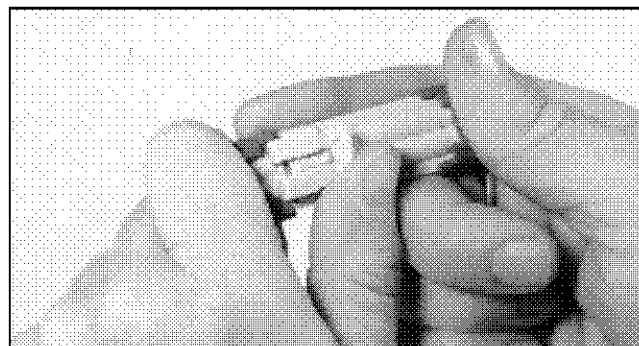
Tool Name	Tool No.	Tool Use
Terminal Removal Tool	JSG777	Used to depress locking tang and remove contact.



M56685

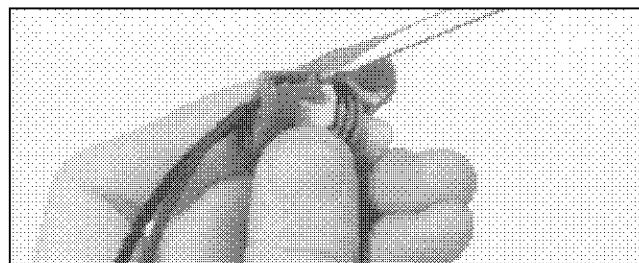
- A- Mounting Post (Optional)
- B- Sleeve Body
- C- Wire Retainer
- D- Sure-Seal
- E- Sleeve
- F- Pin Body
- G- Pin
- H- Sure-Seal
- I- Wire Retainer

Important: Avoid Damage! Identify wire number/ color locations with connector terminal letters.



M56682

1. Open connector body.

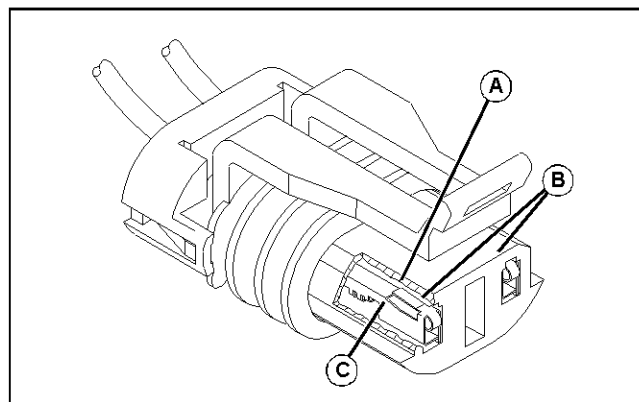


M56684

2. Remove retainer on wire end of connector with a screwdriver.

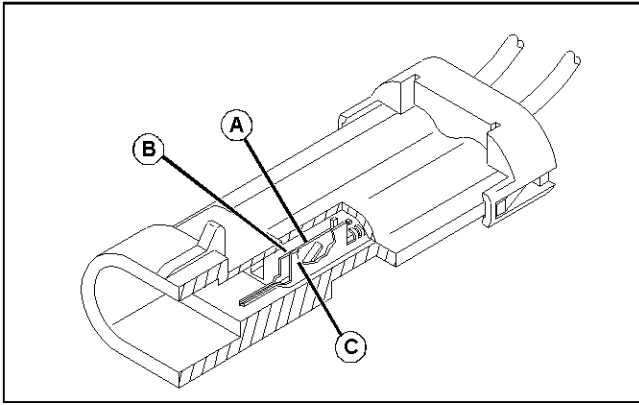
Important: Avoid Damage! Insertion of the tool in the correct location is critical when removing contact from connector body. Incorrect insertion can damage connector.

Note: To remove sleeve contact from sleeve body (short connector half), insert the tool in slot between terminal contact and connector body. To remove pin contact from body (long connector half), insert tool in center of contact.



M83501

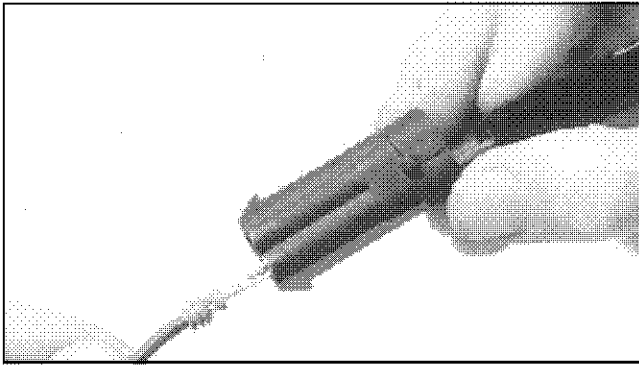
ELECTRICAL REPAIR



M83502

- A- Locking Tang
- B- Tool Insertion Point
- C- Pin Contact

3. Use JSG777 Terminal Removal Tool to depress locking tang. Remove contact from connector body.



M56689

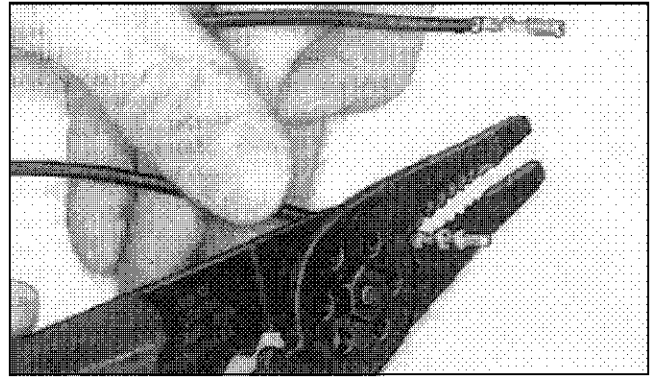
4. Hold the removal tool fully seated and pull wire from connector body.

METRI-PACK™ Connector Replacement

Special or Required Tools

Tool Name	Tool No.	Tool Use
Universal Electrical Pliers	JDG145	Used to cut wire.
Crimper	JDG865	Used to crimp contact in place on wire and secure cable seal to contact.

1. Remove wire from connector.



TSO132

2. Use JDG145 Universal Electrical Pliers to cut wire as close as possible to connector.

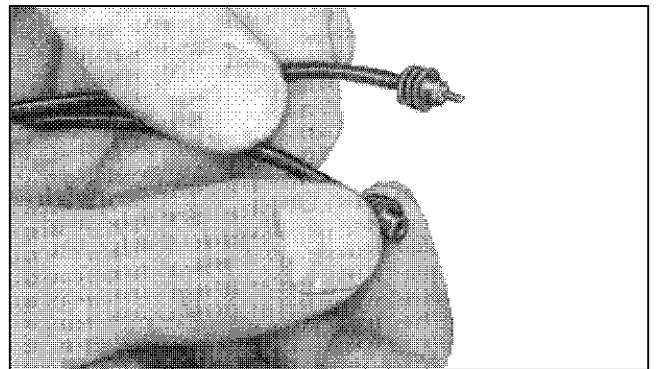
Important: Avoid Damage! METRI-PACK™ connectors are “keyed” (A, B, C, etc.) for proper contact mating. Be sure contacts and wire color/ numbers match and are in proper alignment.

Note: Cable seals are available for three sizes of wire:

Large - 1.0 mm (16 gauge) wire

Medium - 0.8 mm (18 gauge) wire

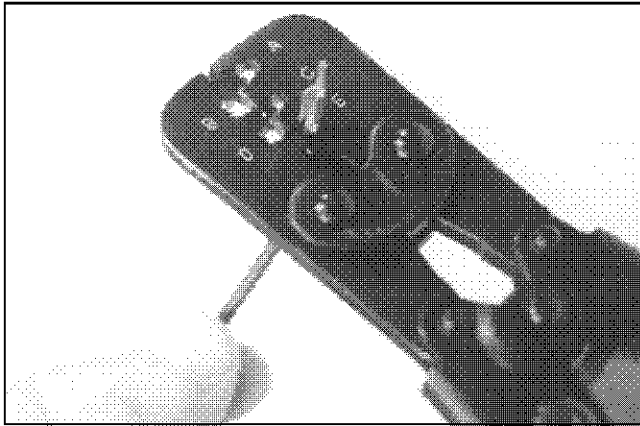
Small - 0.5 mm (20 gauge) wire



TSO136

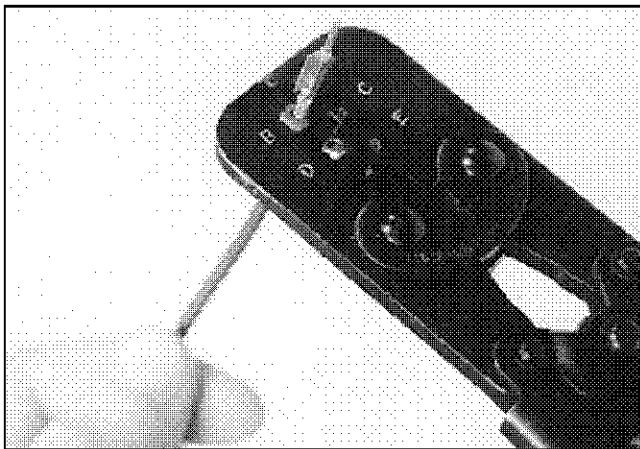
3. Remove enough insulation to expose 6 mm (0.25 in.) of wire. Align cable seal with edge of insulation.

ELECTRICAL REPAIR



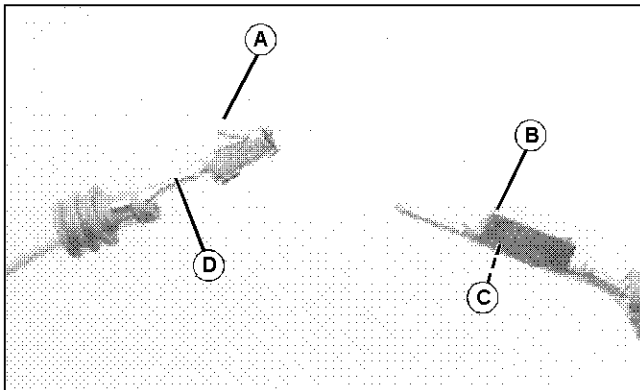
M56686

4. Place proper size contact on wire and use JDG865 Crimper to crimp contact in place with a "W" type crimp.



M56687

5. Use crimper to secure cable seal to contact as shown.

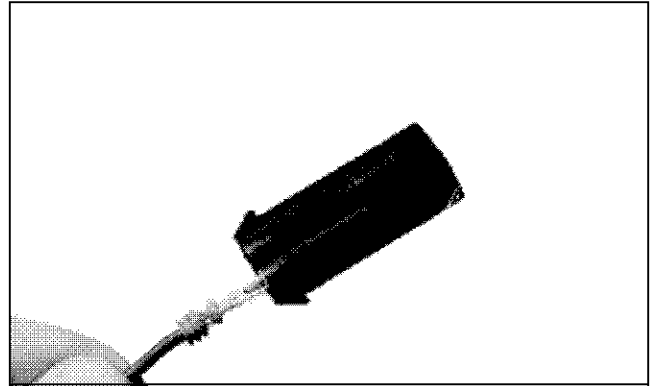


M56688

- A- Barb
B- Pin
C- Barb (Inside)
D- Sleeve

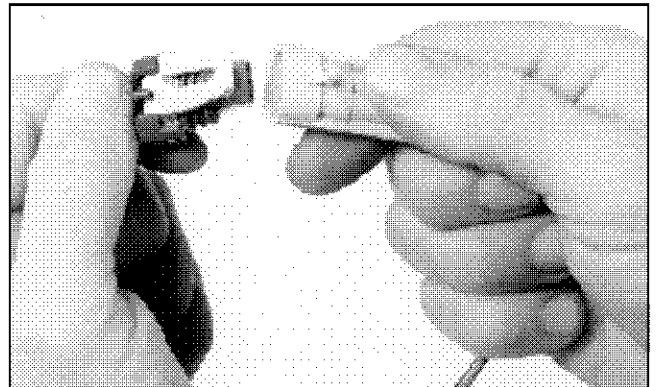
Important: Avoid Damage! Proper barb location and orientation for installation of "sleeve" and "pin" is shown.

Note: Connector bodies are "keyed" for proper contact mating. Be sure contacts are in proper alignment.



M56689A

6. Push contact into new connector body until fully seated.
7. Pull on wire slightly to be certain terminal is locked in place.
8. Install wire retainer.



M56683

9. Transfer remaining wires to correct terminal in new connector.
10. Place retainer on wire end of connector and strap in place.
11. Close connector body.

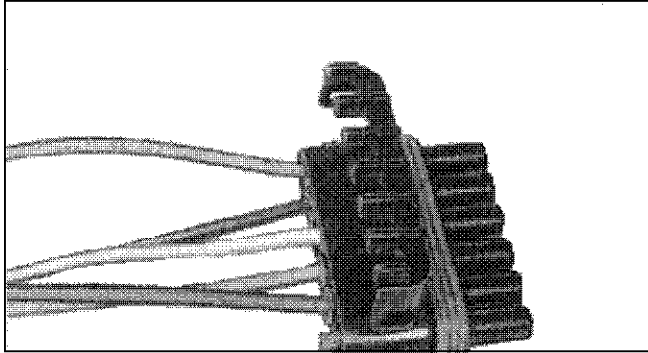
ELECTRICAL REPAIR

WEATHER PACK™ Connector Removal

Special or Required Tools

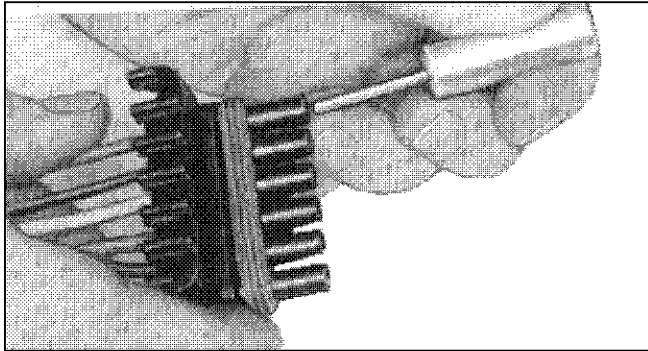
Tool Name	Tool No.	Tool Use
Extraction Tool	JDG364	Used to remove terminals from connector body.

Important: Avoid Damage! Identify wire color locations with connector terminal letters.



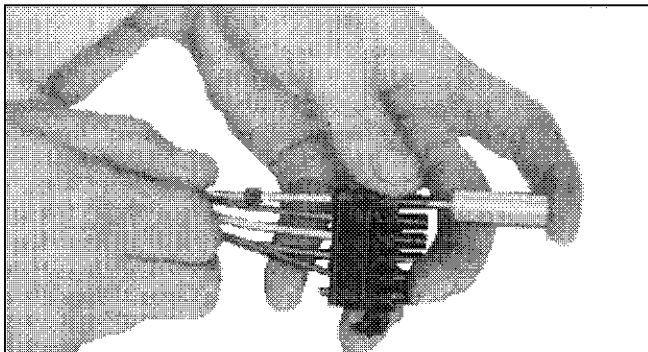
TSO127

1. Open connector body.



TSO128

2. Insert JDG364 Extraction Tool over terminal contact in connector body.



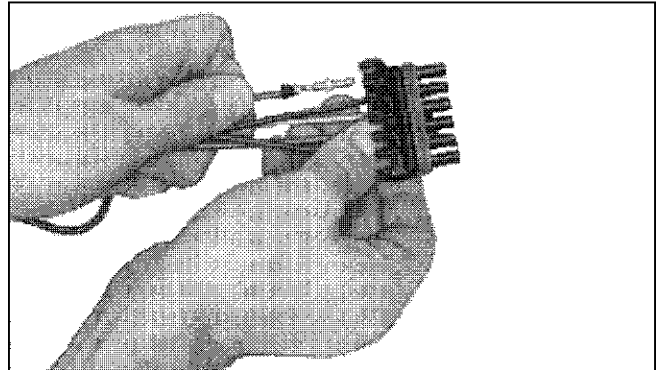
TSO129

3. Hold the extractor tool fully seated and pull wire from connector body.

Important: Avoid Damage! Carefully spread contact lances to ensure good seating on connector body.

Note: If terminal cannot be removed, insert wire or nail through extractor tool handle and push terminal contact from connector.

Connector bodies are “keyed” for proper contact mating. Be sure contacts are in proper alignment.



TSO130

4. Push contact into new connector body until fully seated.
5. Pull on wire slightly to be certain contact is locked in place.
6. Transfer remaining wires to correct terminal in new connector.
7. Close connector body.

HYDROSTATIC POWER TRAIN TABLE OF CONTENTS

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HYDROSTATIC POWER TRAIN TABLE OF CONTENTS



HYDROSTATIC POWER TRAIN SPECIFICATIONS

Specifications

General Specifications

Charge Pump

Make..... Danfoss
Model / Series..... CGP
Type..... Gear, positive displacement
Displacement..... 7 cc
Flow @ 3150 RPM..... 20.8 L/min (5.5 gpm)
Relief Valve Setting in Steering Valve..... 9997 kPa (1450 psi)
Required Pressure at Hydrostatic Input..... 689 kPa (100 psi)

Filter

Type..... Spin on
Clogged Filter Bypasses at..... 345 kPa (50 psi)

Hydrostatic Transmission

Make..... Eaton
Model..... 70160
Type..... Rotating piston, variable flow
Flow @ 3150 RPM, 20 684 kPa (3000 psi) Load (Minimum)..... 40.6 L/min (10.7 gpm)
Operating Pressure..... 20 684 kPa (3000 psi)
Main Relief Valve Setting..... 24 132 kPa (3500 psi)
Required Pressure at Hydrostatic Input..... 689 kPa (100 psi)

Wheel Motor

Make..... Parker Ross
Series, Front..... TF Series
Series, Rear..... TF Series

Repair Specifications

Hydrostatic Pump

Pump Housing Bearing Depth..... 1.78 mm (0.07 in.)
Backplate Bearing Depth..... 2.29 mm (0.09 in.)
Locating Pin Depth..... 4.39 mm (0.17 in.)
Pump Coupler Gap..... 1.5 mm (0.062 in.)

Torque Specifications

Hydrostatic Pump

Bearing Cover Screw..... 39 N•m (29 lb-in.)
Charge Relief Valve..... 37-40 N•m (27-30 lb-ft)
Backplate-to-Housing Cap Screw..... 23-27 N•m (17-20 lb-ft)
Bypass Valve..... 37-40 N•m (27-30 lb-ft)
Relief Valves..... 129-142 N•m (95-105 lb-ft)
Hydrostatic Pump-to-Subframe..... 55 N•m (40 lb-ft)

HYDROSTATIC POWER TRAIN SPECIFICATIONS

Double Pump

Double Pump Mounting Bolt Cap Bolts	50 N•m (35 lb-ft)
Pump Half Socket Head Cap Screw	61 N•m (45 lb-ft)

Wheel Motor

Rear Hub Retaining Nut	407 N•m (300 lb-ft)
End Cover Cap Screw	68 N•m (50 lb-ft)
Check Valve Plug	61-74.5 N•m (45-55 lb-ft)
Rolling Drag	68 N•m (50 lb-ft)
Wheel Motor Mounting Cap Screw	140 N•m (105 lb-ft)
Rotor Retaining Nut	407N•m (300 lb-ft)

HYDROSTATIC POWER TRAIN TOOLS AND MATERIALS

Tools and Materials

Special or Required Tools

Note: Order tools according to information given in the **U.S. SERVICEGARD™ Catalog** or in the **European Microfiche Tool Catalog (MTC)**.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Hose (2) - 3/4 in. Male NPT on Hose Ends	JT03377	Used to check hydrostatic pump flow.
Connector (2) - 3/4 in. Female NPT x 1-1/16 in. Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Connector - 1-1/16 in. -12 Male 37° Flare x 1 in. -14 F ORFS	JT05689	Used to check hydrostatic pump flow.
Connector - 3/4 in. -14 F NPT x 1-7/16 in. -12 M ORFS	JT03492	Used to check hydrostatic pump flow.
Connector - 1 in. -14 M ORFS x 1-7/16 in. -12 F ORFS	JT03493	Used to check hydrostatic pump flow.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.
Hose 34 473 kPa (5,000 psi)	JT03017	Pressure check.
Female Quick Coupler	RE48122	Pressure check.
Male Quick Coupler 11/16 in. -16 F ORFS	RE43774	Pressure check.
T-Fitting, 11/16 in. -16 F ORFS x 11/16 in. -16 M ORFS x 11/16 in. -16 M ORFS	31H1031	Pressure check.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Connector 1/4 in. M NPT x 7/16 in. M 37°	JT05486	Pressure check.
Gauge w/Quick Coupler 0-2000 kPa (0-300 psi)	JT05474	Pressure check.
Flow Tester	JT05984	Check flow.
Wheel Stop Bracket	Fabricated	Stop wheel from moving.
Photo Tachometer	N/A	Measure rpm.
Feeler Gauge	N/A	Measure gap.
Torque Wrench	N/A	Tighten cap screws.

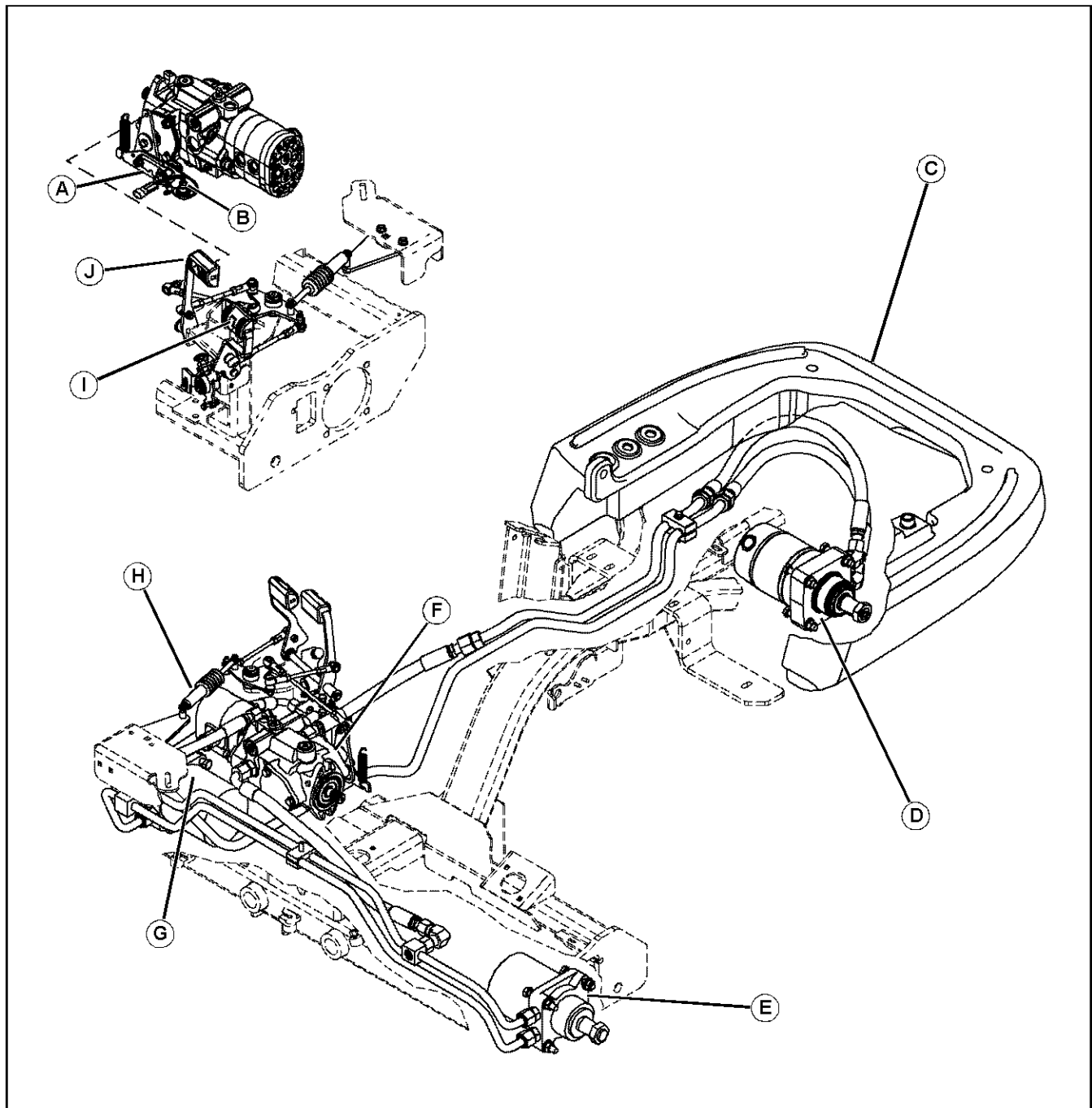
Other Material

Part No.	Part Name	Part Use
N/A	Etching Ink	Mark mating surface.
N/A	Clean Hydraulic Fluid	Replacement fluid.

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

Component Location

Hydrostatic Drive Components



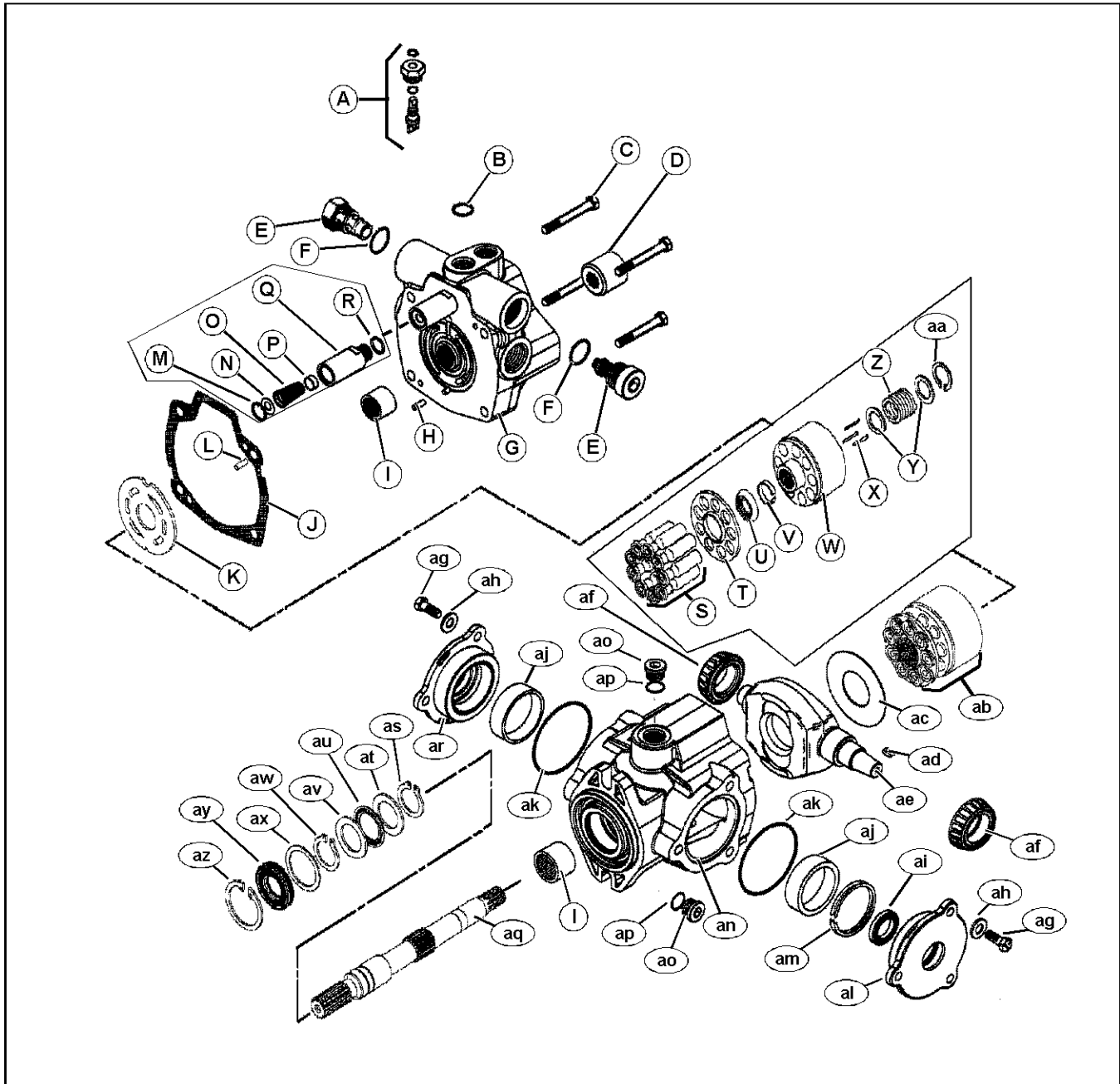
MX23271

J- Forward Pedal

- A- Hydrostatic Pump Centering Mechanism
- B- Neutral Switch
- C- Reservoir
- D- Rear Wheel Motor
- E- Left Drive Wheel Motor
- F- Hydrostatic Pump
- G- Right Drive Wheel Motor
- H- Damper
- I- Reverse Pedal

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

Hydrostatic Pump



MX23270

- A- Bypass Valve
- B- O-Ring
- C- Cap Screw
- D- Coupler
- E- Relief Valve
- F- O-Ring
- G- Backplate
- H- Locator Pin
- I- Main Shaft Bearing
- J- Gasket
- K- Valve Plate

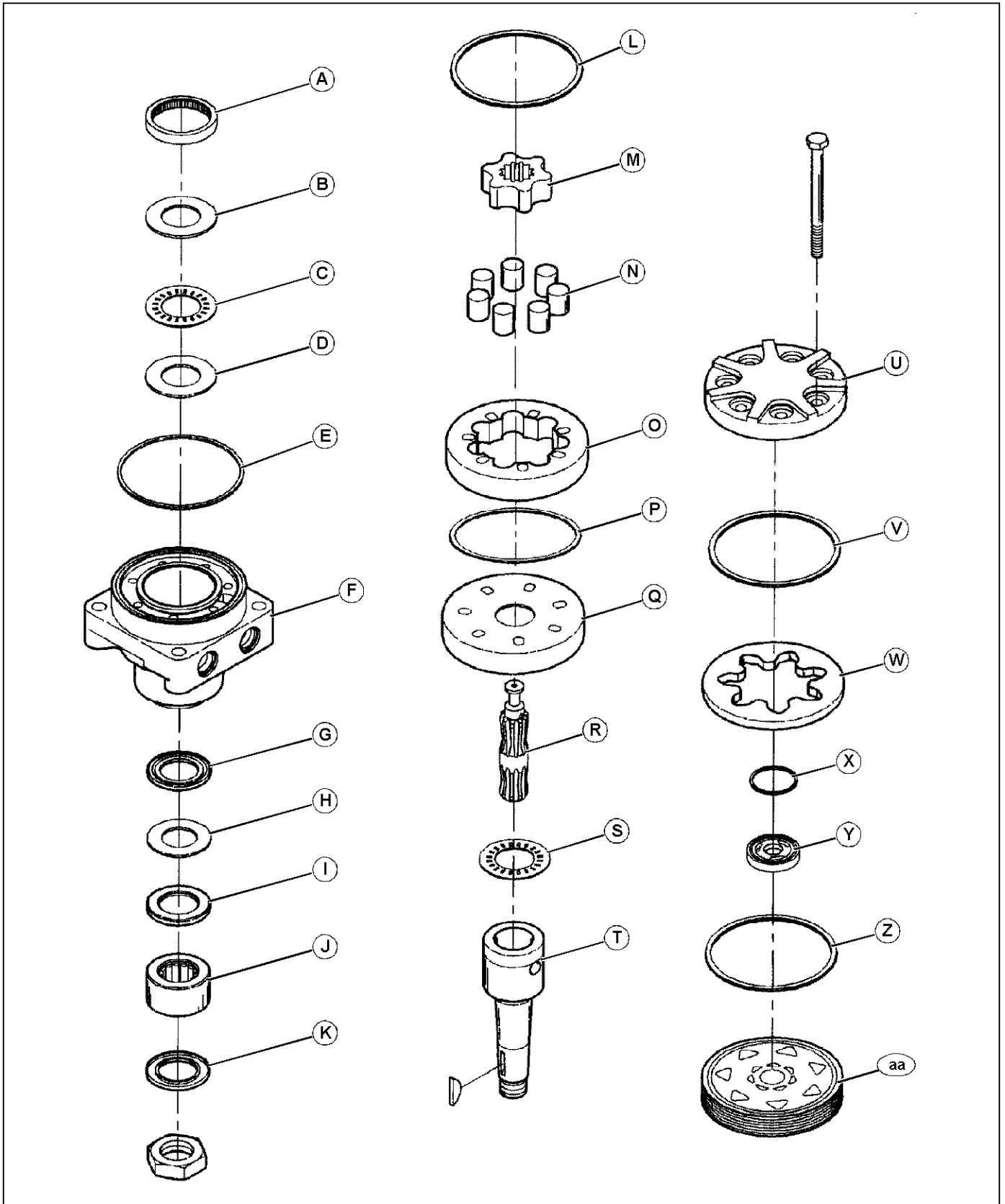
- L- Housing Pin
- M- Snap Ring
- N- Shim
- O- Spring
- P- Plunger
- Q- Charge Relief Valve Housing
- R- O-Ring
- S- Piston Assembly
- T- Spider
- U- Spider Pivot
- V- Pin Retainer
- W- Piston Block

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

X- Pin
Y- Washer
Z- Spring
AA- C-Clip
AB- Rotating Assembly
AC- Thrust Plate
AD- Key
AE- Cam Plate
AF- Trunnion Bearing
AG- Cap Screw
AH- Washer
AI- Trunnion Seal
AJ- Bearing Race
AK- O-Ring
AL- Trunnion Cover
AM- Crush Ring
AN- Housing
AO- Plug
AP- O-Ring
AQ- Shaft, Pump
AR- Trunnion Cover
AS- Snap Ring
AT- Thrust Washer
AU- Thrust Bearing
AV- Thrust Washer
AW- Snap Ring
AX- Washer
AY- Seal, Main Shaft
AZ- Snap Ring

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

Front Wheel Motor



M72904

A- Bearing

B- Thrust Washer

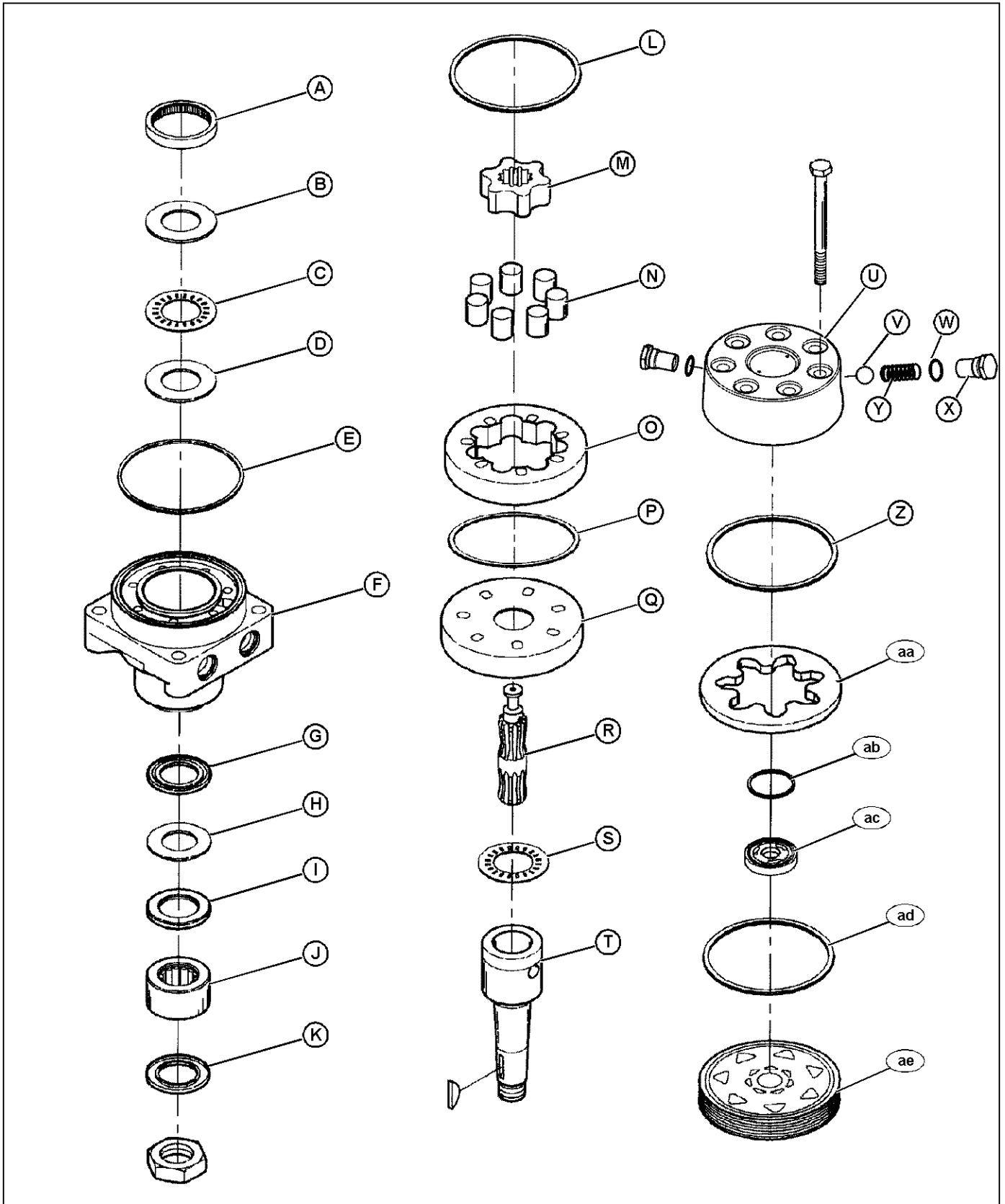
C- Thrust Bearing

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

D- Thrust Washer
E- Seal Ring
F- Housing
G- Seal
H- Flat Washer
I- Chamfered Washer
J- Bearing
K- Seal
L- Seal Ring
M- Rotor
N- Vanes
O- Stator
P- Seal Ring
Q- Wear Plate
R- Drive Link
S- Thrust Bearing
T- Coupling Shaft
U- End Cover
V- Seal Ring
W- Commutator Ring
X- Seal Ring
Y- Commutator
Z- Seal Ring
AA- Manifold

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

Rear Wheel Motor



MX23419

A- Bearing

B- Thrust Washer

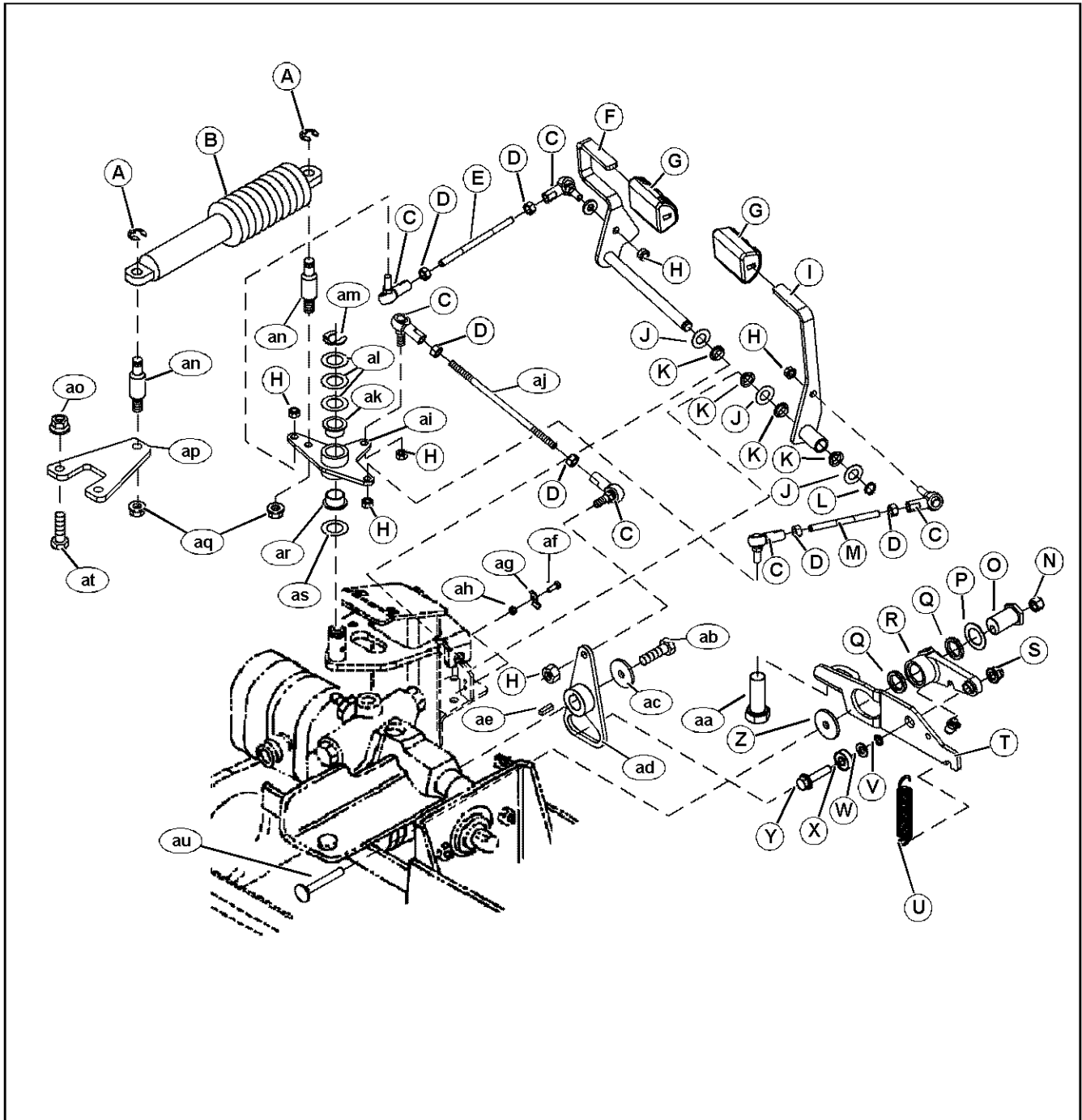
C- Thrust Bearing

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

D- Thrust Washer
E- Seal Ring
F- Housing
G- Seal
H- Flat Washer
I- Chamfered Washer
J- Bearing
K- Seal
L- Seal Ring
M- Rotor
N- Vanes
O- Stator
P- Seal Ring
Q- Wear Plate
R- Drive Link
S- Thrust Bearing
T- Coupling Shaft
U- End Cover
V- Check Ball
W- O-Ring
X- Valve Plug
Y- Spring
Z- Seal Ring
AA- Commutator Ring
AB- Seal Ring
AC- Commutator
AD- Seal Ring
AE- Manifold

HYDROSTATIC POWER TRAIN COMPONENT LOCATION

Pump Control Mechanism



MX23272

- A- C-Clip
- B- Damper
- C- Rod End
- D- Nut
- E- Rod, Reverse
- F- Reverse Pedal
- G- Pedal Pad
- H- Locknut
- I- Forward Pedal

- J- Washer
- K- Bushing
- L- Snap Ring
- M- Rod, Forward
- N- Locknut
- O- Eccentric
- P- Washer
- Q- Fiber Washer
- R- Arm

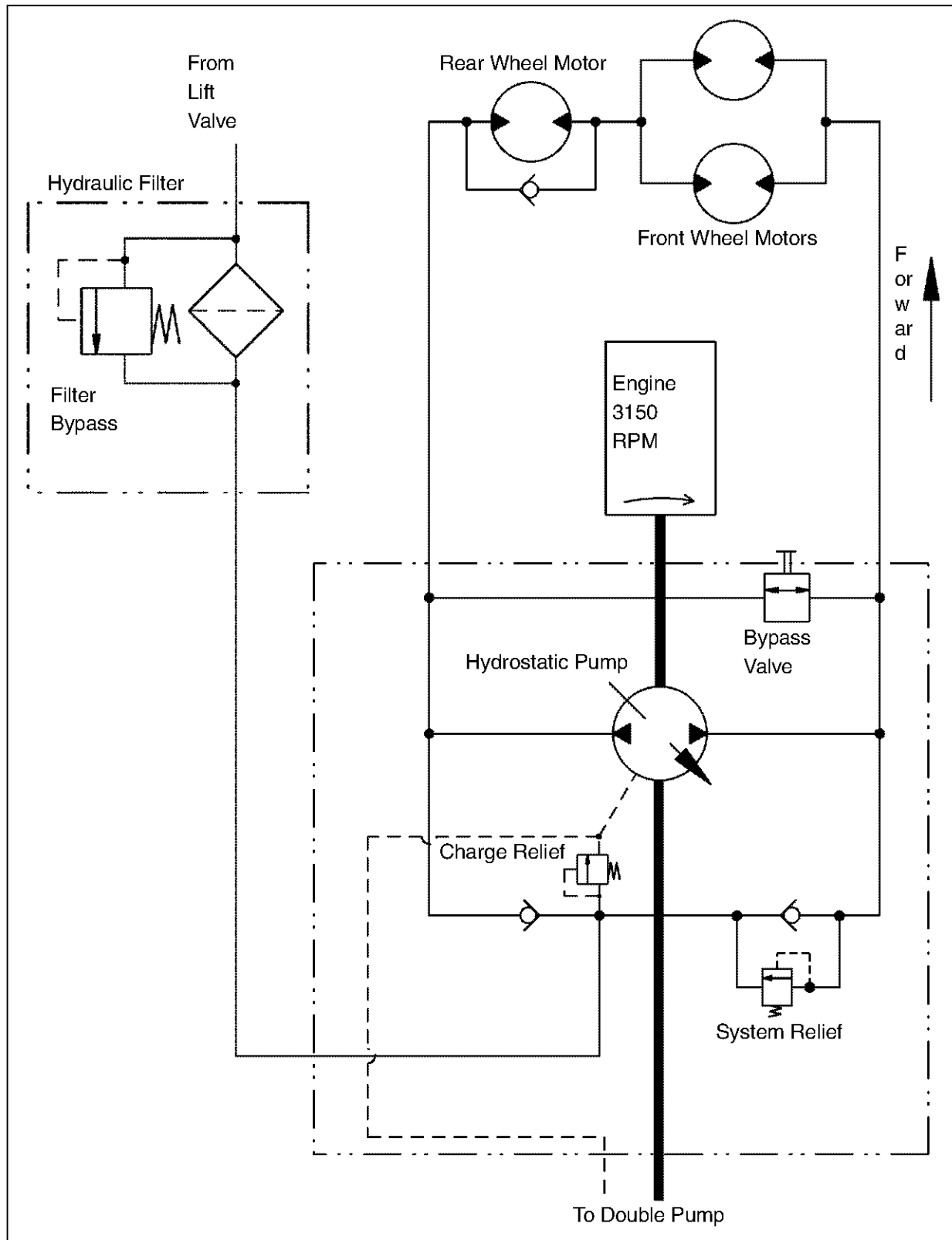
HYDROSTATIC POWER TRAIN COMPONENT LOCATION

S- Locknut
T- Switch Arm
U- Spring
V- Spacer
W- Washer
X- Bearing
Y- Cap Screw
Z- Fender Washer
AA- Cap Screw
AB- Cap Screw
AC- Fender Washer
AD- Pintle Plate
AE- Key
AF- Screw
AG- Clip
AH- Locknut
AI- Control Plate
AJ- Rod, Pump
AK- Bushing
AL- Shims
AM- Spring Clip
AN- Pin
AO- Flange Nut
AP- Plate
AQ- Flange Nut
AR- Bushing
AS- Shim
AT- Cap Screw
AU- Carriage Bolt

HYDROSTATIC POWER TRAIN SCHEMATIC

Schematic

Hydrostatic Power Train Schematic



MX23269

HYDROSTATIC POWER TRAIN THEORY OF OPERATION

Theory of Operation

Hydrostatic Power Train

Function

The hydrostatic drive system provides a means of propelling the machine with infinitely variable speed control.

Theory

The hydrostatic system is a closed loop fluid power system that consists of an Eaton piston pump and three Parker Ross motors. Speed and direction are controlled by two foot pedals.

Hydrostatic Pump

The pump is an Eaton Model 70160 axial piston, manually variable displacement pump. The pump is direct driven by a coupler attached to the engine crank balancer. The pump, or hydrostatic transmission, is mounted transversely in the main frame under the radiator system.

Directional control, forward or reverse, is controlled by varying the direction of fluid flow through the hydrostatic pump by varying the direction of rotation of the swash plate in the pump. Control of the rotation is provided by two foot pedals. The left pedal controls forward motion; the right pedal controls reverse motion.

Speed is controlled by the angle of the swash plate. The greater the displacement of the swash plate from the vertical position, neutral, the greater the volume of fluid the pump will displace and the faster the machine will travel. Speed is governed by depressing the foot pedals.

The hydrostatic pump provides hydraulic fluid to the motors through hydraulic lines and fittings. The hydraulic fluid in the power train circulates in a closed loop. Fluid leaves the pump, flows through the motor and is returned to the pump, not the reservoir. Fluid that leaves this closed loop circuit, such as case drain, is replenished by fluid from the charge pump located on the end of the double pump assembly. (See Hydraulic section.)

Wheel Motors

The wheel motors are Parker Ross, positive displacement Geroler™ motors.

The motors for the front wheels are mounted on the "T" frame. The motor for the rear wheel is mounted on the end of the third wheel steering clevis.

Each motor has a tapered keyed output shaft on which the wheel hubs are mounted. The two front wheel hubs incorporate a park brake disk.

The rear wheel motor contains a check valve. It allows hydraulic fluid to recirculate through the motor to prevent

cavitation during turns since the rear motor travels further than the front two motors during turns. When traveling forward, the check valve closes and pressure is built to drive the motor. In reverse, the check valve opens and fluid is allowed to bypass the motor. During turns, the fluid travels through the motor and, when required, travels through the check valve from the downstream side to supplement the fluid flow, allowing the motor to speed up relative to the front motors without cavitation.

Troubleshooting Hints

The most noticeable result of a worn pump or motor is reduced travel speed. This results from either the pump's inability to provide the necessary flow at the required pressure or the pump/motor bypassing fluid to case drain.

Component wear is normally caused by either fluid contamination or pump cavitation. Pump cavitation can be a result of fluid contamination, a clogged filter, or insufficient fluid in the system.

Before testing the hydrostatic pump, check the charge pump pressure. (See Hydraulic section.) Once you are satisfied that charge pressure is sufficient, test the hydrostatic pump efficiency (forward and reverse) with a flowmeter. If the hydrostatic pump is delivering the required flow at full output pressure, it is probably safe to assume that the problem is with a wheel motor.

Note: The two front wheel motors are plumbed in parallel with each other. The rear wheel motor is in series with the two front wheel motor. Raise and support the machine so that all three wheels are off the ground when performing tests or adjustments which require the wheels to spin.

HYDROSTATIC POWER TRAIN DIAGNOSTICS

Diagnostics

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

Symptom: Mower Will Not Move in Forward or Reverse

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Is the correct grade of hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes: Go to next step.

No: Replace hydraulic oil with correct grade of proper viscosity.

3. Is bypass valve closed?

Yes: Go to next step.

No: Close bypass valve.

4. Do the pedals move freely down and back? Is the linkage connected properly?

Yes: Go to next step.

No: Check linkage for bent or broken components. Repair or replace parts as necessary.

5. Is oil filter clean (free from restrictions)?

Yes: Go to next step.

No: Replace filter. Find source of any excess contamination.

6. Check charge pressure. (See "Check Charge Pressure" on page 253.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

7. Is the drive coupler secure?

No: Secure, repair or replace drive coupler.

Symptom: Mower Will Not Reach Full Speed

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Is the correct grade of hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes: Go to next step.

No: Replace hydraulic oil with correct grade of proper viscosity.

3. Is bypass valve closed?

Yes: Go to next step.

No: Close bypass valve.

4. Do the pedals move freely down and back? Is the linkage connected properly?

Yes: Go to next step.

No: Check linkage for bent or broken components. Repair or replace parts as necessary.

5. Is oil filter clean (free from restrictions)?

Yes: Go to next step.

No: Replace filter. Find source of any excess contamination.

6. Is hydraulic fluid free of air bubbles?

Yes: Go to next step.

No: Check suction line for air leaks. Repair as necessary.

7. Check charge pressure. (See "Check Charge Pressure" on page 253.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

8. Perform hydrostatic transmission flow test. (See "Test Hydrostatic Transmission Flow" on page 251.) Is hydrostatic transmission flow within specifications?

Yes: Go to next step.

No: Check and/or replace relief valves. Repair or replace pump as necessary.

9. Remove drive motors and bench check. (See "Disassemble and Inspect Wheel Motors" on page 271.)

No: Repair or replace as necessary.

HYDROSTATIC POWER TRAIN DIAGNOSTICS

Symptom: Sluggish Response to Acceleration or Deceleration, and Hill Climbing

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Is the correct grade of hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes: Go to next step.

No: Replace hydraulic oil with correct grade of proper viscosity.

3. Is bypass valve closed?

Yes: Go to next step.

No: Close bypass valve.

4. Is oil filter clean (free from restrictions)?

Yes: Go to next step.

No: Replace filter. Find source of any excess contamination.

5. Is hydraulic fluid free of air bubbles?

Yes: Go to next step.

No: Check suction line for air leaks. Repair as necessary.

6. Check charge pressure. (See "Check Charge Pressure" on page 253.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

7. Perform hydrostatic transmission flow test. (See "Test Hydrostatic Transmission Flow" on page 251.) Are hydrostatic transmission flow and pressure within specifications?

No: Replace relief valve(s).

No: Clean oil cooler fins of dirt and debris.

3. Check charge pressure. (See "Check Charge Pressure" on page 253.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

Symptom: Noisy Pump

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Is bypass valve closed?

Yes: Go to next step.

No: Close bypass valve.

3. Is hydraulic fluid free of air bubbles?

Yes: Go to next step.

No: Check suction line for air leaks. Repair as necessary.

4. Is oil filter clean (free from restrictions)?

Yes: Go to next step.

No: Replace filter. Find source of any excess contamination.

5. Check charge pressure. (See "Check Charge Pressure" on page 253.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

6. Disassemble and inspect pump for damage. (See "Disassemble Hydrostatic Pump" on page 260 and "Inspect Hydrostatic Pump" on page 263.) Was any damage found?

No: Repair or replace as necessary.

Symptom: System Operating Hot

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Are oil cooler fins free of dirt and debris?

Yes: Go to next step.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS

Tests and Adjustments

Test Hydrostatic Transmission Flow

Reason

To verify that hydrostatic pump is operating at optimum efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Hose (2) - 3/4" Male NPT on hose ends	JT03377	Used to check hydrostatic pump flow.
Connector (2) - 3/4" Female NPT x 1-1/16" Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Connector - 1-1/16"-12 Male 37° Flare x 1"-14 F ORFS	JT05689	Used to check hydrostatic pump flow.
Connector - 3/4"-14 F NPT x 1-7/16"-12 M ORFS	JT03492	Used to check hydrostatic pump flow.
Connector - 1"-14 M ORFS x 1-7/16"-12-F ORFS	JT03493	Used to check hydrostatic pump flow.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.

Procedure

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

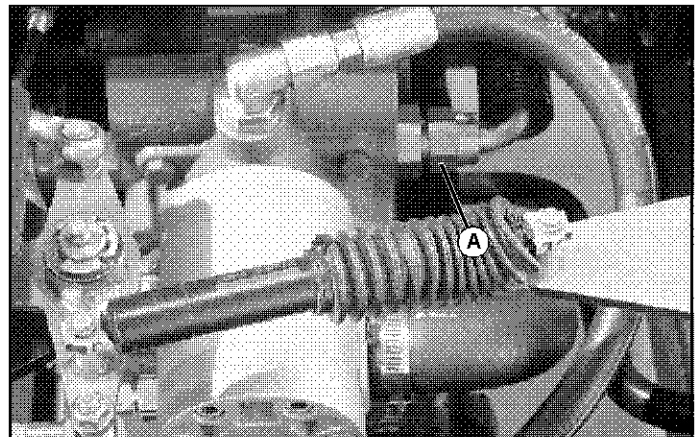
Never work on machine while supported only on mechanical or hydraulic jack.

5. Lift and support machine with jackstands.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

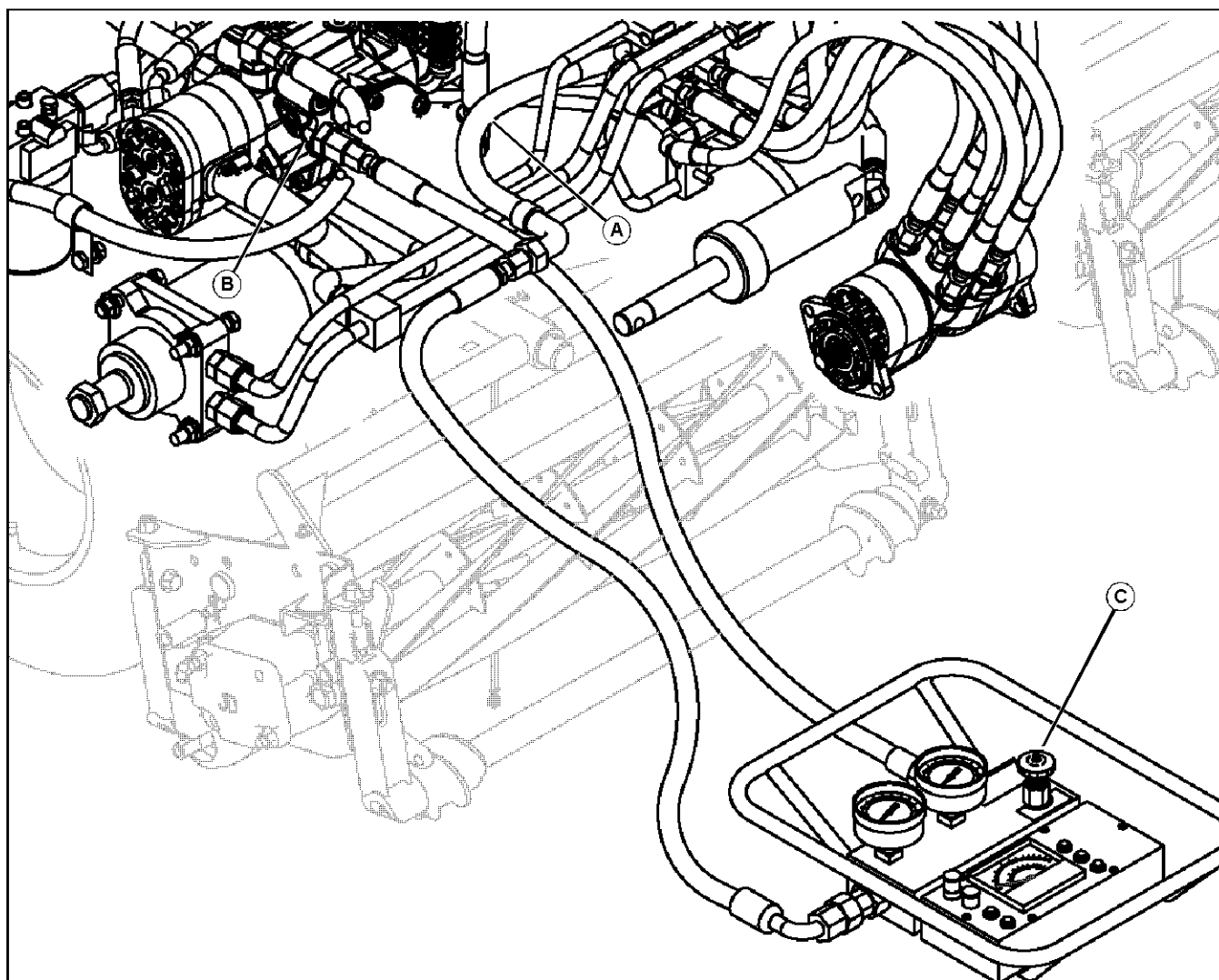
6. Lower cutting units to the ground.
7. Turn key switch to the stop position.
8. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.



MX24081

9. Disconnect hydraulic hose (A) going into forward side of hydrostatic pump.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS



MX24082

10. Connect flow meter in series with hose (A) and hydrostatic pump (B).

Note: Make sure that pressure control valve on tester is screwed out to a non-restrictive setting. Be careful not to screw handle completely out of valve.

11. Turn tester control knob (C) out (counterclockwise) completely.



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.
- Allow fresh outside air into the work area to clear the exhaust fumes out.

12. Start engine.

13. Using JT05719 Hand Held Digital Tachometer, set throttle at 3000 rpm.

14. With an operator in the operator seat, unlock the park brake.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS

15. Depress forward pedal fully.

Note: Accuracy in recording readings is very important!

16. Record flow reading. Note flow reading for efficiency calculation at end of test.

17. Turn hydraulic tester load valve until pressure is 20 684 kPa (3000 psi).

18. Record flow reading. Note flow reading.

19. Return load valve to full flow position and turn off engine.

20. Divide reading recorded at 20 684 kPa (3000 psi) by free flow reading to determine pump efficiency.

Example:

Pump Free Flow: 12.5 gpm

Pump Flow with 20 684 kPa (3000 psi) load: (12 gpm)

Pump Efficiency: $12 \div 12.5 = 0.96$ or 96 percent

Note: Pump efficiency must not be less than 80 percent.

Results

- If pump flow or efficiency is below the minimum requirements, rebuild or replace pump.
- Flow at 20 684 kPa (3000 psi) must be at least 40.6 L/min (10.7 gpm). If not, replace or rebuild pump.

Specifications

Hydraulic Tester Load 20 684 kPa. (3000 psi)

Flow Rate (Minimum) 40.6 L/min (10.7 gpm)

Check Charge Pressure

Reason

To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged.

Note: For further charge pump tests and diagnostics, see Hydraulic section.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose 34 473 kPa (5000 psi)	JT03017	Pressure check.
Male Quick Coupler 11/16 in. -16 F ORFS	RE43774	Pressure check.

Special or Required Tools

Tool Name	Tool No.	Tool Use
T-Fitting, 11/16 in. -16 F ORFS x 11/16 in. -16 M ORFS x 11/16 in. -16 M ORFS	31H1031	Pressure check.
Connector 1/4 in. M NPT x 7/16 in. M 37°	JT05486	Pressure check.
Gauge w/Quick Coupler, 0-2000 kPa (0-300 psi)	JT05474	Pressure check.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.

Procedure

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

Never work on machine while supported only on mechanical or hydraulic jack.

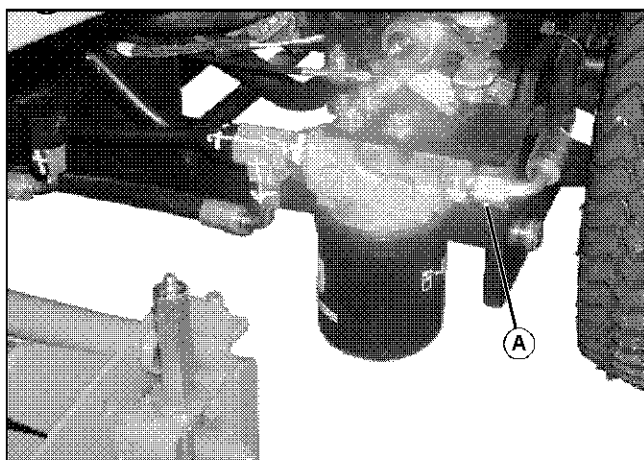
5. Lift and support machine with jackstands.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

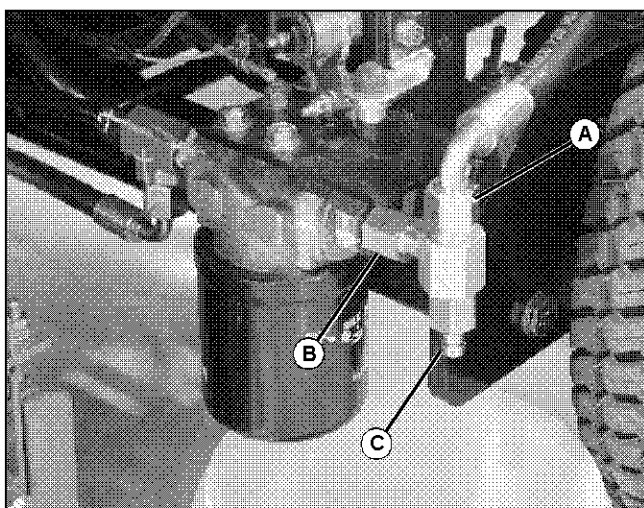
6. Lower cutting units to the ground.
7. Turn key switch to the stop position.
8. Place drip pan under hydraulic oil filter to catch oil that will leak out when line is disconnected.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS



MX23520

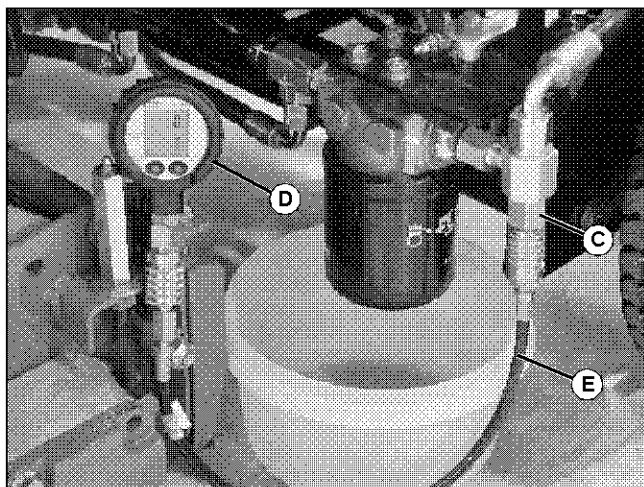
9. Disconnect hose fitting (A) at oil filter inlet port.



MX24093

10. Connect T-Fitting (B) and Male Quick Coupler (C) to oil filter inlet port.

11. Connect hose fitting (A) to T-Fitting (B).



MX24092

12. Connect gauge (D) with hose (E) to T-Fitting (C).



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.
- Allow fresh outside air into the work area to clear the exhaust fumes out.

13. Start engine.

14. Using JT05719 Hand Held Digital Tachometer, set throttle at 3000 rpm.

15. With an operator in the operator seat, unlock the park brake.

Note: If the engine stalls while performing this test, set the throttle to full speed and repeat test.

16. Move reverse pedal to full travel position.

17. Observe pressure gauge. Pressure should be within specifications. If relief valve does not meet specifications, replace relief valve.

Specifications

Charge Pressure 689 ± 138 kPa (100 ± 20 psi)

Adjust Transmission Neutral Creep

Reason

To ensure that the transmission neutral mechanism is operating properly.

Procedure

Important: Avoid Damage! Neutral start switch adjustment must be performed after this procedure has been completed.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

Never work on machine while supported only on mechanical or hydraulic jack.

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

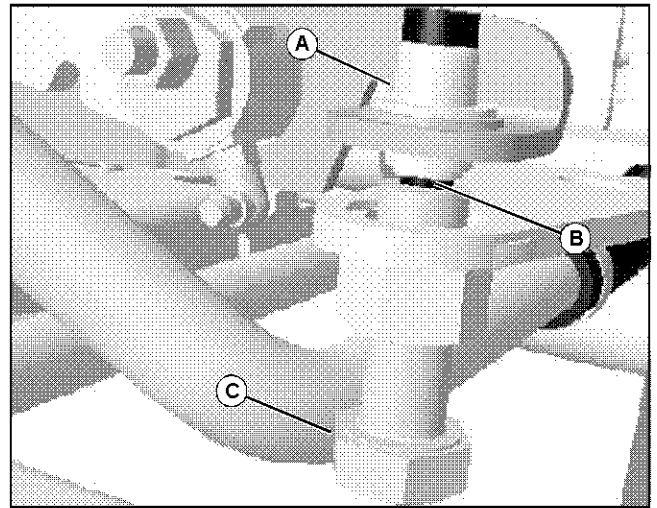
Never work on machine while supported only on mechanical or hydraulic jack.

5. Lift and support machine with jackstands.



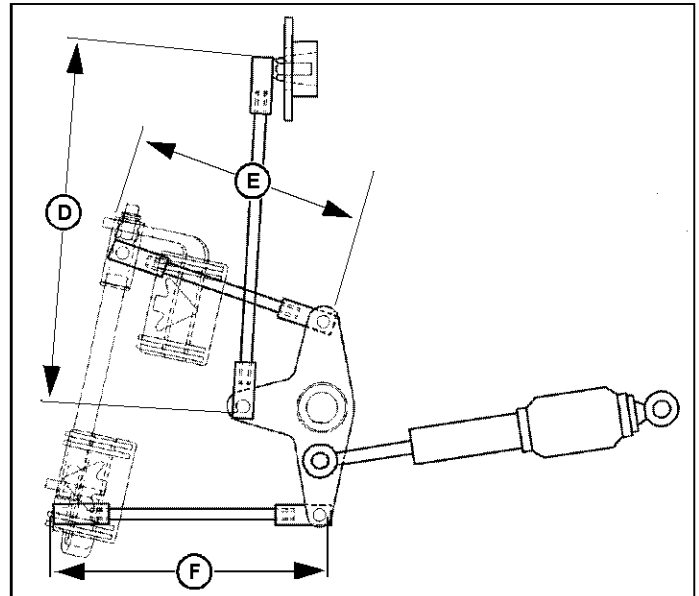
Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

6. Lower cutting units to the ground.
7. Turn key switch to the stop position.
8. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage. Repair or replace as necessary.



MX23546

9. Locate transmission neutral switch (A) and ensure that switch plunger (B) is not "bottoming out." Adjust bolt (C) accordingly.



M56258

10. Check transmission link (D) to ensure that it is within specification from end of rod end to end of rod end. If not, adjust.
11. Set forward pedal link (E) to specification.
12. Set reverse pedal link (F) to specification.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

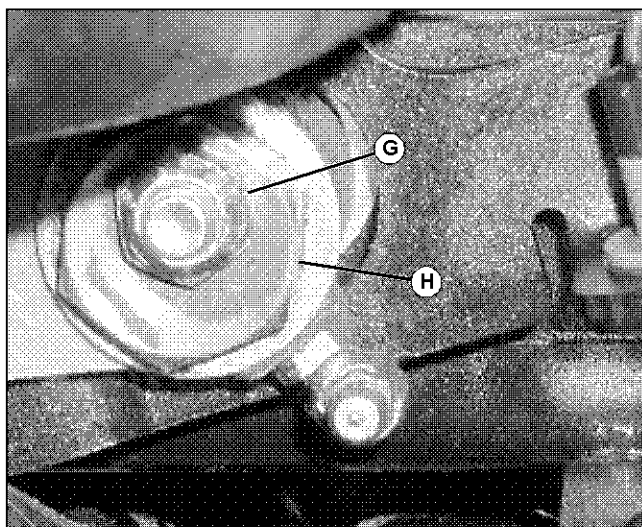
Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.
- Allow fresh outside air into the work area to clear the exhaust fumes out.

13. Start engine and run at slow idle.

14. With an operator in the operator seat, unlock the park brake.



MX23448

15. Loosen eccentric locknut (G).

16. Rotate eccentric (H) clockwise or counterclockwise until drive wheels stop turning. Tighten eccentric locknut while holding eccentric in position.

17. Have the operator depress the drive pedals in both directions and release.

18. Drive wheels should stop turning when pedals are released. If not, repeat adjustment.

19. Adjust reverse pedal link until reverse pedal lines up with forward pedal.

Note: Adjust neutral start switch after this procedure has been completed.

Specifications

Transmission Link (D)

Overall Length 235 mm $\pm$ 5 mm (9.252 $\pm$ 0.2 in.)

Forward Pedal

Link (E) 152 mm $\pm$ 5 mm (5.984 $\pm$ 0.2 in.)

Reverse Pedal

Link (F) 185 mm $\pm$ 5 mm (7.283 $\pm$ 0.2 in.)

Check and Adjust Transmission Neutral Start Switch

Reason

To ensure that the neutral switch is properly set.

Procedure

Important: Avoid Damage! Transmission neutral mechanism adjustment (previous section) should be performed before this adjustment is made.

Note: Before performing this procedure, check switch for proper operation.

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

Never work on machine while supported only on mechanical or hydraulic jack.

5. Lift and support machine with jackstands.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

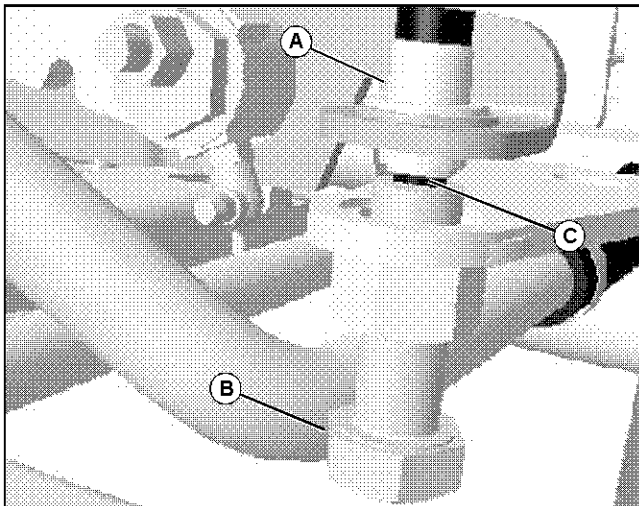
6. Lower cutting units to the ground.
7. Start engine and run at slow idle.
8. Move hydrostatic control forward pedal.
9. Move hydrostatic control reverse pedal.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS

Result

- Engine should stop within first inch of pedal travel in both directions.

Adjust Neutral Switch



MX23546

1. Inspect switch (A).
2. With engine stopped, turn bolt (B) until it lightly presses the plunger (C).
3. Start engine.

Note: If engine fails to start, tighten bolt so it presses more on the plunger and repeat step.

4. Repeat test procedure to ensure that engine stops in the first inch of pedal travel.

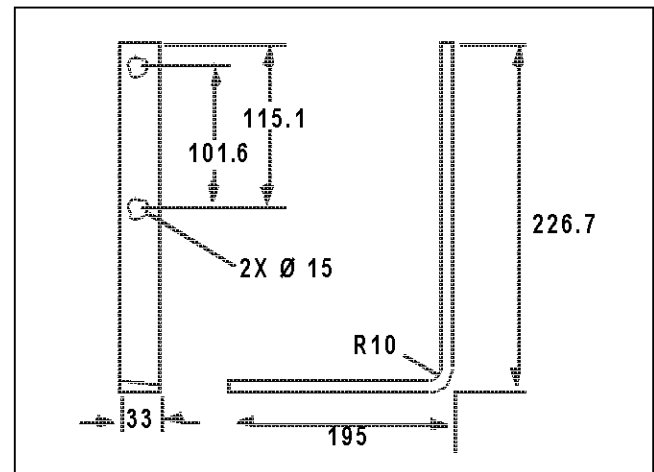
Test Wheel Motor Efficiency

Reason

To determine if the wheel motor is operating at peak efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Tester	JT05984	Check flow.
Wheel Stop Bracket	Fabricated	Stop wheel from moving.
Hand Held Digital Tachometer	JT05719	Measure rpm.



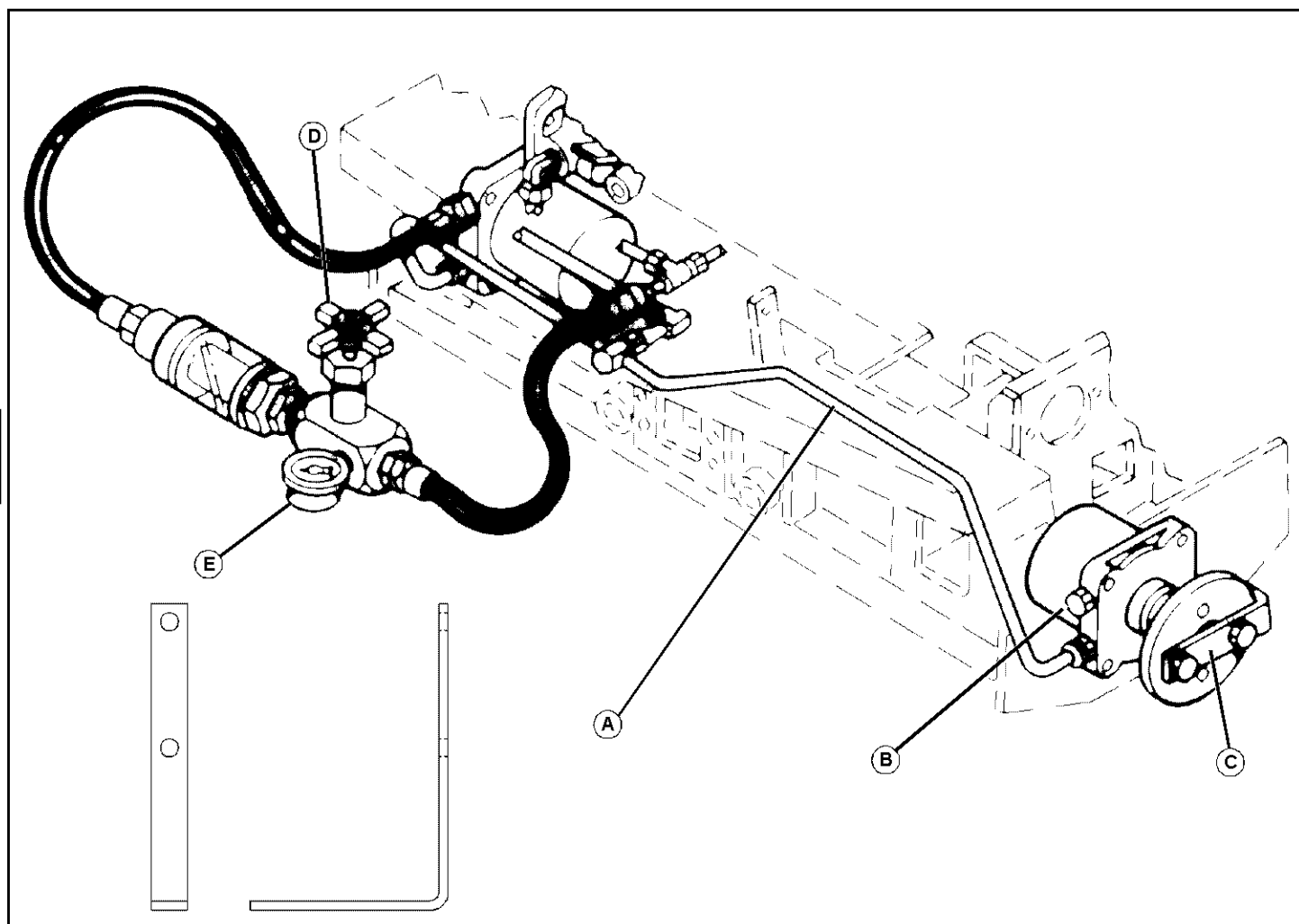
MIF

Dimensions shown are in millimeters.

- Fabricate wheel stop bracket to the dimensions shown.

HYDROSTATIC POWER TRAIN TESTS AND ADJUSTMENTS

Connections



M56532A

5. Remove the upper hydraulic line (A) (forward operation) and install a flow tester capable of handling 30 gpm at 3000 psi on the wheel being tested.
6. Install a cap (B) on the wheel not being tested.

Procedure

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

Never work on machine while supported only on mechanical or hydraulic jack.

5. Lift and support machine with jackstands.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

HYDROSTATIC POWER TRAIN REPAIR

6. Lower cutting units to the ground.
7. Remove both front wheels.
8. Install wheel stop bracket (C) on wheel not being tested.
9. Install flow meter on wheel motor being tested.
10. Start engine and allow it to reach normal operating temperature.
11. Depress foot pedal to full forward position.
12. Slowly build up pressure with the shutoff valve (D) until 1500 psi is indicated on the pressure gauge (E).
13. Using JT05719 Hand Held Digital Tachometer, measure the rpm of the wheel being tested.
14. Indicated rpm should be at least 300 rpm. If not, disassemble and repair the wheel motor. (See "Disassemble and Inspect Wheel Motors" on page 271. See "Assemble Wheel Motors" on page 276.)
15. Remove test equipment and reconnect hydraulic lines.
16. Bleed hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Repair

Remove Hydrostatic Pump

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

Never work on machine while supported only on mechanical or hydraulic jack.

5. Lift and support machine with jackstands.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

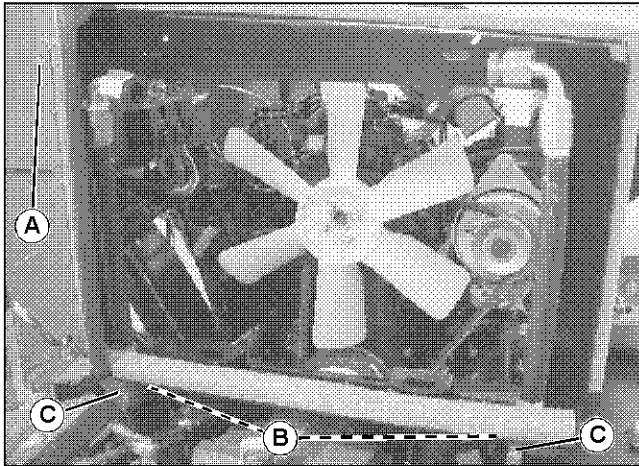
6. Lower cutting units to the ground.
7. Turn key switch to the stop position.
8. Disconnect battery negative (-) cable.
9. Move bypass valve to open position.
10. Raise hood. (See "Hood" on page 388.)
11. Remove right wheel.
12. Place a 40-qt. (10-gal) container below the hydraulic sump and drain oil.
13. Remove double pump assembly. (See "Remove Double Pump" on page 310.)
14. Remove hydraulic oil cooler. (See "Remove, Inspect and Install Hydraulic Oil Cooler" on page 324.)

HYDROSTATIC POWER TRAIN REPAIR



Caution: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Stop engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

15. Remove radiator. (See "Remove, Inspect and Install Radiator" on page 57.)



MX23324

16. Remove carriage bolt and nut (A).

17. Remove four carriage bolts and nuts (B).

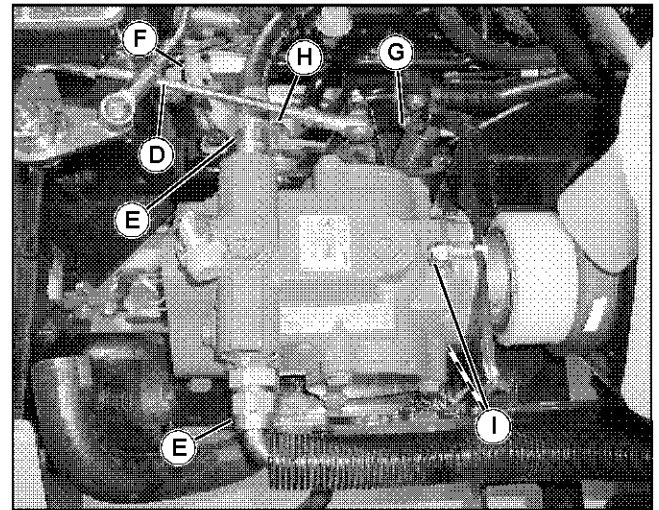
18. Disconnect oil cooler lines (C). Close all lines and fittings using caps and plugs.

19. Remove radiator support.

20. Clean port areas of the hydrostatic pump with a suitable solvent.

21. Identify and mark lines for assembly purposes.

22. Place drip pan under hydrostatic pump to catch oil that will leak out when lines are disconnected.



MX23323

23. Remove transmission link (D).

24. Disconnect hydraulic lines (E) from hydrostatic pump. Close all lines and fittings using caps and plugs.

25. Disconnect neutral switch connector (F).

26. Remove spring (G) from frame.

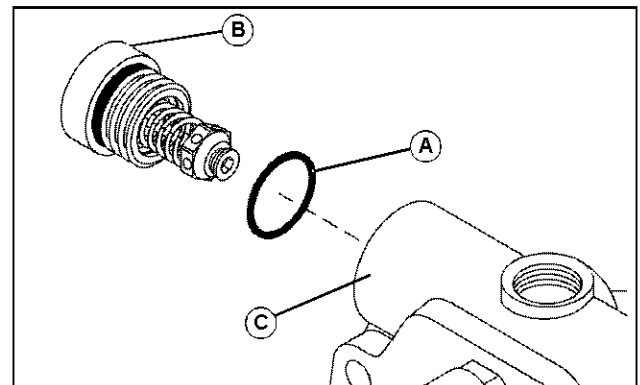
27. Remove neutral mechanism eccentric and spring arm assembly by removing locknut (H).

28. Remove carriage bolts and flange locknuts (I) securing the hydraulic pump unit to the engine subframe.

29. Remove hydrostatic pump.

Disassemble Hydrostatic Pump

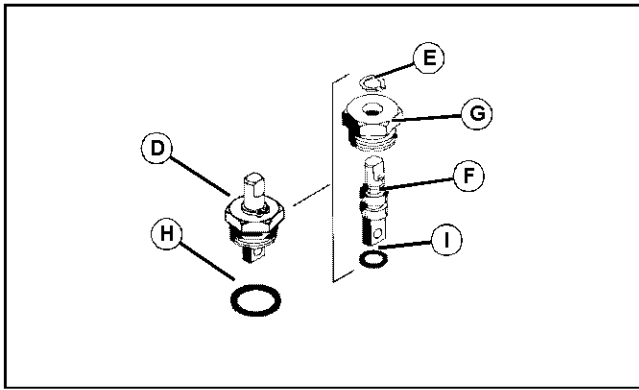
Important: Avoid Damage! Plug all ports and thoroughly clean the outside of the pump. Remove plugs and drain oil.



MX20246

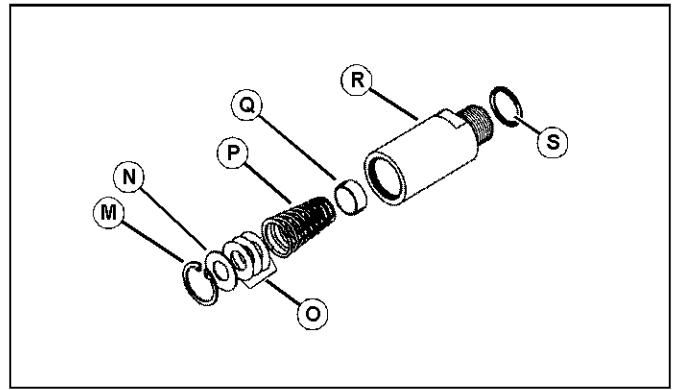
1. Remove O-ring (A) and relief valve (B) from backplate (C). Repeat step for other relief valve.

HYDROSTATIC POWER TRAIN REPAIR



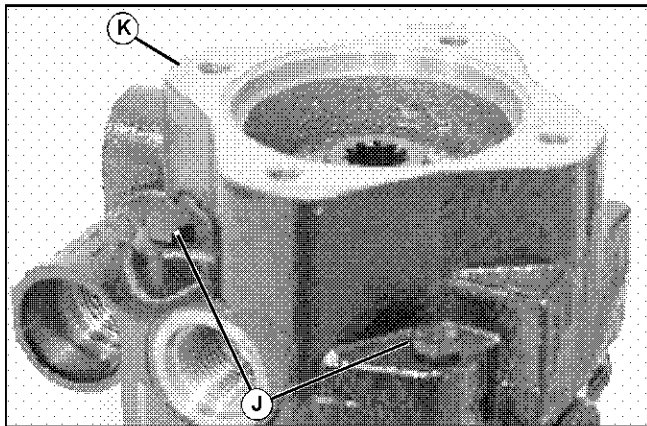
M56551

2. Remove bypass valve assembly (D) from backplate.
3. Disassemble bypass valve by removing retaining ring (E) and pulling the spreader (F) from the spreader plug (G). Remove O-rings (H and I).



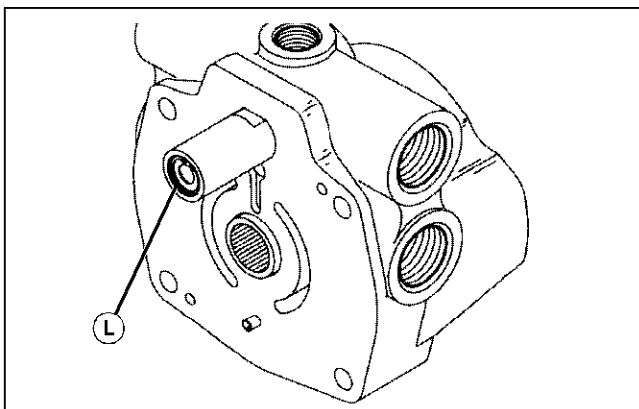
M56535

7. Disassemble by removing retaining ring (M), washer (N), shim(s) (O), conical spring (P), and plunger (Q) from charge relief valve (R). Remove O-ring (S) from charge relief valve body. Make note of the number of shims removed for reassembly.



MX20247

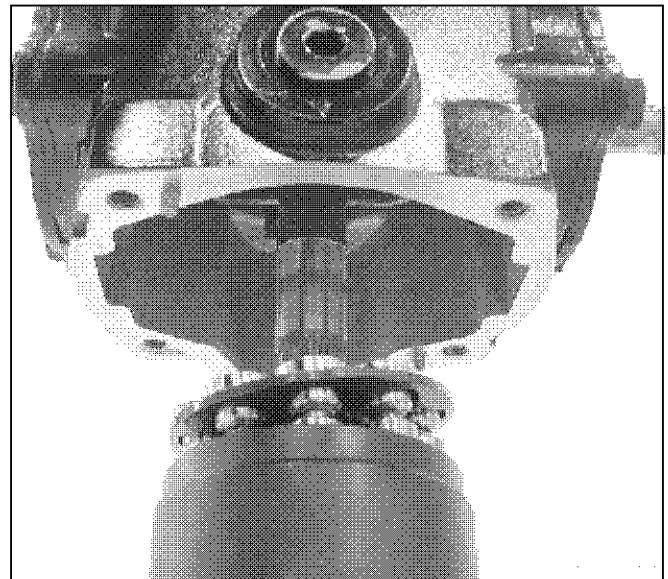
4. Remove four cap screws (J) from the backplate (K).
5. Tap backplate with a plastic mallet to loosen, then pull the backplate straight up to remove. Remove gasket and valve plate from backplate.



M56540

6. Remove charge relief valve (L) from backplate.

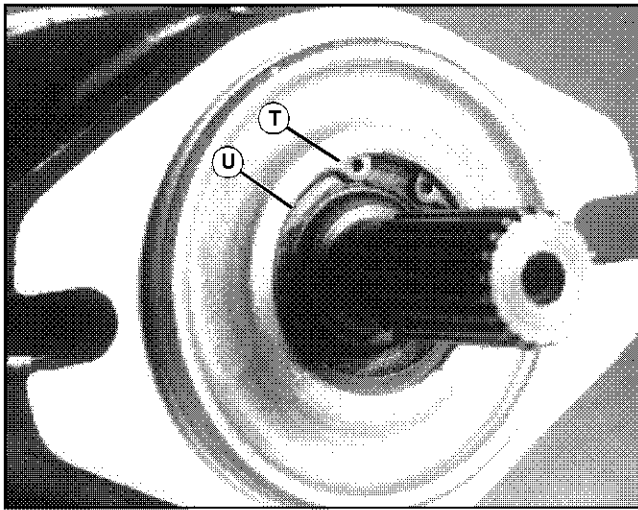
Important: Avoid Damage! Try to keep the pistons and piston block together as an assembly when removing the rotating assembly.



MX20248

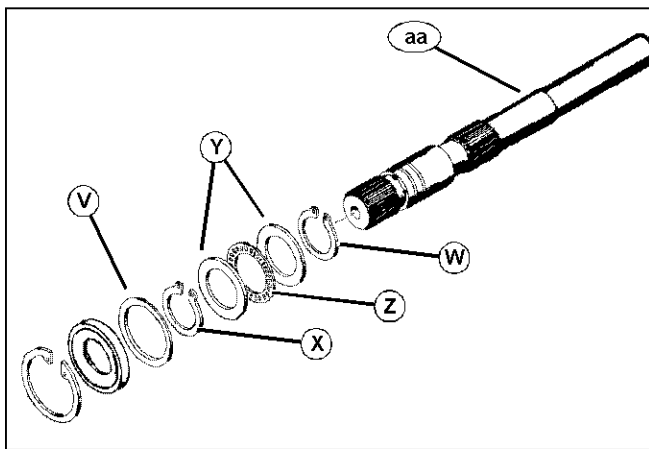
8. Hold your hand over the rotating assembly and turn the housing upside down. Remove the rotating assembly and any pistons that did not come out with the assembly.

HYDROSTATIC POWER TRAIN REPAIR



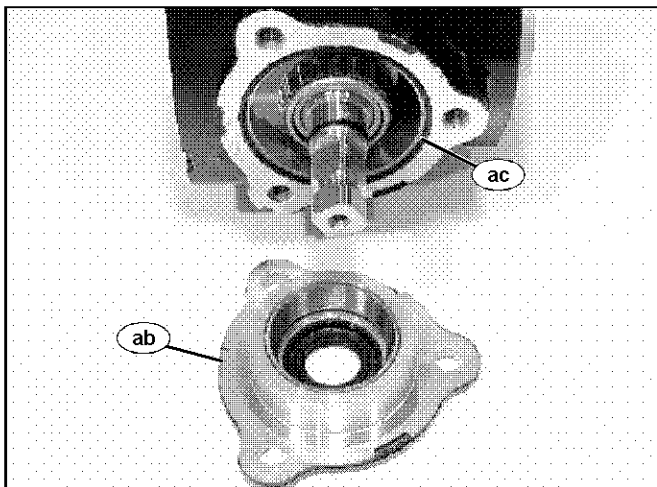
M56564

9. Remove snap ring (T) and tap the shaft and oil seal (U) from the housing with a soft-faced mallet.



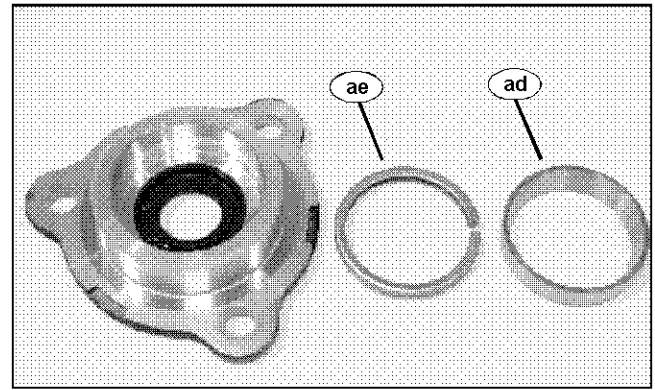
M57918

10. Remove washer (V), snap rings (W and X), thrust washers (Y), and thrust bearing (Z) from main pump shaft (aa).



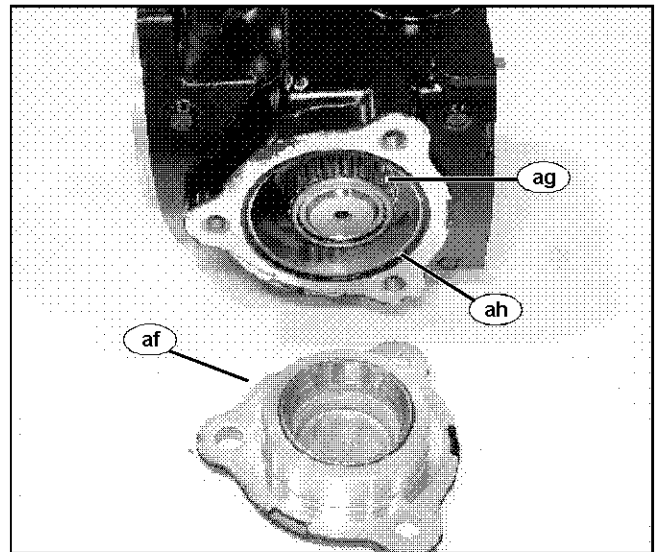
MX20250

11. Remove bearing cover (ab) and O-ring (ac).



MX20259

12. Remove bearing race (ad) and crush ring (ae).



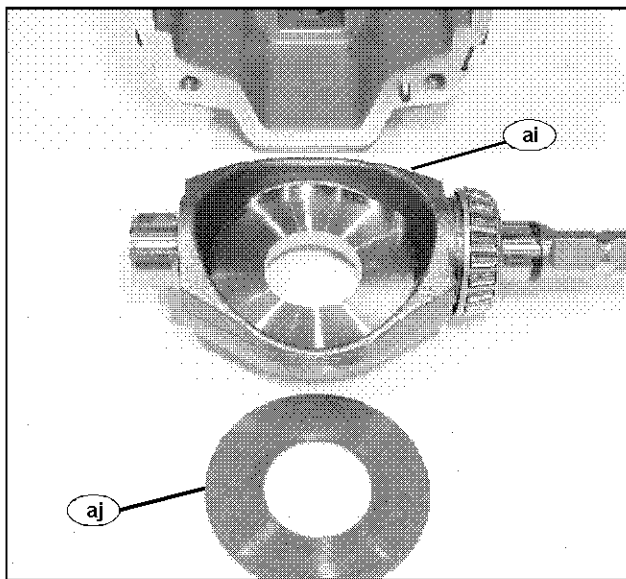
MX20249

13. Remove bearing cover (af).

14. Remove bearing (ag) and O-ring (ah).

Note: The cam plate control shaft will fit out either side of the pump housing. Be sure to note on which side of the housing the control shaft protrudes before removing cam plate from housing for correct reassembly orientation.

HYDROSTATIC POWER TRAIN REPAIR



MX20251

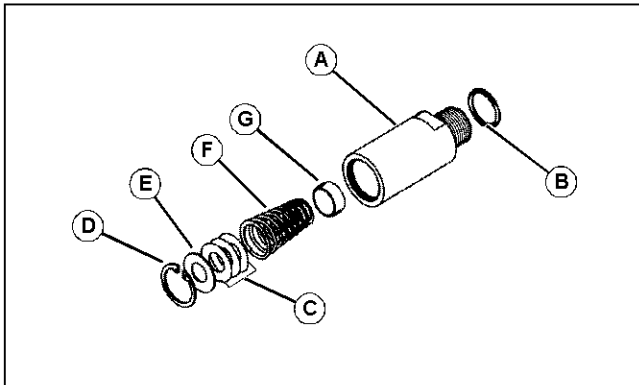
15. Remove cam plate (ai) from housing.

16. Remove thrust plate (aj).

Inspect Hydrostatic Pump

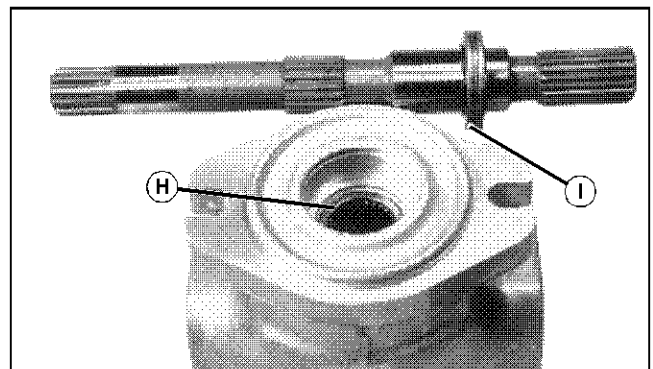
Important: Avoid Damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection.

1. Inspect the main pressure relief valves for condition and wear. Replace if necessary.



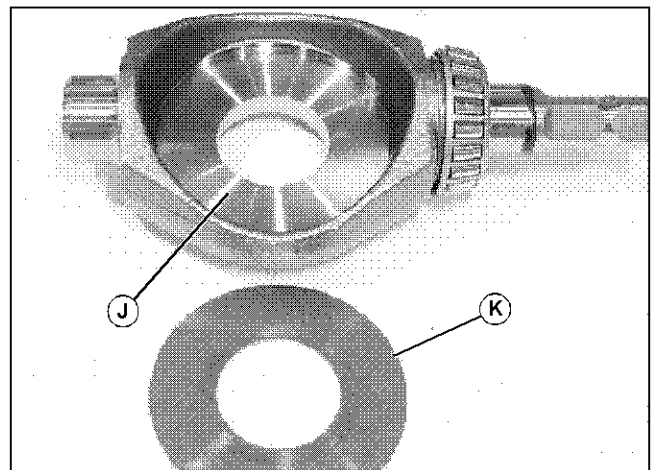
M56535

2. Inspect the charge pump relief valve components (A-G) for wear. Replace the entire relief valve if worn.



M56557

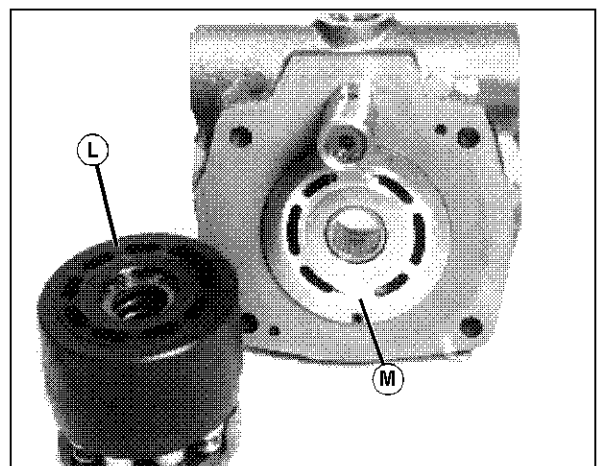
3. Inspect the needle bearings (H) in the housing and backplate assemblies, making sure bearings remain in bearing cage. Inspect the complete shaft, thrust bearing (I), and thrust washers for wear.



MX20269

4. Inspect the polished surface (J) of the cam plate for scoring, galling or fretting. Replace if necessary.

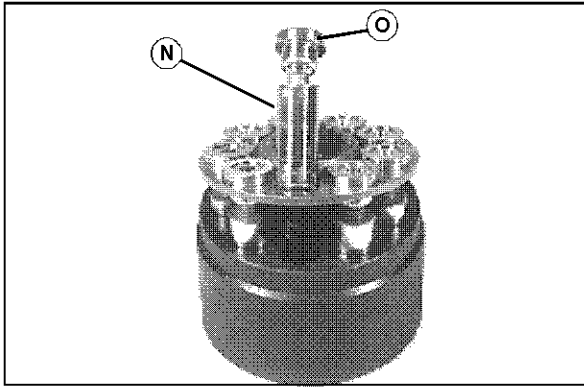
5. Inspect both sides of thrust plate (K) for scoring, galling, or fretting. Replace if necessary.



MX20268

6. Inspect the piston block surface (L) and the valve plate (M) for scoring or wear. Replace if necessary.

HYDROSTATIC POWER TRAIN REPAIR



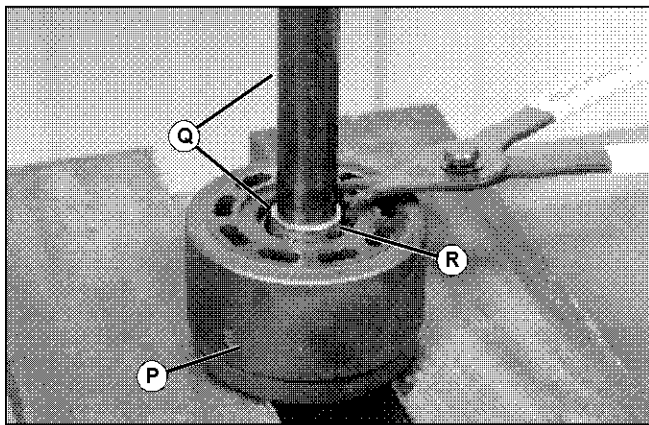
M56554

7. Examine the outside diameter of each piston (N) for finish condition. They should not show wear or deep scratches. Inspect each shoe (O) for a snug fit on the ball end of the pistons and a flat, smooth surface that comes in contact with the valve plate. **DO NOT LAP PISTON SHOES.**



Caution: Avoid Injury! The spring inside the piston block is compressed and should not be removed without compressing the spring first. Use the following procedure to remove the spring safely.

Note: Disassembling the piston block assembly is not required unless the pins are damaged.



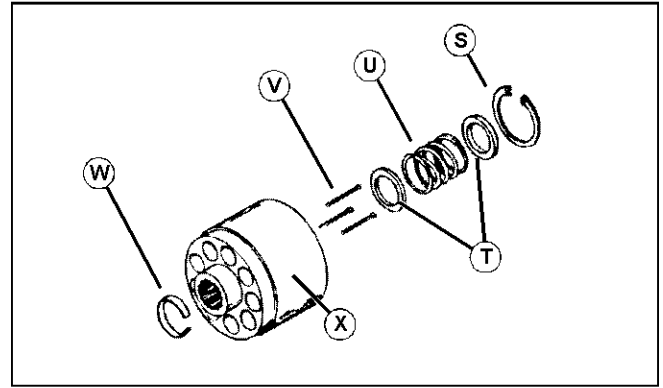
M76495

8. Place piston block (P) in an arbor press. **DO NOT** support piston block by pins. Place supports outside splined hole.

Note: Select a seal driver with a large enough diameter to cover ID of washer inside block, yet small enough in diameter to allow snap ring to be removed.

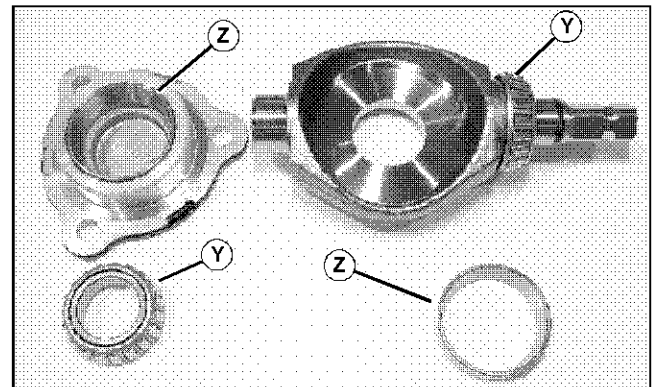
9. Use a seal driver (Q) to compress spring (R) inside piston block.

10. Remove snap ring. Release pressure on spring and remove piston block from press.



M56625

11. Remove snap ring (S), washers (T), spring (U), pins (V), and pin retainer (W) from piston block (X).



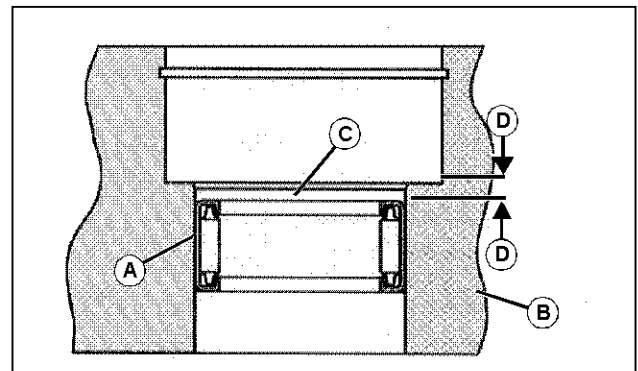
MX20270

12. Inspect the cam plate bearings (Y) and races (Z) for wear or galling. Replace if necessary.

Assemble Hydrostatic Pump

Important: Avoid Damage! Ensure work area is clean. Ensure all parts are clean and free of lint. Use plenty of clean hydraulic fluid when assembling the pump.

Always replace O-rings and seals. Old O-rings and seals will leak. Lubricate new seals and O-rings with petroleum jelly when assembling.

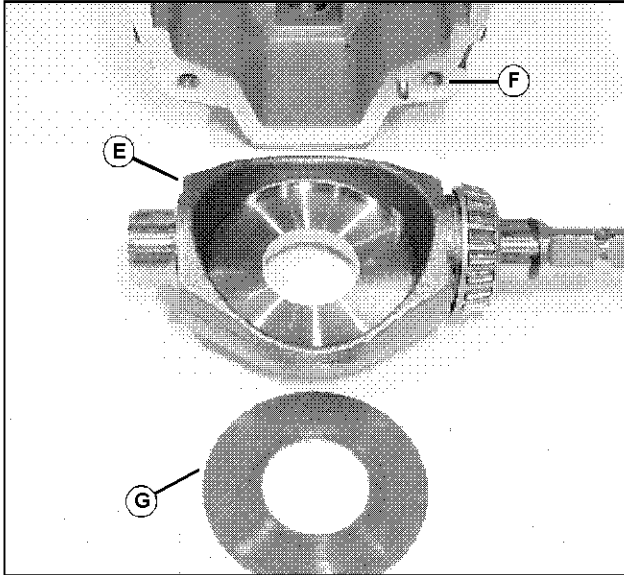


M20271

HYDROSTATIC POWER TRAIN REPAIR

1. If replacing main shaft bearing (A) in pump housing (B), install bearing with numbered side (C) facing outside of housing. Press bearing to specified depth (D).

Note: Install cam plate with long control shaft end through side of housing as previously noted in disassembly.

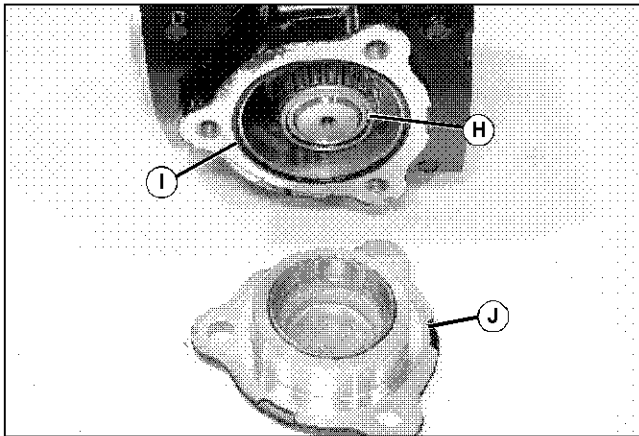


MX20251

2. Install cam plate (E) in housing (F), long end first.

Note: Thrust plate may be installed with either face against cam plate.

3. Install thrust plate (G) in cam plate.

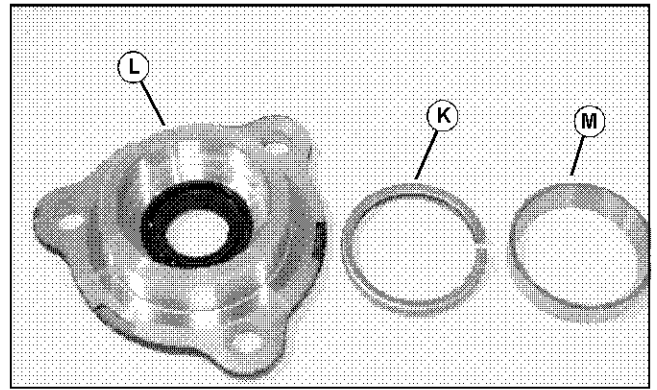


MX20249

4. Install bearing (H), O-ring (I), and bearing cover (J). Use plenty of hydraulic fluid to lubricate bearings.

5. Tighten bearing cover screws to specification.

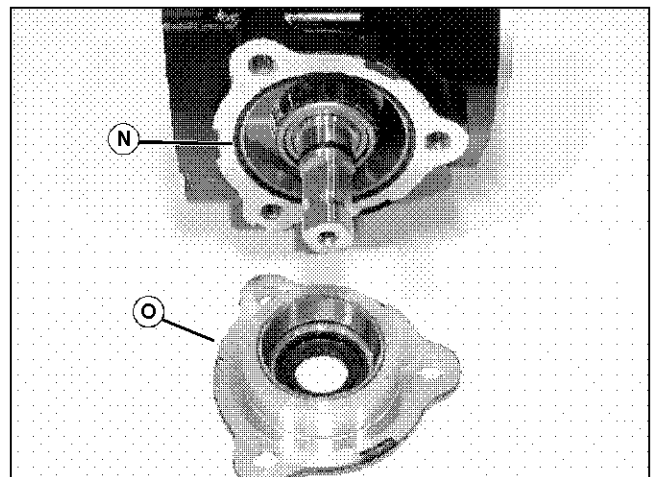
Note: If bearing covers, cam plate or pump housing have been replaced, do not use crush ring. A new shim kit must be installed in its place. See parts catalog for shim kit.



MX20259

6. Install crush ring (K) in bearing cover (L).

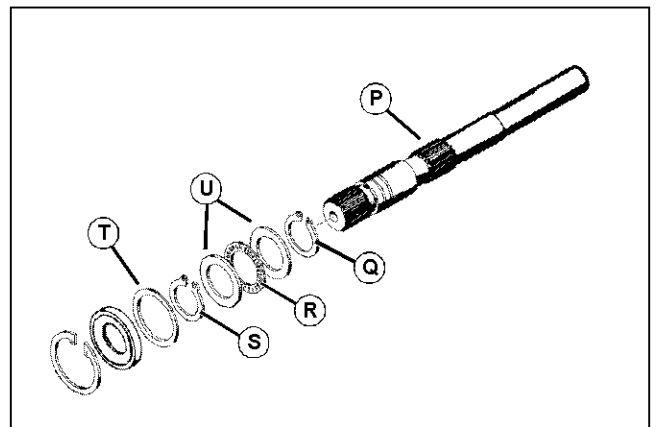
7. Install bearing race (M) with bevel toward cam plate.



MX20250

8. Assemble O-ring (N) and bearing cover (O). Use plenty of hydraulic fluid to lubricate bearings. Ensure cam plate has full travel and moves freely.

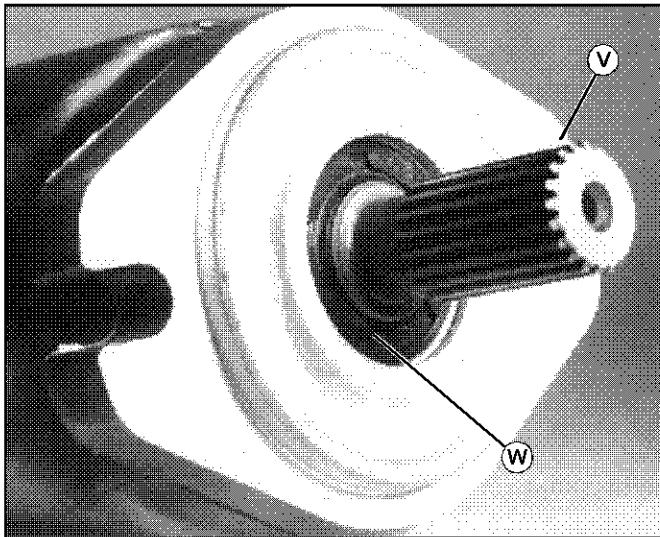
9. Tighten bearing cover screws to specification.



M57918

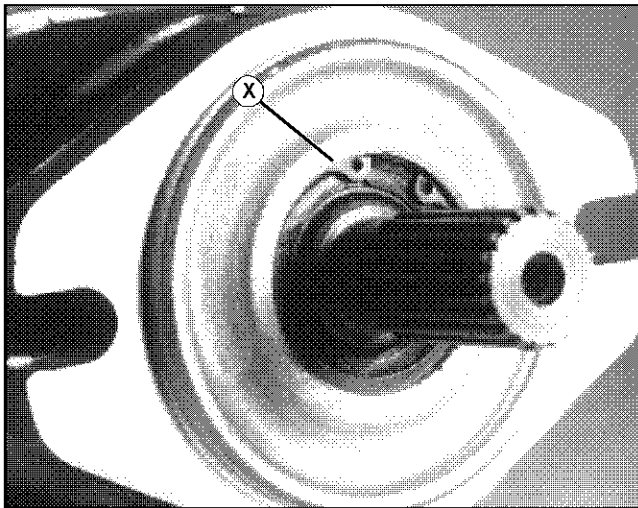
10. If main shaft (P) was disassembled, assemble parts (Q-U) to main shaft.

HYDROSTATIC POWER TRAIN REPAIR



M56560

11. Install shaft (V) and shaft seal (W). Use hydraulic fluid liberally to avoid damaging the seal during installation. Ensure seal is positioned below the retaining ring groove. Use 1-1/8 in. deep well socket to drive seal into pump housing.

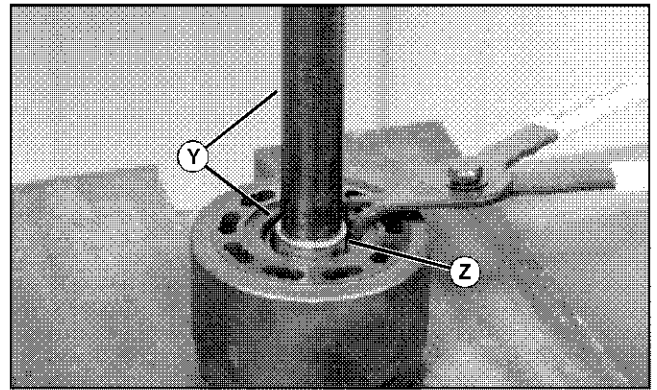


M56564

12. Install retaining ring (X) with sharp edge of ring facing the outside of the case. The sharp edge can be felt with your finger.

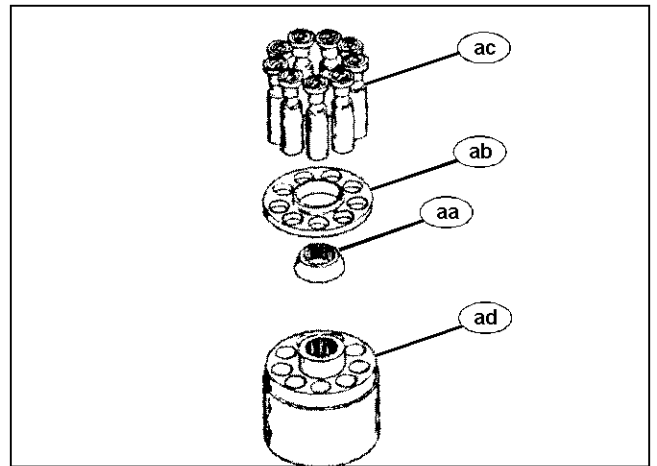
13. If the piston block assembly was disassembled, complete the following.

- Compress the pin keeper and install in the spline of the piston block.
- Install the three pins with the head end to the inside of the block and install in the special grooves of the piston block spline.
- Install the washer, spring and second washer in the piston block.



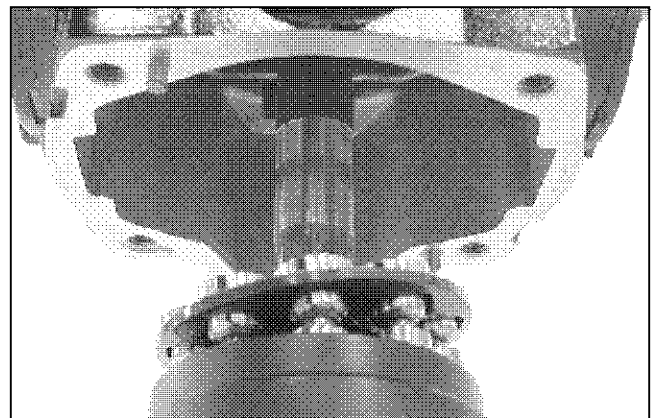
M76495

- Compress the spring with the arbor press and seal driver (Y) used to compress the spring during disassembly.
- Install the retaining ring (Z). Ensure the sharp edge of the retaining ring faces away from the spring.



M56559

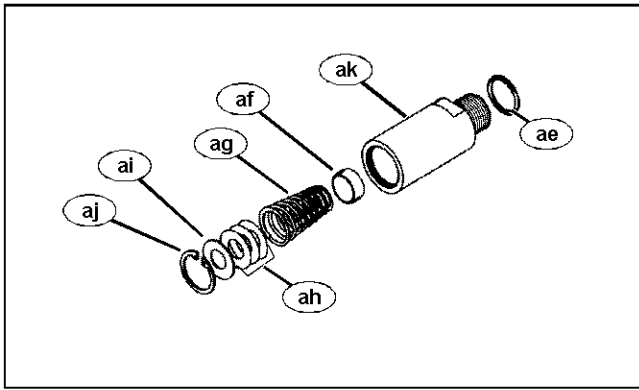
14. Assemble spider pivot (aa), spider plate (ab), and pistons (ac) to piston block (ad).



MX20248

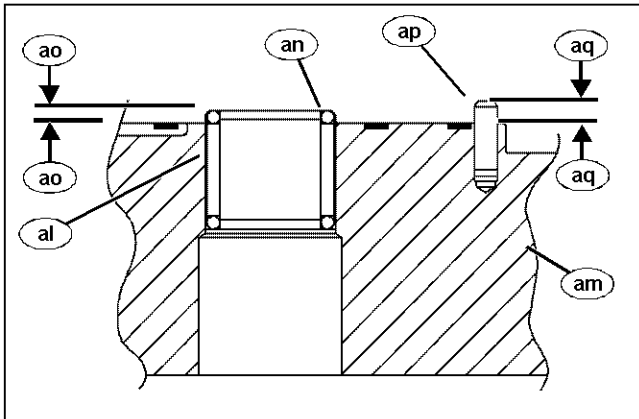
15. Hold the housing upside down and install the rotating assembly. Make sure the rotating assembly shoes are seated against the cam plate.

HYDROSTATIC POWER TRAIN REPAIR



M56535

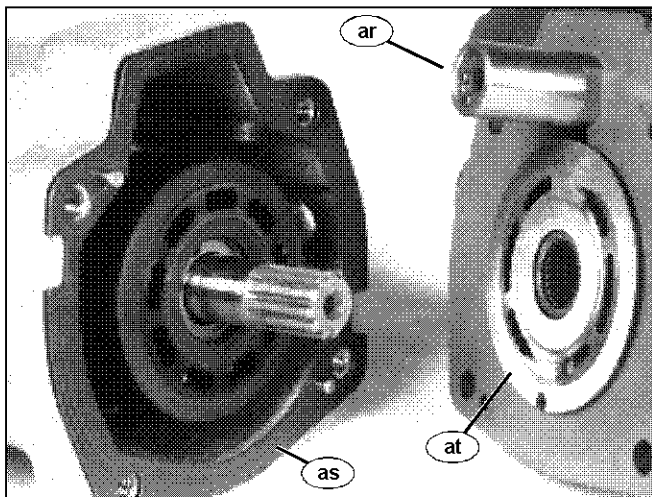
16. Assemble O-ring (ae), plunger (af), spring (ag), shim(s) (ah) (use the same number and thickness of shims as removed), washer (ai), and retaining ring (aj) into relief valve body (ak).



MX20272

17. If replacing main shaft bearing (al) in backplate (am), install bearing with numbered side (an) facing valve plate side of housing. Press bearing to specified depth (ao).

18. If locating pin (ap) was removed, install new pin to specified depth (aq).

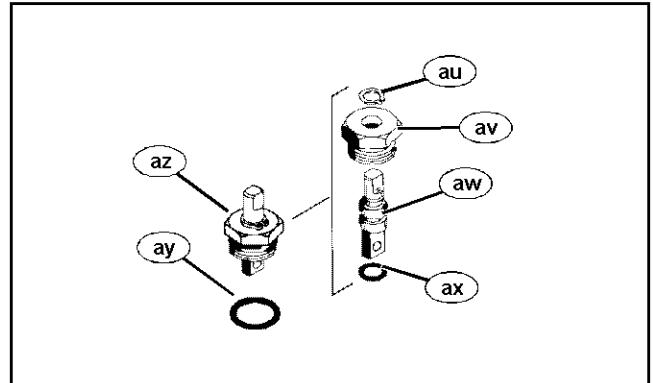


M56567

19. Install charge relief valve (ar), gasket (as) and valve plate (at). Be sure valve plate bronze side faces piston block. Tighten relief valve to specification.

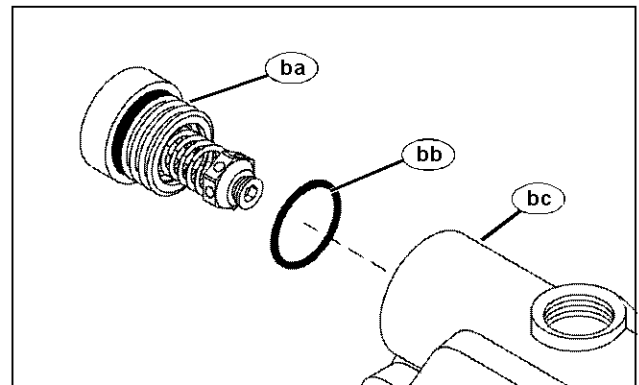
20. Assemble the backplate and housing. Secure with four cap screws and tighten to specifications.

Important: Avoid Damage! DO NOT use the bolts to force the parts to mate when assembling backplate to housing.



M56551

21. Assemble and install bypass valve parts (au-az) and tighten to specifications.



MX20246

22. Install each relief valve (ba) and O-ring (bb) into backplate (bc). Tighten plug to specifications.

Specifications

Pump Housing Bearing Depth (D) . . 1.78 mm (0.07 in.)

Backplate Bearing Depth (ao) 2.29 mm (0.09 in.)

Locating Pin Depth (aq) 4.39 mm (0.17 in.)

Bearing Cover Cap Screw Torque . . . 39 N•m (29 lb-in.)

Charge Relief Valve Torque 37-40 N•m (27-30 lb-ft)

Backplate-to-Housing

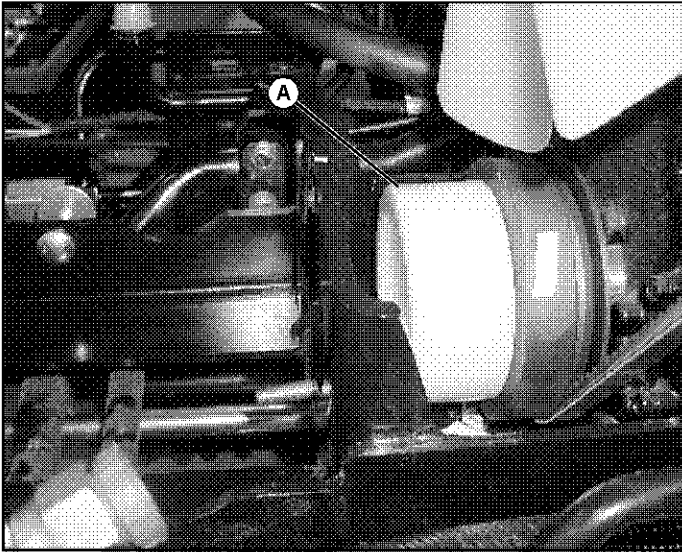
Cap Screw Torque 23-27 N•m (17-20 lb-ft)

Bypass Valve Torque 37-40 N•m (27-30 lb-ft)

Relief Valves Torque 129-142 N•m (95-105 lb-ft)

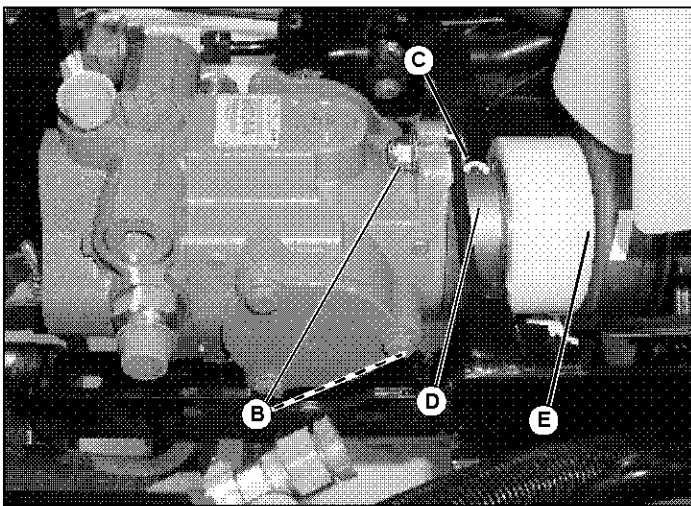
HYDROSTATIC POWER TRAIN REPAIR

Install Hydrostatic Pump



MX23368

1. Place nylon connector (A) on coupler of engine.

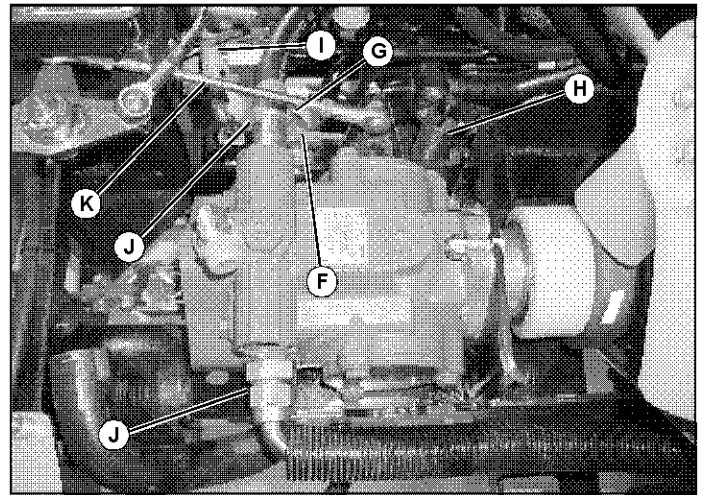


MX23369

2. Slide the hydrostatic pump into position to connect the drive shaft coupler. Secure hydrostatic pump to subframe with two M10 x 35 carriage bolts and flange locknuts (B). Ensure that socket head cap screw (C) on pump half of coupler is loose and coupler is free to move on pump shaft.
3. Tighten hydrostatic pump flange locknuts to specification.
4. Adjust nylon connector by shifting pump coupler section (D) until there is 1.5 mm (0.062 in.) gap (E) between engine coupler and nylon connector.

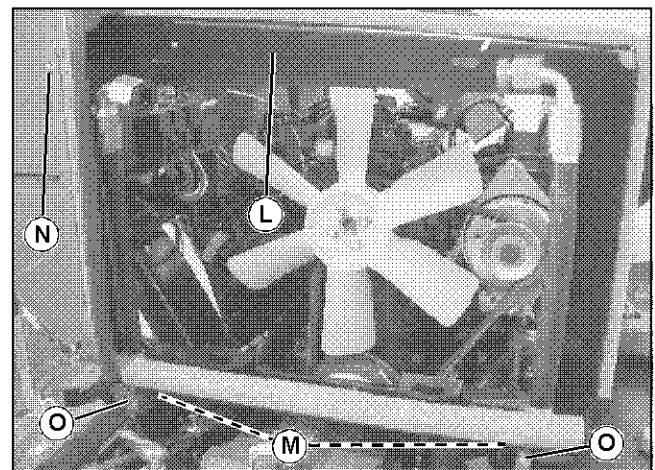
Note: Nylon connector must be free to move on coupler. If nylon connector binds and cannot be shifted by hand, realign pump and/or engine.

5. Tighten socket head cap screw on pump half of coupler to specification.



MX23323

6. Install eccentric mechanism and spring arm (F) with locknut (G) to subframe.
7. Install tension spring (H).
8. Connect neutral switch connector (I).
9. Connect hydraulic lines (J) to hydrostatic transmission.
10. Install transmission link (K).



MX23324

11. Place radiator support (L) in position.
12. Install four carriage bolts and locknuts (M) holding support to frame.
13. Install carriage bolt and locknut (N).
14. Tighten lines (O) for hydraulic oil cooler.
15. Install radiator. (See "Remove, Inspect and Install Radiator" on page 57.)
16. Install hydraulic oil cooler. (See "Remove, Inspect and Install Hydraulic Oil Cooler" on page 324.)
17. Install double pump. (See "Install Double Pump" on page 313.)
18. Install right wheel.

HYDROSTATIC POWER TRAIN REPAIR

19. Install hood. (See "Hood" on page 388.)
20. Move bypass valve to CLOSED position.
21. Install drain plug in hydraulic reservoir and fill to specification with hydraulic fluid.



Caution: Avoid Injury! Because transmission mechanism has been disturbed, vehicle may move when engine is started if wheels are on ground. Neutral adjustment must be performed before unit is lowered to ground.

22. Connect battery.
23. Bleed air from hydraulic system. (See "Bleed Hydraulic System" on page 309.)
24. Perform transmission neutral adjustment. (See "Adjust Transmission Neutral Creep" on page 254.)

Specifications

Pump Coupler Gap 1.5 mm (0.062 in.)

Hydrostatic Pump-to-Subframe 55 N•m (40 lb-ft)

Double Pump Mounting Bolts 50 N•m (35 lb-ft)

Pump Half Socket Head Cap Screw . . . 61 N•m (45 lb-ft)

Remove Front Wheel Motor

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! The machine can fall or slip from an unsafe lifting device or supports.

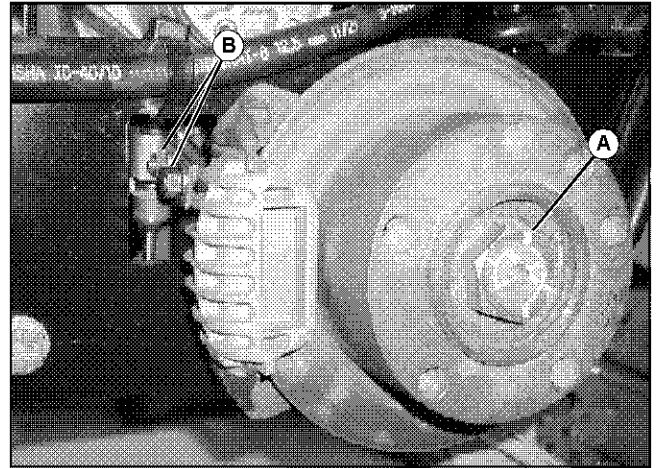
- Use a safe lifting device rated for the load to be lifted.
- Lower machine onto jack stands or other stable supports and block wheels before servicing.

5. Lift and support machine with jackstands.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

6. Lower cutting units to the ground.
7. Turn key switch to the stop position.
8. Disconnect battery negative (-) cable.
9. Raise hood. (See "Hood" on page 388.)
10. Place a 40-quart (10-gal) container below the hydraulic sump and drain oil.
11. Remove wheel. (See "Remove and Install Front Wheels" on page 391.)

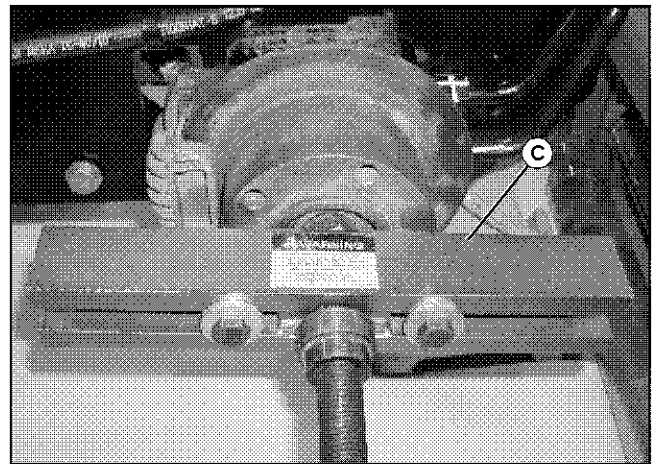


12. Remove nut (A) securing brake rotor to wheel motor.

13. Unlock park brake.

14. Remove flange cap screws and flange nuts (B) and remove brake linkage.

Note: Rotor is a press fit on a tapered shaft. Loosely reinstall rotor retaining nut on wheel motor shaft to prevent rotor from popping off shaft. Do not tighten nut until it touches rotor.



15. Use a suitable puller (C) to loosen rotor from wheel motor.

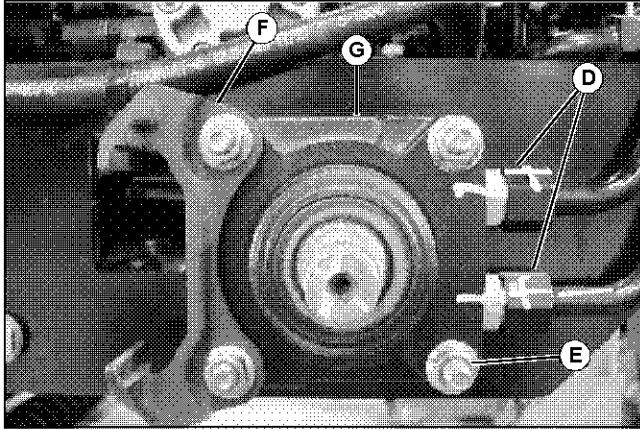
16. Remove puller and rotor retaining nut.

HYDROSTATIC POWER TRAIN REPAIR

17. Remove brake caliper and rotor.



Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

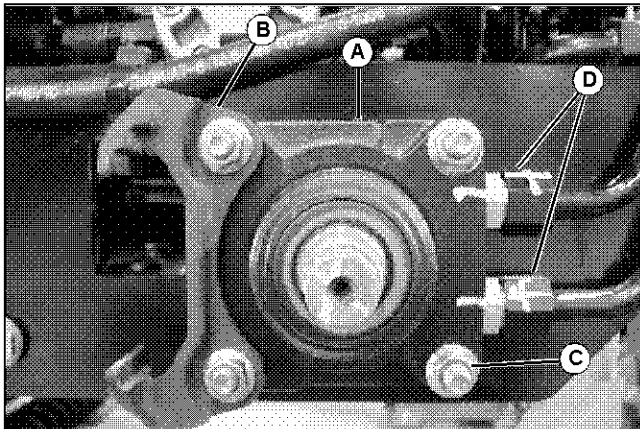


18. Disconnect hydraulic lines (D) from motor.

19. Remove four cap screws and nuts (E) securing motor to frame.

20. Remove brake caliper mount (F) and wheel motor (G).

Install Front Wheel Motor

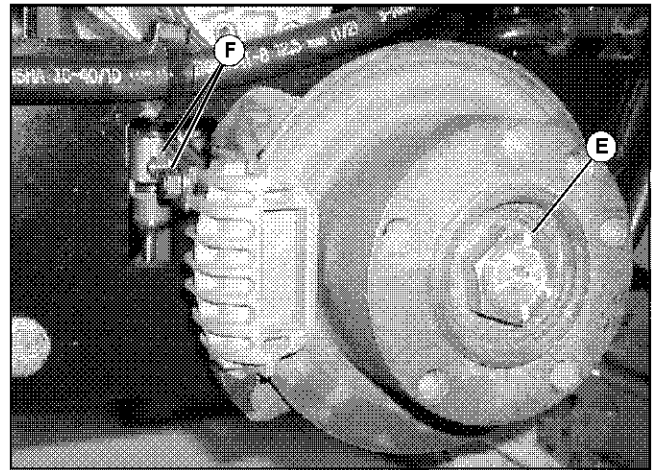


1. Install wheel motor (A) in frame with fittings facing front of mower.

2. Install brake caliper bracket (B) and wheel motor using four cap screws and nuts (C) to secure to frame. Tighten to specification.

3. Connect hydraulic lines (D) to motor.

Note: Ensure that key is installed in shaft and that rotor properly engages key.



4. Slide caliper and rotor into place on caliper mount and motor shaft.

5. Install rotor nut (E) on shaft and finger tighten only at this time.

6. Install caliper linkage using flange cap screws and flange nuts (F).

7. Lock park brake.

8. Tighten rotor nut to specification.

9. Install wheel.

10. Install drain plug in hydraulic reservoir and fill to specification with hydraulic fluid.

11. Connect battery.

12. Bleed air from hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Specifications

Wheel Motor Mounting

Cap Screw Torque 140 N•m (105 lb-ft)

Rotor Retaining Nut Torque 407 N•m (300 lb-ft)

Remove and Install Rear Wheel Motor

Removal



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

- Raise machine safely and support it with suitable jackstands.

1. Use a safe lifting device to raise the machine high enough to remove weight from wheel. Place blocks or jackstands under machine frame.

2. Place a 40-qt (10-gal) container below the hydraulic

HYDROSTATIC POWER TRAIN REPAIR

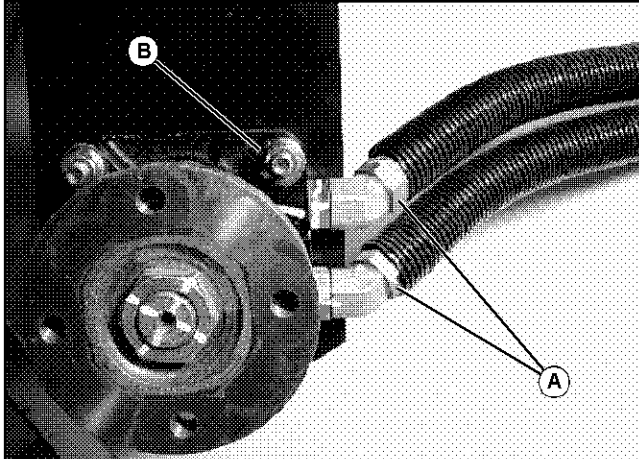
sump and drain oil.

3. Remove rear wheel. (See "Remove and Install Rear Wheel" on page 392.)



Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

Note: Mark position of wheel motor hoses to ensure correct installation.



MX23405

4. Disconnect hydraulic hoses (A).
5. Remove four cap screws and nuts (B).
6. Remove wheel motor.
7. If the motor is to be repaired, remove:
 - Fittings.
 - Nut, wheel hub and key.

Installation

Installation is done in the reverse order of removal.

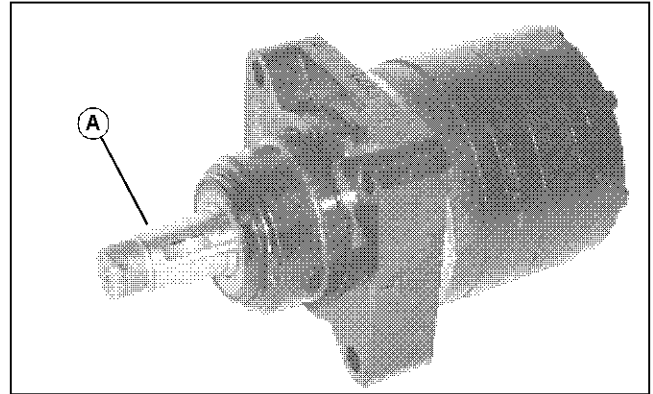
- Apply multi-purpose grease to wheel motor output shaft and key.
- Tighten the nut securing the wheel hub to the motor to specification.
- Fill hydraulic reservoir to correct level with oil of proper specifications.
- Bleed air from hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Specifications

Rear Hub Retaining Nut Torque . . . 407 N•m (300 lb-ft)

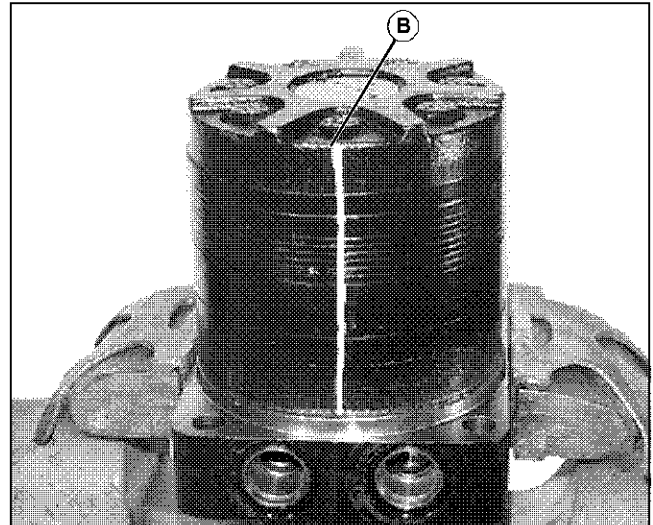
Disassemble and Inspect Wheel Motors

Note: Disassembly and inspection of front and rear wheel motors is similar. Front wheel motor shown in procedure except where noted.



M84266

1. Clean rust, dirt and corrosion from coupling shaft (A).

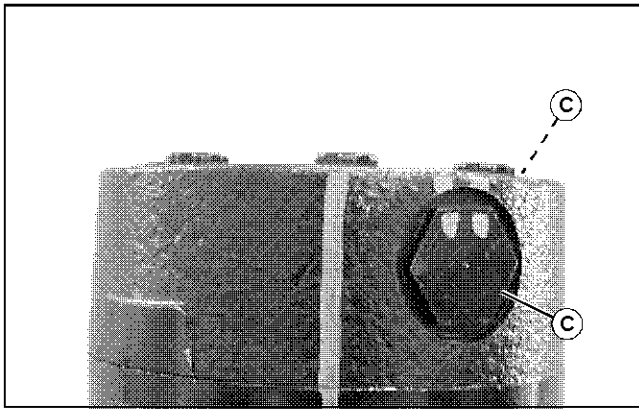


M84267

2. Place wheel motor in a soft-jawed vise with the output shaft down, clamping firmly on sides of the housing, mounting flange or port bosses.
3. Scribe (or paint) an alignment mark (B) across the motor housing.

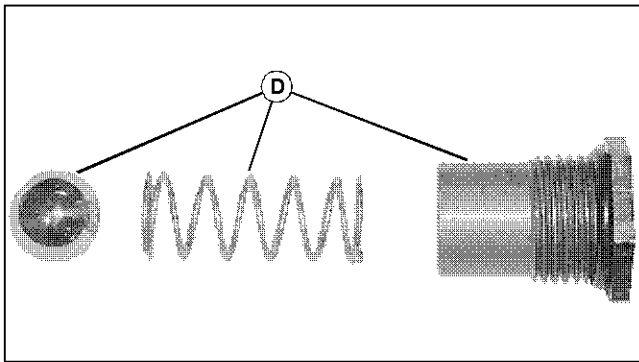
Note: Check valve components **MUST** be installed in original location. To ensure correct installation identify two check valve plugs with different markings and note which location contains check valve.

HYDROSTATIC POWER TRAIN REPAIR



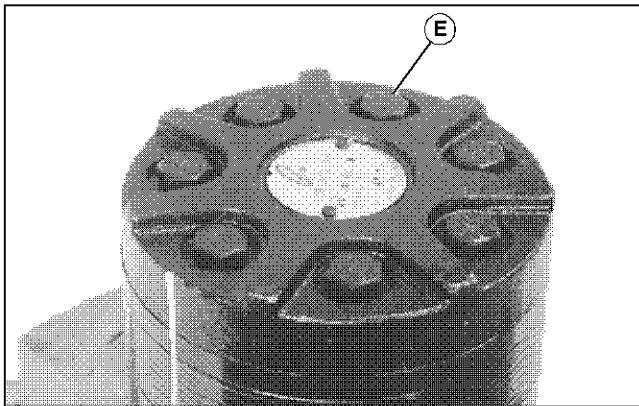
MX23410

4. On rear wheel motors: Mark and remove check valve plugs (C) and valve components.



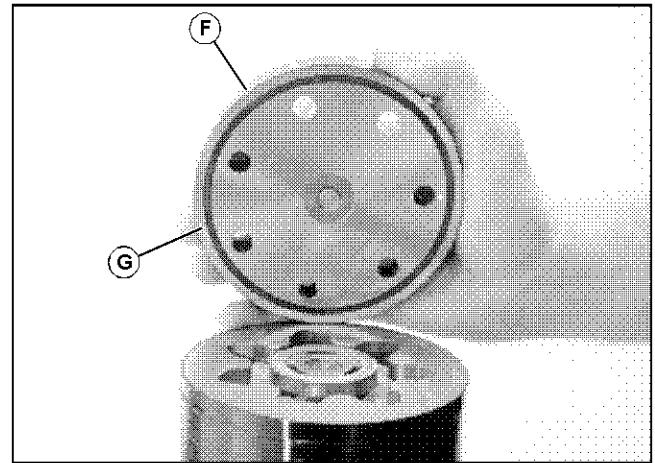
MX23411

5. On rear wheel motors: Inspect the check valve (D) for condition and wear.



M84268

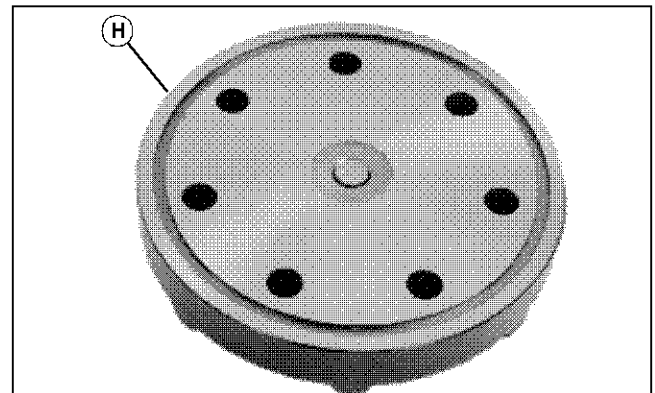
6. Remove seven end cover cap screws (E).
7. Inspect cap screws for damaged threads and damage to sealing ring under the cap screw head.



M84270

8. Remove end cover assembly (F) and seal ring (G). Discard seal ring.

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.



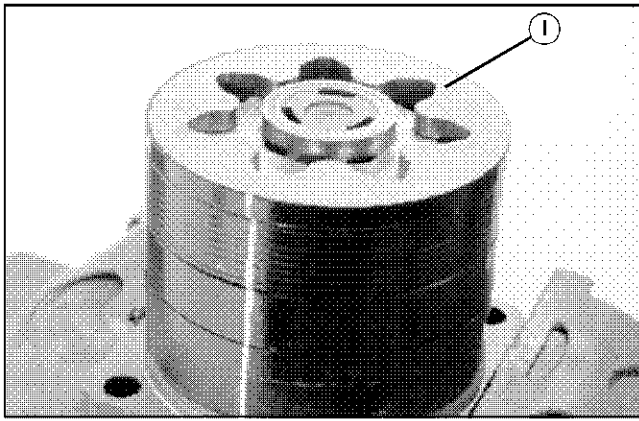
M84271

9. Thoroughly clean end cover (H) with solvent and blow dry with compressed air.

Note: A polished pattern on the face of the cover caused by rotation of the commutator is normal; however, the face should be free of scratches. Discoloration of the face surface may be caused by excessive fluid temperature, thermal shock or excessive speed. If discoloration is noted, thoroughly inspect all motor components for further damage. Inspect the entire drive/hydraulic system and correct any problems to prevent any possible further damage.

10. Inspect end cover for cracks, damage, discoloration or unusual wear.

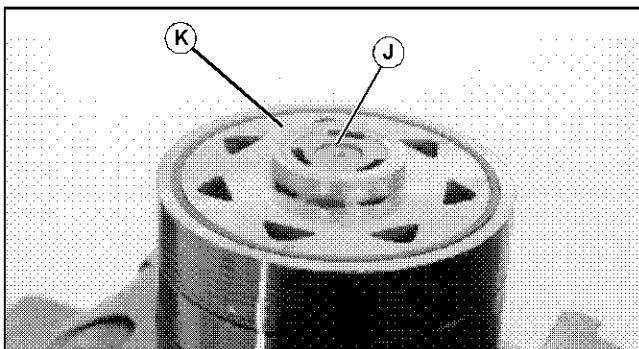
HYDROSTATIC POWER TRAIN REPAIR



M84272

11. Remove commutator ring (I).

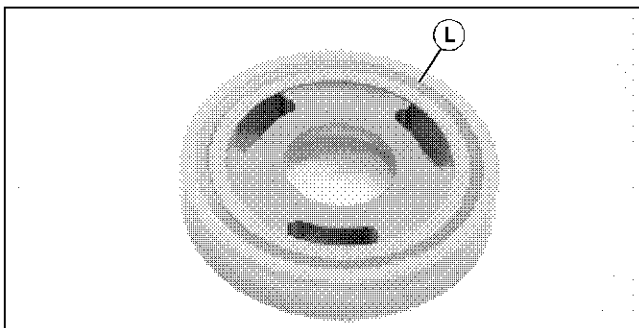
12. Inspect commutator ring for cracks or burrs.



M84273

Note: Drive link (J) may stick to commutator (K). Hold drive link in place while removing commutator.

13. Remove commutator.

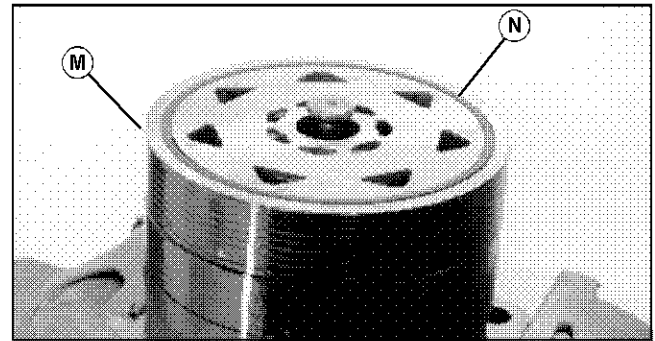


M84274

14. Remove seal ring (L) from commutator by blowing compressed air into the ring groove until the seal ring is lifted out of the groove. Discard seal ring.

15. Inspect commutator for cracks, burrs, scoring, spalling, brinelling or unusual wear.

Note: Make note of orientation of manifold to ensure correct installation.



M84275

16. Remove manifold (M).

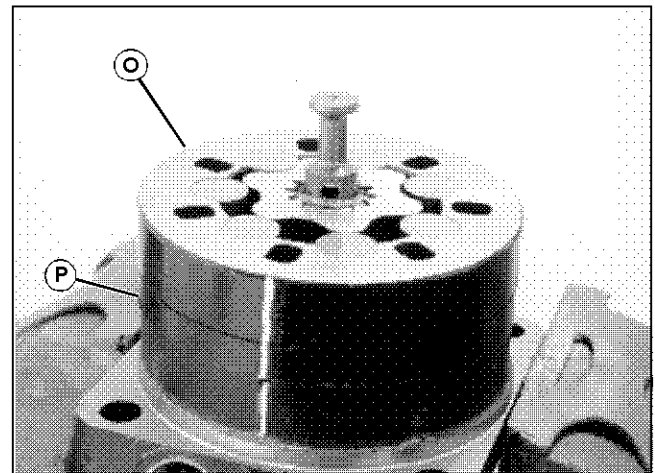
17. Remove seal rings (N) from both sides of the manifold. Discard seals.

Note: A polished pattern on the ground surface of the manifold caused by rotation of the commutator is normal.

18. Inspect manifold for cracks, surface scoring, spalling or brinelling.

Note: Hold rotor set and wear plate together while removing to maintain rotor vane-to-stator contact surfaces.

The drive link may come out with the rotor set. If it does, hold the drive link while removing the rotor set/wear plate.



M84276

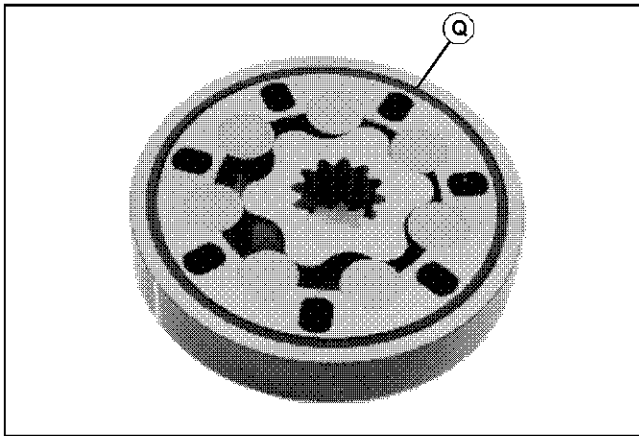
Picture Note: Bottom of rotor set shown.

19. Remove rotor set (O) and wear plate (P) as a set.

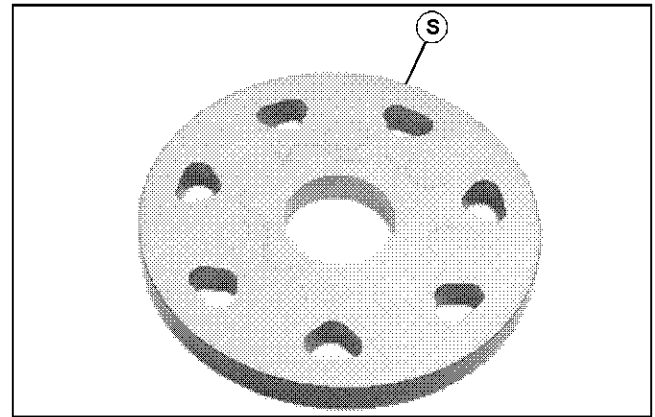
Note: Maintain rotor set components in their original positions. DO NOT disassemble.

If disassembly is required, mark the upper surface of the rotor and stator, and all rotor components to ensure correct installation during assembly.

HYDROSTATIC POWER TRAIN REPAIR



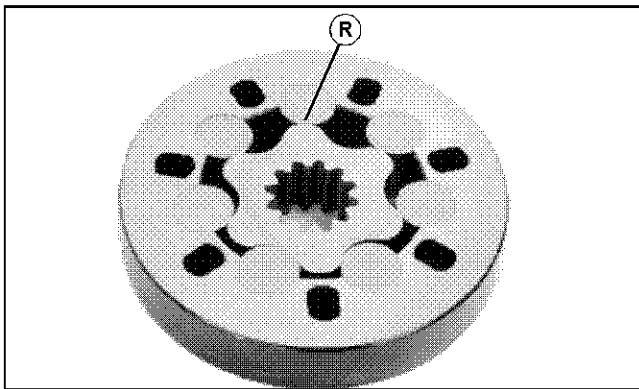
M84277



M84279

20. Separate the rotor set from the wear plate. Discard seal ring (Q).

21. Inspect rotor set for nicks, scoring or spalling on any surface, or for broken or worn splines.



M84278

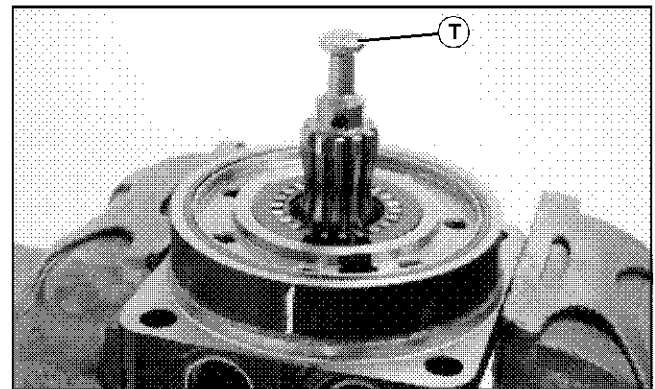
22. Place rotor set on a surface plate.

23. Position the rotor in the stator so that two rotor lobes (180° apart) and roller vane centerline are on the same stator centerline.

24. Check the rotor lobe-to-roller vane clearance at the common centerline (R) using a feeler gauge. Clearance should not be greater than 0.13 mm (0.005 in.).

Note: A polished pattern on the ground surface of the wear plate caused by rotation of the rotor is normal.

25. Inspect wear plate (S) for cracks, brinelling or scoring.

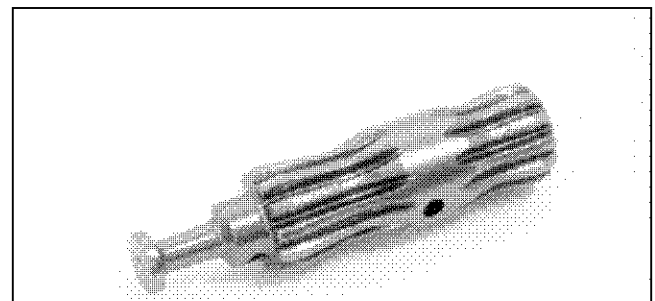


M84280

26. Inspect for play between drive link (T) and coupling shaft. There should be no noticeable play.

27. Mark drive link and coupling shaft splines to ensure reassembly in the original positions.

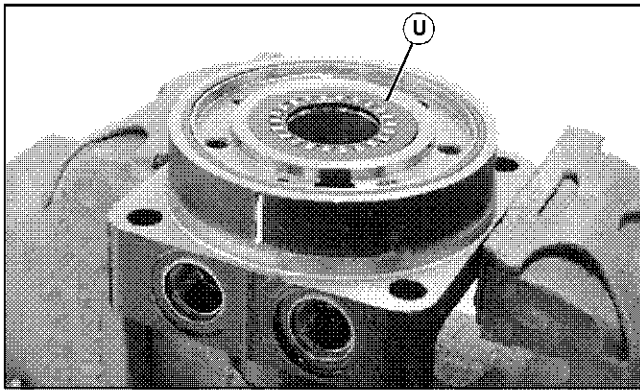
28. Remove drive link from the coupling shaft.



M84281

29. Inspect the drive link for cracks and worn or damaged splines.

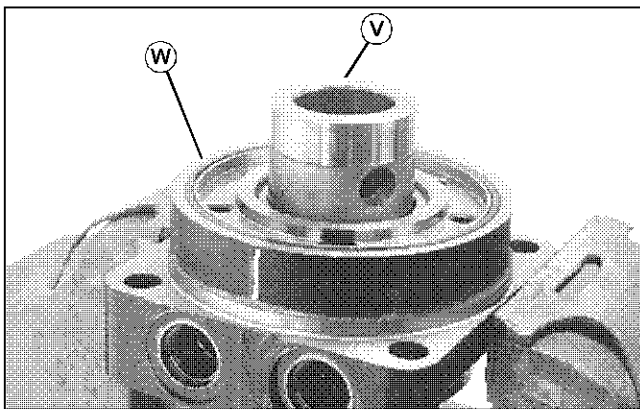
HYDROSTATIC POWER TRAIN REPAIR



M84282

30. Remove thrust bearing (U) from coupling shaft.

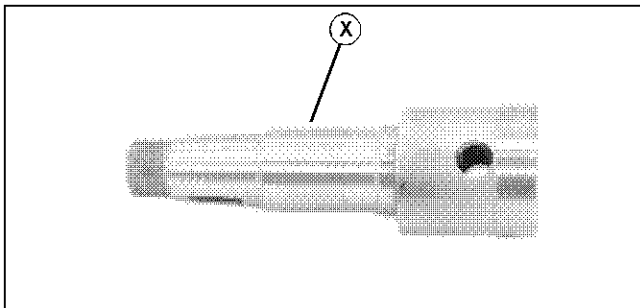
31. Inspect thrust bearing for wear, brinelling, corrosion and missing rollers.



M84283

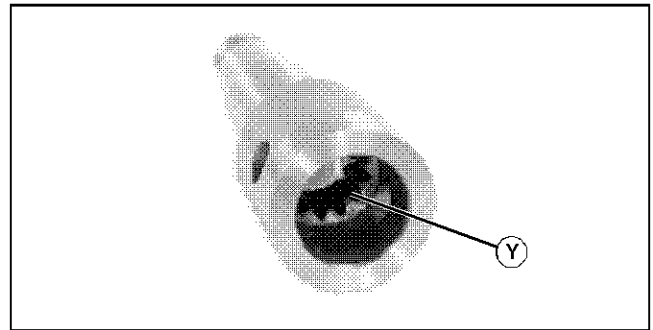
32. Remove coupling shaft (V).

33. Remove seal ring (W) from housing. Discard seal.



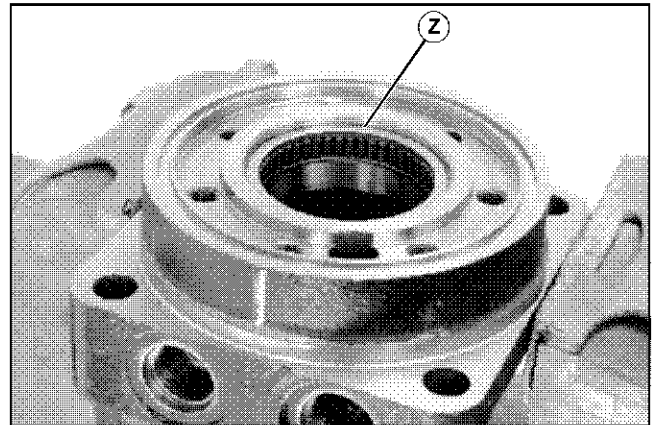
M84284

34. Inspect coupling shaft bearing and seal surface (X) for spalling, nicks, excessive wear or corrosion.



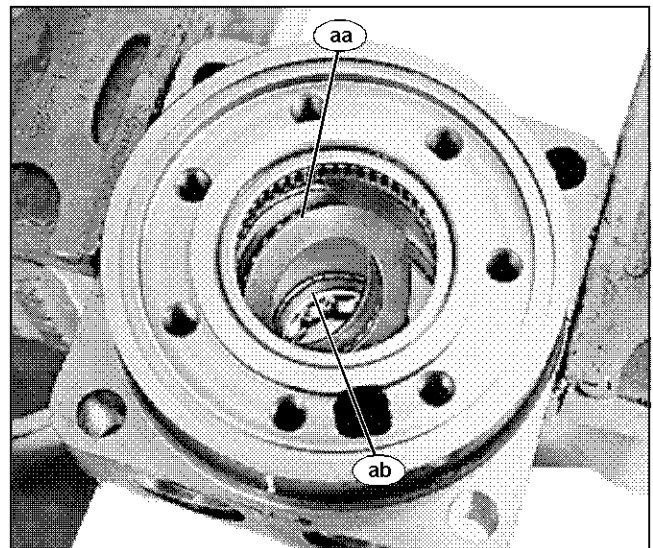
M84285

35. Inspect coupling shaft splines (Y) for wear or damage.



M84286

36. Inspect inner bearing (Z) for free rotation and excessive play in bearing cage. Also inspect bearing for brinelling or corrosion.



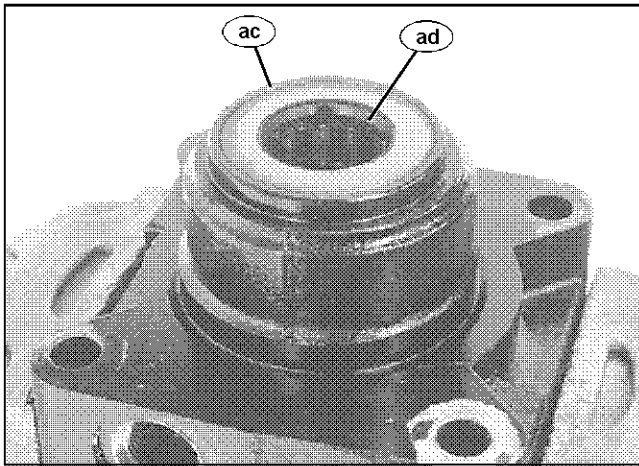
M84339

37. Inspect thrust bearing.

Note: A dental pick or similar device can be used to remove the seal.

38. Push thrust bearing and washers (aa) aside and remove seal and backup washers (ab).

HYDROSTATIC POWER TRAIN REPAIR



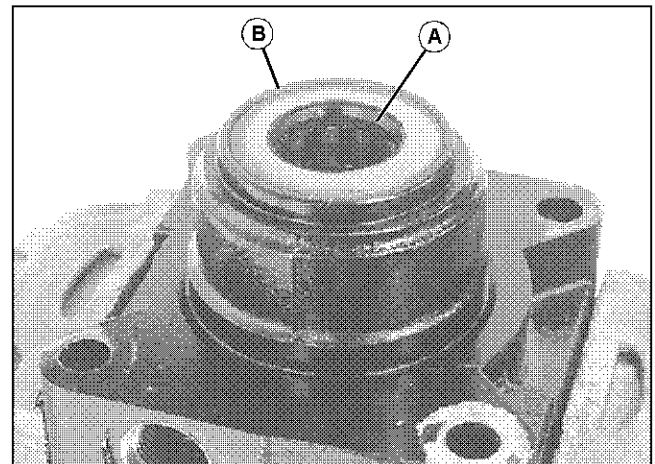
Assemble Wheel Motors

Important: Avoid Damage! Always use new O-rings. Damaged or used parts will leak.

Note: Assembly of front and rear wheel motors is similar. Front wheel motor shown in procedure except where noted. Alignment studs screwed finger tight into the bolt holes 180° apart can be used to assist alignment during assembly. Alignment studs can be made by cutting the heads off 3/8-24 UNF 2A x 5-in. cap screws.

Lubricate all seals and seal rings with Mobilith SHC™ 460 grease (supplied with seal kit) during assembly.

Important: Avoid Damage! The outer bearing is not lubricated by the system's hydraulic oil. Thoroughly pack the bearing with grease before installation.



M84289



Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

Important: Avoid Damage! Absolute cleanliness is essential when working on wheel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/hydraulic system and cause damage.

39. Remove wheel motor from vise. Invert it and install it in vise.

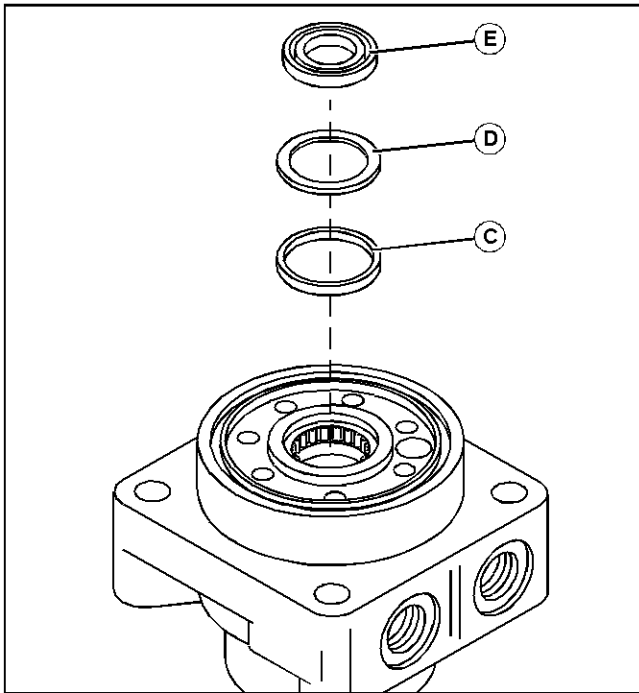
40. Remove seal (ac) using a blind-hole bearing or seal puller.

41. Inspect the housing for cracks, excessive wear or damage. Inspect machined surfaces for nicks, burrs, brinelling or corrosion. Inspect tapped holes for thread damage.

42. Inspect bearings (ad) for free rotation and excessive play in bearing cages. Also inspect bearings for brinelling or corrosion.

1. Pack and coat the new outer bearing/bushing (A) with anti-corrosion grease.
2. Install a new outer bearing seal (B) with the lip facing out. Press seal into housing until the seal is flush with the end of the housing.
3. Remove wheel motor from vise. Invert it and reinstall it in vise.

HYDROSTATIC POWER TRAIN REPAIR

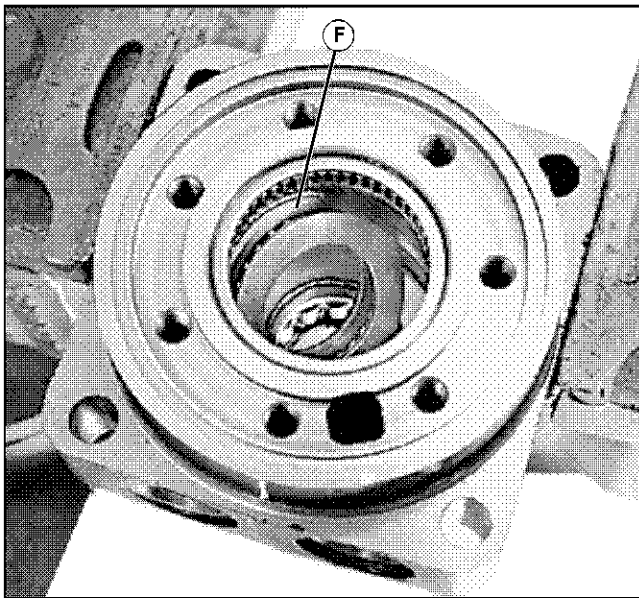


M84288

4. Install backup ring (C) and washer (D).

Important: Avoid Damage! Make sure the seal is completely seated in bore. Improper seating may result in seal damage when installing coupling shaft, resulting in leakage.

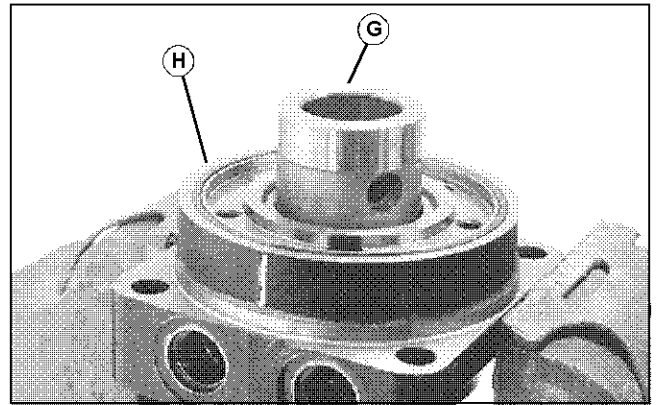
5. Install a new seal (E) with the lip facing toward the inside of the motor.



M84339

6. Seat thrust bearing and thrust washers (F) (one above and one below the thrust bearing).

Important: Avoid Damage! Apply anti-corrosion grease to the outer bearing/bushing and tape to the threads and keyway of the coupling shaft to prevent damage to the seal during installation.



M84283

7. Apply tape to the threads and keyway of the coupling shaft (G) to prevent damage to the seal during installation.

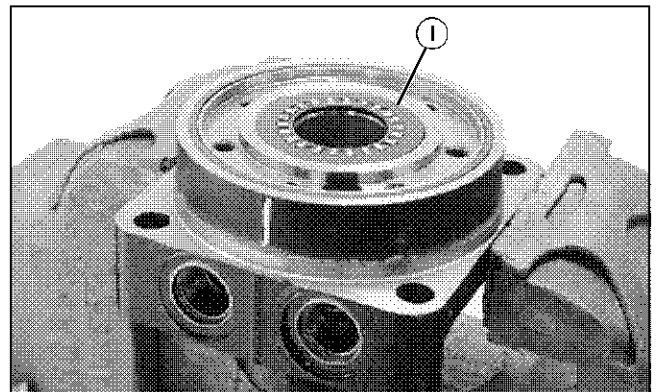
8. Apply grease to the seal.

Note: When properly installed, the coupling shaft will be approximately 2.54 mm (0.10 in.) below the housing wear surface plate. The coupling shaft must rotate freely on the thrust bearing assembly.

9. Install the coupling shaft into the housing until it rests against the thrust washer.

10. Apply a light coat of grease to the seal ring (H).

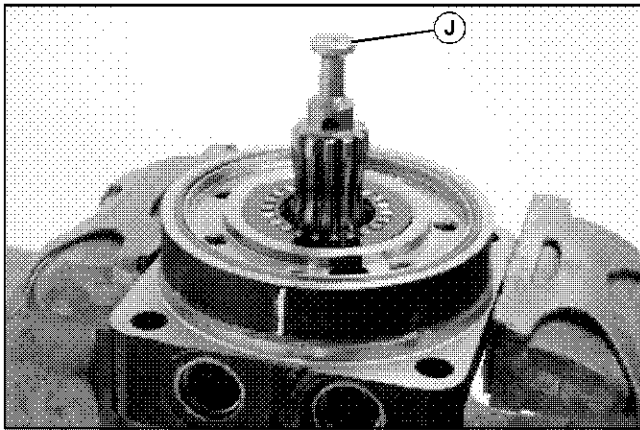
11. Install seal ring in the groove in the housing.



M84282

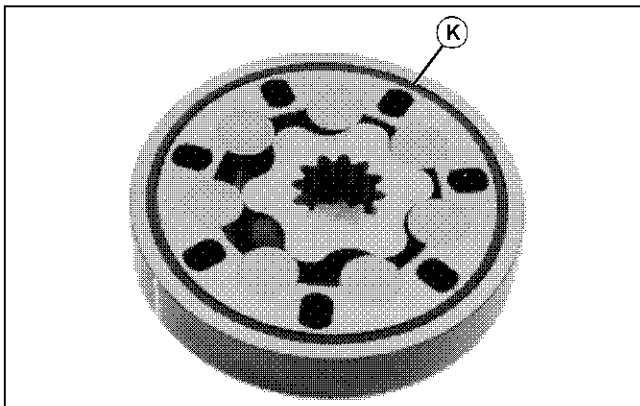
12. Install thrust bearing (I) on the coupling shaft.

HYDROSTATIC POWER TRAIN REPAIR



M84280

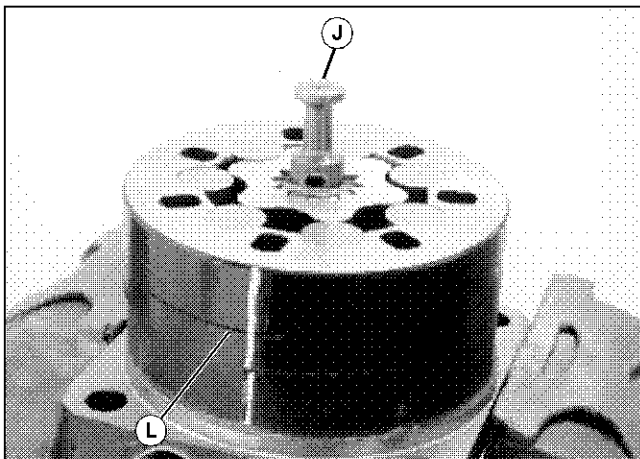
13. Install drive link (J) with the splined end toward the coupling shaft. Align marked splines on drive link and coupling shaft.



M84277

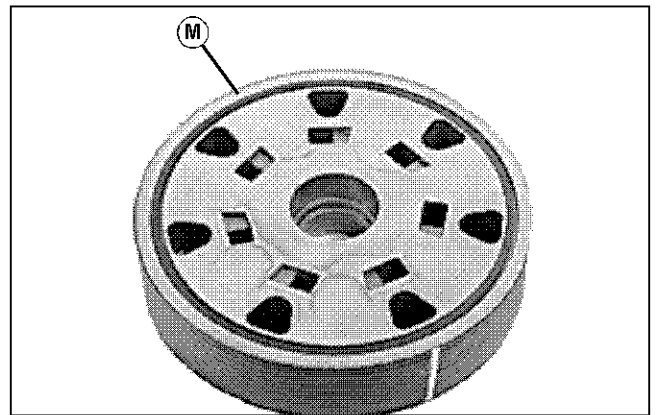
Picture Note: Bottom of rotor set shown.

- 14. Apply a light coat of grease to seal ring (K).
- 15. Install seal ring in the groove in the rotor set assembly.
- 16. Install wear plate on rotor set.
- 17. Carefully flip rotor set/wear plate assembly over, while holding rotor set components in place.



M84276

18. Install rotor set/wear plate assembly (L) over the drive link (J).

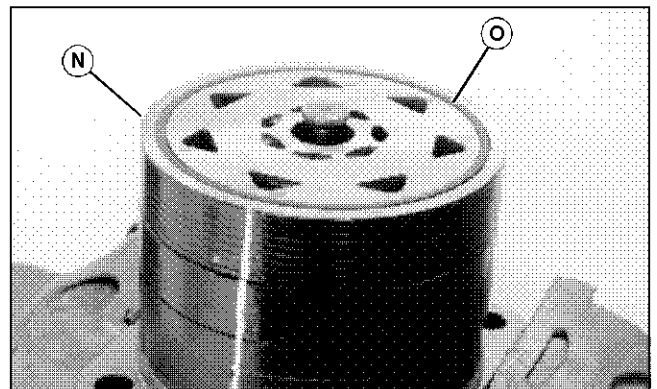


M84340

Picture Note: Bottom of manifold shown.

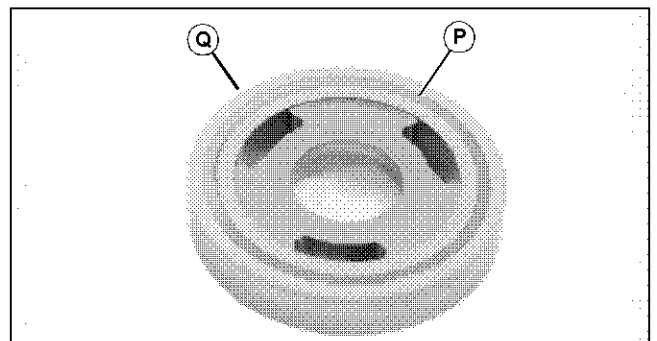
- 19. Apply a light coat of grease to seal ring (M).
- 20. Install seal ring in the groove in the bottom of manifold.

Note: Correct installation of the manifold is important for proper operation. The manifold should be installed with the surface with the irregular shaped cavities on the largest circumference toward the rotor set.



M84275

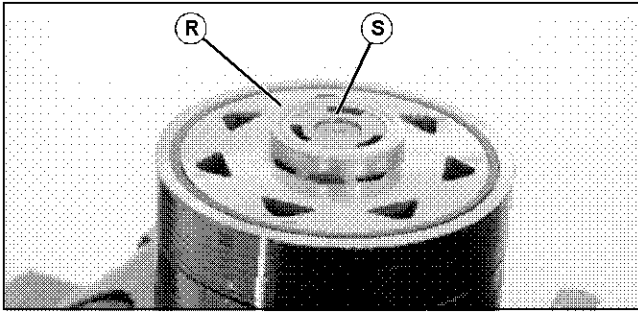
- 21. Install manifold (N).
- 22. Apply a light coat of grease to the seal ring (O).
- 23. Install seal ring in the groove in the manifold.



M84274

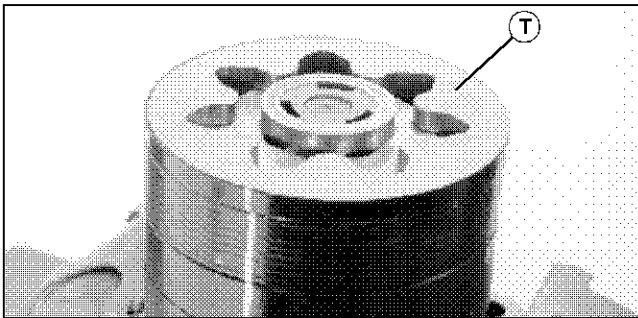
HYDROSTATIC POWER TRAIN REPAIR

24. Apply a light coat of grease to the seal ring (P).
25. Install seal ring in the groove in the commutator (Q).



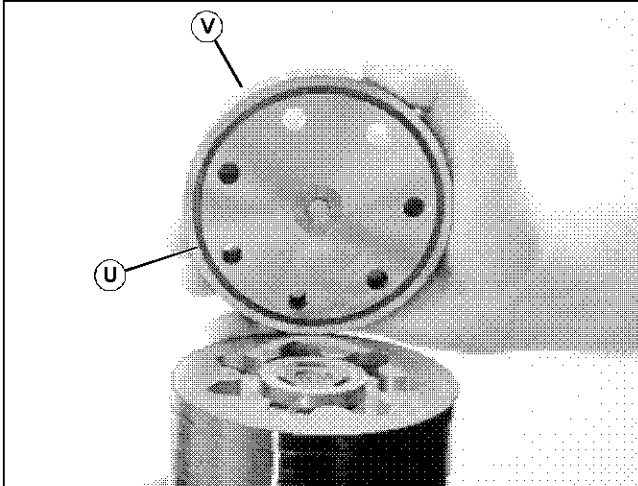
M84273

26. Install commutator (R) on drive link (S).



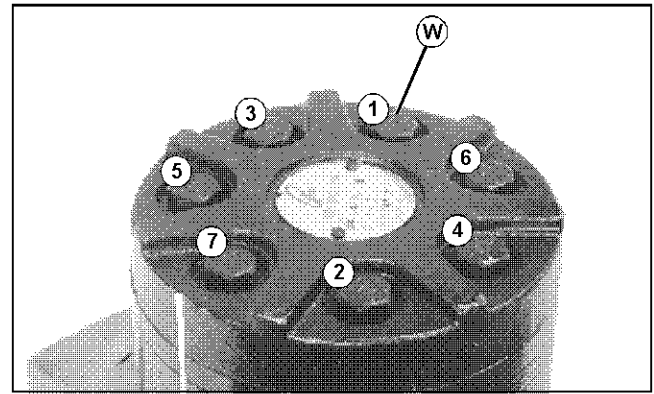
M84272

27. Install commutator ring (T).



M84270

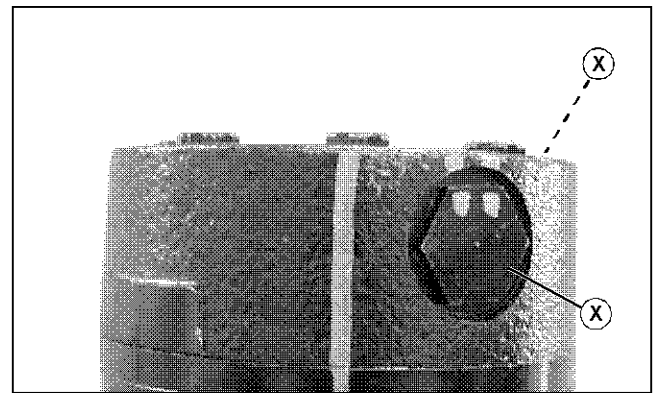
28. Apply a light coat of grease to seal ring (U).
29. Install seal ring in the groove in the end cover (V).
30. Install end cover.



M84268

31. Install end cover cap screws (W).
32. Tighten cap screws evenly, in the sequence shown, to specification.

Note: Check valve components **MUST** be installed in original location. Use markings made during disassembly to ensure correct installation of check valve and two check valve caps.



MX23410

33. On rear wheel motors: Install check valve and plugs (X). Tighten plugs to specification.

Specifications

End Cover Cap Screw Torque 68 N•m (50 lb-ft)
Check Valve Plugs Torque . . . 61-74.5 N•m (45-55 lb-ft)

Wheel Motor Final Checks

1. Pressurize the wheel motor with 689 kPa (100 psi) dry air or nitrogen and submerge in solvent to check for external leaks.
2. Check wheel motor for rolling drag. Torque required to rotate the coupling shaft should not be more than specifications.

Note: Pressure port with "B" cast under it on housing is for clockwise rotation, and port "A" is for counterclockwise rotation.

HYDROSTATIC POWER TRAIN REPAIR

3. Use test stand, if available, to check for proper operation of the wheel motor.

Note: *Bleed hydraulic system after installing wheel motor to the machine. (See “Bleed Hydraulic System” on page 309.)*

Specifications

Rolling Drag Torque 68 N•m (50 lb-ft)

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HYDRAULICS TABLE OF CONTENTS



HYDRAULICS SPECIFICATIONS

Specifications

General Specifications

Charge Pump

Make..... Danfoss
Model / Series..... CGP
Type..... Gear, positive displacement
Displacement..... 5.73 cc/rev (0.35 cu-in./rev)
Minimum Flow @ 3150 RPM..... 19.5 L/min (5.15 gpm)
Pump Flow @ 6895 kPa (1000 PSI) Load..... 13.2 L/min (3.5 gpm)
Relief Valve Setting in Steering Valve..... 9997 kPa (1450 psi)
Relief Valve Setting in Hydrostatic Pump..... 689-1034 kPa (100-150 psi)
Fast Idle..... 3150 ± 50 rpm
Slow Idle..... 1400 ± 50 rpm

Reel Pump

Make..... Danfoss
Model / Series..... CGP
Type..... Gear, positive displacement
Displacement..... 9.50 cc/rev (0.58 cu-in./rev)
Minimum Flow @ 3150 RPM..... 27.9 L/min (7.4 gpm)
Pump Flow @ 20 684 kPa (3000 PSI) Load (Minimum)..... 22.7 L/min (6.0 gpm)
Case Drain Flow..... Not to exceed 6.3 ml/sec (1.0 gpm)
Reel Pump Relief Pressure..... 20 684 ± 1034 kPa (3000 ± 150 psi)

Reel Mower Motors

Make..... Casappa
Displacement..... 28.8 cm³ (1.76 cu in.)
Type..... Gear

Front Inboard and Rear Lift Cylinders

Stroke..... 101.6 mm (4 in.)
Compressed Length..... 203.2 mm (8 in.)

Hydraulic Filter

Type..... Spin on
Clogged Filter Bypasses Fluid to Tank At..... 345 kPa (50 psi)
Hydraulic Oil Operating Temperature..... 43°C (110°F)

HYDRAULICS SPECIFICATIONS

Torque Specifications

Double Pump

Reel Pump End Plate Hex Head Bolts (3/8 in.)	40.7-43.0 N•m (30-32 lb-ft)
End Pump-to-Center Pump Housing Hex Head Bolts (5/16 in.)	21.5-23.7 N•m (190-210 lb-in.)
Reel Pump End Plate Hex Head Bolts (3/8 in.)	40.7-43.0 N•m (30-32 lb-ft)
Charge Pump-to-Reel Pump Assembly Hex Head Bolts (5/16 in.)	21.5-23.7 N•m (190-210 lb-in.)

Hydrostatic Pump

Double Pump-to-Hydrostatic Pump Hex Socket Head Bolts	50 N•m (35 lb-ft)
Support Bracket-to-Frame Carriage Bolt Nuts	55 N•m (40 lb-ft)

CGM Series Reel Motors

Cover-to-Housing Hex Socket Head Bolt (5/16 in.)	21.5-23.7 N•m (190-210 lb-in.)
--	--------------------------------

Mow Valve with Backlapping Capability

Solenoid Coil.	31 N•m (22 lb-ft)
Solenoid Plunger	95 N•m (70 lb-ft)
Flow Control Valve	65 N•m (47 lb-ft)
Pressure Relief Valve	65 N•m (47 lb-ft)
Forward-Reverse Valve	237 N•m (175 lb-ft)
Forward-Reverse Switch	17 N•m (150 lb-in.)

HYDRAULICS TOOLS AND MATERIALS

Tools and Materials

Special or Required Tools

Note: Order tools according to information given in the **U.S. SERVICEGARD™ Catalog** or in the **European Microfiche Tool Catalog (MTC)**.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Swivel T-Fitting	38H1030	Used to test reel motors pressure relief. Used to test lift system relief valve pressure. Part of BM18319 Diagnostic Kit.
Hose	AMT846	Used to test reel motors pressure relief. Part of BM18319 Diagnostic Kit.
In-Line Hydraulic Tester	D01074AA	Used to measure reel motor case drain.
Flowmeter Kit	JDG2034	Used to measure oil flow out of charge pump and reel pump.
Diagnostic Hose and Fitting Kit	JDG2032	Used to install flowmeter.
Connector 3/4 in. F NPT x 1-1/16 in. F 37° (2)	JT03012	Used to test reel pump flow. Used to measure reel motor case drain.
Pressure Gauge 0-40 000 kPa (0-6000 psi)	JT07047	Connect pressure gauge for steering and lift system relief valve pressure test.
Hose 34 474 kPa (5000 psi)	JT03017	Used to test lift system relief valve pressure.
Gauge 70 000 kPa (10,000 psi)	JT03362	Used to read front reel motor pressure.
120 in. Hydraulic Test Hose (2)	JT03377	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1-1/16 in. M 37° x 1-3/16 in. M ORFS	JT03483	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1-3/16 in. F ORFS x 13/16 in. M ORFS	JT03484	Used to test reel pump flow. Used to measure reel motor case drain.

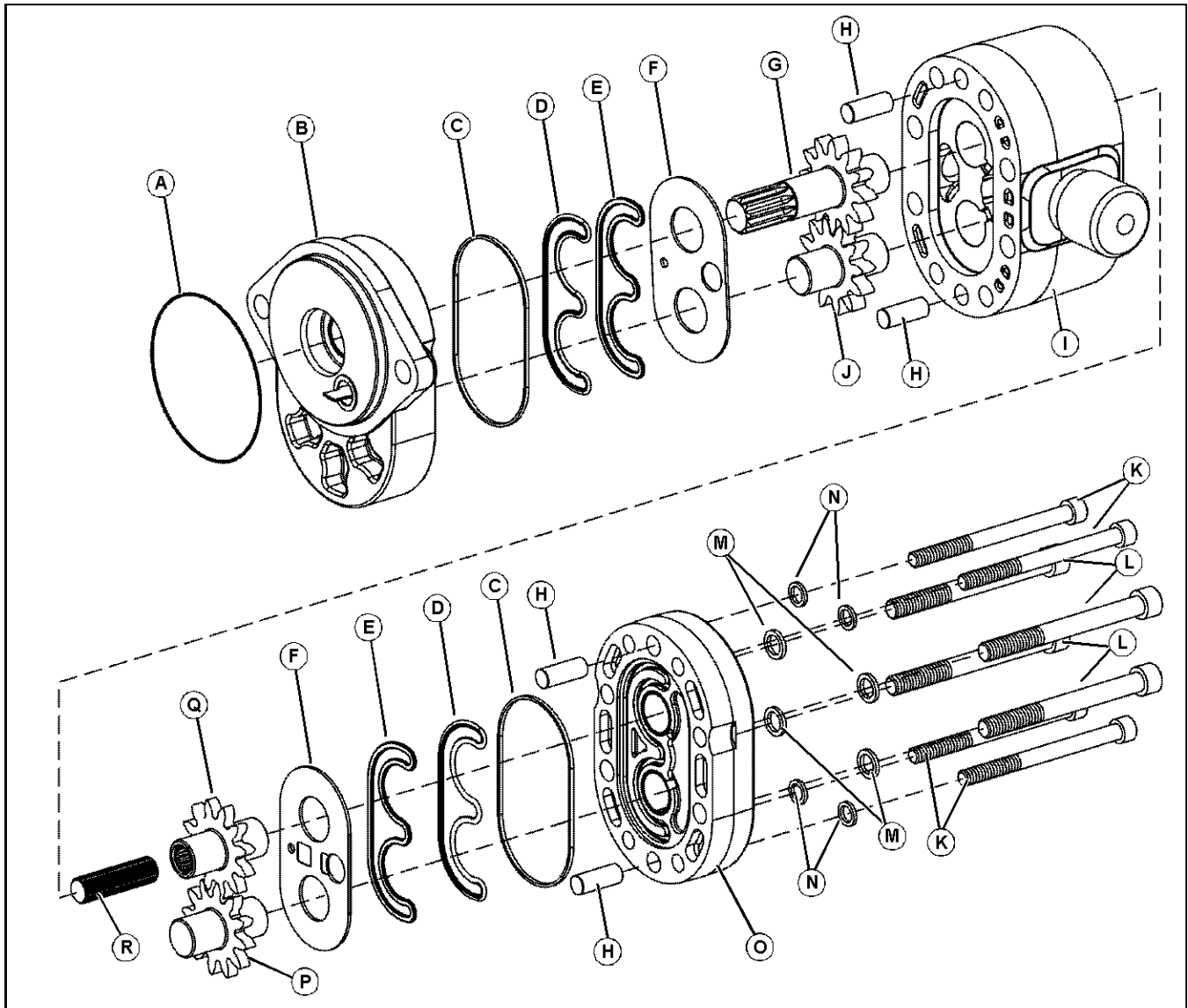
Special or Required Tools

Tool Name	Tool No.	Tool Use
Connector 1/4 in. M NPT x 7/16 in. M 37°	JT05486	Used to test reel motor relief pressure. Used to test lift system relief valve pressure.
Connector 1-1/16 in. M 37° x 13/16 in. F ORFS	JT05688	Used to test reel pump flow. Used to measure reel motor case drain.
Quick Disconnect Fitting	MT1531	Used to test reel motors pressure relief. Part of BM18319 Diagnostic Kit. Used to test lift system relief valve pressure.
Female Quick Coupler	RE48122	Used to test reel motors relief pressure. Used to test lift system relief valve pressure. Part of BM18319 Diagnostic Kit.
1/2 in. ID Hose 24 in. long (2)	N/A	Used to measure reel motor case drain.
Lift Arm Bushing Installer	JDG892	Used to install lift arm bushing.
Plug, 13/16 in. M ORFS	JT03392	Used to plug port on reel motor.

HYDRAULICS COMPONENT LOCATION

Component Location

Double Pump



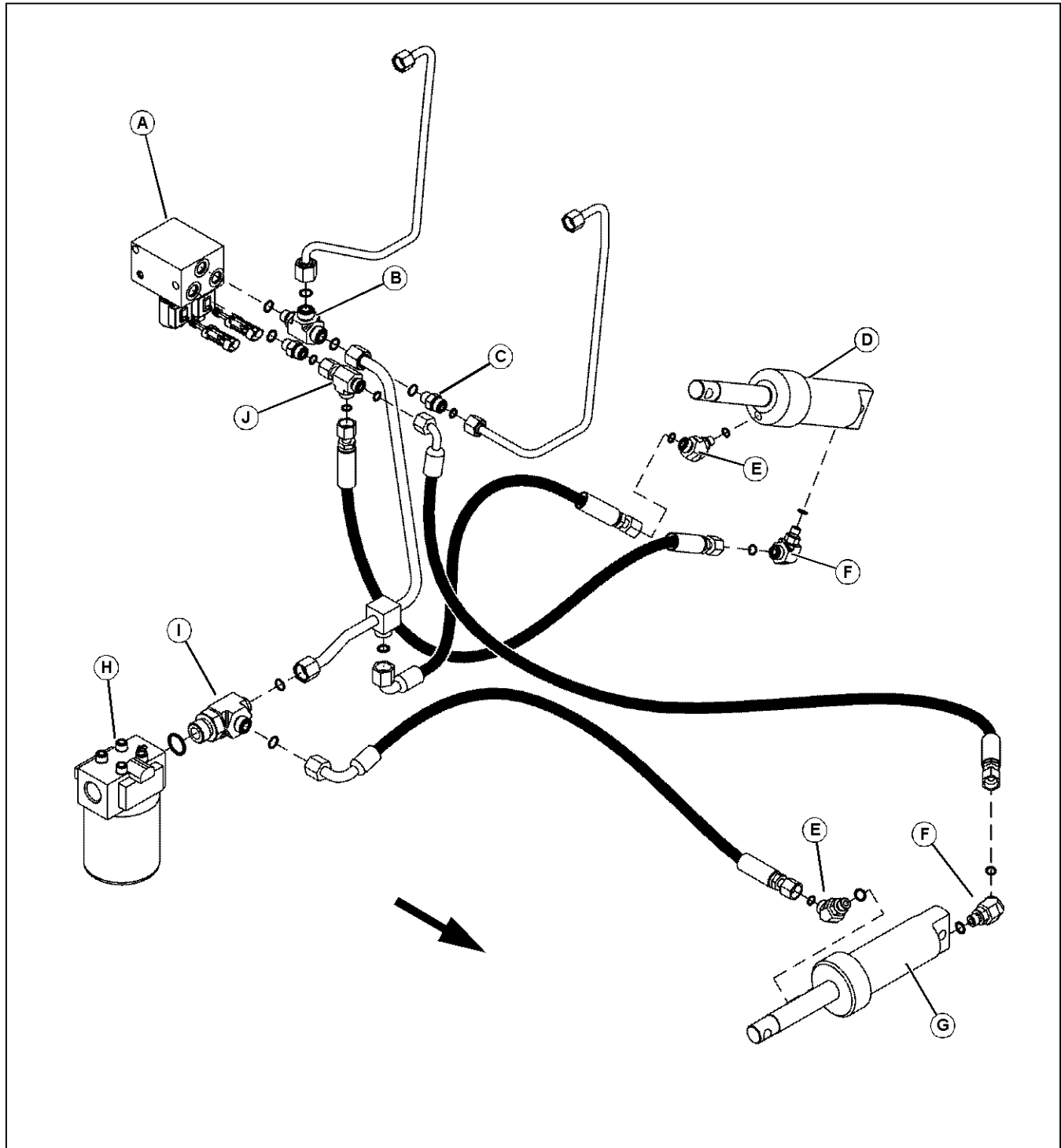
MX23319

- A- O-Ring
- B- Front Plate
- C- O-Ring, Formed
- D- Gasket, Formed
- E- Gasket, Formed
- F- Wear Plate
- G- Drive Gear
- H- Dowel
- I- Body
- J- Idler Gear
- K- Socket Head Cap Screw
- L- Socket Head Cap Screw
- M- Washer, Plain
- N- Washer, Plain

- O- End Plate
- P- Drive Gear
- Q- Idler Gear
- R- Coupler

HYDRAULICS COMPONENT LOCATION

Lift System Hydraulic



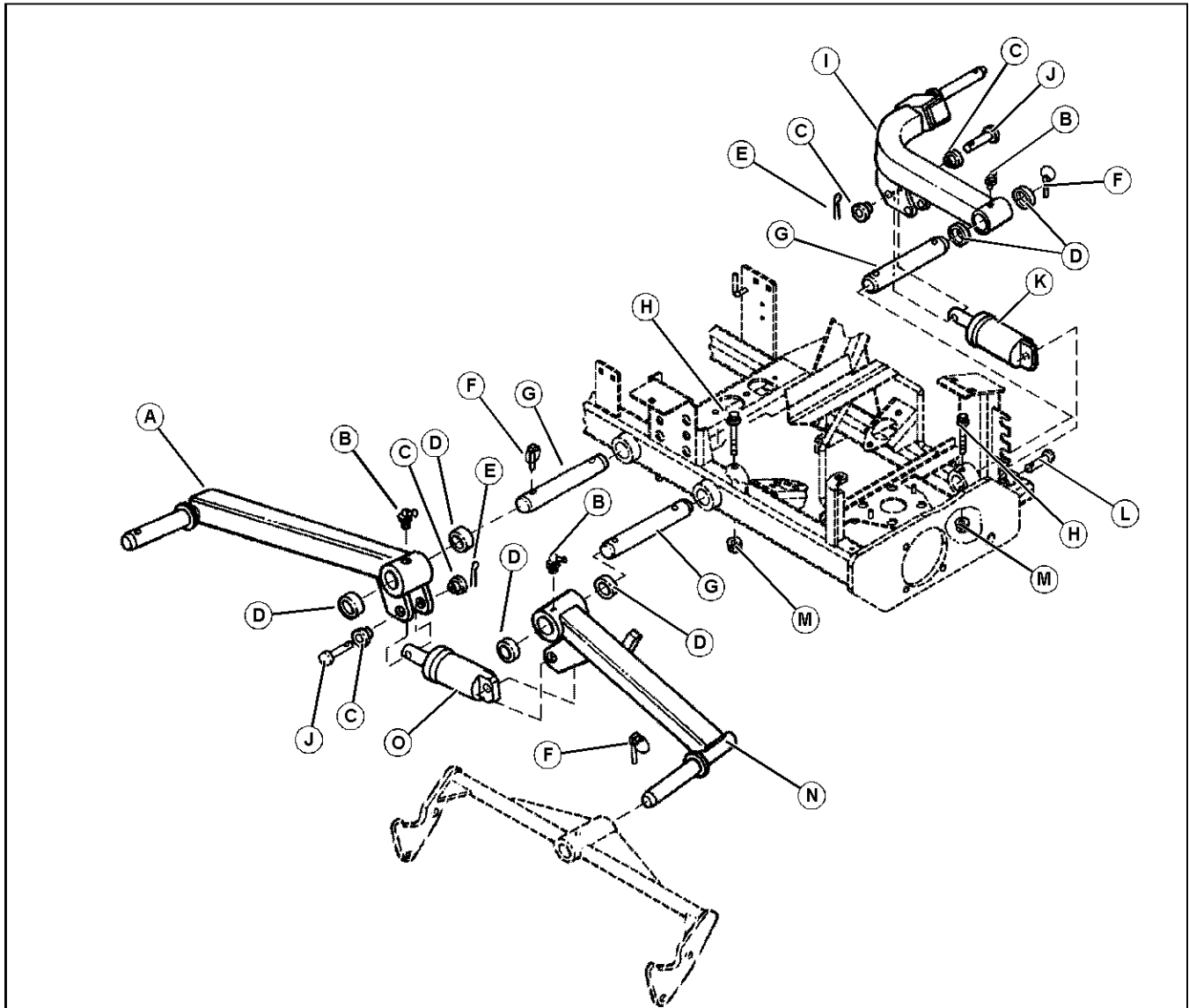
MX23340

- A- Hydraulic Lift Valve
- B- Adapter Fitting
- C- Adapter Fitting
- D- Rear Lift Cylinder
- E- 45° Elbow Fitting
- F- 90° Elbow Fitting
- G- Front Lift Cylinder

- H- Hydraulic Oil Filter and Manifold
- I- Tee Fitting
- J- Tee Fitting

HYDRAULICS COMPONENT LOCATION

Lift Arms and Cylinders - 26 Inch Reel

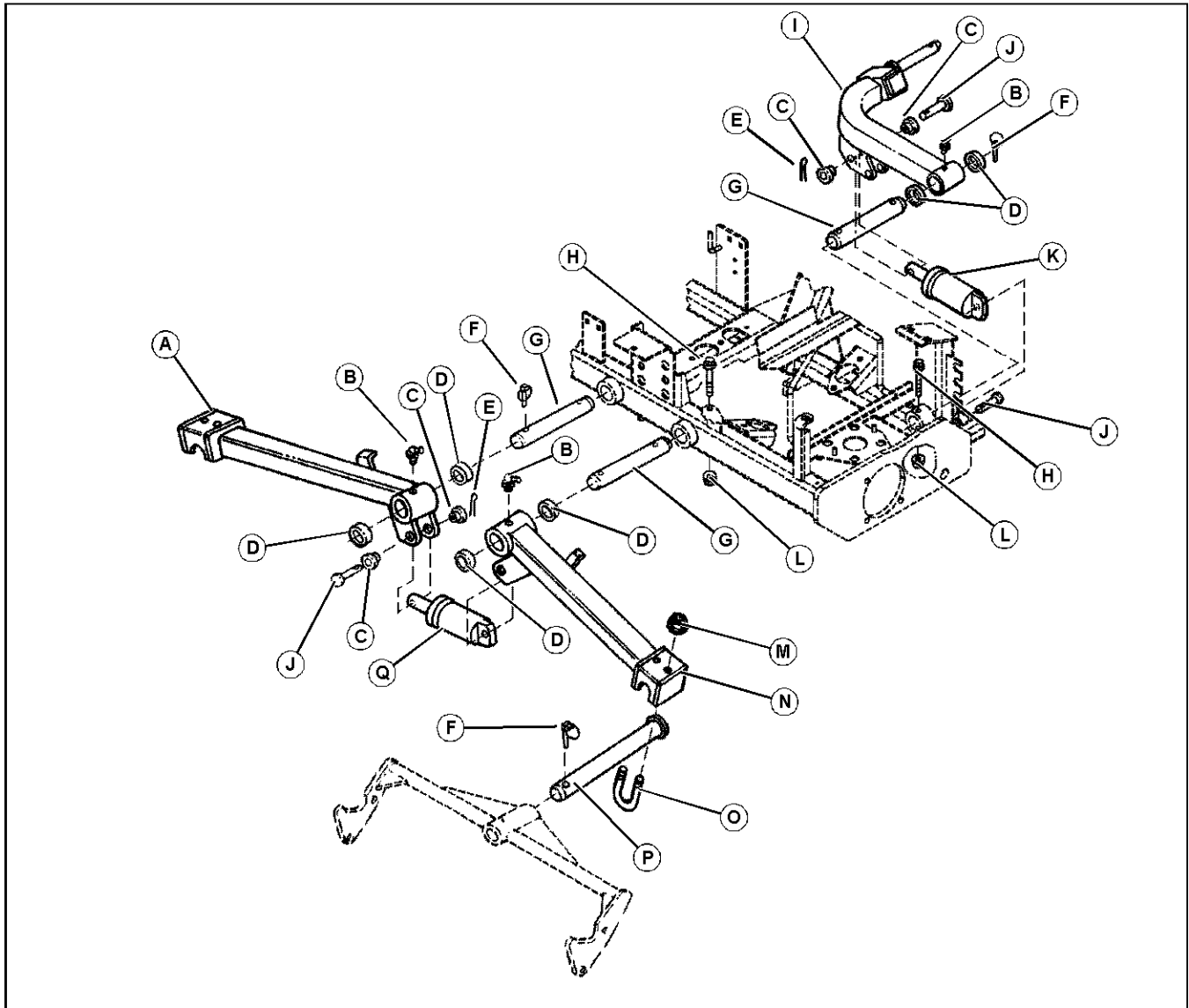


MX23389

- A- Front Right Lift Arm
- B- Grease Fitting
- C- Bushing, Flange
- D- Bushing, Lift Arm
- E- Cotter Pin
- F- Quick-Lock Pin
- G- Pin
- H- Cap Screw
- I- Rear Lift Arm
- J- Pin
- K- Rear Lift Cylinder
- L- Cap Screw
- M- Flange Nut
- N- Front Left Lift Arm
- O- Front Lift Cylinder

HYDRAULICS COMPONENT LOCATION

Lift Arms and Cylinders - 30 Inch Reel



MX23390

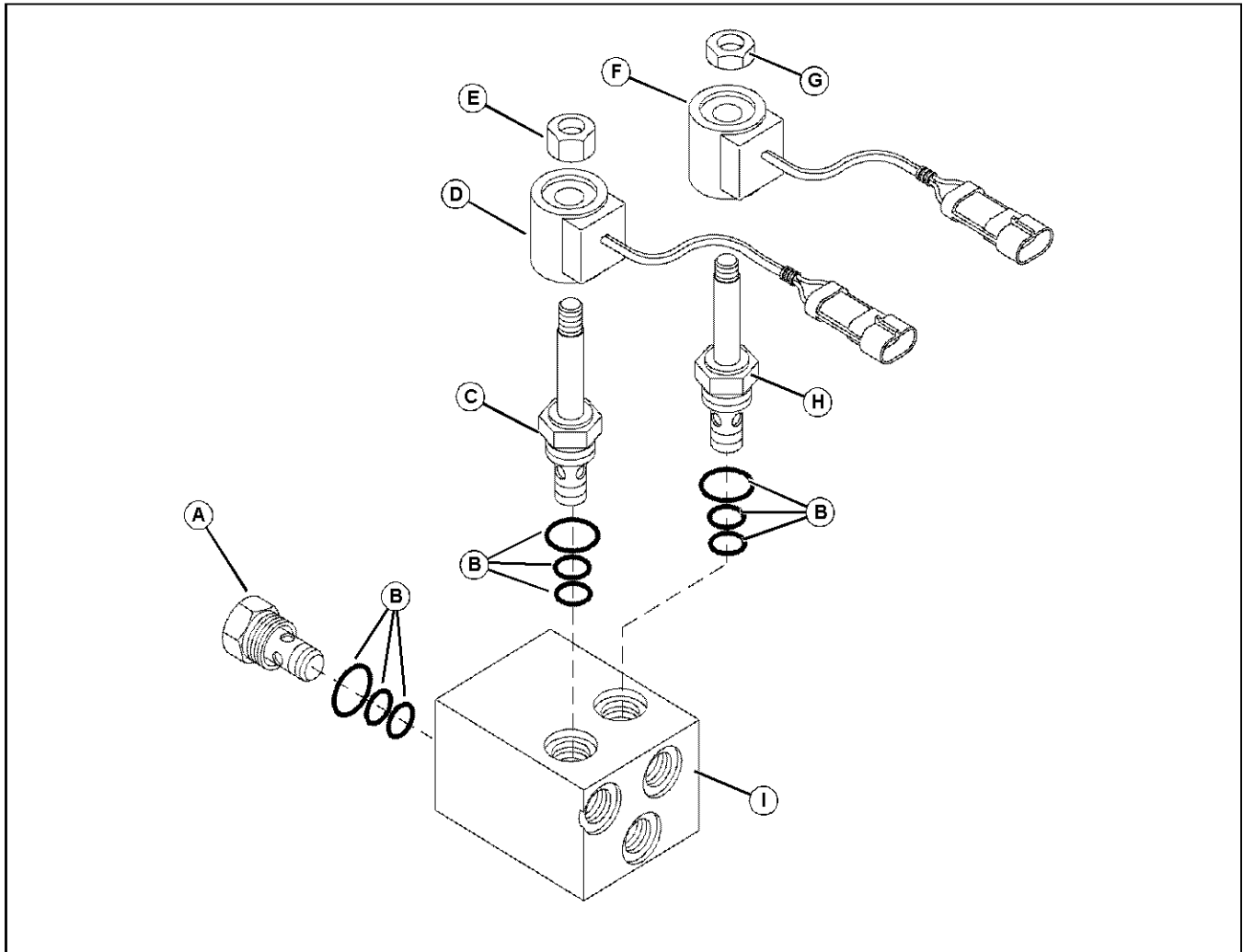
P- Pivot Arm

Q- Front Lift Cylinder

- A- Front Right Lift Arm
- B- Grease Fitting
- C- Bushing, Flange
- D- Bushing, Lift Arm
- E- Cotter Pin
- F- Quick-Lock Pin
- G- Pin
- H- Cap Screw
- I- Rear Lift Arm
- J- Pin
- K- Rear Lift Cylinder
- L- Flange Nut
- M- Flange Nut
- N- Front Left Lift Arm
- O- U-bolt

HYDRAULICS COMPONENT LOCATION

Lift Valve

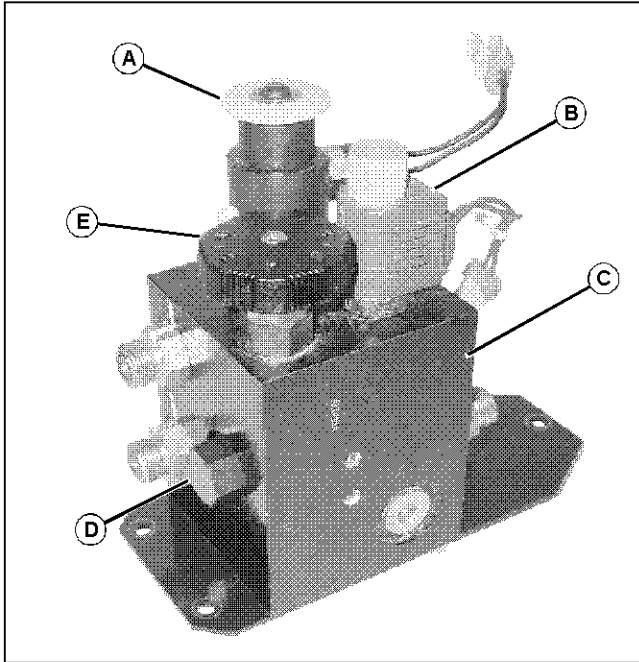


MX23341

- A- Check Valve
- B- Seal Kit
- C- Solenoid Valve
- D- Solenoid Coil
- E- Nut
- F- Solenoid Coil
- G- Nut
- H- Solenoid Valve
- I- Valve Body

HYDRAULICS COMPONENT LOCATION

Backlap Valve Assembly

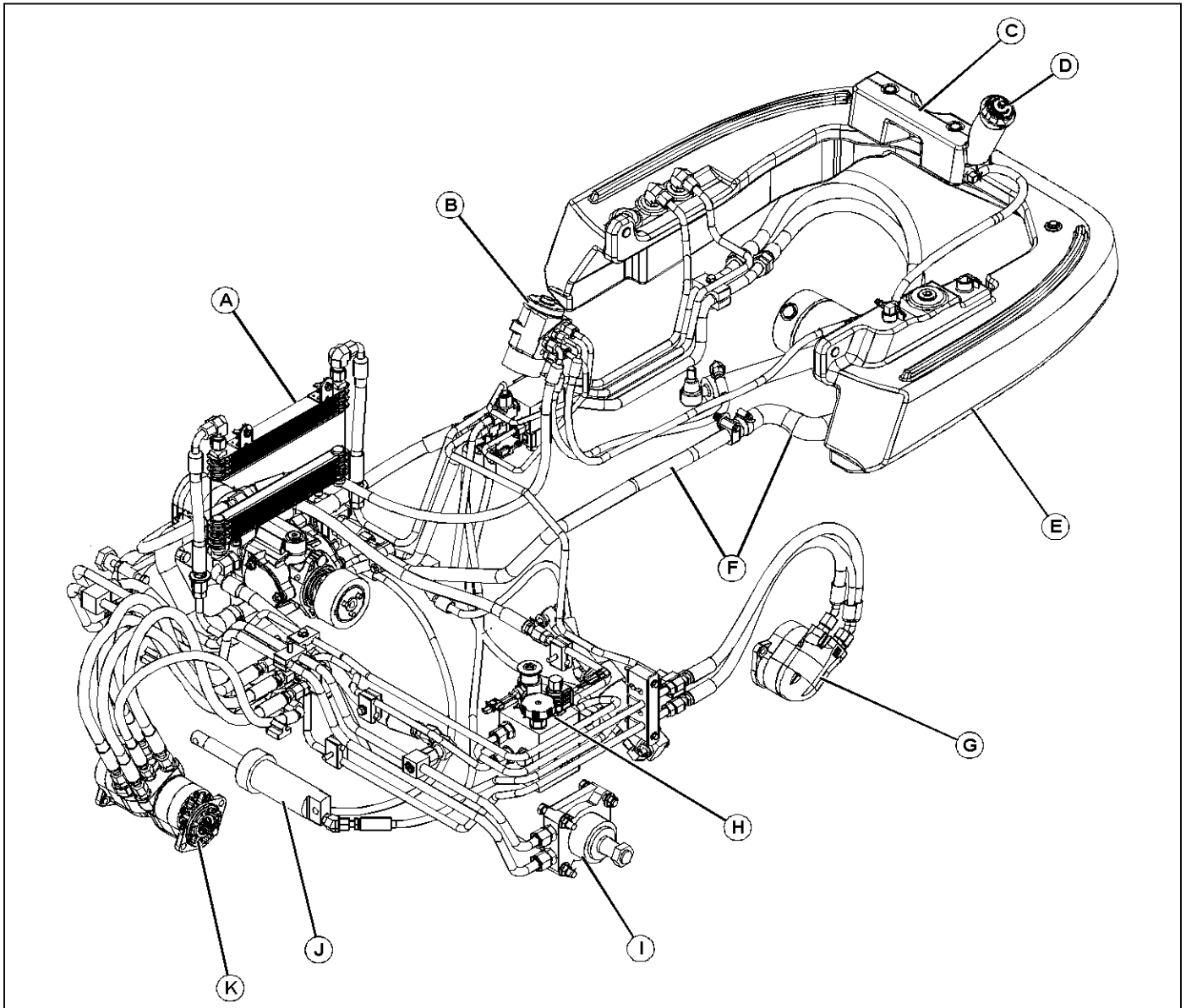


MX23454

- A- Forward-Reverse Valve
- B- Mow Valve Solenoid
- C- Valve Body
- D- Logic Element
- E- Flow Control Valve

HYDRAULICS COMPONENT LOCATION

Component Location (Sheet 1 of 2)

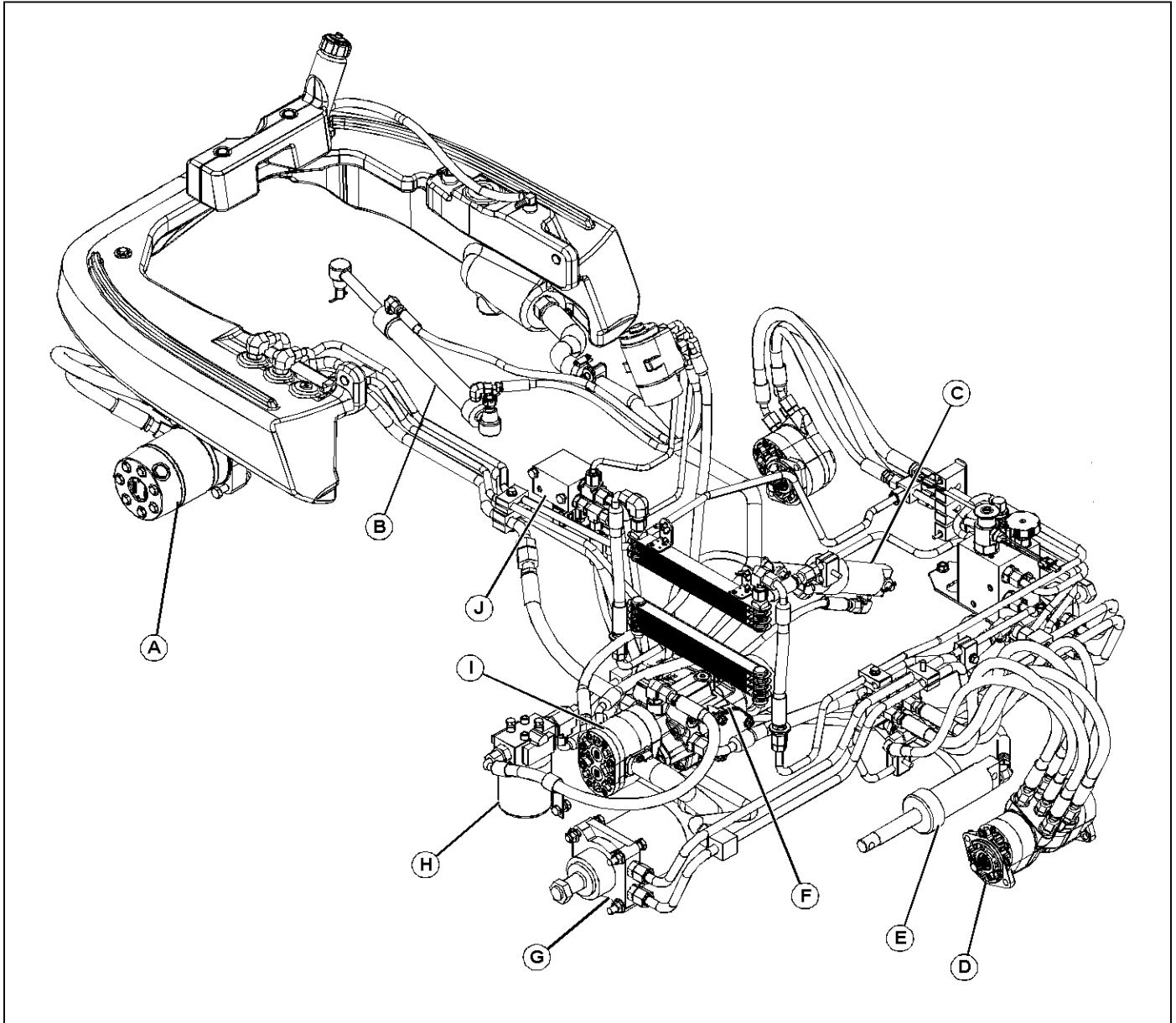


M76427

- A- Hydraulic Radiator
- B- Steering Control Unit
- C- Hydraulic Fill Tank
- D- Hydraulic Oil Filler Cap
- E- Hydraulic Tank
- F- Suction Line from Reservoir
- G- Rear/Center Reel Motor
- H- Backlap Valve Assembly
- I- Left Wheel Motor
- J- Front Lift Cylinder
- K- Front Left Reel Motor

HYDRAULICS COMPONENT LOCATION

Component Location (Sheet 2 of 2)



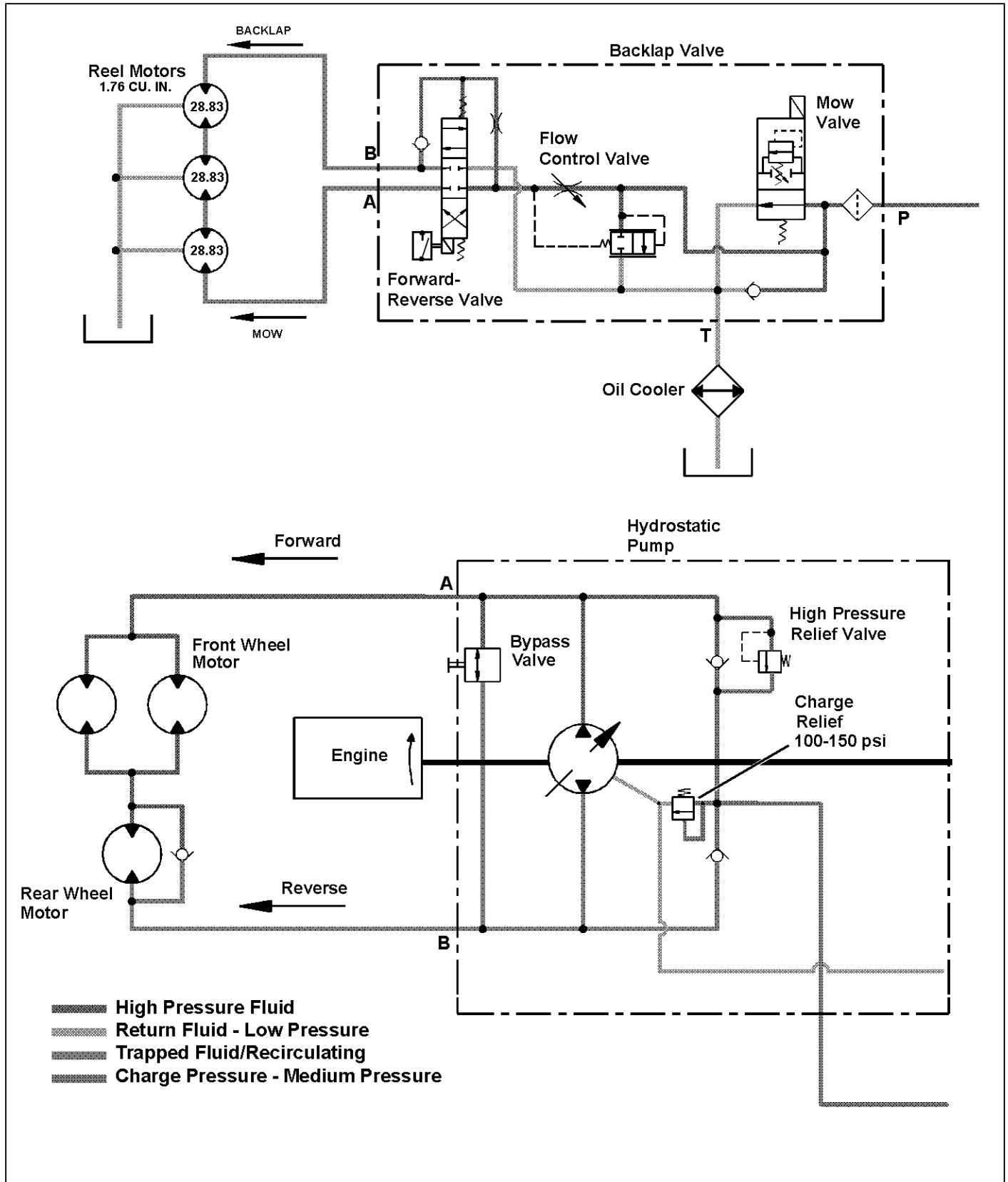
MX23523

- A- Rear Wheel Motor
- B- Steer Cylinder
- C- Rear Lift Cylinder
- D- Front Right Reel Motor
- E- Front Lift Cylinder
- F- Hydrostatic Pump
- G- Right Wheel Motor
- H- Hydraulic Oil Filter
- I- Double Pump
- J- Raise-Lower Valve

HYDRAULICS SCHEMATICS

Schematics

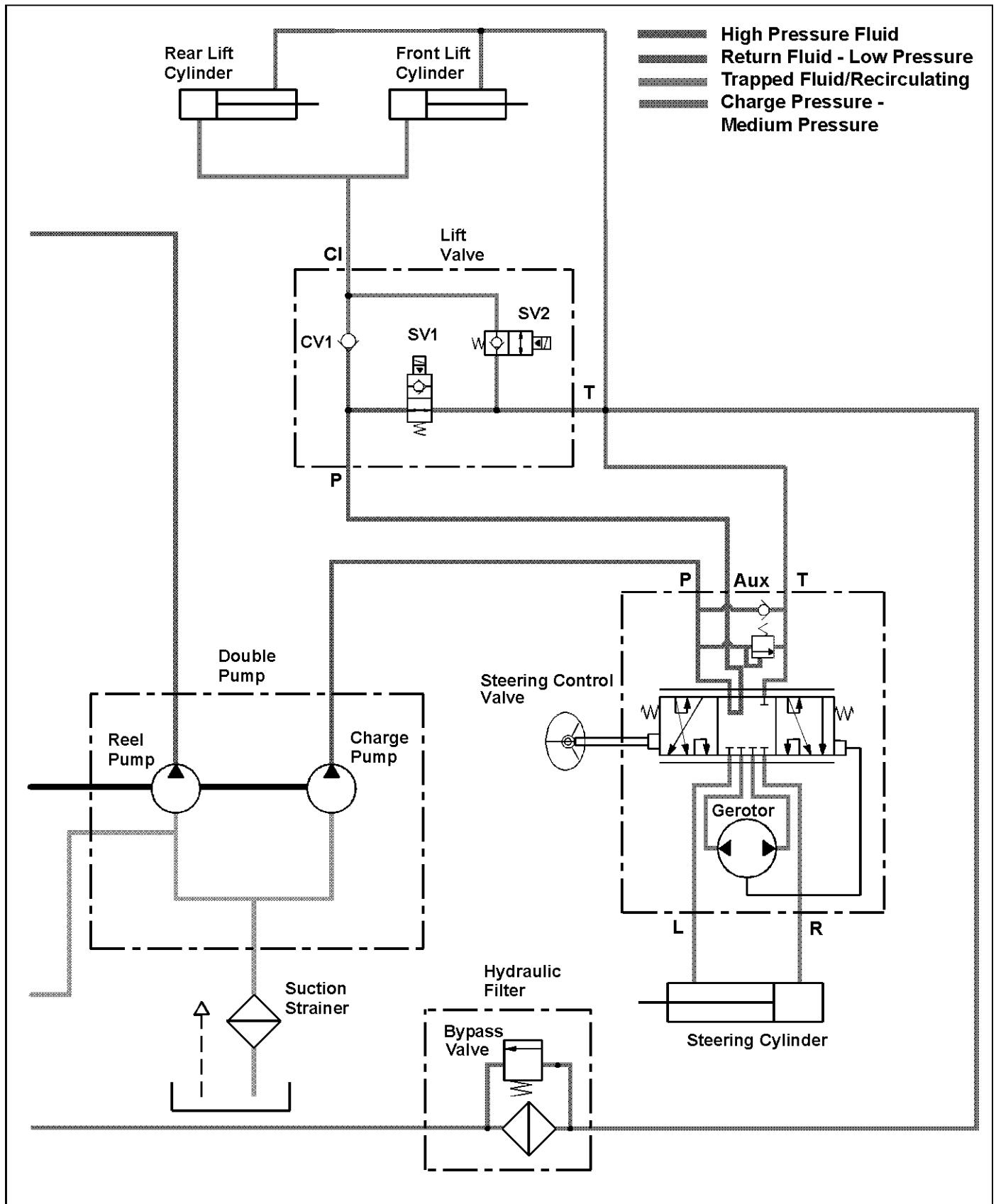
Hydraulic Schematic (1 of 2)



MX23349

HYDRAULICS SCHEMATICS

Hydraulic Schematic (2 of 2)



MX23350

HYDRAULICS THEORY OF OPERATION

Theory of Operation

Reel Drive System

System Function

Rotates the cutting reels for forward mowing and, if equipped, reverses for backlapping operations.

Reel Pump

The reel pumps are Danfoss Series CGP, positive-displacement gear pumps rated at 27.9 L/min (7.4 gpm). The pump is located between the hydrostatic transmission and the steering and lift system pump.

Mow Valve

The mow valve is a solenoid actuated, pressure limiting shuttle valve. It is used to control the flow to the reel motors. The mow valve is energized through the time delay control (TDC) module during mowing operations. It limits pressure in the reel drive circuit to 20 684 kPa (3000 psi). The mow valve is contained within the backlapping valve assembly.

Note: European models may not have a backlapping valve assembly installed. If not, the mow valve is located in a valve block.

Flow Control Valve

The flow control valve, located in the backlapping valve assembly, is a manually operated flow restrictor. It is used to control reel speed when backlapping or in normal mode. It is adjusted by rotating the knob clockwise to restrict and counterclockwise to increase flow.

Backlapping Valve

The backlapping valve, located in the backlapping valve assembly, is a manually operated, three-position, push-pull valve that changes fluid flow direction. The knob, when pushed in, directs the fluid flow to the motors for forward cutting. When pulled out, the cutting units will reverse direction for backlapping, and a switch is actuated to allow the mow valve solenoid to be energized with the operator off the seat and the mow-transport lever in the mow position.

Shut-Off Valve

The shut-off valve, installed in-line prior to the first reel motor, is a solenoid operated shut-off valve used to stop the flow of hydraulic fluid to the cutting units and prevent "reel creep." An off delay timer provides a one-second delay before closing the shut-off valve. This delay allows the reels to slow down before shutting off hydraulic fluid flow to prevent the reel motors from cavitating.

Theory

When the mow solenoid is energized, the pressure limiting part of the mow valve shifts to limit pressure in the mow circuit to a maximum of 20 684 kPa (3000 psi) at a maximum flow rate of 27.9 L/min (7.4 gpm).

Pressure and flow are now routed to the flow control valve and logic element. The flow control valve determines the rpm of the reels. Pressure in the reel circuit will vary according to the amount of resistance that the cutting units are generating.

The logic element, a pilot-operated dump valve, compares pressure at the inlet and outlet ports of the flow control valve. As the flow is restricted, pressure builds on the input side of the flow control valve to a value higher than that on the output side. This forces the logic element to open and dump excess flow to the tank. As flow returns to the reservoir, pressure to the input side of the flow control valve drops and the logic element closes. The logic element will continue this cycle as needed to equalize pressure on both sides of the flow control valve.

After leaving the flow control valve, fluid enters the forward-reverse valve, where it is directed to the forward or reverse side of the reel motors. The forward-reverse valve is equipped with a detent to hold the valve in the forward position.

A soft start feature is used in the mow valve to prevent damage to the cutting units from full pressure start-ups.

After leaving the backlapping valve, flow is directed to the forward or reverse side of the reel motors. The reel motors are connected in series beginning with the left front, the center, and then finally the right front reel motor.

HYDRAULICS THEORY OF OPERATION

Lift System

Function

Provides a means to raise or lower the cutting units for three operating modes:

- Transport
- Mowing
- Service and Backlapping

Charge Pump

The charge pump is a Danfoss model CGP direct drive, positive-displacement gear pump capable of displacing 13.2 L/min (3.5 gpm) @ 6895 kPa (1000 psi) and it is the forward pump of the double pump assembly. The charge pump operates in an “open center series” type hydraulic system consisting of the steering, raise, and hydrostatic drive systems. Each system has a controlling valve with an open center that allows fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit (lift).

Lift Valve

The lift valve consists of two solenoid controlled spool valves that are controlled by output signals from the interlock module. These output signals are dependant on input signals sent from the raise-lower lever. Solenoid valve 1 or SV1 is the lift valve solenoid. Solenoid valve 2 or SV2 is the lower valve solenoid. Both solenoid valves contain internal check valves. Both solenoid valves are spring loaded to allow the spool valve to shift when the solenoids are de-energized. The lift valve contains one check valve that is not part of either solenoid valve. This is check valve 1 or CV1.

Lift System Theory

The lift system receives pressure from the charge pump through the steering valve and enters the lift valve at port “P”. The steering valve will take first priority, and limited pressure will be available to the lift system during steering operations.

When the raise-lower lever is momentarily placed in the lift position, the interlock module grounds the coil in SV1 for several seconds. The coil in SV1 energizes and shifts the spool valve. Charge pressure seats the check valve in SV1 and closes the charge pressure’s path to reservoir via port “T” and the hydraulic oil filter. Charge pressure opens CV1 and flows to seat the check valve in SV2. Charge pressure is then forced out of the lift valve via port “CL” into the piston side of the front and rear lift cylinders. The cylinders extend, raising the lift arms and cutting units off the ground.

Oil on the low-pressure side of the lift cylinders is routed through the hydraulic oil filter and then to the hydrostatic

pump. This oil is “make-up” or “charge” oil if the pressure on the low-pressure side of the hydrostatic pump drops.

When the interlock module times out and de-energizes the coil in SV1, the spool valve shifts via spring pressure and once again charge pressure is free to flow to reservoir via port “T” on the lift valve and the hydraulic oil filter. CV1 seats and the check valve in SV2 remains seated, trapping oil on the piston side of the lift cylinders. The lift arms and cutting units remain in the raised position.

When the raise-lower lever is momentarily placed in the lower position, the interlock module grounds the coil in SV2. The coil in SV2 energizes and shifts the spool valve. Trapped oil in the lift cylinders flows to the low-pressure side of the system via port “T” on the lift valve. As the pressure is relieved, the lift cylinders retract and low-pressure oil fills the rod side of the lift cylinders to prevent cavitation. After several seconds, the interlock module times out and de-energizes the coil in SV2. The spool valve then shifts back via spring pressure.

Diagnostics

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

System: Reel Drive Diagnosis

One Reel Turns Slowly

1. Is reel-to-bed knife clearance adjusted properly?

Yes: Go to next step.

No: Adjust reel-to-bed knife clearance to specification. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

2. Are cutting unit bearings in good condition?

Yes: Go to next step.

No: Replace cutting unit bearings.

3. Is reel drive motor operating properly?

No: (See "Test Reel Motor Case Drain" on page 307.)

All Reels in One System Are Turning Slowly

1. Is system relief valve operating properly?

Yes: Go to next step.

No: Perform mow valve pressure relief test. (See "Test Mow Valve Relief Pressure" on page 301.)

2. Is first reel motor in series operating properly?

Yes: Go to next step.

No: (See "Test Reel Motor Case Drain" on page 307.)

3. Is first cutting unit in series operating properly?

Yes: Go to next step.

No: Check cutting reel for binding. Adjust or replace worn or damaged parts. See Attachments section for disassembly and inspection procedures.

4. Is reel drive pump operating properly?

Yes: Go to next step.

No: Check pump for wear. (See "Test Reel Pump Flow" on page 302.)

5. Is flow control valve open fully?

Yes: Go to next step.

No: Move flow control valve to the fully open position.

6. Is mow solenoid operating properly?

Yes: Go to next step.

No: Check if solenoid is energized.

No: Check if solenoid is stuck open.

7. Is backlapping valve in the down position?

No: Place backlapping valve in the down position.

Second and Third Reels Turn Slowly

1. Is middle cutting unit reel-to-bed knife clearance adjusted properly?

Yes: Go to next step.

No: Adjust reel-to-bed knife clearance to specification. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

2. Are middle cutting unit bearings operating properly?

No: Replace cutting unit bearings.

One Cutting Unit Is Not Turning

1. Is reel-to-bed knife clearance adjusted properly?

Yes: Go to next step.

No: Adjust reel-to-bed knife clearance to specification. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

2. Are cutting unit bearings in good working condition?

Yes: Go to next step.

No: Replace cutting unit bearings.

3. Is reel drive motor operating properly?

Yes: Go to next step.

No: (See "Test Reel Motor Case Drain" on page 307.)

4. Is coupler between motor and cutting unit in place and in good condition?

No: Repair or replace as necessary.

One System Will Not Backlap

1. Check if solenoid valve is stuck open.

Yes: Go to next step.

No: Check if solenoid valve is stuck open.

2. Is flow control valve fully open?

Yes: Go to next step.

No: Move control valve to fully open position.

3. Is backlapping valve in the up position?

No: Place backlapping valve in the up position.

Pump Noisy

1. Is hydraulic oil reservoir at proper level?

Yes: Go to next step.

No: Fill reservoir to proper level with recommended oil.

2. Is reel drive pump operating properly?

HYDRAULICS DIAGNOSTICS

Yes: Go to next step.

No: Check pump for wear. (See “Test Reel Pump Flow” on page 302.)

System: Lift System Troubleshooting

Front and Rear Lift Arms Will Not Lower

1. Is lift valve operating properly?

No: Repair or replace lift valve as required.

Front and Rear Lift Arms Will Not Rise

1. Is engine speed to specification?

Yes: Go to next step.

No: Perform fast idle adjustment.

2. Is steering system leakage within specification?

Yes: Go to next step.

No: Perform steering system leakage test. (See “Test System Leakage” on page 334.)

3. Is lift system free of air?

Yes: Go to next step.

No: Start engine and cycle lift arms to purge air from system.

4. Are lift system hydraulic fittings tight and free from leaks?

Yes: Go to next step.

No: Tighten fittings and replace O-rings as needed.

5. Is lift valve operating properly?

No: Repair or replace as needed.

Front and Rear Lift Arms Will Not Stay in Raised Position

1. Are lift system hydraulic fittings tight and free from leaks?

Yes: Go to next step.

No: Tighten fittings and replace O-rings as needed.

2. Is lift valve operating properly?

No: Repair or replace lift valve as needed.

Rear Lift Arm Will Not Rise

1. Is engine speed to specification?

Yes: Go to next step.

No: Perform fast idle adjustment.

2. Is lift system free of air?

Yes: Go to next step.

No: Start engine and cycle lift arms to purge air from system.

3. Are lift system hydraulic fittings tight and free from leaks?

Yes: Go to next step.

HYDRAULICS DIAGNOSTICS

No: Tighten fittings and replace O-rings as needed.

4. Is steering system leakage within specification?

Yes: Go to next step.

No: Perform steering system leakage test. (See “Test System Leakage” on page 334.)

5. Is rear lift cylinder hydraulic line free from obstructions?

Yes: Go to next step.

No: Repair or replace line as needed.

6. Is lost motion linkage on rear lift cylinder operating properly?

No: (See “Remove and Install Lift Cylinder” on page 323.)

Rear Lift Arm Will Not Lower

1. Is rear lift cylinder hydraulic line free from obstructions?

Yes: Go to next step.

No: Repair or replace line as needed.

2. Is lost motion linkage on rear lift cylinder operating properly?

No: (See “Remove and Install Lift Cylinder” on page 323.)

Rear Lift Arm Rises Too High

1. Is rear lift arm stop in the down position?

No: Move stop to the down position.

HYDRAULICS TESTS AND ADJUSTMENTS

Tests and Adjustments

Test Mow Valve Relief Pressure

Reason

To ensure that the mow valve relief valve is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
T-Fitting	61H1031	Used to connect pressure gauge for mow valve pressure test.
Male Quick Connect	RE43774	Used to connect pressure gauge to mow valve.
Pressure Gauge Kit 0-40 000 kPa (0-6000 psi)	JDG2033	Used to measure mow valve relief pressure.

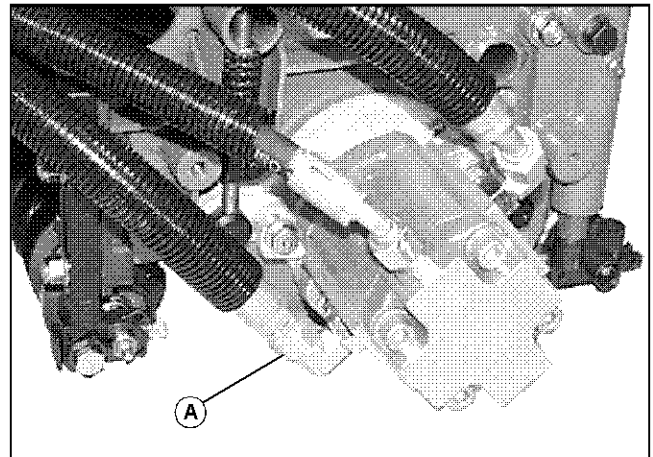
Procedure

Note: Test is performed by measuring system pressure at test fitting installed at left front reel motor.

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Move mow-transport lever to the transport position.
4. Lock park brake.
5. Turn key to stop position.
6. Block front and rear of all wheels on machine.
7. Check level of hydraulic oil. Fill as needed.

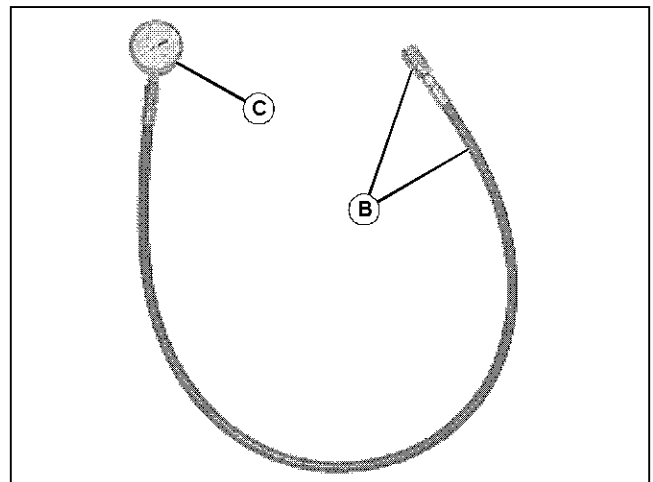


Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.



MX41547

8. Disconnect front hydraulic line (A) from left front reel motor. Install 61H1031 T-Fitting and RE43774 Male Quick Connect between reel motor and hydraulic hose.



M98645

9. Using JDG2033 Pressure Gauge Kit, assemble appropriate hose and fitting (B) to pressure gauge (C).
10. Connect gauge and hose assembly to male quick connect.
11. With cutting units lowered to the ground, block all three reels with wooden blocks to prevent reels from rotating.

HYDRAULICS TESTS AND ADJUSTMENTS



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

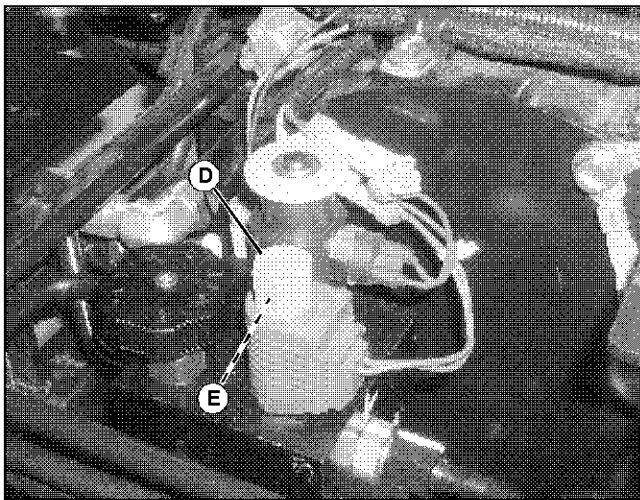
- Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.
- Allow fresh outside air into the work area to clear the exhaust fumes out.

Note: Operator must be on seat with travel pedals in neutral position. Block wheels to prevent sudden movement of machine.

12. Start engine and run at fast idle.
13. Unlock park brake.
14. Move mow-transport lever to the mow position.
15. Momentarily place the raise-lower lever in the lower position to engage the reels.
16. Note reading on gauge.

Results

- Reading on gauge should be to specification. If reading is not to specification perform following steps.
- Raise hood.



MX24391

- Remove solenoid retaining nut (D).
- Adjust relief valve by turning socket head screw (E) to the right (clockwise) to increase pressure or to the left (counterclockwise) to decrease pressure.

Specifications

Mow Valve Relief Valve Pressure . . . $20\,684 \pm 1034$ kPa
(3000 ± 150 psi)

Test Reel Pump Flow

Reason

To determine if reel pump is worn by testing hydraulic flow at reel motors.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flowmeter Kit	JDG2034	Used to measure oil flow out of reel pump.
Diagnostic Hose and Fitting Kit	JDG2032	Used to install flowmeter.

Procedure

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



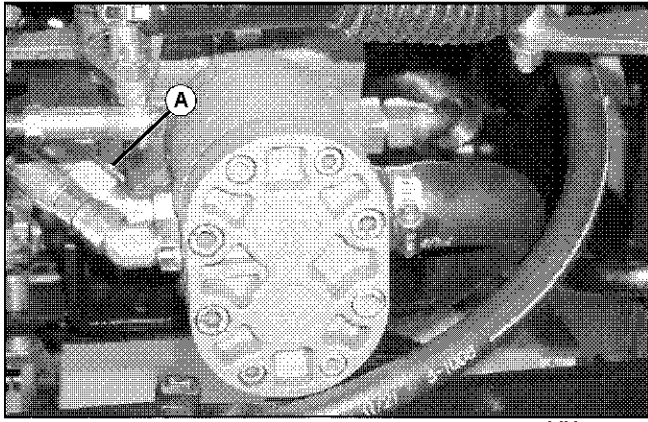
Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

5. Lower cutting units to the ground.
6. Turn key switch to the STOP position.
7. Block wheels to prevent inadvertent movement of the machine.
8. Check and top off hydraulic reservoir.



Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

HYDRAULICS TESTS AND ADJUSTMENTS



MX23414

9. Place drain pan under reel pump. Clean hydraulic hose fittings and disconnect reel pump output hose (A).
10. Connect hose from inlet side of flow gauge to reel pump using connectors from JDG2032 Diagnostic Hose and Fitting Kit.
11. Connect hose from outlet side of flow gauge to reel pump outlet hose using connectors from JDG2032 Diagnostic Hose and Fitting Kit.
12. Set front backlapping valve to forward (mow) position.

Important: Avoid Damage! Flowmeter valve MUST be open before starting engine; otherwise damage to hydraulic components may result.

13. Open flowmeter valve fully (counterclockwise).



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- **Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.**
- **Allow fresh outside air into the work area to clear the exhaust fumes out.**

14. Start machine and run at fast idle. Use JT05719 tachometer to verify RPM.
15. Slowly turn tester control knob in (clockwise) and note flow at specified load.
16. Turn out control knob and stop engine.

Results

If reel pump flow is not within specifications, replace or

rebuild pump as necessary.

Important: Avoid Damage! After completing test top off hydraulic reservoir.

Specifications

Hydraulic Tester Load 20 684 kPa (3000 psi)
Pump Flow @ 20 684 (3000 psi) Load
(Minimum) 22.7 L/min (6.0 gpm)
Fast Idle 3150 ± 50 rpm

Test Lift System Relief Valve Pressure

Reason

To determine if the charge pump is producing enough pressure to operate lift system.

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose 34474 kPa (5000 psi)	JT03017	Used to attach pressure gauge.
T-Fitting, 9/16-16 F ORFS x 9/16-16 M ORFS x 9/16-16 M ORFS	AMT1043	Connect pressure gauge for steering and lift system relief valve pressure test.
Pressure Gauge 0-40 000 kPa (0-6000 psi)	JT07047	Connect pressure gauge for steering and lift system relief valve pressure test.
Male Quick Coupler, 11/16-16 F ORFS	RE43774	Connect pressure gauge for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gauge for steering and lift system relief valve pressure test.
Hand Held Digital Tachometer	JT05719	Used to verify proper RPM setting.

Procedure

Test is performed by reading system pressure between rear section of double pump and steering valve.

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.

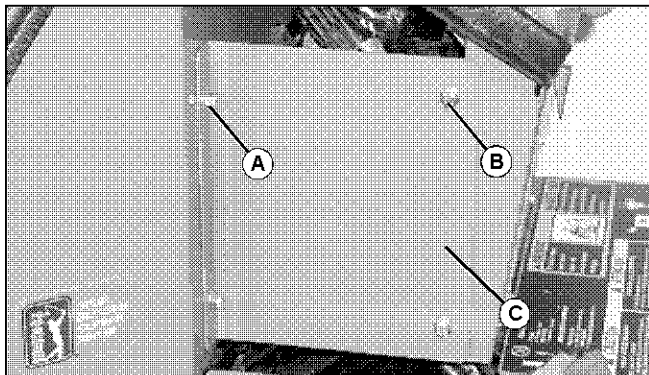
HYDRAULICS TESTS AND ADJUSTMENTS

4. Turn key switch to stop position.
5. Lock park brake.



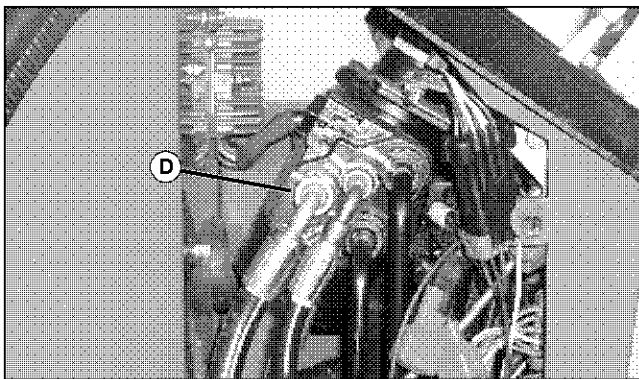
Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.



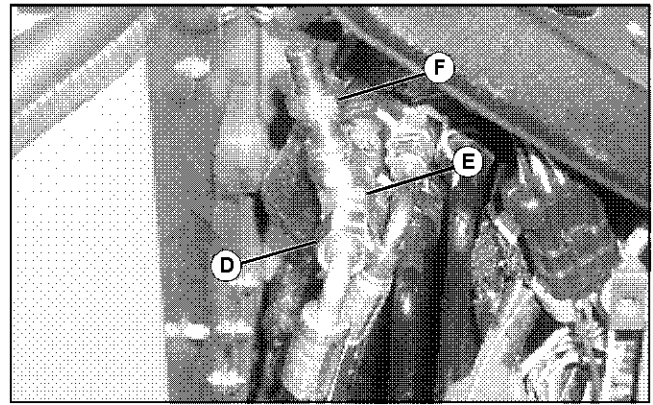
MX23256

6. Remove two flange nuts (A), two cap screws (B), and access panel (C).



MX23257

7. Disconnect charge pump hose fitting (D) on forward port as shown.



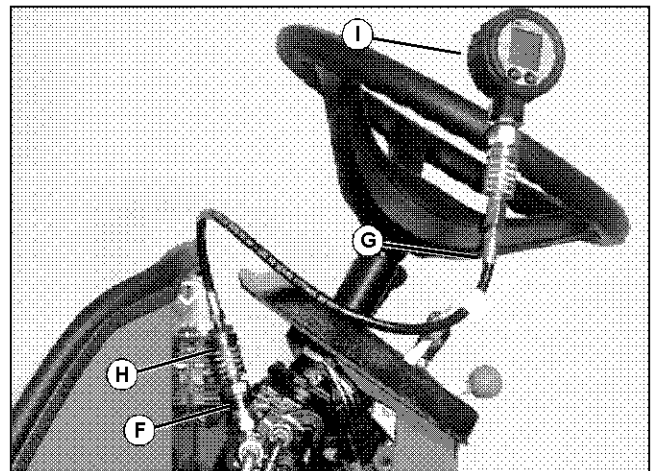
MX23258

8. Install AMT1043 T-Fitting (E) and RE43774 Male Quick Coupler (F).

9. Connect charge pump hose (D) to AMT1043 T-Fitting.



Caution: Avoid Injury! Do not use a test pressure gauge rated lower than recommend. Do not move steering wheel or raise-lower lever while test is in progress.



MX23259

10. Assemble JT03017 Hose (G), RE48122 Female Quick Coupler (H) and JT07047 Gauge (I). Connect to RE43774 Male Quick Coupler (F).

HYDRAULICS TESTS AND ADJUSTMENTS



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.
- Allow fresh outside air into the work area to clear the exhaust fumes out.

11. Start engine and run at fast idle. Use JT05719 tachometer to verify RPM.

Important: Avoid Damage! DO NOT turn steering wheel or operate lift system while performing this test. Doing so will result in readings above the pressure setting because of system back pressure.

12. Note reading on gauge.

Results

- If charge pump does not meet specifications, rebuild or replace charge pump.
- Bleed air from hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Specifications

Lift System Relief

Valve Pressure 9997 kPa (1450 psi)

Fast Idle 3150 ± 50 rpm

Test Charge Pump Flow

Reason

To determine if lift/steering circuit (charge) pump is worn by testing hydraulic flow at pump.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flowmeter Kit	JDG2034	Used to measure charge pump flow rate.
Diagnostic Hose and Fitting Kit	JDG2032	Used to connect flowmeter to charge pump.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hand Held Digital Tachometer	JT05719	Used to verify proper RPM setting.

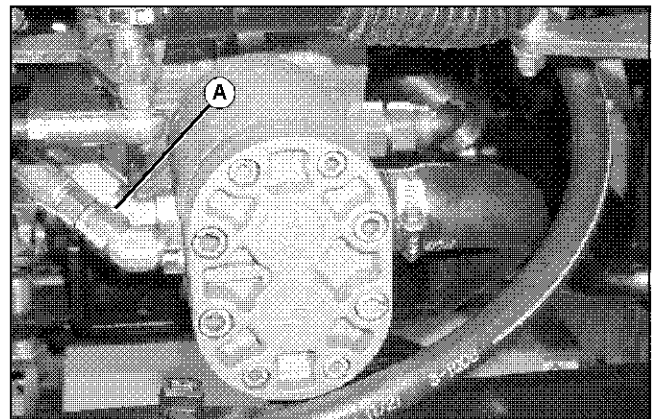
Procedure

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

5. Lower cutting units to the ground.
6. Turn key switch to the stop position.
7. Block wheels to prevent inadvertent movement of the machine.
8. Place a drain pan under the charge pump to capture escaping fluid.



MX23414

9. Clean and disconnect output hose fitting (A) from charge pump.
10. Connect hose from inlet side of flow gauge to charge pump using connectors from JDG2032 Diagnostic Hose and Fitting Kit.
11. Connect hose from outlet side of flow gauge to steering supply hose using connectors from JDG2032 Diagnostic Hose and Fitting Kit.

HYDRAULICS TESTS AND ADJUSTMENTS

Important: Avoid Damage! Flowmeter valve MUST be open before starting engine; otherwise damage to hydraulic components may result.

12. Open flowmeter valve fully (counterclockwise).



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- **Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.**
- **Allow fresh outside air into the work area to clear the exhaust fumes out.**

13. Start engine and set throttle to fast idle. Use JT05719 tachometer to verify RPM.

14. Slowly turn tester control knob clockwise until pressure reading is 6895 kPa (1000 psi).

15. Record flow reading.

Results

Flow must meet minimum specification. If flow is not within specification, repair or replace pump as necessary. (See "Disassemble Double Pump" on page 310. See "Assemble Double Pump" on page 312.)

Specifications

Fast Idle.....3150 ± 50 rpm

**Minimum Flow at 6895 kPa (1000 psi)
..... 13.2 L/min (3.5 gpm)**

Test Lift System Leakage

Reason

To determine cause of lift arm drift.

Procedure

1. Park machine on a level surface.
2. Lock the park brake.



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- **Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.**
- **Allow fresh outside air into the work area to clear the exhaust fumes out.**

3. Start the engine.
4. Raise lift arms.
5. Stop engine.
6. Support lift arms with a block or hoist.
7. Remove hose from rod end of cylinder. Close end of hose and cylinder fitting using caps or plugs.
8. Remove block or hoist from lift arms.
9. If within 5 minutes any of the lift arms drift down, replace the corresponding lift cylinder.

If no lift arms drift down

1. Connect cylinder hose and lower lift arms to the ground.
2. Remove CV1 check valve and SV2 solenoid cartridge from lift valve.
3. Clean and inspect both and install in lift valve.
4. Raise lift arms and check for drift.
5. If lift arms continue to drift, replace CV1 check valve.
6. Raise lift arms and check for drift.
7. If lift arms continue to drift, replace SV2 solenoid cartridge.

HYDRAULICS TESTS AND ADJUSTMENTS

Test Reel Motor Case Drain

Reason

To test the reel motor bypass to case drain. As the motor gears wear, more fluid is bypassed to the hydraulic reservoir.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to test hydraulic motor.
120 in. Hydraulic Test Hoses (2)	JT03377	Used to connect hydraulic tester to motor.
Connector 3/4 in. F NPT x 1-1/16 in. F 37° (2)	JT03012	Used to connect hydraulic tester to motor.
Connector 1-1/16 in. M 37° x 13/16 in. F ORFS	JT05688	Used to connect hydraulic tester to motor.
Connector 1-1/16 in. M 37° x 1-3/16 in. M ORFS	JT03483	Used to connect hydraulic tester to motor.
Connector 1-3/16 in. F ORFS x 13/16 in. M ORFS	JT03484	Used to connect hydraulic tester to motor.
Plug, 13/16 in. M ORFS	JT03392	Used to plug port on reel motor.
1/2 in. ID hose 24 in. long	N/A	Used to measure reel motor case drain.
Hand Held Digital Tachometer	JT05719	Used to verify proper RPM setting.

Procedure



Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

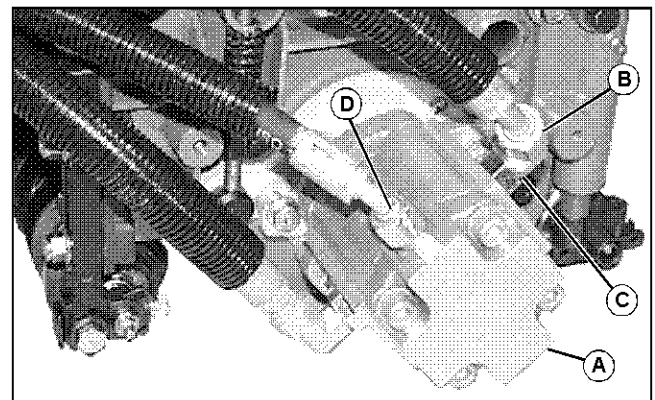
1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.

4. Stop engine.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

5. Lower cutting units to the ground.
6. Turn key switch to the stop position.
7. Block wheels to prevent inadvertent movement of the machine.
8. Check and top off hydraulic reservoir.



MX41547

9. Place drain pan under reel motor (A) to be tested. Clean hydraulic hose fittings and remove return hose (B) from fitting (C) on motor.
10. Connect JT03377 Hose to motor using JT03012 and JT05688 Connectors. Connect another JT03377 Hose to hose from backlap valve using JT03012, JT03483, and JT03484 Connectors.
11. Connect JT03377 Hose connected to return hose (B) into inlet port of D01074AA In-Line Hydraulic Tester. Install hose from reel motor (A) into outlet port.
12. Remove case drain hose (D) from motor. Close hose with JT03392 Plug.
13. Place a 1/2 in. ID hose on center port fitting of reel motor and place other end into a clean container.
14. Turn tester control knob out (counterclockwise) completely.
15. Set backlapping valve to forward (mow) position (knob pushed in).

HYDRAULICS TESTS AND ADJUSTMENTS



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.
- Allow fresh outside air into the work area to clear the exhaust fumes out.

16. Have an assistant start machine, run at fast idle and engage reels. Use JT05719 tachometer to verify RPM.

17. Turn tester control knob in (clockwise) until pressure reaches 17 236 kPa (2500 psi). Hold for 15 seconds.

18. Turn control knob out (counterclockwise) to a non-restrictive setting and stop engine.

19. Measure amount of oil in the container.

20. Multiply volume of oil in the container by 4 to arrive at amount of case drain in one minute.

Results

Important: Avoid Damage! After completing test, top off hydraulic reservoir.

Reel motor case drain should not exceed 3.78 L/m (1 gpm). If case drain exceeds specifications, rebuild or replace motors.

Specifications

Reel Motor Case Drain @ 17 236 kPa (2500 psi)
(Maximum)..... 3.78 L/m (1 gpm)
Fast Idle..... 3150 ± 50 rpm

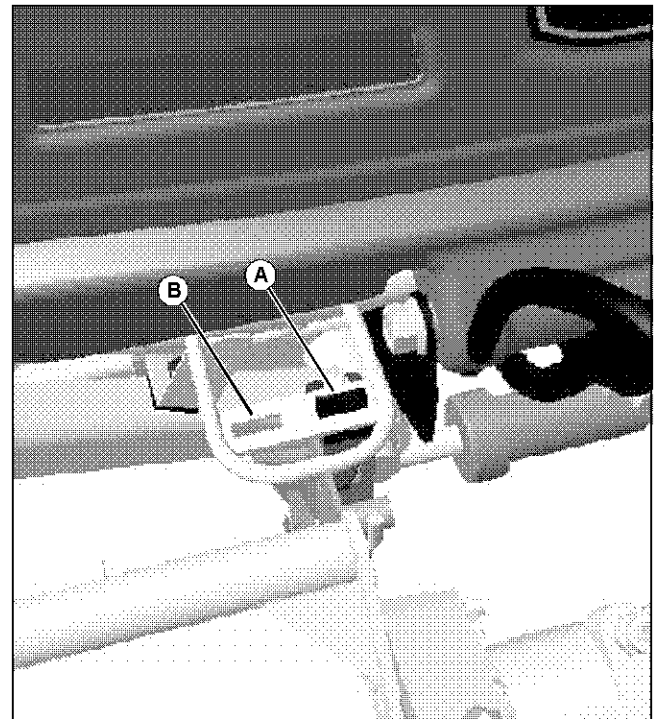
Adjust Front Lift Arm

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lock park brake.
4. Stop engine.



Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings. To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

5. Lower cutting units to the ground.
6. Turn key switch to the stop position.



MX23526

7. Install rubber isolators in the appropriate location for the cutting units being used.

- **26-inch cutting units:** Install isolators in the inside position (A) on both sides.
- **30-inch cutting units:** Install isolators in the outside position (B) on both sides.

HYDRAULICS TESTS AND ADJUSTMENTS

Warm Up Hydraulic Oil

Reason

When performing hydraulic system tests, the oil must be heated to a specified temperature for the tests to be accurate.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Temperature Gauge	JDG282	Used to measure hydraulic system oil temperature.
Hand Held Digital Tachometer	JT05719	Used to verify proper RPM setting.

Procedure

1. Park machine on a level surface.
2. Move forward and reverse travel pedals to neutral position.
3. Lower cutting units to the ground.
4. Move mow-transport lever to the transport position.
5. Turn key switch to stop position.
6. Lock park brake.
7. Install JDG282 Temperature Gauge on hydraulic pump assembly.



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- **Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.**
- **Allow fresh outside air into the work area to clear the exhaust fumes out.**

8. Start and run engine at fast idle.

Note: Periodically cycle all hydraulic functions to distribute heated oil.

9. Run engine until oil temperature reaches operating temperature (reservoir warm to the touch).

Specifications

Hydraulic Oil Operating Temperature 43°C (110°F)
Fast Idle 3150 ± 50 rpm

Bleed Hydraulic System

Reason

To ensure that air is purged from hydraulic system after the hoses or lines have been disconnected.

Procedure

1. Park machine on a level surface.
2. Move forward and reverse travel pedals to neutral position.
3. Move mow-transport lever to the transport position.
4. Lower cutting units to the ground.
5. Turn key switch to stop position.
6. Lock park brake.
7. Check level of hydraulic oil. Fill as needed.



Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- **Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.**
- **Allow fresh outside air into the work area to clear the exhaust fumes out.**

8. Start engine and run at slow idle.
9. Turn steering wheel full left and hold for 5 seconds.
10. Turn steering wheel straight forward and hold for 10 seconds.
11. Turn steering wheel full right and hold for 5 seconds.
12. Cycle cutting units up and down ten times. Leave in raised position.
13. Return steering wheel to straight forward position.
14. Drive machine straight forward for 6 meters (20 feet), then make two hard left turns, then make two hard right turns.
15. Drive machine in reverse approximately 3 meters (10 feet).
16. Lower cutting units to the ground.
17. Turn key switch to stop position.
18. Lock park brake.
19. Check all hoses and connections for leaks. Tighten

HYDRAULICS REPAIR

connections and/or replace hoses as needed.

20. Check hydraulic oil level. Add oil as needed.

Specifications

Slow Idle 1400 ± 50 rpm

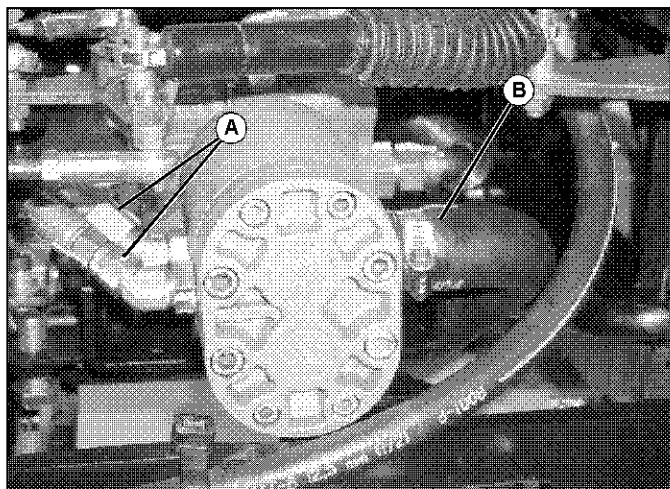
Repair

Remove Double Pump



Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on a level surface.
2. Move forward and reverse travel pedals to neutral position.
3. Move mow-transport lever to the transport position.
4. Lower cutting units to the ground.
5. Turn key switch to stop position.
6. Lock park brake.
7. Block wheels to prevent inadvertent movement of the machine.
8. Disconnect battery.
9. Place a 40-qt (10-gal) container below the hydraulic sump and drain oil.

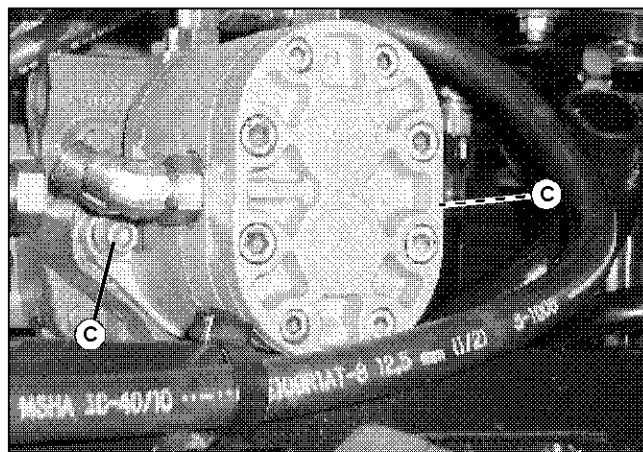


MX23414

10. Clean port areas of the double pump assembly and hydrostatic pump with a suitable solvent.

11. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.

12. Disconnect hydraulic lines (A) and pump intake line (B) connected to the double pump assembly.



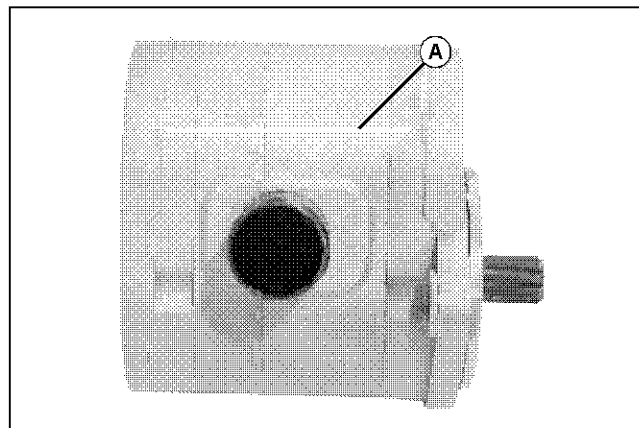
MX23416

13. Remove hex socket head bolts (C) securing the double pump to hydrostatic pump.

14. Remove double pump assembly from hydrostatic pump by sliding outward to disengage spline shaft from coupler.

Disassemble Double Pump

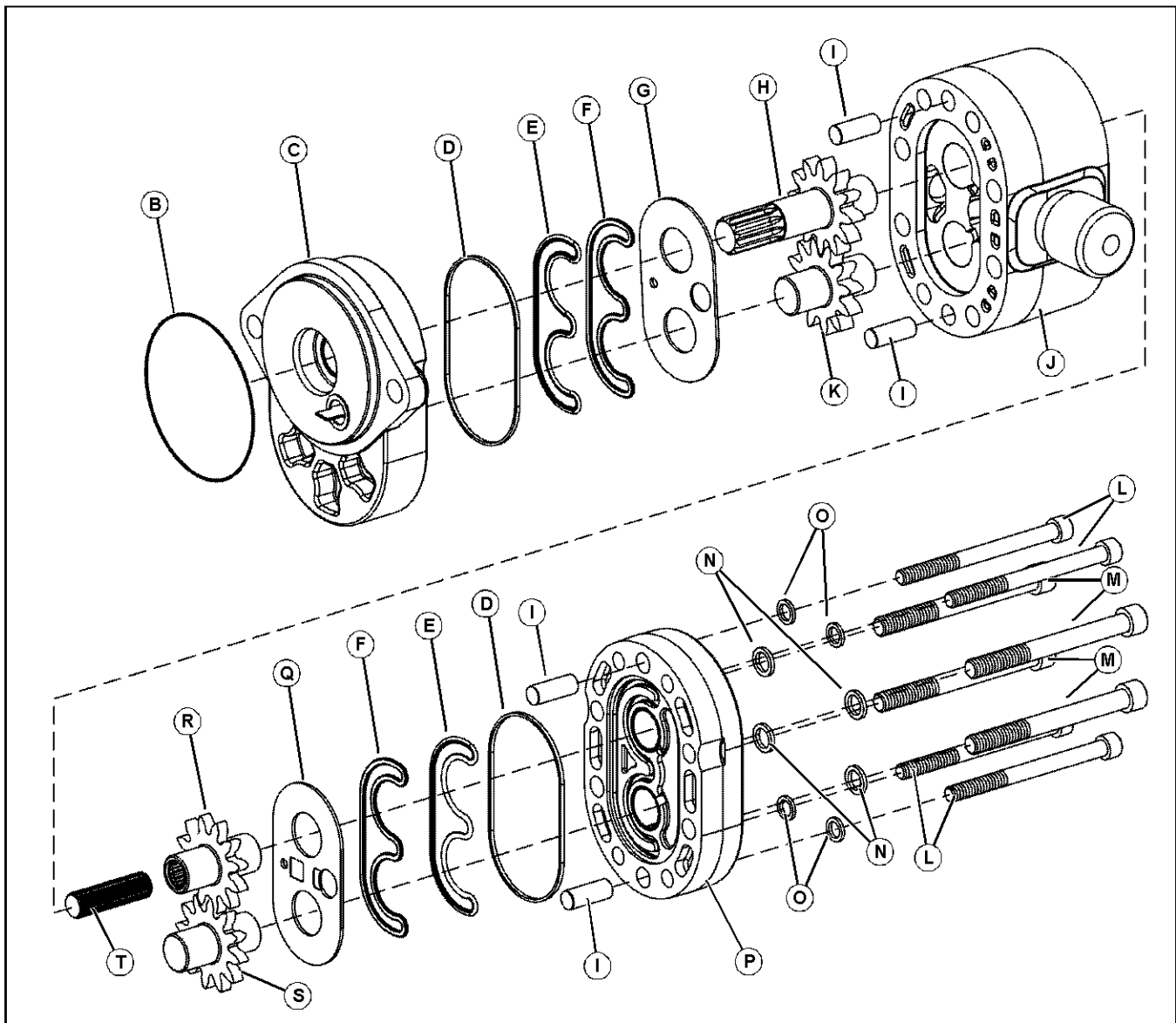
Important: Avoid Damage! Pump components are aluminum. Use extreme care in cleaning all machine surfaces of old gasket materials. Use of steel pry bars, etc., can severely damage the machined surfaces of the pumps.



MX23420

1. Mark pump housing (A) with solvent resistant marker or paint to aid during assembly.

HYDRAULICS REPAIR



MX23319

2. Remove four 5/16 in. hex socket head bolts (L) and washers (O).

3. Remove O-ring (B) and discard.

4. Remove four 3/8 in. hex socket head bolts (M) and washers (N).

Note: It may be necessary to tap lightly on the end of the drive shaft with a soft-faced hammer to assist in separating the pump halves.

5. Remove end plate (P) and front plate (C) from pump body (J). Note location of dowel pins (I) and install in same location during assembly if removed.

6. Place alignment marks on gear mating teeth and remove gears (H, K, R, and S) and coupler (T) from assembly.

7. Inspect pump body (J), end plate (P), front plate (C) and

shaft bearings for scratches, scoring, or fretting. Replace individual pump section if worn.

8. Remove and inspect the wear plates (G and Q); replace if damaged.

9. Remove and discard tan seals (F), black seals (E) and blue O-rings (D).

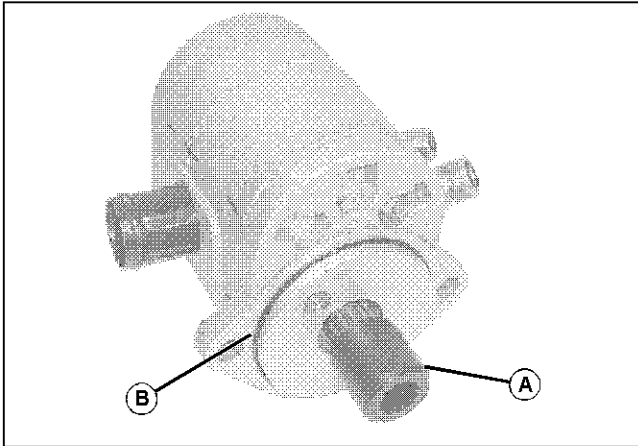
HYDRAULICS REPAIR

Install Double Pump

Specifications

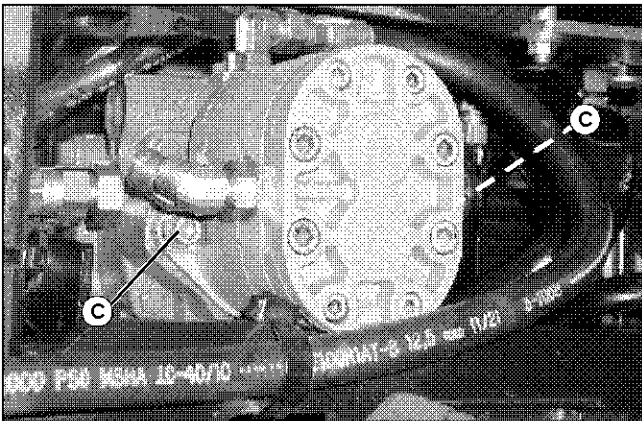
Double Pump-to-Hydrostatic Pump

Hex Socket Head Bolts Torque 50 N•m (35 lb-ft)



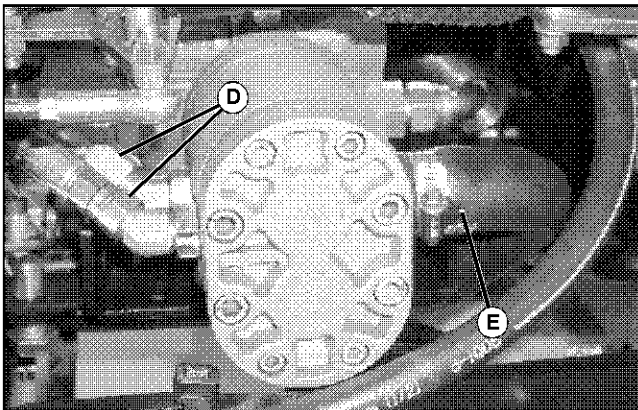
MX23440

1. Install coupler (A) onto drive shaft.
2. Install new O-ring (B) on pump flange.



MX23416

3. Install two hex socket head bolts (C). Tighten bolts to specifications.



MX23414

4. Install two high-pressure hoses (D) to left side of double pump.
5. Install pump intake line (E) from reservoir to right side of double pump.

HYDRAULICS REPAIR

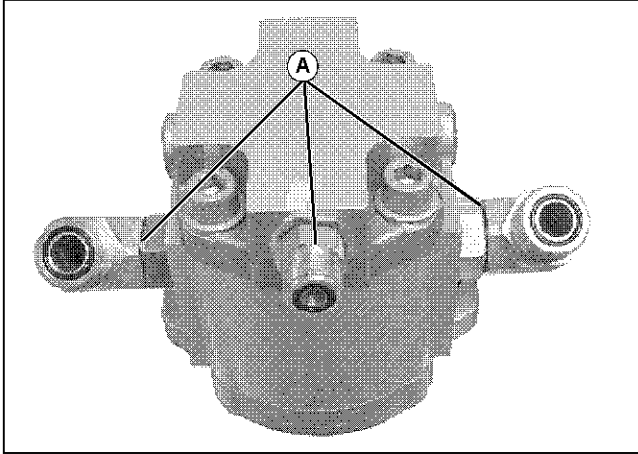
Disassemble and Assemble Reel Motor

Disassembly

1. Thoroughly clean and dry outside of motor.

Important: Avoid Damage! Never pry components apart. Light tapping with a plastic hammer on input shaft will separate components without damage.

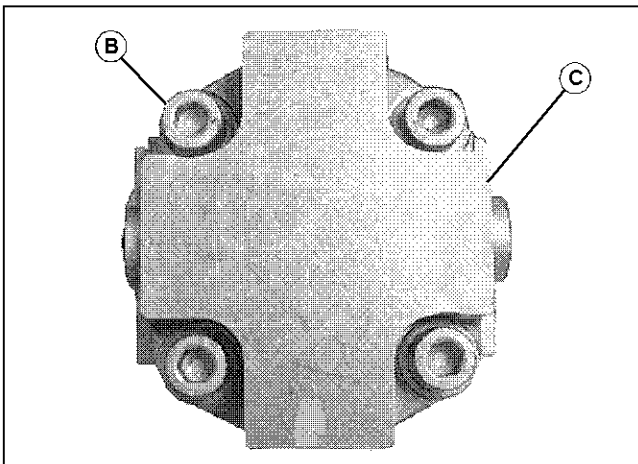
Be careful not to drop any parts or disengage gear mesh when separating assemblies.



MX26624

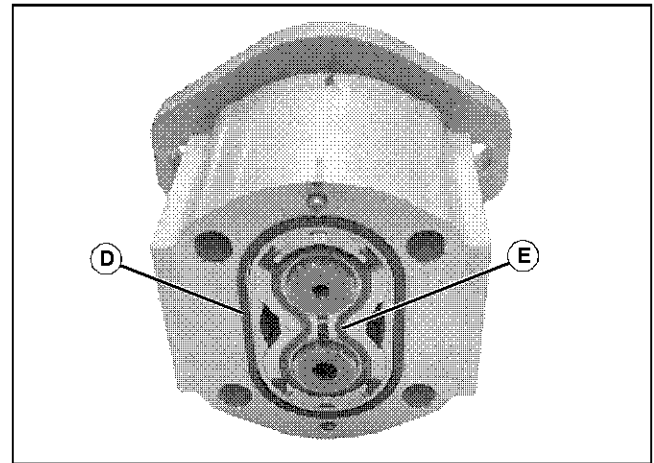
2. Place motor in a soft-jawed vise using just enough pressure to prevent the motor from turning when removing fittings.

3. Remove three fittings (A).



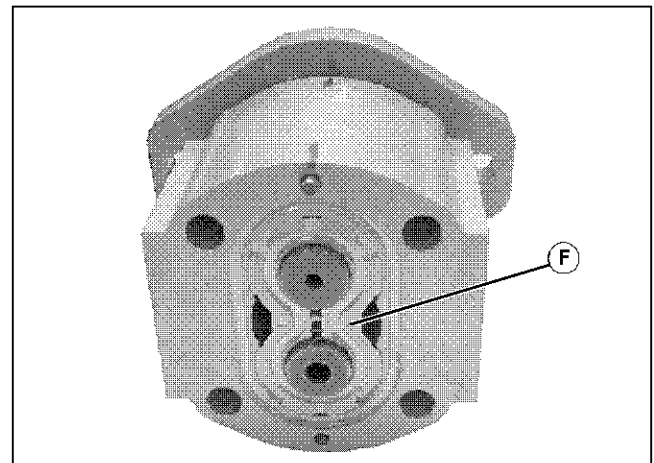
MX26625

4. Remove four cap screws (B).
5. Separate front end cover (C) from main body.



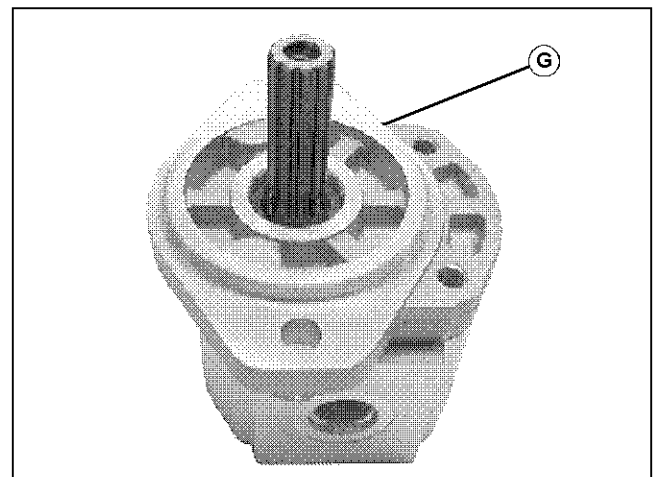
MX26626

6. Remove O-ring (D) from main body.
7. Remove seals (E) from main body.



MX26627

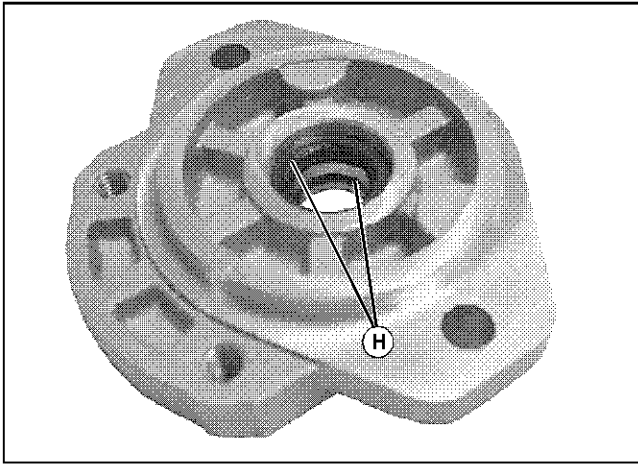
8. Remove rear wear block (F).



MX26628

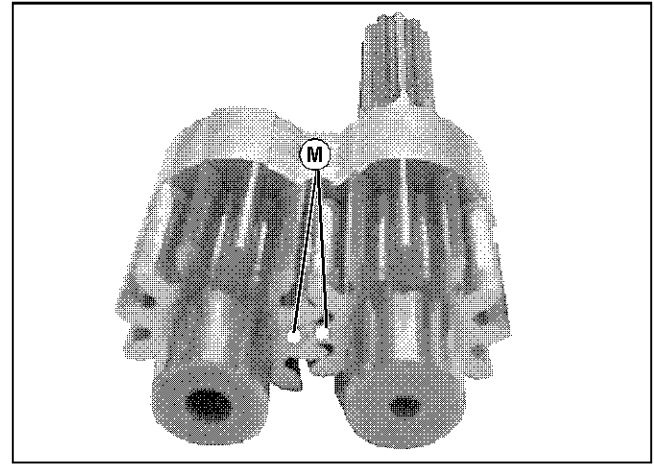
9. Remove front end cover (G).

HYDRAULICS REPAIR



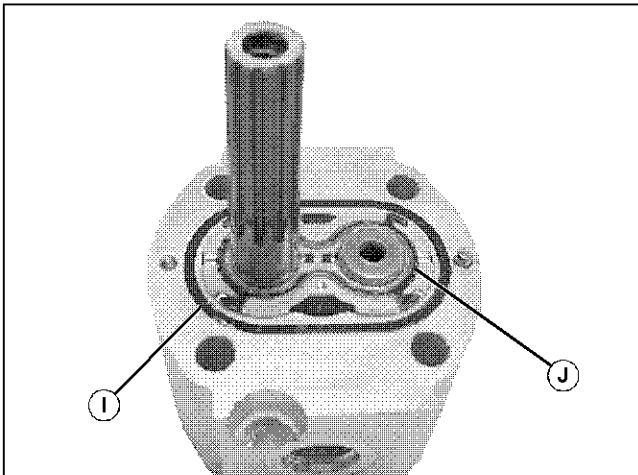
MX26629

10.Remove seals (H).



MX26632

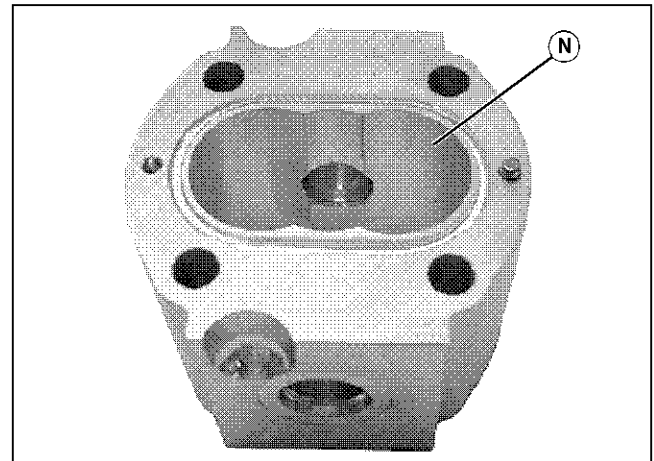
14.Place alignment marks (M) on gear mating teeth and remove gears from wear block assembly.



MX26630

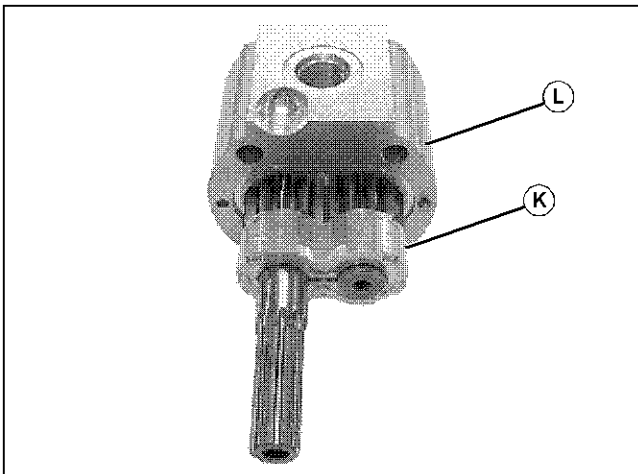
11.Remove O-ring (I).

12.Remove seals (J).



MX26633

15.Inspect housing bore (N) for signs of damage.



MX26631

13.Remove front block assembly (K) from main body (L).



Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

Important: Avoid Damage! Absolute cleanliness is essential when working on reel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/hydraulic system and cause damage.

16.Clean all metal parts with solvent and blow dry with regulated compressed air.

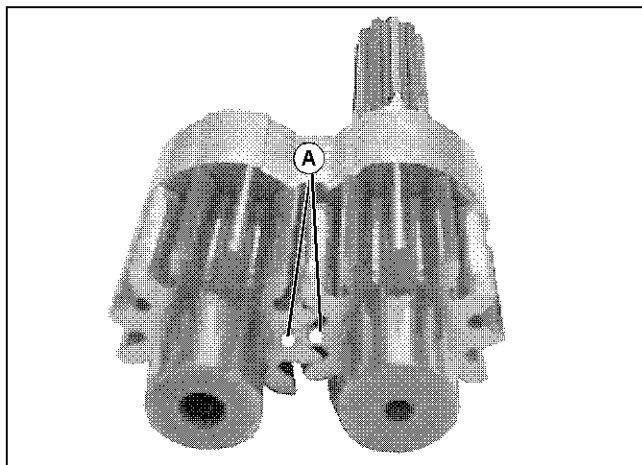
HYDRAULICS REPAIR

17. Inspect all parts for damage, nicks, or unusual wear. Replace entire rotary motor assembly if any parts other than O-rings and seals are worn or damaged.

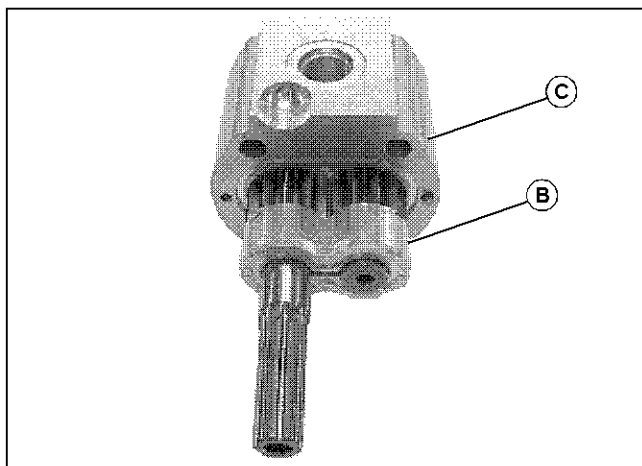
Assembly

Important: Avoid Damage! Always use new O-rings and seals. Used or damaged O-rings and seals will leak.

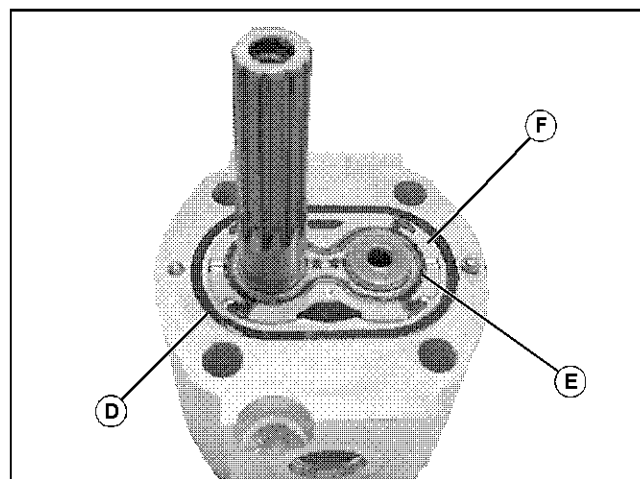
Note: Apply a light coat of clean hydraulic oil to all internal parts when assembling the rotary motor.



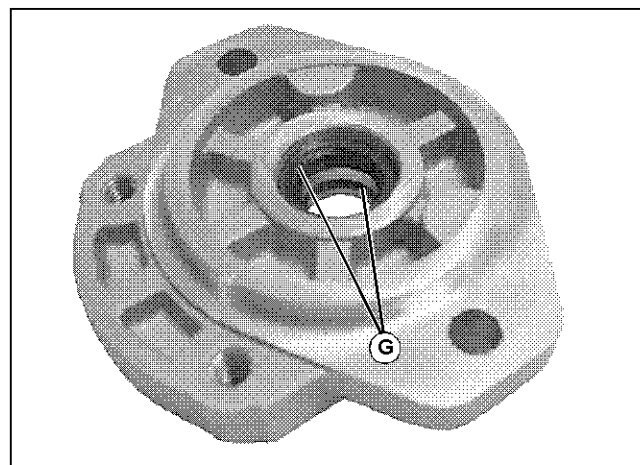
1. Align marks (A) on mating teeth and install gears to wear block assembly.



2. Install front block assembly (B) into main body (C).

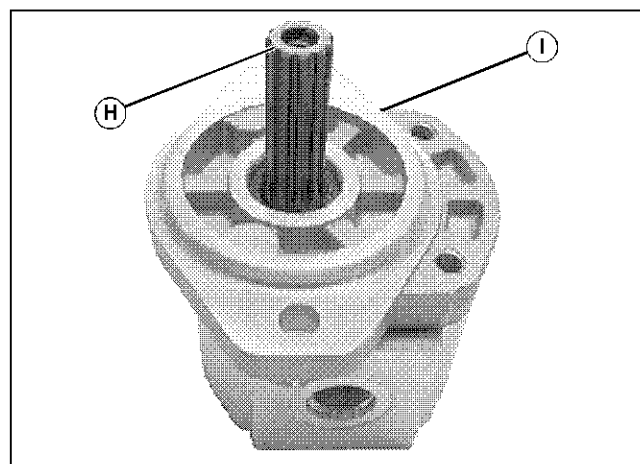


3. Install new O-ring (D) and seals (E) in wear block (F).



4. Apply petroleum jelly to lips of new seals (G).

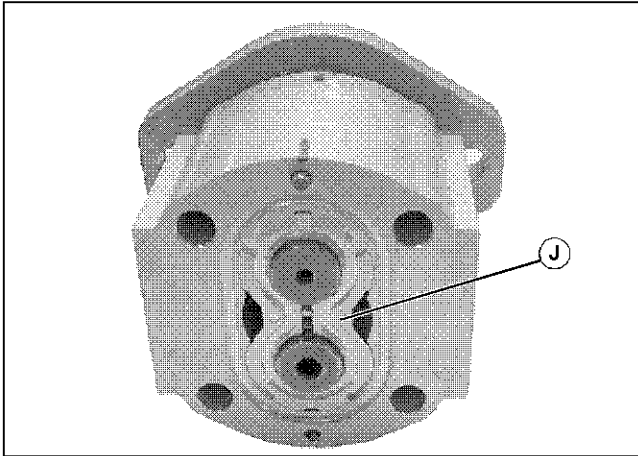
5. Install new seals parallel to bore and seat tight against shoulder of bore.



HYDRAULICS REPAIR

6. Cover the splines of input shaft (H) with tape (or sleeve included with repair kit) to prevent damaging seals during installation.

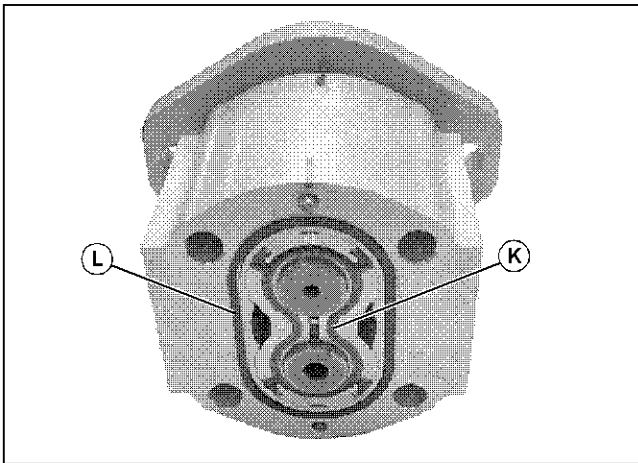
Install front end cover (I).



MX26627

7. Apply a light coat of clean hydraulic oil to rear wear block (J).

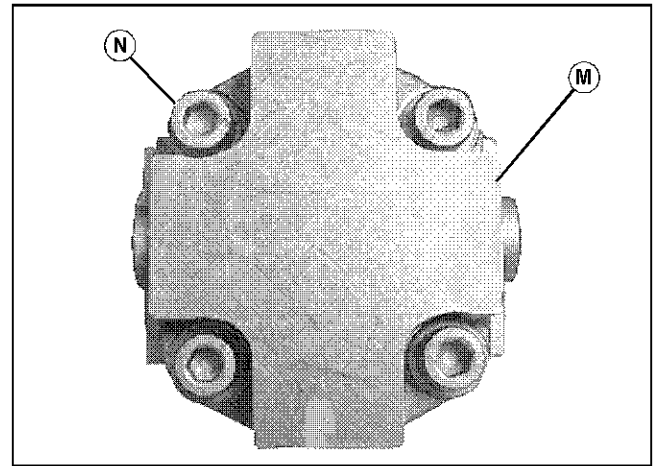
8. Install rear wear block in main body.



MX26626

9. Install new seals (K).

10. Install new O-ring (L).



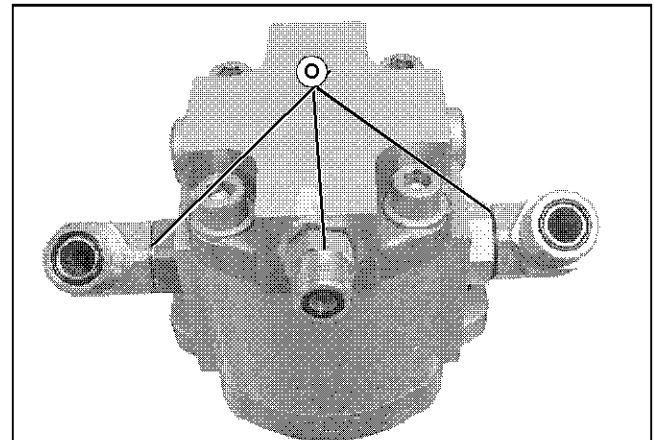
MX26625

11. Install end cover (M).

12. Install cap screws (N). Do not tighten to specification at this time.

13. Rotate input shaft to verify that all parts are mating smoothly.

14. Tighten cap screws in an alternating pattern to specifications.



MX26624

15. Install fittings (O).

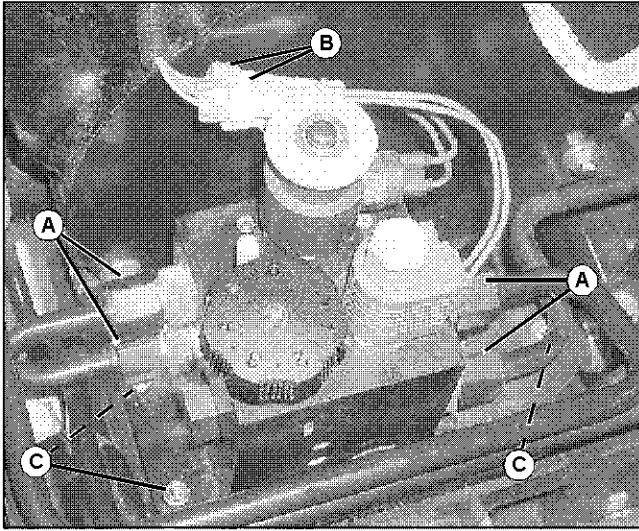
Specifications

Standard Duty, Cap Screw Torque 45 N•m (33 lb-ft)

Remove and Install Backlap Valve

Removal

1. Place drain pan under valve.



MX23453

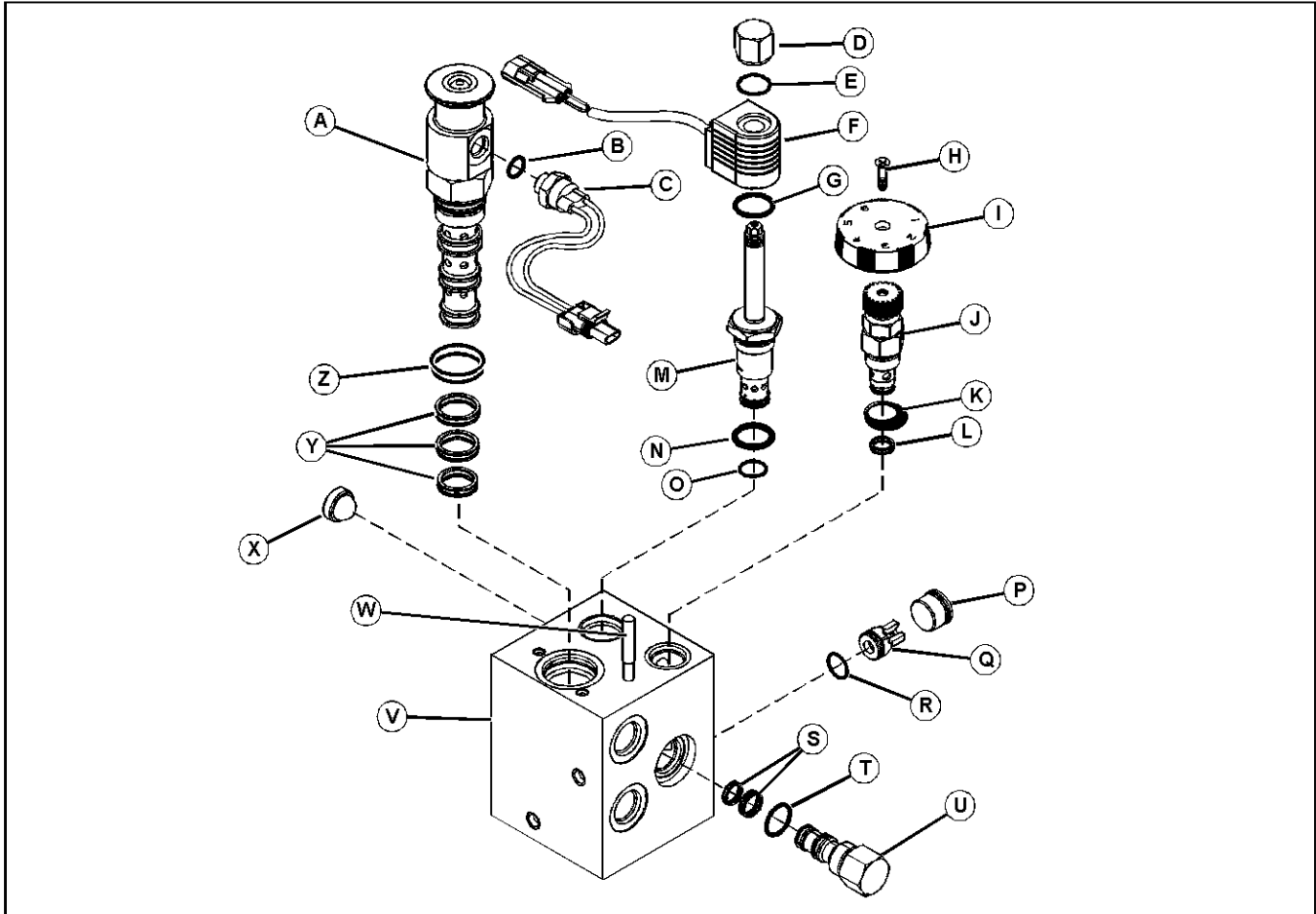
2. Label and disconnect four hydraulic lines (A) from valve body.
3. Disconnect two electrical connectors (B) from harness.
4. Remove three mounting nuts (C) holding valve bracket to frame. Remove valve and bracket.

Installation

Installation is done in the reverse order of removal.

HYDRAULICS REPAIR

Disassemble and Assemble Backlap Valve



MX23456

The valve body (V) is a single machined block. The valves, O-rings and backup seals may be removed, inspected for wear and replaced.

1. Remove and inspect parts (A through Z); replace as necessary.
2. Inspect filter screen (X) for holes. Clean debris or replace if necessary.
3. Make sure O-rings and backup seals are lubricated before installing valves.
4. Tighten components to specification when assembling components into valve body.
5. Turn valve stem on flow control valve (J) clockwise until seated. Align the number 1 on knob (I) to yellow indicator (W) in valve body.

Specifications

Mow Valve Torque	27-34 N•m (20-25 lb-ft)
Mow Valve Coil Cap Torque	88-102 N•m (65-75 lb-ft)
Flow Control Valve Torque	34-41 N•m (25-30 lb-ft)
Logic Element Torque	41-47 N•m (30-35 lb-ft)
Forward-Reverse Valve Torque	108-135 N•m (80-100 lb-ft)
Forward-Reverse Switch Torque	4-7 N•m (35-62 lb-in.)

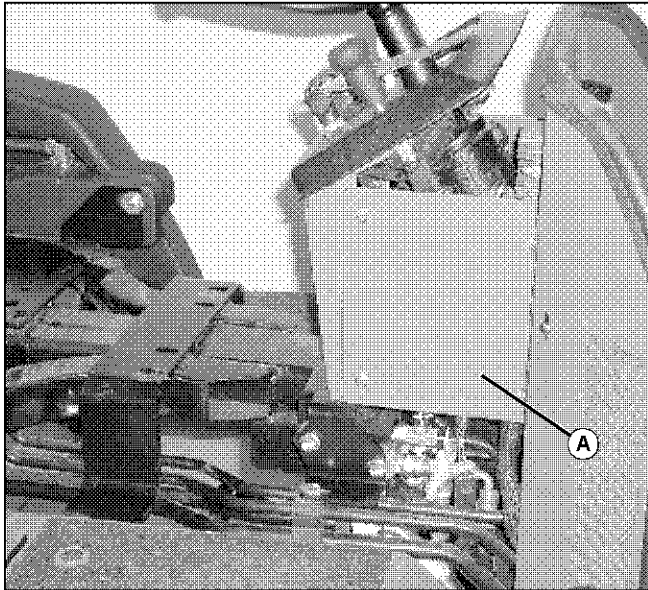
HYDRAULICS REPAIR

Remove Lift Valve



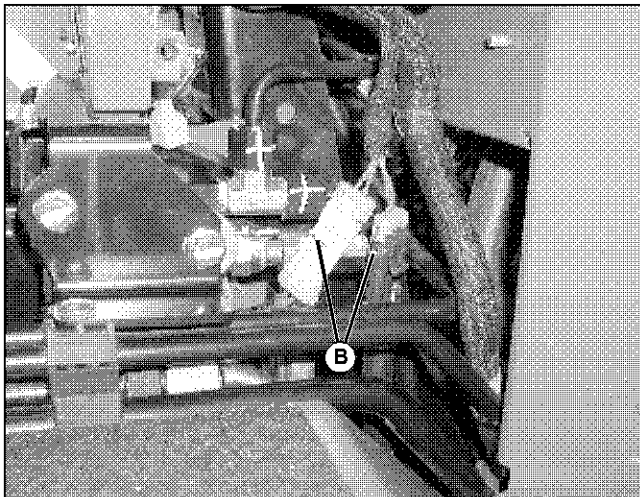
Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Remove seat. (See "Remove and Install Seat" on page 392.)
2. Remove seat base plate. (See "Remove and Install Seat Base Plate" on page 393.)
3. Remove center floor panel. (See "Remove and Install Center Floor Panel" on page 394.)



MX23461

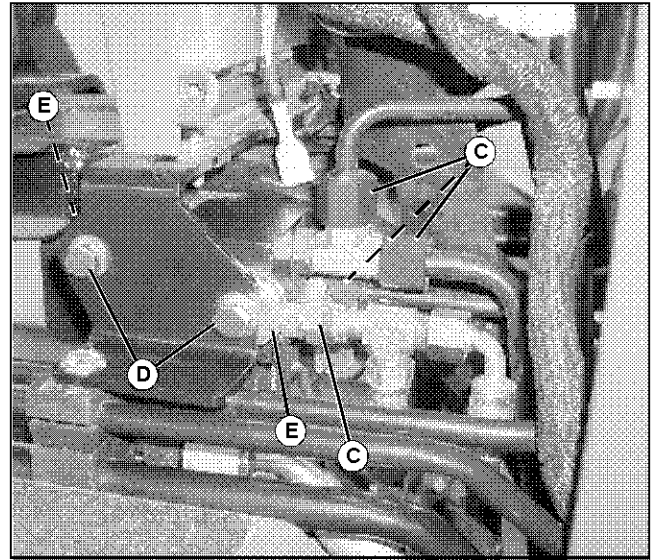
4. Remove inspection panel (A) on right side of steering housing to gain access to lift valve.



MX23462

5. Disconnect two wiring connectors (B) going to mow valve solenoids.

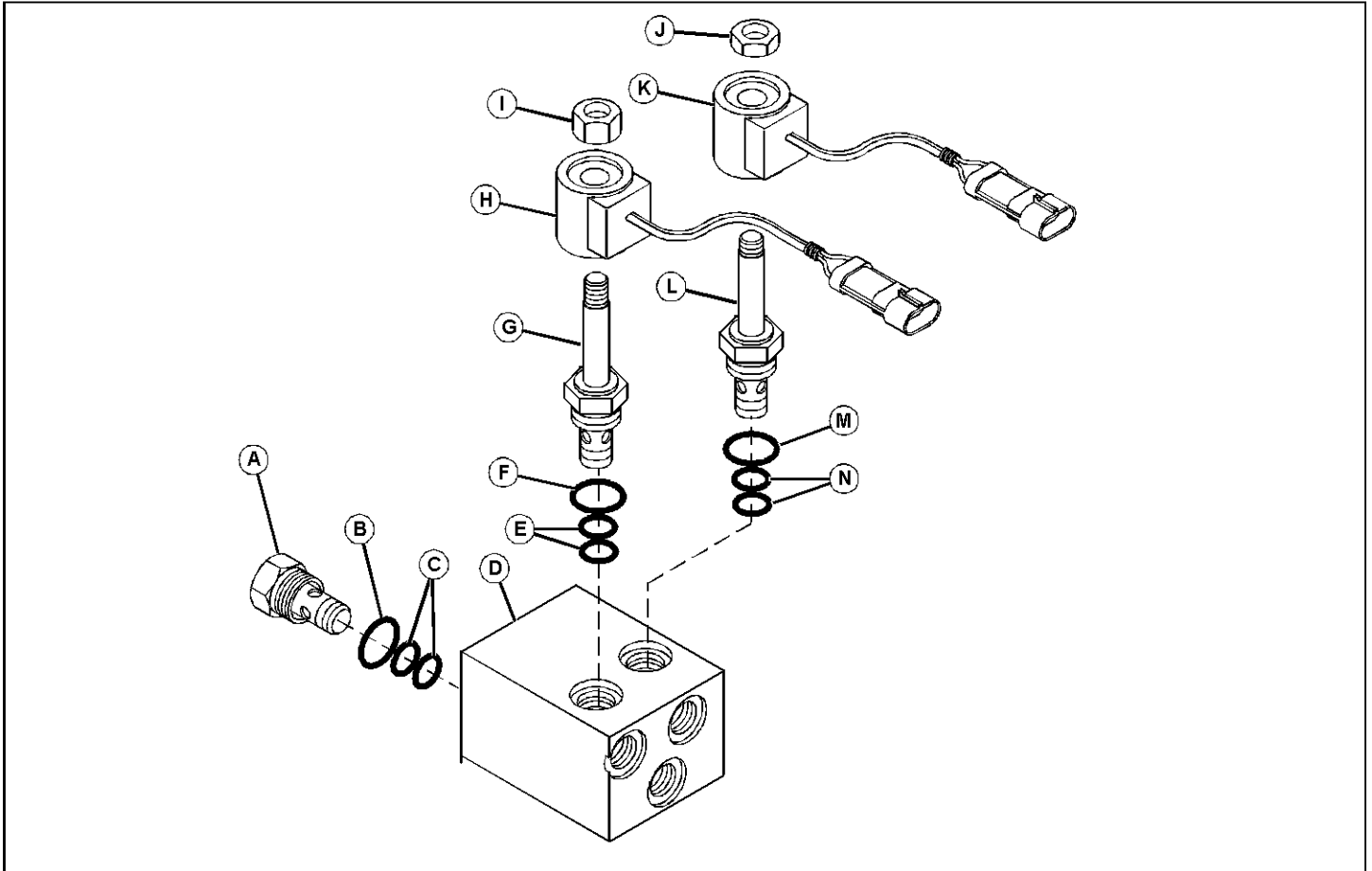
Note: Tag or label hydraulic lines to aid during installation.



MX23463

6. Disconnect hydraulic lines (C) at lift valve. Remove cap screws (D) and spacers (E).

Disassemble Lift Valve



MX23464

1. Remove and inspect parts (A through N). Replace as necessary.

Assemble Lift Valve

Note: Replace all O-rings and seals. Used or damaged O-rings and seals will leak.

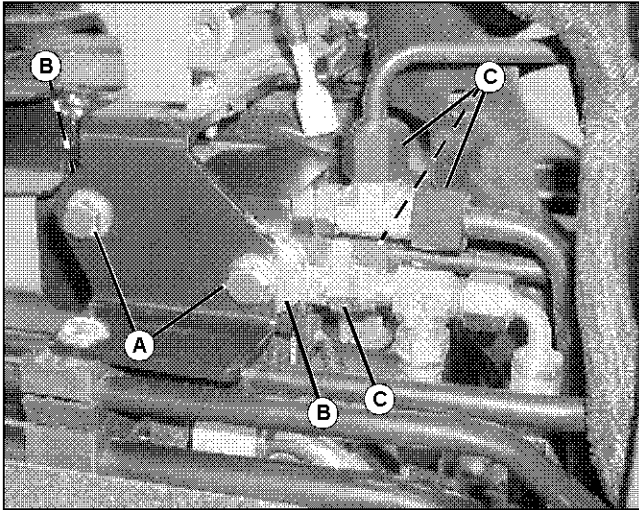
1. Lubricate and install new O-ring and seals.
2. Install check valve (A). Tighten to specifications.
3. Install valves (G and L). Tighten to specifications.
4. Install valve coils (H and K) until seated on valves.
5. Install coil nuts (I and J). Tighten to specifications.

Specifications

Check Valve Torque 26-28 N•m (19-21 lb-ft)
Valves Torque 26-28 N•m (19-21 lb-ft)
Coil Nuts Torque 5-7 N•m (44-62 lb-in.)

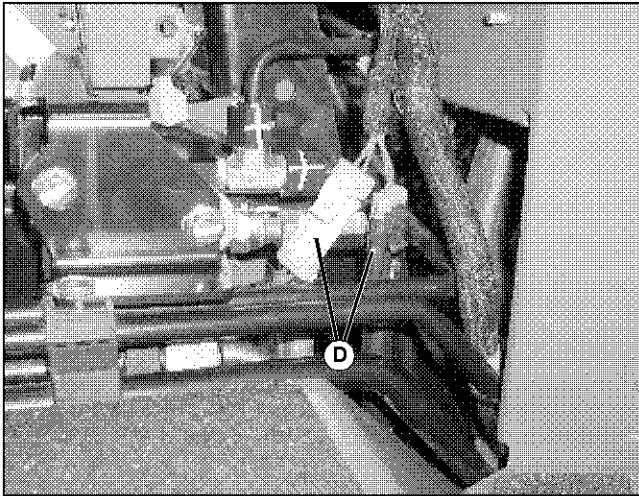
HYDRAULICS REPAIR

Install Lift Valve



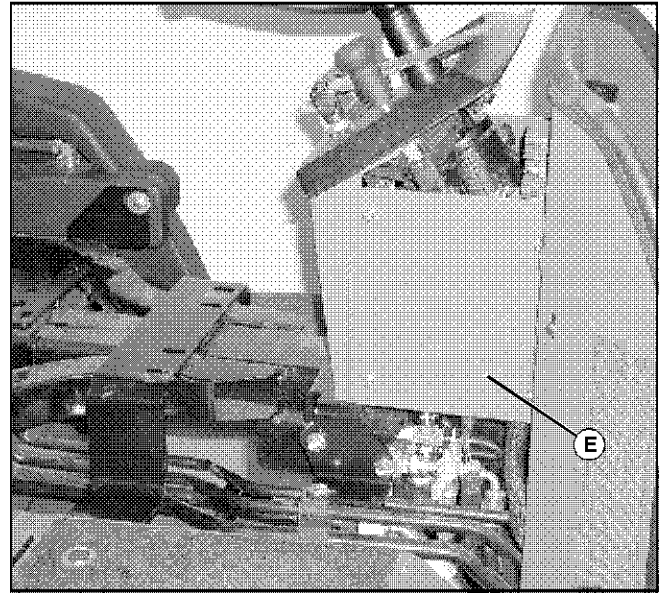
MX23463

1. Secure valve to frame with cap screws (A) and spacers (B).
2. Connect hydraulic lines (C).



MX23462

3. Connect wiring connectors (D).



MX23461

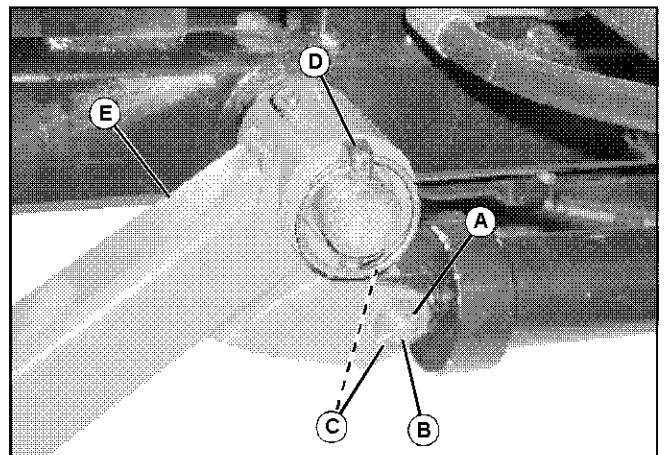
4. Install inspection panel (E).
5. Install center floor panel. (See "Remove and Install Center Floor Panel" on page 394.)
6. Install seat base plate. (See "Remove and Install Seat Base Plate" on page 393.)
7. Install seat. (See "Remove and Install Seat" on page 392.)
8. Bleed hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Remove and Install Lift Arm

Removal

Note: Front right lift arm show in this procedure.

1. Remove cutting units from lift arm being serviced.



MX23476

2. Remove cotter pin (A) from cylinder pin (B) and remove cylinder pin from lift arm yoke.

HYDRAULICS REPAIR

3. Inspect lift cylinder bushings (C) and replace if necessary.
4. Secure lift cylinder to frame with wire to keep work area clear.
5. Remove quick-lock pin (D) from lift arm pivot shaft.
6. Remove lift arm (E) from lift arm pivot shaft.

Installation

1. Install lift arm onto lift arm pivot shaft.
2. Install quick-lock pin.

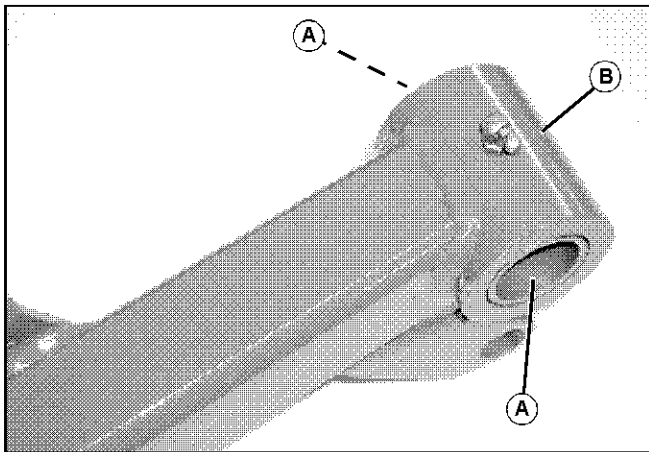
Important: Avoid Damage! Cylinder pin (B) should always be installed from the reel side of the bracket (as shown).

3. Ensure lift cylinder bushings are installed properly and secure lift cylinder to lift arm yoke with cylinder pin and new cotter pin.

Inspect and Replace Lift Arm Bushing

Note: Lift arm bushings are press fit. Remove bushing only if worn or damaged.

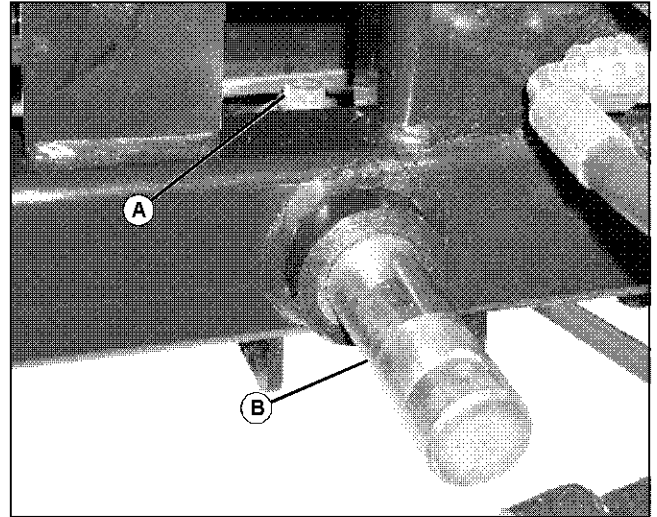
1. Remove lift arm. (See "Remove and Install Lift Arm" on page 322.)
2. Inspect bushings for wear. Replace if necessary.



MX23477

3. Remove excess grease from bushings (A) and lift arm mounting tube (B).
4. Using a bearing driver, drive front and rear bushings out back of lift arm mounting tube.
5. Install new bushings flush with outer edge of lift arm mounting tube using arbor press.

Remove and Install Lift Arm Pivot Shaft



MX23478

1. Remove cap screw and nut (A) retaining shaft (B) in machine frame.
2. Inspect shaft for scoring or excessive wear. Replace if necessary.
3. Install shaft and secure with cap screw and nut (A).

Remove and Install Lift Cylinder

Removal

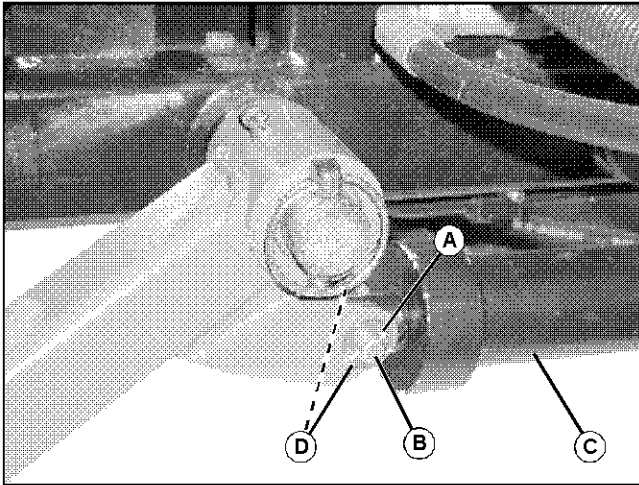
1. Park machine on level surface, reels lowered, park brake locked, engine off.
2. Block wheels to prevent inadvertent movement of the machine.



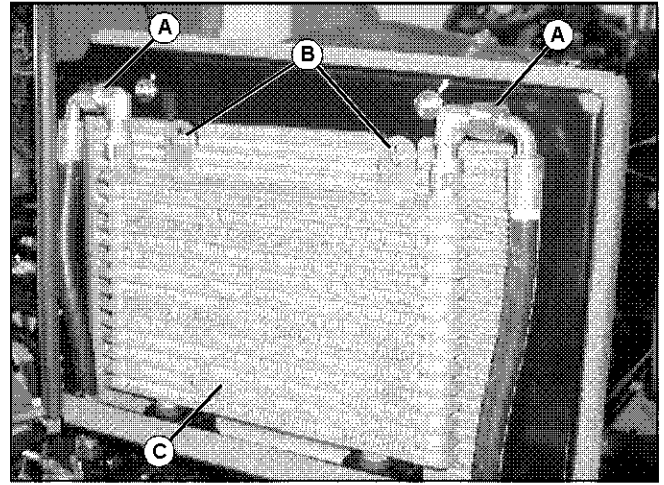
Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

3. Remove hydraulic hoses.

HYDRAULICS REPAIR



MX23476



MX23479

4. Remove cotter pins (A), cylinder pins (B), and lift cylinder (C) from lift arm.
5. Inspect lift cylinder bushings (D) and replace if necessary.

Installation

Note: Lift cylinders are not rebuildable. If a cylinder is defective, replace entire unit.

Important: Avoid Damage! Cylinder pin (C) should always be installed from the reel side of the bracket (as shown).

1. Ensure lift cylinder bushings are installed properly and secure lift cylinder using cylinder pins and new cotter pins.
2. Install and tighten hydraulic hoses.
3. Bleed hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Remove, Inspect and Install Hydraulic Oil Cooler



Caution: Avoid Injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Place a 40-qt (10-gal) container below the hydraulic tank and drain oil.

2. Disconnect two oil cooler lines (A).
3. Close all lines and fittings using caps and plugs.
4. Remove two wing nuts (B) and remove hydraulic oil cooler (C).
5. Clean hydraulic oil cooler with compressed air.



Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment, including eye protection.

Important: Avoid Damage! Do not apply high-pressure spray directly at fins when cleaning the oil cooler, as this could result in damage. Direct the spray parallel to the fins.

6. Inspect hydraulic oil cooler for bent fins, cracks, and damaged seams. Repair or replace as necessary.
7. Install and secure oil cooler with two wing nuts. Connect and tighten hydraulic oil cooler lines.
8. Bleed hydraulic system. (See "Bleed Hydraulic System" on page 309.)

STEERING TABLE OF CONTENTS

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STEERING TABLE OF CONTENTS



STEERING SPECIFICATIONS

Specifications

General Specifications

Steering Control Unit

Make.....	Eaton
Type	Char-Lynn™ 2 Series
Maximum Operating Pressure.....	6895 kPa (1000 psi)
Maximum Back Pressure.....	1034 kPa (150 psi)
Maximum Operating Temperature	93°C (200°F)
Maximum Flow	15 L/min (4 gpm)
Maximum Differential Temperature (Between Steering Unit and System Temperature)	10°C (50°F)
Input Torque (Powered)	1-2 N•m @ 690kPa (15-25 lb-in. @ 100 psi) Tank Pressure
(Non-Powered)	81 N•m (60 lb-ft)
Check Valve for Limited Manual Steering	Yes

STEERING TOOLS AND MATERIALS

Tools and Materials

Special or Required Tools

Note: Order tools according to information given in the U.S. **SERVICEGARD™** Catalog or in the European Microfiche Tool Catalog (MTC).

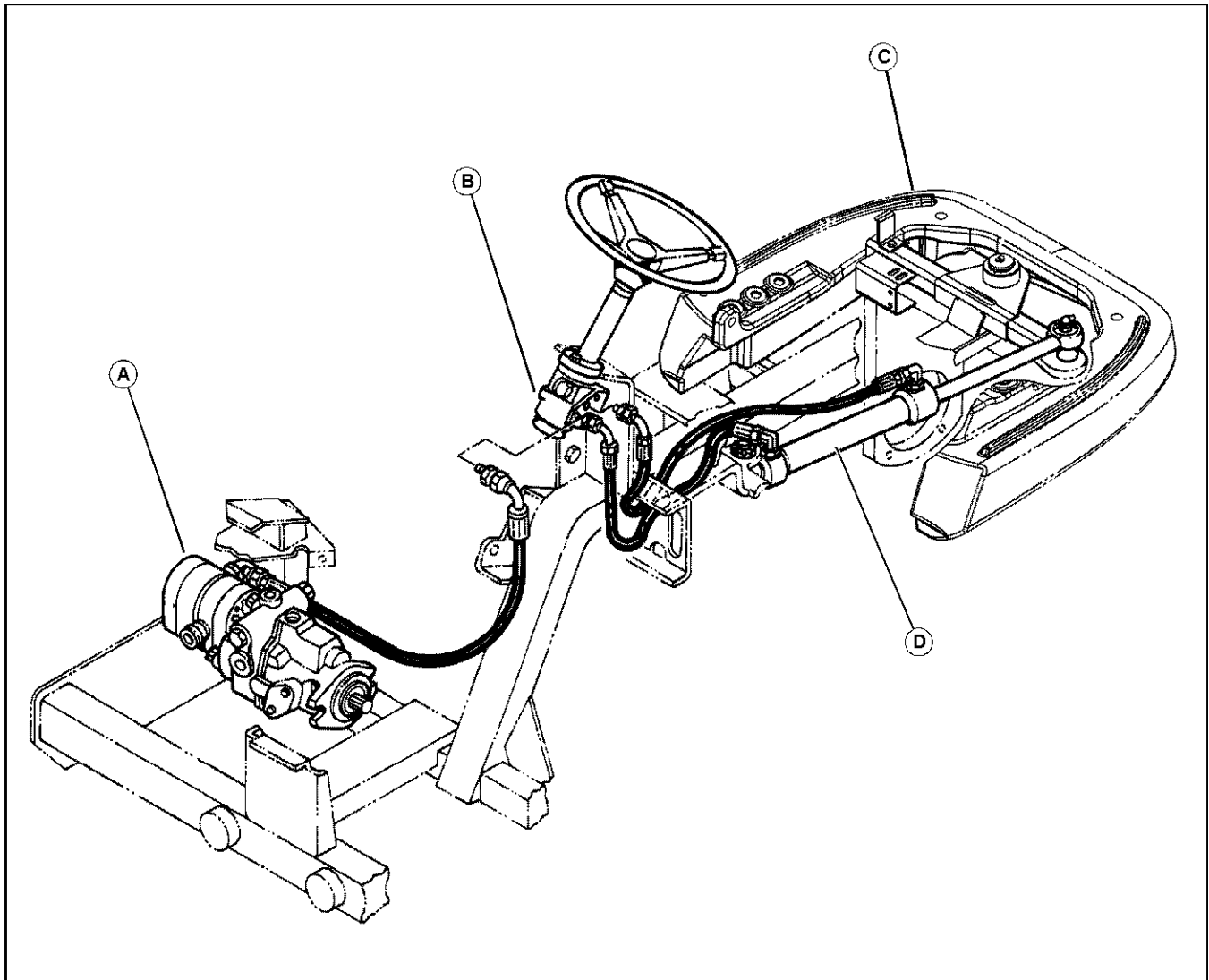
Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose 34,473 kPa (5,000 psi)	JT03017	Pressure check.
T-Fitting, 9/16-16 F ORFS x 9/16-16 M ORFS x 9/16-16 M ORFS	AMT1043	Connect pressure gauge for steering and lift system relief valve pressure test.
Pressure Gauge 0-40 000 kPa (0-6000 psi)	JT07047	Connect pressure gauge for steering and lift system relief valve pressure test.
Male Quick Coupler, 11/16-16 F ORFS	RE43774	Connect pressure gauge for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gauge for steering and lift system relief valve pressure test.

STEERING COMPONENT LOCATION

Component Location

Steering Components



M76407

- A- Charge Pump
- B- Steering Control Unit
- C- Reservoir
- D- Steering Cylinder

Steering Theory of Operation - 330

STEERING DIAGNOSTICS

Diagnostics

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

System: Steering System Troubleshooting

Steering Wanders

1. Are tires of proper type and inflated to proper pressure?

Yes: Go to next step.

No: Replace tire(s) with tire(s) of proper type. Inflate tire(s) to proper pressure.

2. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

3. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

4. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

5. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

6. Perform steering system leakage test. (See "Test System Leakage" on page 334.) Is test within specifications?

No: Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 334.) Follow results of test.

Steering Shimmy

1. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

2. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

3. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

4. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

5. Check hydraulic fluid. Is fluid free of contamination?

No: Remove contaminated fluid, flush system, and find source of contamination.

Sluggish Steering Response

1. Is engine rpm within operating range?

Yes: Go to next step.

No: Adjust slow and/or fast idle speed. (See "Adjust Slow Idle Speed" on page 48, and "Fast Idle Speed Check" on page 50.)

2. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

3. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

4. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

5. Check hydraulic fluid. Is fluid free of contamination?

Yes: Go to next step.

No: Remove contaminated fluid, flush system, and find source of contamination.

6. Is hydraulic filter clean and free from restrictions?

Yes: Go to next step.

No: Replace filter as needed.

7. Are hydraulic lines and oil cooler free from any restrictions?

Yes: Go to next step.

No: Clear lines or cooler of restrictions. Replace parts as needed.

STEERING DIAGNOSTICS

8. Perform steering system leakage test. (See "Test System Leakage" on page 334.) Is test within specifications?

No: Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 334.) Follow results of test.

Excessive Steering Wheel Free Play

1. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

2. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

3. Is steering valve mounted securely?

Yes: Go to next step.

No: Secure steering valve.

4. Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 338.) Is SCU in good condition with no noticeable damage?

No: Repair or replace steering control unit as needed.

High Steering Effort in One Direction

1. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

2. Perform steering system leakage test. (See "Test System Leakage" on page 334.) Is test within specifications?

Yes: Go to next step.

No: Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 334.) Follow results of test.

3. Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 338.) Is SCU in good condition with no noticeable damage?

No: Repair or replace steering control unit as needed.

High Steering Effort in Both Directions

1. Are tires of proper type and inflated to proper pressure?

Yes: Go to next step.

No: Replace tire(s) with tire(s) of proper type. Inflate tire(s) to proper pressure.

2. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

3. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

4. Is hydraulic filter clean and free from restrictions?

Yes: Go to next step.

No: Replace filter as needed.

5. Test double pump (charge pump). Is there sufficient hydraulic fluid flow?

Yes: Go to next step.

No: Repair or replace pump as necessary.

6. Perform steering system leakage test. (See "Test System Leakage" on page 334.) Is test within specifications?

Yes: Go to next step.

No: Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 334.) Follow results of test.

7. Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 338.) Is SCU in good condition with no noticeable damage?

No: Repair or replace steering control unit as needed.

Steering Cylinder Will Not Fully Extend or Retract

1. Is engine rpm within operating range?

Yes: Go to next step.

No: Adjust slow and/or fast idle speed. (See "Adjust Slow Idle Speed" on page 48, and "Fast Idle Speed Check" on page 50.)

2. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

3. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

STEERING DIAGNOSTICS

4. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

5. Are hydraulic lines and oil cooler free from any restrictions?

Yes: Go to next step.

No: Clear lines or cooler of restrictions. Replace parts as needed.

6. Is steering cylinder rod free of damage, not bent?

Yes: Go to next step.

No: Replace steering cylinder.

7. Is steering clevis free of damage, not bent?

Yes: Go to next step.

No: Repair or replace steering clevis.

8. Test double pump (charge pump). Is there sufficient hydraulic fluid flow?

Yes: Go to next step.

No: Repair or replace pump as necessary.

9. Perform steering system leakage test. (See "Test System Leakage" on page 334.) Is test within specifications?

Yes: Go to next step.

No: Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 334.) Follow results of test.

10. Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 338.) Is SCU in good condition with no noticeable damage?

No: Repair or replace steering control unit as needed.

Wheels Continue to Turn After Steering Wheel Is Stopped

1. Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 338.) Is SCU in good condition with no noticeable damage?

No: Repair or replace steering control unit as needed.

STEERING TESTS AND ADJUSTMENTS

Tests and Adjustments

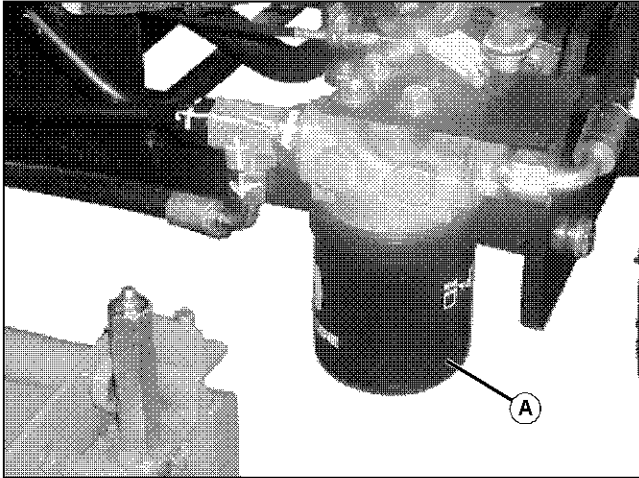
Test System Leakage

Reason

To determine if steering system has excessive internal leakage.

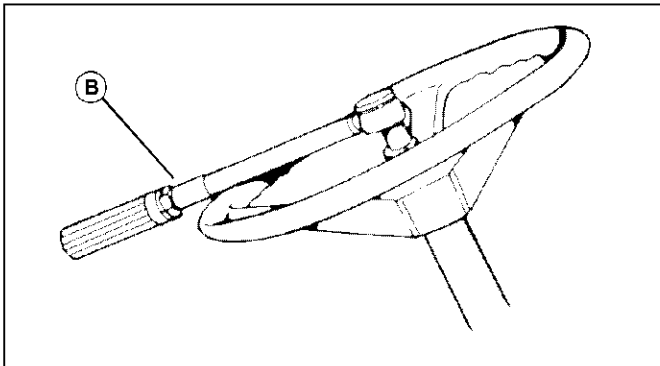
Procedure

Note: Ensure hydraulic fluid temperature is 43°C (110°F) or above.



MX23520

1. Start engine and set throttle to slow idle.
2. Place thermometer on hydraulic oil filter (A) and run system until oil temperature reaches 43°C (110°F).



M46864A

3. With steering wheel at a maximum right turn position, use a torque wrench (B) to apply a constant torque of 8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.
4. Repeat step 3 with the steering wheel at a maximum left turn position.

Results

- If rpm/min exceeds specification, perform the steering

valve leakage test. (See "Test Steering Valve Leakage" on page 334.)

Specifications

Steering Wheel Turns per Minute

at 8 N•m (72 lb-in.) Constant Torque 6 Maximum

Test Steering Valve Leakage

Reason

To determine if leakage is in steering valve or in steering cylinder.

Procedure

Note: Ensure hydraulic fluid temperature is 43°C (110°F) or above.

1. Park machine on a level surface.
2. Move mow-transport lever to transport position.
3. Lower cutting units to the ground.
4. Turn key switch to stop position.
5. Lock park brake.



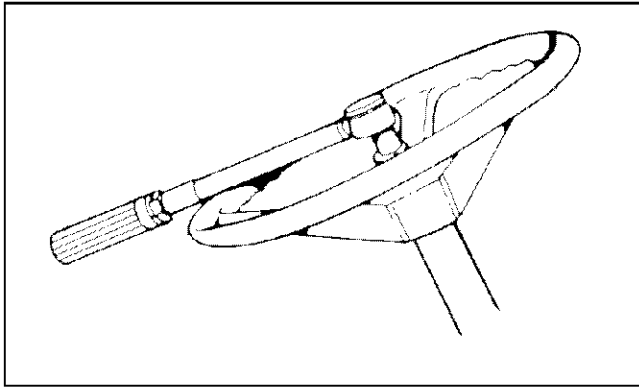
Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Important: Avoid Damage! Cap or plug all openings to avoid contamination.

6. Disconnect and cap the lines at the steering cylinder.
7. Start engine and set throttle to slow idle.

STEERING TESTS AND ADJUSTMENTS



M46864A

8. With steering wheel at a maximum right turn position, apply a constant torque of 8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.
9. Repeat step 3 with the steering wheel at a maximum left turn position.

Results

- If rpm/min. exceeds specification, repair the steering valve.
- If rpm/min. is less than specification, replace the steering cylinder.

Specifications

Steering Wheel Turns per Minute
at 8 N•m (72 lb-in.) Constant Torque.6 Maximum

Test Steering System Relief Valve Pressure

Reason

To determine if the charge pump is producing enough pressure to operate steering system.

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose 34,473 kPa (5,000 psi)	JT03017	Pressure check.
T-Fitting, 9/16-16 F ORFS x 9/16-16 M ORFS x 9/16-16 M ORFS	AMT1043	Connect pressure gauge for steering and lift system relief valve pressure test.
Pressure Gauge 0-40 000 kPa (0-6000 psi)	JT07047	Connect pressure gauge for steering and lift system relief valve pressure test.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Male Quick Coupler, 11/16-16 F ORFS	RE43774	Connect pressure gauge for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gauge for steering and lift system relief valve pressure test.

Procedure

Test is performed by reading system pressure between rear section of charge pump and steering valve.

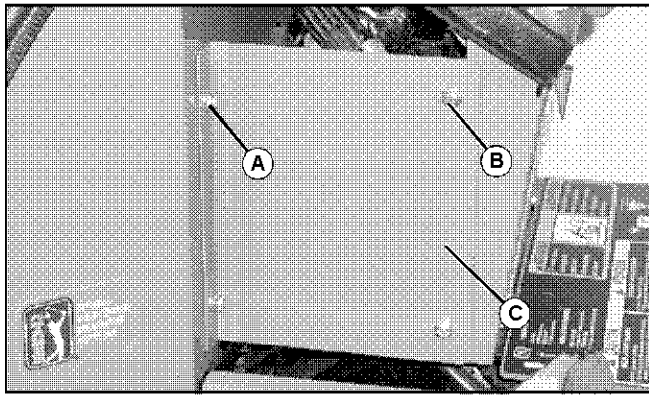
1. Park machine on a level surface.
2. Move mow-transport lever to transport position.
3. Lower cutting units to the ground.
4. Turn key switch to stop position.
5. Lock park brake.



Caution: Avoid Injury! 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 connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

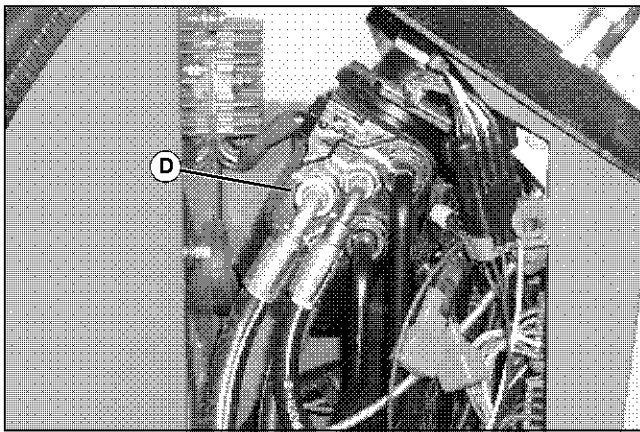
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

STEERING TESTS AND ADJUSTMENTS



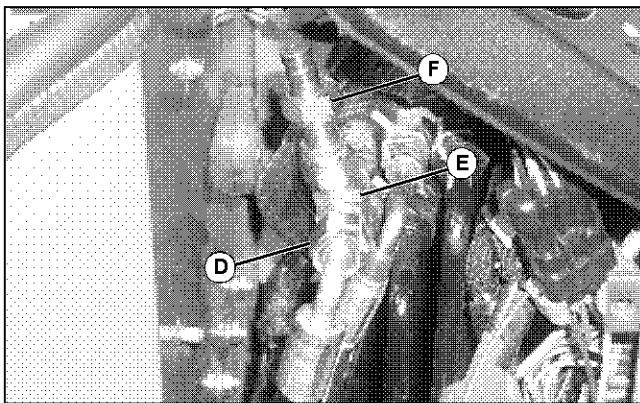
MX23256

6. Remove two flange nuts (A), two cap screws (B), and access panel (C).



MX23257

7. Disconnect charge pump hose fitting (D) on forward port as shown.

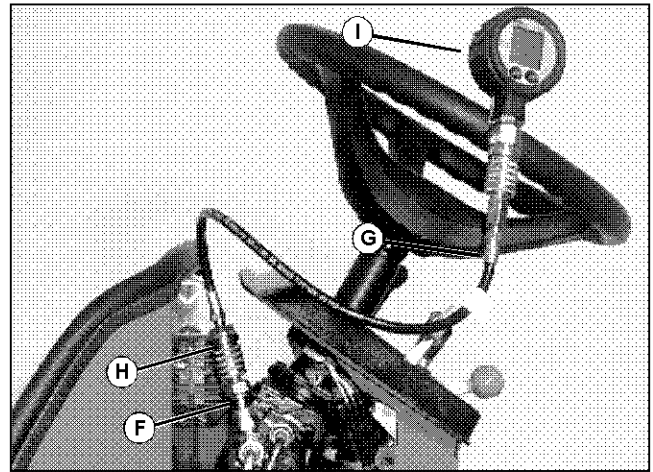


MX23258

8. Install AMT1043 T-Fitting (E) and RE43774 Male Quick Coupler (F).
9. Connect charge pump hose (D) to AMT1043 T-Fitting.



Caution: Avoid Injury! Do Not Use A Test Pressure Gauge Rated Lower Than Recommend. Do Not Move Steering Wheel Or Lift Levers While Test Is In Progress.



MX23259

10. Assemble JT03017 Hose (G), RE48122 Female Quick Coupler (H) and JT07047 Gauge (I). Connect to RE43774 Male Quick Coupler (F).

11. Start engine and run at full throttle.

Important: Avoid Damage! DO NOT turn steering wheel or operate lift system while performing this test. Doing so will result in readings above the pressure setting because of system back pressure.

12. Note reading on gauge.

Results

- If charge pump does not meet specifications, rebuild or replace charge pump.
- Bleed air from hydraulic system. (See "Bleed Hydraulic System" on page 309.)

Specifications

Steering System Relief

Valve Pressure 9997 kPa (1450 psi)

STEERING REPAIR

Repair

Remove and Install Steering Control Unit (SCU)

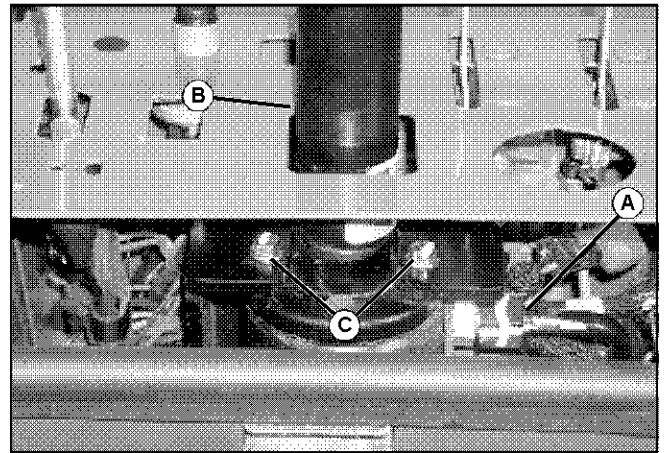
Removal

1. Park machine on a level surface.
2. Move mow-transport lever to transport position.
3. Lower cutting units to the ground.
4. Turn key switch to stop position.
5. Lock park brake.
6. Chock front wheels to prevent inadvertent movement of machine.
7. Raise hood and secure in the upright position.
8. Disconnect negative (-) battery cable.
9. Remove control console. (See "Disassemble and Assemble Control Console" on page 393.)



Caution: Avoid Injury! 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 connections before applying pressure. Search 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. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.



MX23263

10. Label and disconnect five hydraulic hoses (A) from side of SCU (B).
11. Remove two cap screws (C) securing SCU to machine frame.
12. Remove SCU.

Installation

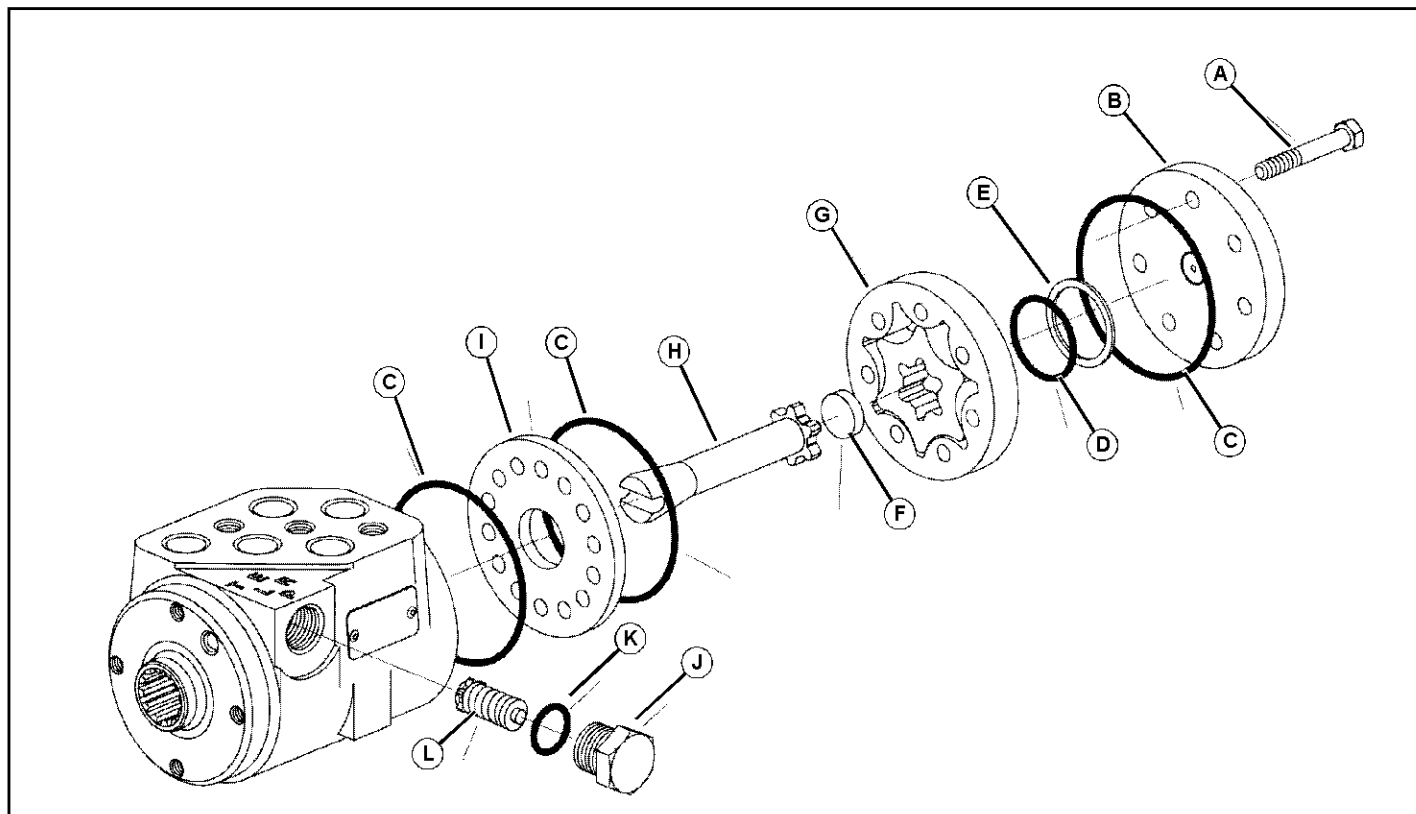
Installation is done in the reverse order of removal.

- Verify proper operation of the hydraulic system.
- Bleed air from hydraulic system. (See "Bleed Hydraulic System" on page 309.)

STEERING REPAIR

Disassemble Steering Control Unit (SCU)

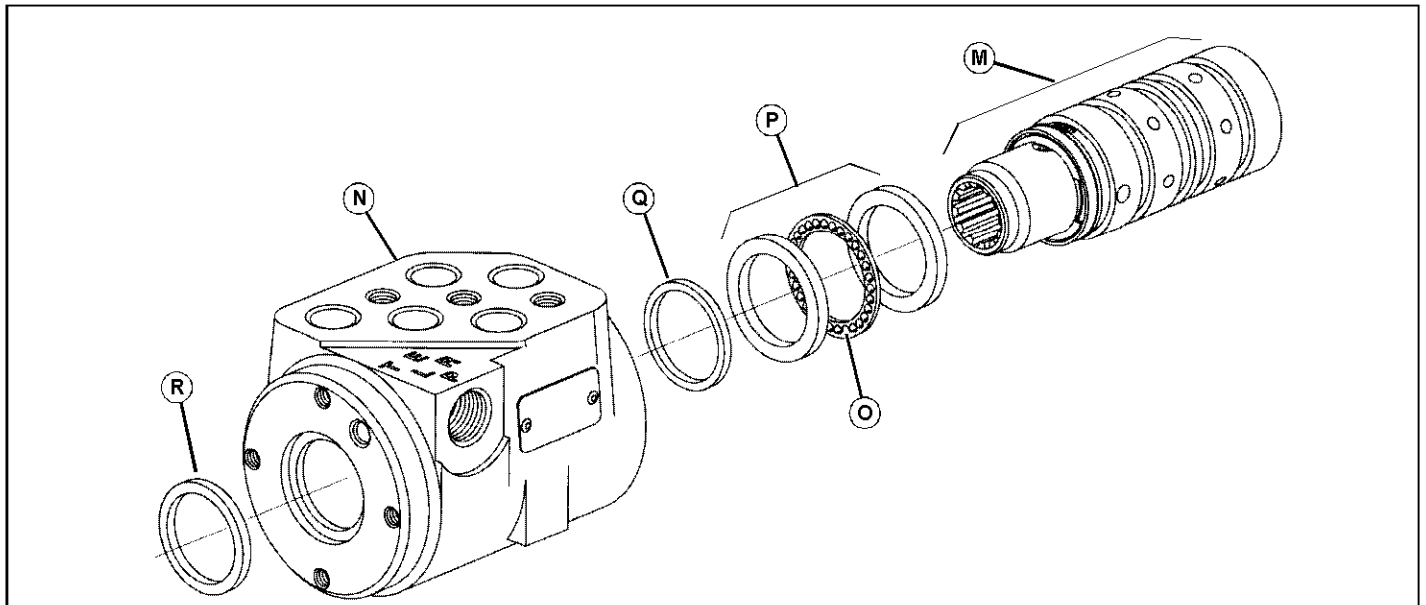
Important: Avoid Damage! Cleanliness is extremely important when repairing the hydraulic Steering Control Unit (SCU). Before disconnecting the hydraulic lines, clean the port area of the SCU, then drain the fluid and plug all ports. Clean the exterior of the SCU thoroughly and protect the machined surfaces during the repair procedure.



M72934

1. Remove seven cap screws (A) and end cover (B).
2. Remove O-rings (C and D), seal ring (E), and spacer (F).
3. Remove gerotor (G) and O-ring.
4. Remove drive (H).
5. Remove wear plate (I) and O-ring.
6. Remove plug (J), O-ring (K), and manual steering check/relief valve (L).

STEERING REPAIR



M72935

Assemble Steering Control Unit (SCU)

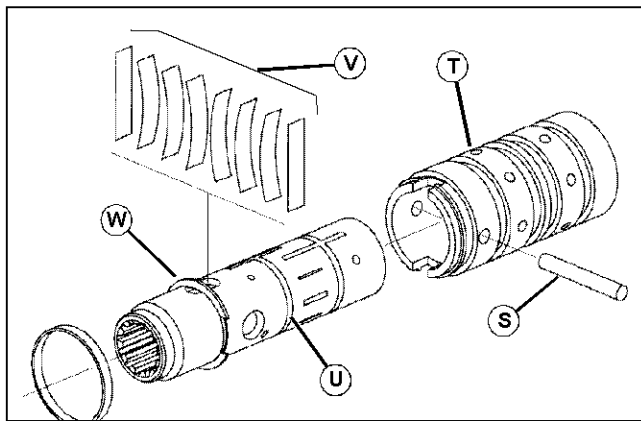
7. Slide the spool and sleeve (M) from the housing (N).
8. Remove the thrust bearing (O) and bearing races (P).
9. Remove the quad seal (Q).

Important: Avoid Damage! Do not damage the dust seal seat.

10. Remove dust seal (R).

Important: Avoid Damage! Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with compressed air. DO NOT dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

Note: Always use new seals when reassembling the hydraulic steering control unit. During reassembly, lubricate the new seals with petroleum jelly. Also lubricate the machined surfaces and bearings with clean hydraulic fluid.



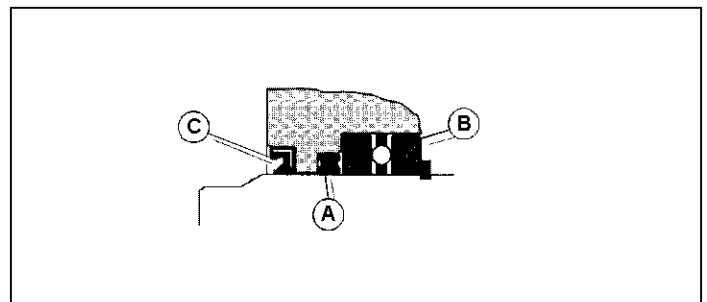
M72936A

11. Remove the pin (S) that holds the sleeve (T) and spool (U) together.
12. Carefully slide the spool out of the sleeve. The springs (V) and retaining ring (W) will stay with the spool when it is removed.



Caution: Avoid Injury! The centering springs are under tension. Remove the retaining ring carefully.

13. Remove the retaining ring and springs.



M72937

1. Install the quad seal (A):
 - Put one of the bearing races (B) and sleeve into the housing.
 - Together, the housing and bearing race create a groove into which the quad seal will be installed.
 - Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.
 - Fit the quad seal into its seat through the input end of

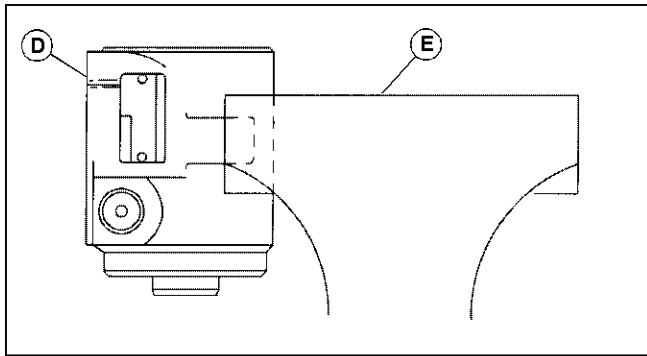
STEERING REPAIR

the housing. Ensure the seal is not twisted.

2. Remove the sleeve and bearing race.
3. Lubricate and install the dust seal (C) using a seal driver. Position the seal as shown above.
4. Install the centering springs in the spool. It is best to install the two flat pieces first. Next, install the curved pieces, three at a time.
5. Fit the retaining ring over the centering springs.
6. Apply a light coat of clean hydraulic fluid to the spool and slide it into the sleeve. Ensure the centering springs fit into the notches in the sleeve.
7. Install the pin.
8. Apply a light coat of petroleum jelly to the inner edge of the dust and quad seals.
9. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races.

Important: Avoid Damage! DO NOT damage the dust or quad seals while installing spool and sleeve assembly. Slight back and forth rotation while installing spool and sleeve will help to prevent damage to seals.

10. Apply a light coat of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing. Be sure pin is installed in spool and sleeve before installing in housing.



M72938

11. Clamp the housing (D) in a vise (E), using just enough clamping force to hold the housing secure.
12. Lubricate and install a new O-ring seal in the groove in the housing.
13. Install the wear plate and align the holes in the wear plate with the threaded holes in the housing.

Note: The holes in the wear plate are symmetrical.

14. Install the drive, ensuring that the slot in the drive engages the pin.
15. Lubricate and install a new O-ring seal in the groove of

the wear plate.

16. Install the gerotor and align the screw holes.
17. Lubricate and install a new O-ring and seal ring in the groove of the gerotor star.
18. Install the spacer.
19. Install the end cap and seven cap screws. Tighten cap screws in alternating pattern to specification.

Specifications

Steering Control Unit

Cap Screw Torque 17 N•m (150 lb-in.)

Remove Steering Clevis

1. Park machine on a level surface.
2. Move mow-transport lever to transport position.
3. Lower cutting units to the ground.
4. Turn key switch to stop position.
5. Lock park brake.
6. Chock front wheels to prevent inadvertent movement of machine.
7. Move seat to full forward position.



Caution: Avoid Injury! The machine can fall or slip from an unsafe lifting device or supports.

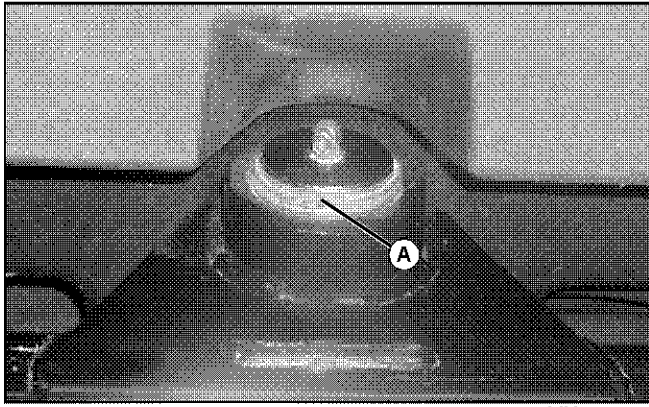
- Use a safe lifting device rated for the load to be lifted.
- Lower machine onto jack stands or other stable supports and block wheels before servicing.

8. Raise and support the rear of the machine with jackstands.

Note: It is not necessary to remove hydraulic hoses from wheel motor for this procedure.

9. Remove the rear wheel and wheel motor from the steering clevis. (See "Remove and Install Rear Wheel" on page 392. See "Remove and Install Rear Wheel Motor" on page 270.)
10. Remove cotter pin and castled nut securing steering cylinder rod to steering clevis. Remove steering cylinder rod from steering clevis.

STEERING REPAIR

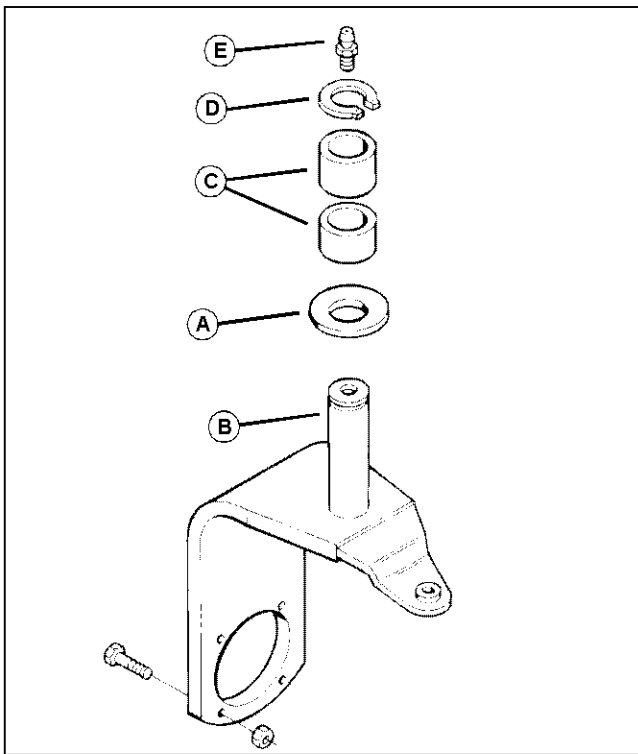


MX23521

11. Remove snap ring (A) and lower the steering clevis to the ground.

12. Inspect steering clevis shaft and bushings, and replace parts as necessary.

Install Steering Clevis



MIF M72958

1. Install thrust washer (A) on steering clevis shaft (B).
2. Apply a light film of grease to the steering clevis shaft and bushings (C).
3. Carefully guide the steering clevis shaft into the shaft housing, being careful not to damage the bushings.
4. Install the snap ring (D) with the sharp edge of the snap ring up. Be sure it is locked in the groove.
5. Install steering cylinder rod to steering clevis and secure

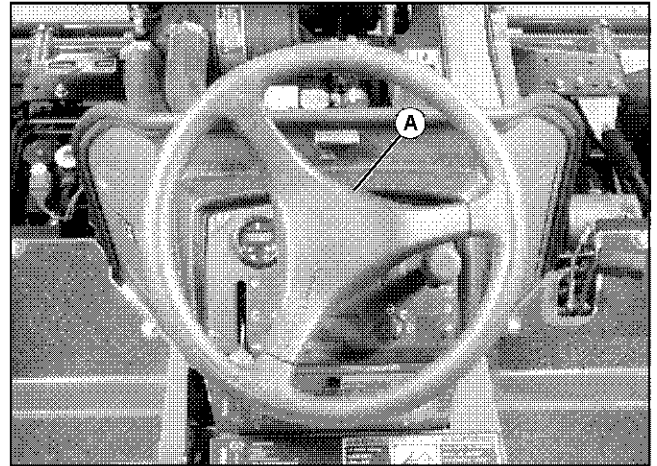
with castled nut and cotter pin.

6. Install the rear wheel motor and rear wheel. (See "Remove and Install Rear Wheel" on page 392. See "Remove and Install Rear Wheel Motor" on page 270.)

7. Grease the steering clevis shaft at the grease fitting (E).

Remove and Install Steering Wheel

Removal

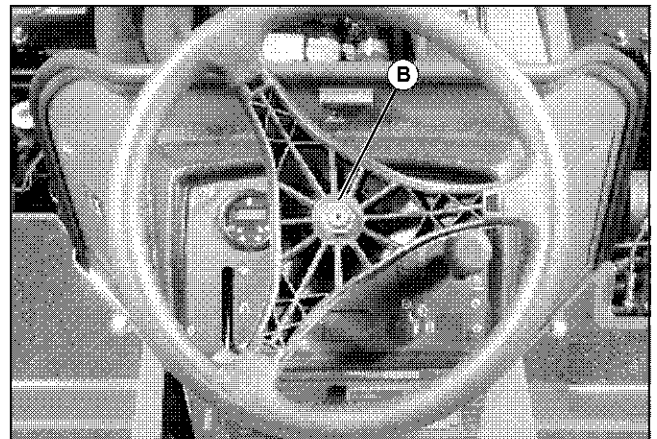


MX23264

1. Remove steering wheel cap (A).

Important: Avoid Damage! DO NOT use a hammer on the end of steering shaft. Damage can occur to steering valve or shaft.

Note: If steering wheel cannot be pulled off shaft easily, use a knife-edge puller to remove.



MX23265

2. Remove nut (B) and steering wheel.

Installation

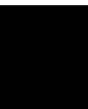
Installation is done in the reverse order of removal.

- Tighten nut to specification.

STEERING REPAIR

Specifications

Steering Wheel Retaining Nut Torque 38 N•m (28 lb-ft)



BRAKES TABLE OF CONTENTS

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BRAKES TABLE OF CONTENTS

BRAKES SPECIFICATIONS

Specifications

General Specifications

Brake Type	Mechanical
Rotor Diameter (Nominal)	203.835 mm (8.025 in.)
Rotor Thickness (New)	4.775 mm (0.188 in.)
Rotor Minimum Thickness.....	3.556 mm (0.140 in.)
Rotor Run-Out.	0.635 mm (0.025 in.)
Brake Pad Minimum Thickness.....	3 mm (0.125 in.)

Torque Specifications

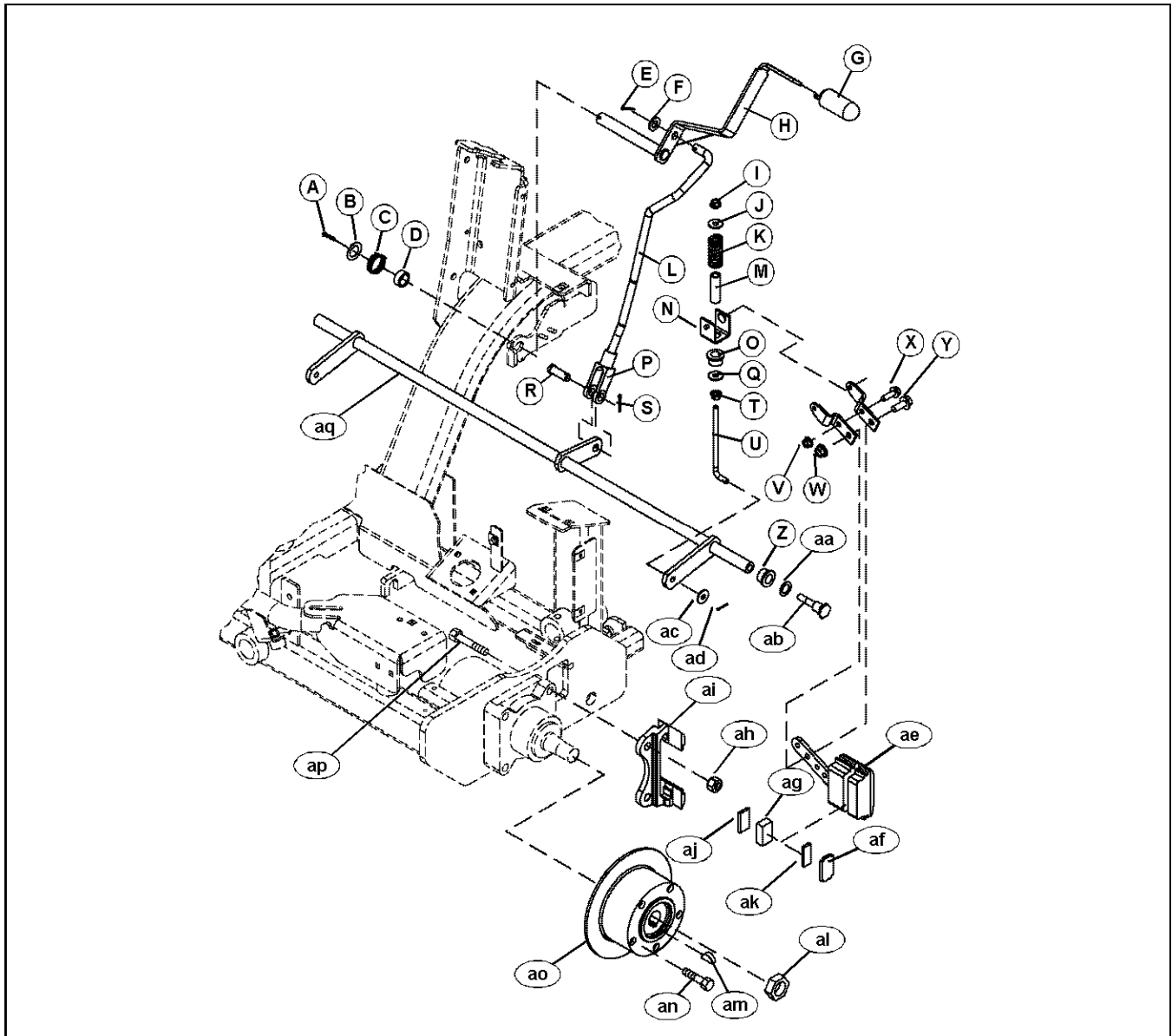
Rotor Retaining Nut	407 N•m (300 lb-ft)
Top Flange Nut	10 N•m (7 lb-ft)



BRAKES COMPONENT LOCATION

Component Location

Brake Components



MX23248

- A- Cotter Pin
- B- Shim
- C- Torsion Spring
- D- Spacer
- E- Cotter Pin
- F- Washer
- G- Knob
- H- Park Brake Lever
- I- Flange Nut
- J- Washer
- K- Spring
- L- Rod
- M- Spacer

- N- Clevis
- O- Bushing
- P- Clevis
- Q- Washer
- R- Pin Fastener
- S- Cotter Pin
- T- Flange Nut
- U- Hook Bolt
- V- Flange Nut
- W- Flange Nut
- X- Cap Screw
- Y- Cap Screw
- Z- Bushing
- AA- Washer

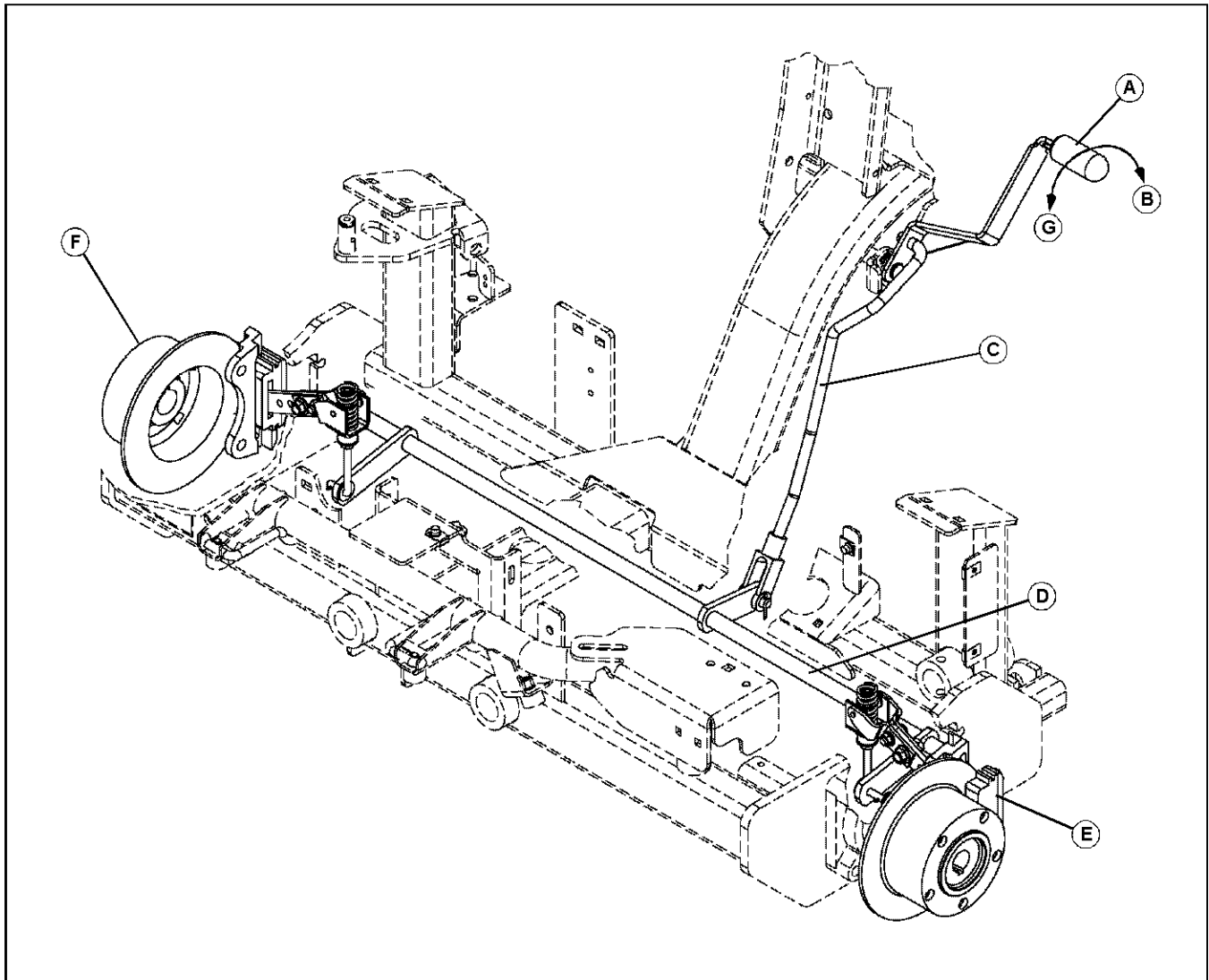
BRAKES COMPONENT LOCATION

AB- Shoulder Bolt
AC- Washer
AD- Cotter Pin
AE- Caliper LH
AF- Backing Plate
AG- Brake Pad, Thick
AH- Flange Nut
AI- Bracket
AJ- Backing Plate
AK- Brake Pad, Thin
AL- Nut
AM- Key
AN- Lug Bolt
AO- Brake Disc
AP- Bolt
AQ- Pivot Rod

BRAKES THEORY OF OPERATION

Theory of Operation

Brake System



MX23249

will stop the engine under certain circumstances.

Function

The park brake is used to prevent movement when the mower is not in use. The park brake is not intended for use in controlling speed or stopping the mower while it is in motion. Primary braking is accomplished by the back pressure in the hydrostatic transmission.

The park brake interlock switch will stop the engine if the operator attempts to move the unit with the park brake locked or leaves the seat without locking the park brake.

Theory

When the park brake lever (A) is pulled toward (B) the operator, the link rod (C) rotates the pivot rod (D), which in turn actuates the caliper link, which causes the brake caliper (E) to force the brake pads against the brake disc (F). This prevents the unit from moving. Operating the park brake lever also operates the brake interlock switch, which

The park brake is automatically locked by moving the park brake lever fully toward the operator. It is unlocked by pushing the lever to the top of the slot (G). When the park brake lever is locked, the brakes will remain locked until the lever is disengaged.

BRAKES DIAGNOSTICS

Diagnostics

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

System: Brake System Troubleshooting

Park Brake Does Not Hold

1. Are brakes adjusted properly? Linkage not worn, binding, or damaged?

Yes: Go to next step.

No: Adjust brakes. (See "Adjust Brakes" on page 350.)

No: Repair or replace linkage as required.

2. Are pads and rotors clean, with no excessive wear or damage?

Yes: Go to next step.

No: Replace pads.

No: Cut or replace rotors.

3. Are calipers functioning properly?

No: Repair or replace as required.

Excessive Brake Wear

1. Are brakes adjusted properly? Linkage not worn, binding, or damaged?

Yes: Go to next step.

No: Adjust brakes. (See "Adjust Brakes" on page 350.)

No: Repair or replace as required.

2. Are calipers functioning properly, not binding or damaged?

Yes: Go to next step.

No: Repair or replace linkage as required.

3. Are rotor machined surfaces smooth and free of excessive wear or damage?

No: Cut or replace rotors.

Brakes Do Not Release

1. Are brakes adjusted properly? Linkage not worn, binding, or damaged?

Yes: Go to next step.

No: Adjust brakes. (See "Adjust Brakes" on page 350.)

No: Repair or replace linkage as required.

2. Are calipers functioning properly, not binding or damaged?

No: Repair or replace as required.

Brake Lever Does Not Return

1. Are brakes adjusted properly? Linkage not worn, binding, or damaged?

Yes: Go to next step.

No: Adjust brakes. (See "Adjust Brakes" on page 350.)

No: Repair or replace linkage as required.

2. Are calipers functioning properly, not binding or damaged?

Yes: Go to next step.

No: Repair or replace as required.

3. Is the park brake lever return spring functioning properly, not broken?

No: Replace brake lever return spring.

Brakes Noisy

1. Are pads and rotors clean, with no excessive wear or damage?

Yes: Go to next step.

No: Replace pads.

No: Cut or replace rotors.

2. Are calipers functioning properly, not binding or damaged?

No: Repair or replace as required.

BRAKES TESTS AND ADJUSTMENTS

Tests and Adjustments

Adjust Brakes

1. Park machine on a level surface.
2. Lock the park brake.



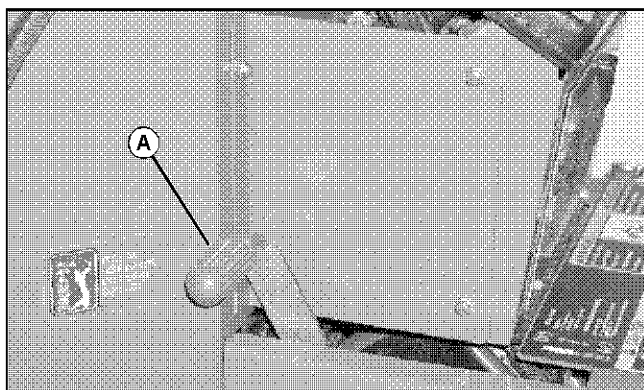
Caution: Avoid Injury! The machine can fall or slip from an unsafe lifting device or supports.

- Use a safe lifting device rated for the load to be lifted.
- Lower machine onto jack stands or other stable supports and block wheels before servicing.

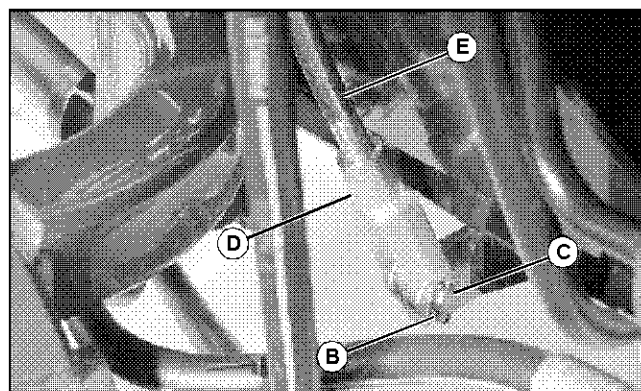
3. Lift and support machine with jack stands.
4. Lower cutting units to the ground.
5. Inspect all rods and linkages for wear or other damage. Replace if required.

Note: There are two pads in each caliper. The inboard pad (closest to actuator) is approximately 1/2 in. thick when new. The outboard pad is approximately 3/8 in. thick when new.

6. Visually inspect brake pads for excessive wear. Replace both pads if either is less than specifications. (See "Remove and Install Brake Pads" on page 353.)



7. To adjust park brake tension, place park brake lever (A) in the unlocked position as shown.



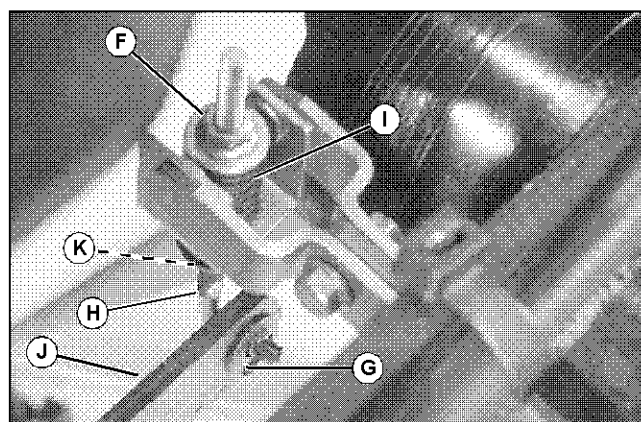
MX23418

8. Remove cotter pin (B) and drilled pin (C).
9. Turn yoke (D) clockwise to shorten rod (E) and counterclockwise to lengthen.
10. Install yoke and drilled pin to check adjustment of park brake.
11. Adjust yoke until brake pads just begin to drag on brake rotor. Then back off one revolution.
12. Install drilled pin and new cotter pin.

If all yoke adjustment has been used:

1. Back off the yoke so threads on rod are flush with yoke.

Important: Avoid Damage! Do not loosen top nut until spring is loose. If top nut is backed off too far, spacer on inside of spring may jump out of hole in spring bracket and bind up brake when top nut is tightened.



MX23423

2. Loosen top flange nut (F) approximately 6 mm (1/4 in.).
3. Remove cotter pin (G) and washer from end of hook bolt (H).
4. While holding caliper arm with spring assembly (I) up as far as possible, adjust hook bolt until end of rod aligns with hole in brake lever arm (J).
5. Install hook bolt, washer, and new cotter pin.

BRAKES TESTS AND ADJUSTMENTS

6. Tighten top flange nut while holding bottom flange nut (K), until top flange nut contacts spacer. Tighten to 10 N•m (7 lb-ft).

7. Repeat steps 2-6 on opposite side.

Specifications

Brake Pad Minimum Thickness 3 mm (0.125 in.)

Top Flange Nut Torque..... 10 N•m (7 lb-ft)

Adjust Park Brake Switch

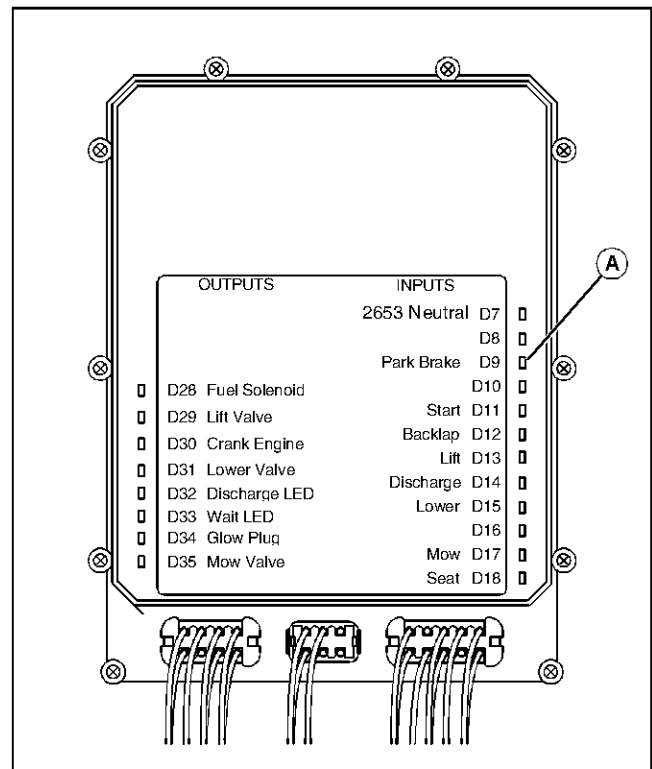
Reason

To ensure the park brake switch is being activated when the park brake is locked.

Procedure

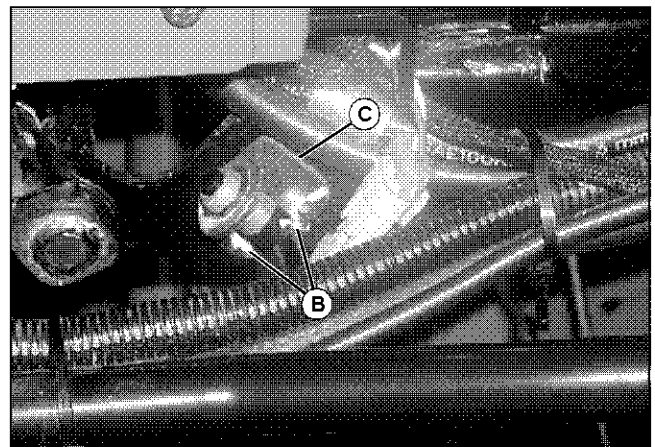
1. Park machine on a level surface.
2. Place mow-transport lever in the transport position.
3. Lower attachments to the ground.
4. Lock the park brake.
5. Stop engine.
6. Open interlock module compartment panel.
7. Turn key switch to the run position.

Note: When checking the input/output lights, identify lights from the numbers printed next to the lights directly on the circuit board. DO NOT read identification numbers to determine location from label, as they may not necessarily align.



M98629 MIF

8. Check the park brake input light "D9" (A) on the interlock module. The light should be on when the park brake is locked. If the light does not come on, proceed to next step.
9. Unlock park brake.



MX23522

10. Loosen cap screws and nuts (B) and slide bracket (C) towards the park brake lever until the park brake input light "D9" on the interlock module is on when the park brake is locked. Tighten nuts.

Results

Unlock the park brake; the brake input light "D9" on the interlock module should be off. Lock the park brake; the brake input light "D9" on the interlock module should be on.

BRAKES TESTS AND ADJUSTMENTS

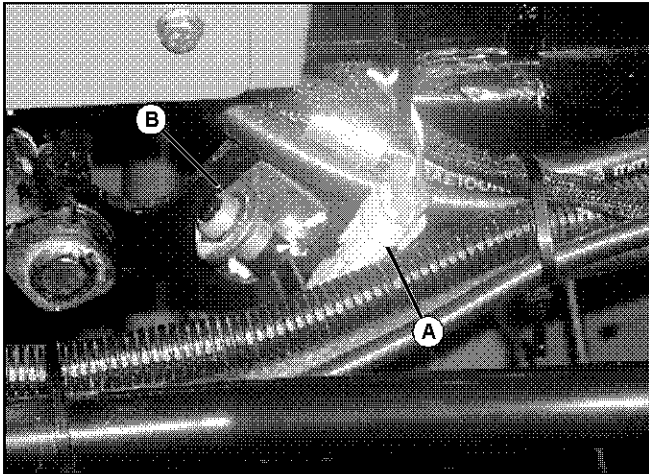
Test Brake Switch

Reason

To ensure that park brake switch is operating properly.

Procedure

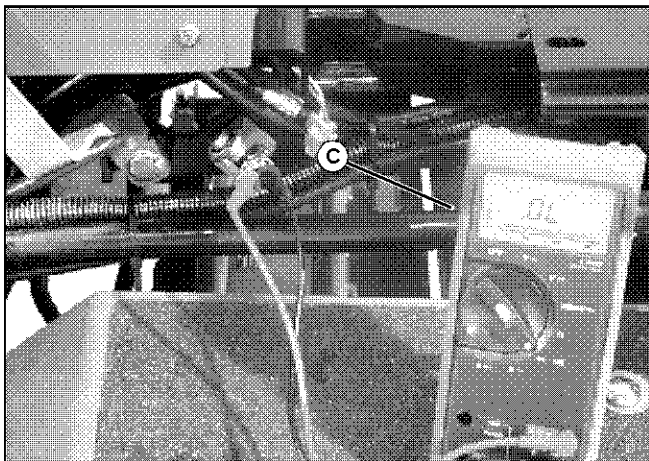
1. Park machine on a level surface.
2. Unlock the park brake.



MX23522

Picture Note: Center channel plate removed for photo clarity.

3. Disconnect connector (A) from brake switch (B).



MX23518

Picture Note: Center channel plate removed for photo clarity.

4. Use test meter (C) to test continuity from center terminal to either side. One contact will have continuity; the other should not.
5. Lock the park brake.
6. Ensure switch is completely depressed. Adjust park brake switch if necessary. (See "Adjust Park Brake Switch" on page 351.)

7. Use test meter to test continuity from center terminal to either side. The opposite terminal should have continuity from step 4. If not, replace switch.

Results

- Engine should start and run under normal operating conditions.

BRAKES REPAIR

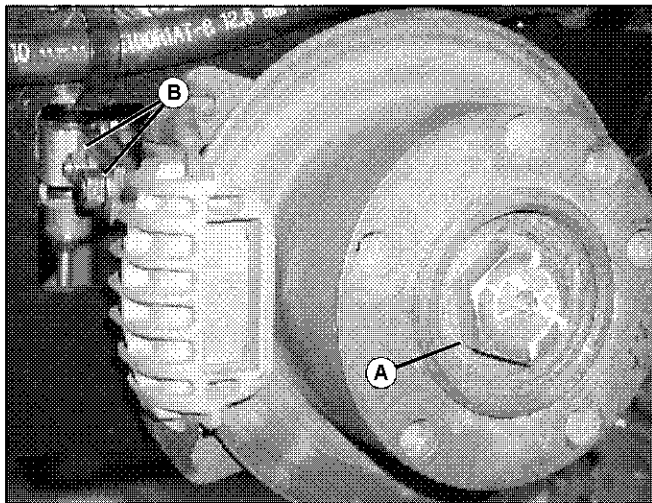
Repair

Remove and Install Brake Pads

Removal

Important: Avoid Damage! Complete pad replacement on one side of vehicle at a time. Right and left units are different internally. Do Not reverse units .

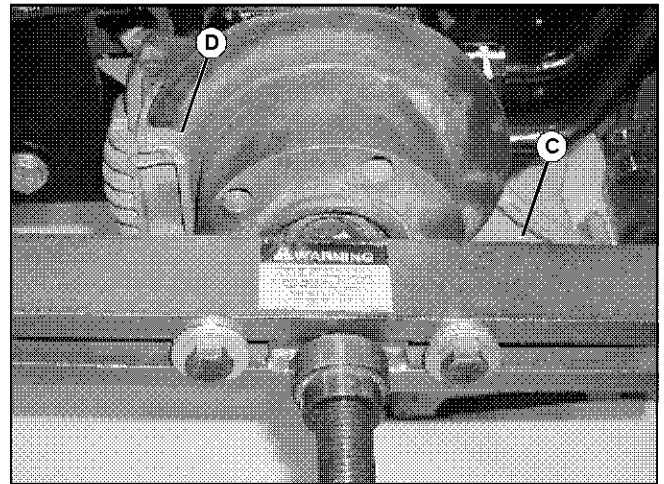
1. Park machine on a level surface.
2. Lock the park brake.
3. Block rear wheel.
4. Lift and support machine with jack stands.
5. Move mow-transport lever to the transport position.
6. Lower cutting units to the ground.
7. Turn key switch to stop position.
8. Unlock the park brake.
9. Disconnect battery negative (-) cable.
10. Raise hood and block in upright position.
11. Remove wheel and tire assembly. (See "Remove and Install Front Wheels" on page 391.)



MX23374

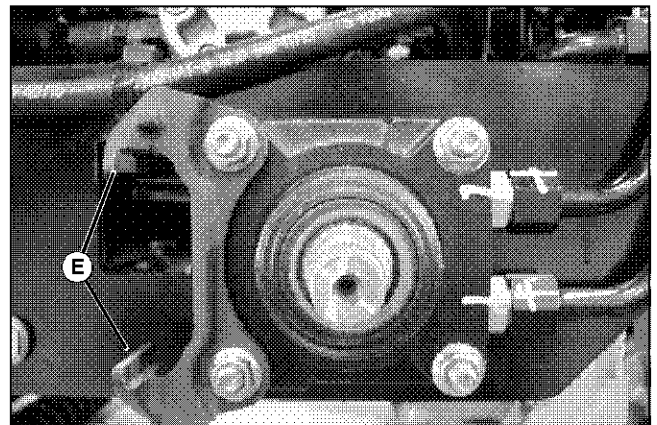
12. Remove rotor retaining nut (A) securing brake rotor to wheel motor.
13. Remove flange cap screws and nuts (B) and remove caliper actuating arm from brake linkage.

Note: Rotor is press fit on a tapered shaft. Loosely reinstall rotor retaining nut on wheel motor shaft to prevent rotor from falling off shaft during removal. Do not tighten nut until it touches rotor.



MX23375

14. Use a suitable puller (C) to loosen rotor from wheel motor.
15. Remove puller and rotor retaining nut.
16. Remove brake caliper (D) and rotor as an assembly.
17. Remove caliper from rotor and inspect caliper housing for damage or wear. Repair or replace if necessary.



MX23376

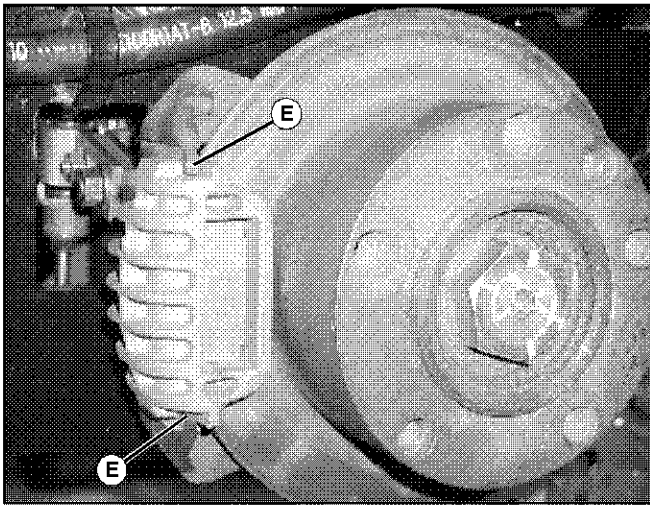
18. Ensure that caliper slides easily on caliper bracket mounting bosses (E). Remove dirt and corrosion as necessary using a wire brush.
19. Remove brake pads and backing plates from caliper.

Installation

Note: There are two pads in each caliper. The inboard one (closest to actuator) is approximately 1/2 in. thick when new. The outboard pad is approximately 3/8 in. thick when new.

1. Install backing plates and brake pads in caliper.

BRAKES REPAIR



MX23374

2. Slide caliper onto rotor and install as an assembly onto tapered shaft of wheel motor. Ensure caliper properly engages caliper bracket mounting bosses (E) as shown.
3. Install rotor retaining nut and torque to specifications.
4. Install caliper actuating arm to brake linkage and secure with flange cap screws and nuts.
5. Install wheel and tire assembly. (See "Remove and Install Front Wheels" on page 391.)
6. Adjust park brake. (See "Adjust Brakes" on page 350.)

Specifications

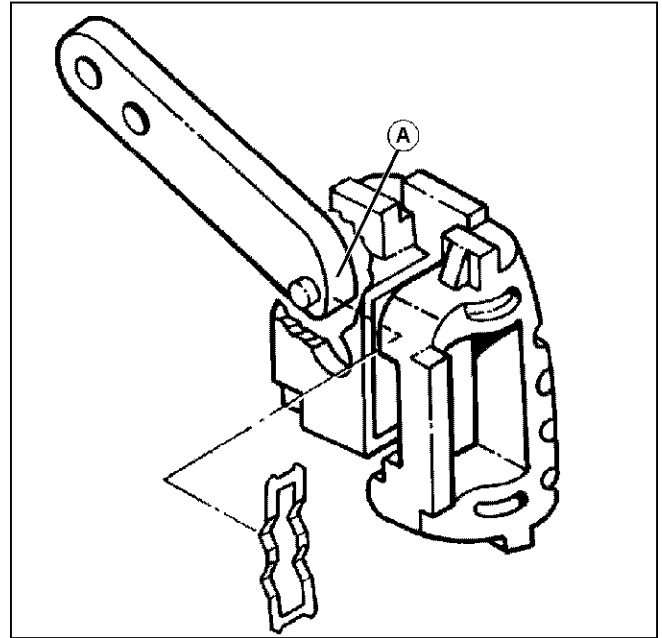
Rotor Retaining Nut Torque. 407 N•m (300 lb-ft)

Replace Brake Caliper

Removal

1. Remove brake caliper, pads, and backing plates. (See "Remove and Install Brake Pads" on page 353.)
2. Remove retaining clip and actuator arm from caliper.

Installation



MX23354

Picture Note: Left caliper shown.

Note: Pay special attention to orientation of actuator arm cam surface (A). Pins should be in top slot in caliper body.

1. Install actuator arm and retaining clip as shown.
2. Install backing plates, pads, and brake caliper. (See "Remove and Install Brake Pads" on page 353.)

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ATTACHMENTS SPECIFICATIONS

Specifications

General Specifications

Make.....	John Deere QA-7
Size	66 cm (26 in.) or 76.2 cm (30 in.)
Backlapping	On machine variable speed (standard)
Clip Ratio	
5-Blade.....	0.320 kph (0.201 mph)
8-Blade.....	0.200 kph (0.126 mph)
Front Rollers.....	Optional (smooth or grooved)
Reel Diameter	17.8 cm (7 in.)
Bed Knife Adjustment	Reel-to-bed knife
Number of Blades.....	5 or 8
Cutting Unit Drive.....	Hydraulic

Repair Specifications

Bed Knife Top Surface	6.5° Relief angle
Front Surface	5° Relief angle
Reel	Spin grind with 20° Relief angle
Roller	Smooth, grooved
Reel-to-Bed Knife Clearance	0.050 mm (0.002 in.)

Torque Specifications

Bed Knife Support

Hex Screw Torque (Initial)	26 N•m (19 lb-ft)
Hex Screw Torque (Final).....	47 N•m (35 lb-ft)
Bed Knife Support-to-Cutter Frame Bolt Torque.....	61 N•m (45 lb-ft)

Reel Mounting

Reel Retaining Nut Torque.....	68 N•m (50 lb-ft) min
Pivot Arm Forward Shoulder Bolt.....	47 N•m (35 lb-ft)
Pivot Arm Rear Shoulder Bolt.....	81 N•m (60 lb-ft)
Shaft Rotation Torque	0.80 N•m (7 lb-ft) w/ ET 15755 Grease

Roller Mounting

Bolts.....	47 N•m (35 lb-ft)
Shaft End Play	0.152 mm (0.006 in.)
Self-Locking Nut Torque	0.35-0.79 N•m (3-7 lb-in.)

ATTACHMENTS TOOLS AND MATERIALS

Tools and Materials

Special or Required Tools

Note: Order tools according to information given in the *U.S. SERVICEGARD™ Catalog* or in the *European Microfiche Tool Catalog (MTC)*.

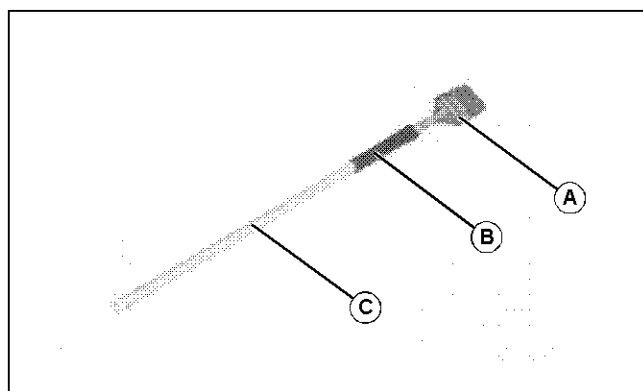
Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	TCU13823	Used to adjust cutting height.
Feeler Gauge, 0.051 mm (0.002 in.)	N/A	Used to measure reel-to-bed knife clearance.

Other Material

Part No.	Part Name	Part Use
N/A	Lapping Compound	Used to perform backlapping procedure.
TY25083	John Deere Golf and Turf Cutting Unit Grease	Used to lubricate mower bearings and seals.
TY24425	John Deere Special Purpose HD Water Resistant Grease	Used to lubricate roller shaft bearing.
TY24811	NEVER-SEEZ™	Applied to bed knife support mounting bolts.

Dealer Fabricated Tools



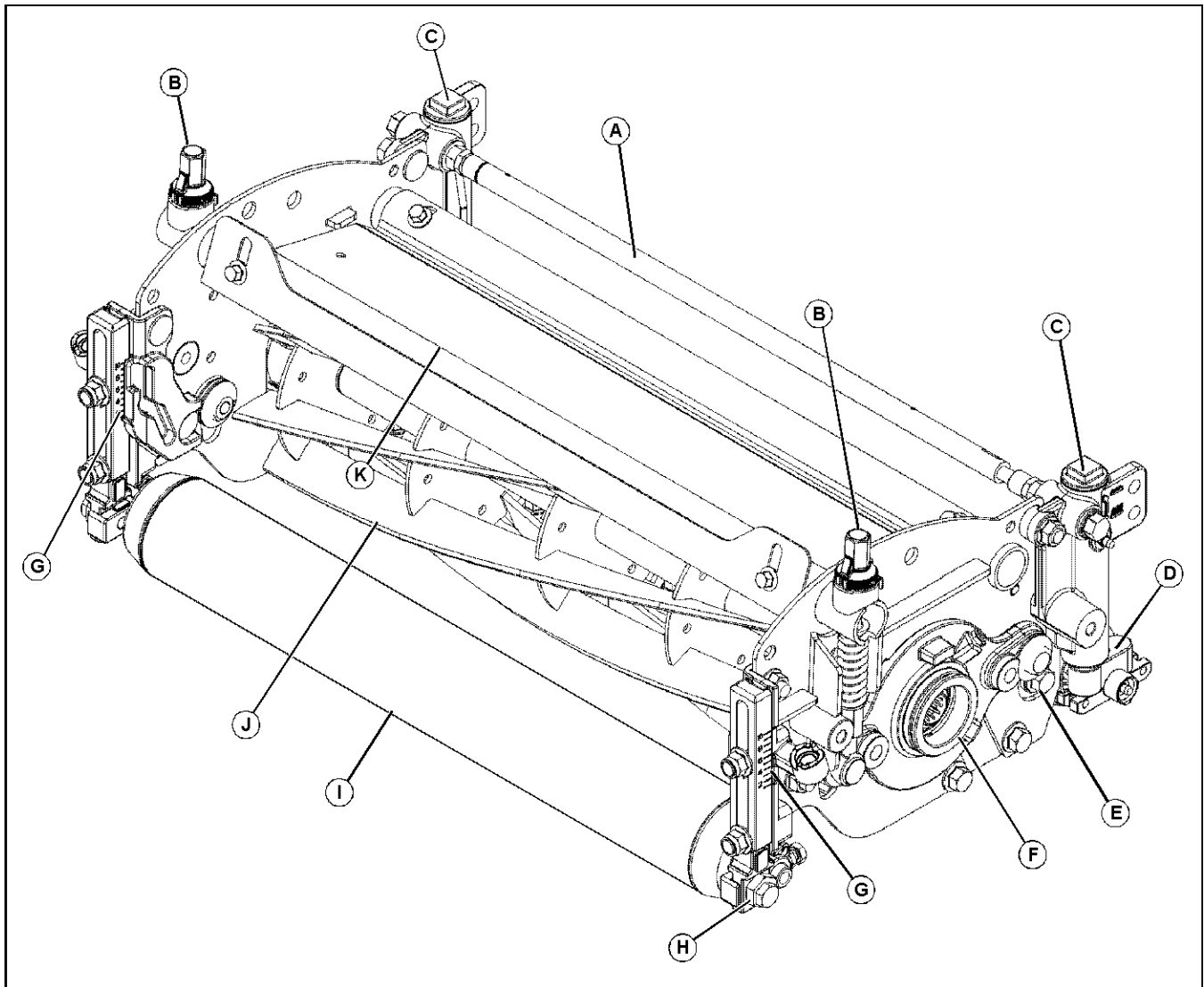
M32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

ATTACHMENTS COMPONENT LOCATION

Component Location

Reel Mower QA-7 Series



MX42125

- A- Connecting Shaft, Rear Roller Height
- B- Bed Knife Adjusters
- C- Rear Roller Height Adjuster
- D- Rear Roller Attachment
- E- Cam Plate
- F- Bearing Housing / Motor Mount¹
- G- Front Roller Height-of-Cut Range Adjustment
- H- Front Roller Parallel Adjustment Cam
- I- Front Roller
- J- Reel
- K- Discharge Shield

¹. Motor may be mounted on either side of reel with balance weight mounted on opposite side.

Theory of Operation

Reel and Bed Knife Grinding

Reel and Bed Knife Relationship

Reel mowers are precision machines requiring daily maintenance to maintain the well-groomed appearance of turfgrass. The scissor-like shearing action, which only a reel mower is capable of achieving, is possible only if the reel and bed knife are sharp and the reel-to-bed knife clearance is maintained.

Close examination of the reel-to-bed knife relationship reveals two square edges passing one another with approximately 0.050 mm (0.002 in.) clearance. There are several reasons why this clearance is necessary.

- When the reel is allowed to contact the bed knife, the square (sharp) edges of the reel and bed knife will roll over, becoming dull.
- Contact between the reel and bed knife generates heat. Heat generated through this contact will distort the shape of the bed knife. Distortion causes the bed knife to draw closer to the reel, resulting in more rollover of the cutting surfaces and more heat generated in the bed knife.
- Drag produced by an improperly adjusted cutting unit may result in an unacceptable clip ratio, undue strain on drive mechanisms, and premature wear of the cutting unit.

Reasons for Grinding

- To restore the cylindrical shape of a reel that has become cone-shaped due to improper adjustment of the reel-to-bed knife clearance or worn reel bearings.
- To restore the edge when the grass is not being cut across the entire length of the bed knife, evidenced by streaks of grass left after the mower has passed, usually the result of nicked blades caused by hitting foreign objects in the grass.
- To restore the edge when the lack of frequent backlapping allowed the edge to be rounded beyond the capability of the backlapping procedure to restore the edge.
- To restore the edge when the reel-to-bed knife clearance has been improperly adjusted (reel contacting bed knife).

Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass toward the bed knife, where it is sheared by the cutting edges as they pass one another.

In order for the grass to be cut at the proper height, it must contact the bed knife at the cutting edge. This is accomplished by grinding a 5° relief angle on the front face of the bed knife. Without a relief angle, the blade of grass will contact the lower edge of the bed knife and be bent

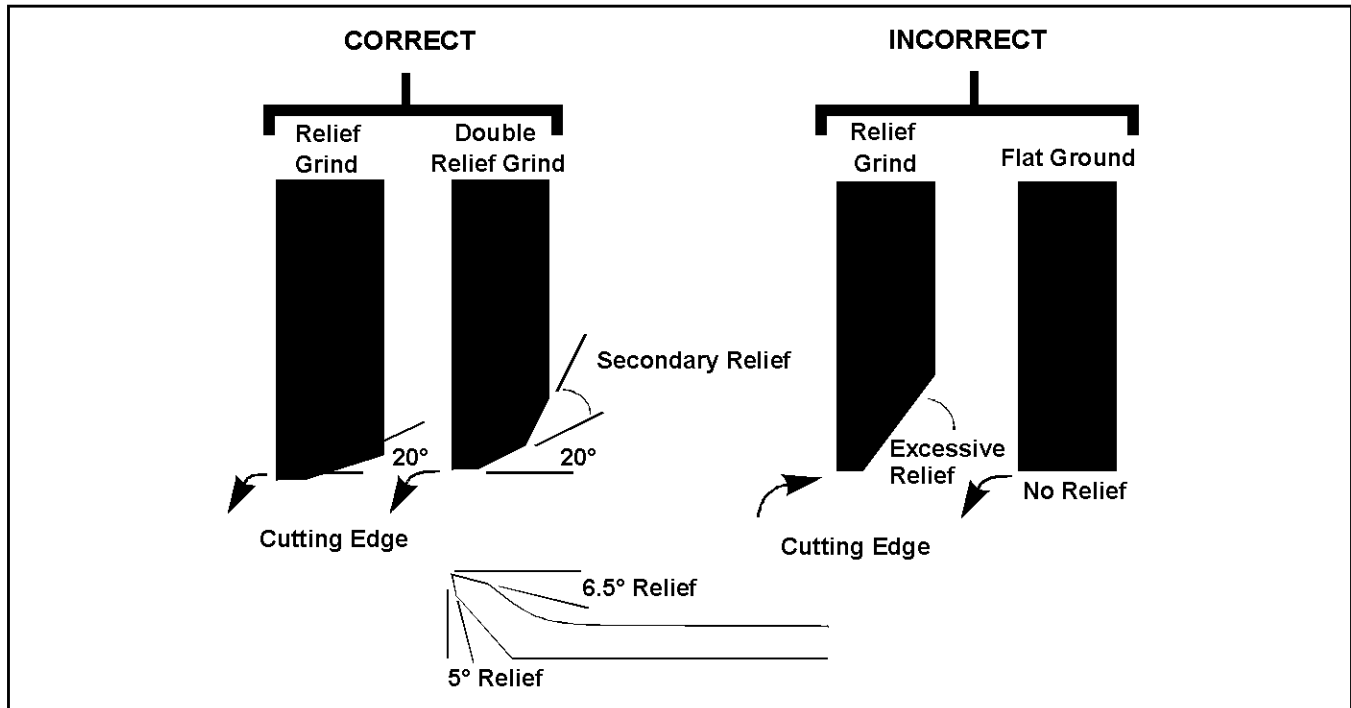
over at too much of an angle prior to being cut. In the case of mowing greens, where very small cuts are being taken, the reel may not capture the grass at all, and no grass will be cut.

Although some spin grinding machine manufacturers say backlapping is not necessary, John Deere recommends backlapping after spin grinding to remove burrs and rough edges left from the spin grinding procedure. Backlapping produces a honed edge that will cut the grass evenly and leave the tops of the grass with clean, straight edges.

It is important to note that dull cutting edges will tear rather than shear the grass drawn into the bed knife. This will shock the grass plant and retard its growth.

ATTACHMENTS THEORY OF OPERATION

Relief Grinding



MIF

John Deere recommends relief grinding the reels before spin grinding for the following reasons:

- Reduces blade contact area, results in less friction, requiring less horsepower to drive the reels.
- Ensures longer wear life.
- Less time is required to backlap.
- Reduces pulling and tearing of the grass as the unit gets dull by use.
- Provides an area for backlapping compound to be trapped to more effectively backlap reels.
- Relief grinding removes metal from the trailing edge of the blade, forming an angle (relief angle) to reduce the contact area of the cutting edges.
- Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is 0.025-0.052 mm (0.001-0.002 in.) out-of-round.

Backlapping

This procedure is used to sharpen the cutting edges when grinding is not necessary. Determine if grinding is necessary. (See "Reel and Bed Knife Grinding" on page 360.)

Backlapping, when compared to grinding, removes a very small amount of metal, requires less time, and will effect a smooth, clean cut.

The backlapping procedure is accomplished by spinning the reel backwards while applying special abrasive

compounds to the reel. Usually, coarse compounds are used initially, followed by a finer abrasive for final honing. Recommended grits for fairways and roughs are 60, 80, and 120. Reel sharpening compounds should not be toxic, oily, or greasy.

The cutting unit should be inspected, backlapped, adjusted, and checked daily for a uniform cut along the complete length of the bed knife. It is important that the adjustment allows the reel to turn freely without dragging against the bed knife. Metal-to-metal contact will generate heat, causing the reel to expand and intensifying the dragging that produces more heat. This vicious cycle will quickly "shut down" the mower.

Smooth Roller

The roller is used as a ground-sensing device to detect changes in the contour of the turf as the mower moves forward.

A smooth roller is generally used on the rear of a cutting unit to establish the cutting height range. (Under certain circumstances, grooved rollers are used on the rear.)

A front roller used in conjunction with a rear roller is needed to achieve more exact cutting heights under 25.4 mm (1 in.).

Grooved Roller

The grooved roller is used as a ground-sensing device to detect changes in the contour of the turf as the mower moves forward. The main advantage in using a grooved roller rather than a smooth one comes when cutting long grass that is very wet. Grass that is wet will tend to stay

ATTACHMENTS THEORY OF OPERATION

down rather than spring up after the roller passes. Grooved rollers will not bend the grass over, allowing it to be cut rather than passed over.

Along with advantages come disadvantages. Because of the reduced contact area, inherent with a grooved roller, the roller may penetrate deeper into the soil, lowering the effective cutting height and possibly scalping the turf.

Performance Variables

Three performance variables that affect the quality of cut are these:

- Number of reel blades
- Reel rpm
- Ground speed of machine

Note: When discussing performance variables, we must assume that other factors such as rate of growth, mowing frequency, mowing patterns, soil fertility, and equipment condition have been considered and are not affecting the quality of cut.

To apply performance variables to a formula, we need to understand three terms:

- Shear point - A single point of cutting contact between the cutting unit and the turf. Due to the reel mower design, there are an infinite number of shear points across the bed knife.
- Clip Ratio (CR) - The forward distance traveled between successive cutting contacts at any one shear point.
- Cutting Height (CH) - The distance above the soil line that grasses are clipped.

The most uniform cut occurs when the Clip Ratio (CR) equals the Cutting Height (CH). If CR is greater than CH, marcelling (a wavy, rib-like appearance) occurs. If CH is greater than CR, the rotating blades create a fanning effect that blows the grass down without cutting it. CR is controlled by the performance variables (the number of blades selected, ground speed, and reel speed).

Of these performance variables, only two, in most cases, are we able to change. We can use a reel with a different number of blades, and/or we can change the vehicle ground speed.

Since we know the number of blades the reel has, what the reel speed is, the cutting height, and the clip ratio (since CR must equal CH), let's find the vehicle ground speed.

Here's the formula:

$$\text{MPH} = (\text{Reel RPM}) \times (\text{CR or CH}) \times (\text{Number of Reel Blades}) \div 1056$$

Example

Using:

- 2653 Professional Utility Mower at a tested reel speed of 1000-1050 rpm
- 8-blade reel on a cutting unit
- CH = CR (0.58)

Find: MPH (Vehicle Speed)

Note: To calculate MPH, multiply 0.68148 x ft traveled/sec. Another way to calculate speed is to measure off an 88-ft distance, record the length of time (in seconds) it takes to travel that distance, and divide 60 by that time.

Diagnostics

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

System: Attachments Troubleshooting

Marcelling

1. Is the ground speed correct?

Yes: Go to next step.

No: Increase or decrease ground speed as necessary. (See "Performance Variables" on page 362.)

2. Is engine rpm correct (not too low)?

Yes: Go to next step.

No: Increase engine speed to specification. (See Operator's Manual.

3. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See "Backlapping Procedure" on page 366. See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

4. Is the correct number of reel blades being used for desired clip ratio (CR)?

Yes: Go to next step.

No: Install reel with correct number of blades. (See "Performance Variables" on page 362.)

Streaking

1. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes: Go to next step.

No: Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

2. Are the reel and bed knife in good condition (no nicks, uneven wear, or distortions)?

No: Grind reel and bed knife. (See "Reel and Bed Knife Grinding" on page 360, and "Grinding the Bed Knife and Reel" on page 383.)

Height-of-Cut (HOC) Changes

1. Is the grass dry enough for proper cutting (not too wet)?

Yes: Go to next step.

No: Allow sufficient time for grass to dry before cutting.

2. Is the roller clean (no grass or dirt collecting on the roller)?

Yes: Go to next step.

No: Install scraper or power brush on roller.

3. Is the condition of the soil good (not rough or changing)?

Yes: Go to next step.

No: Use a smooth roller.

4. Is the cutting unit floating properly?

Yes: Go to next step.

No: See Operator's Manual.

5. Are the roller clamp bolts tight?

Yes: Go to next step.

No: Perform height-of-cut (HOC) adjustment. (See "Adjust Height-of-Cut (HOC)" on page 368.)

6. Are the rollers concentric (not out-of-round)?

Yes: Go to next step.

No: Replace roller. (See "Remove and Install Front Roller" on page 376. See "Remove and Install Rear Roller" on page 377.)

7. Are the roller bearings in good condition (not worn)?

No: Replace roller bearings. (See "Repair Front Roller" on page 376. Front and rear roller are repaired in the same manner.

Poor Quality of Cut

1. Is the grass at an acceptable height (not too high)?

Yes: Go to next step.

No: Mow grass more frequently.

2. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See "Backlapping Procedure" on page 366.)

3. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

No: Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

Reel Does Not Rotate

1. Is the machine operating properly?

Yes: Go to next step.

No: See Operator's Manual.

2. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes: Go to next step.

No: Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

3. Are the roller bearings in good condition (not worn or seized)?

No: Replace roller bearings. (See "Repair Front Roller" on page 376 or "Disassembly - Roller" on page 377.) and "Assembly - Roller" on page 378

Unit Not Cutting

1. Is the grass dry and height of the grass not too excessive?

Yes: Go to next step.

No: Allow sufficient time for grass to dry and mow more frequently.

2. Are the engine and ground speeds correct?

Yes: Go to next step.

No: Adjust engine speed to specification. (See Operator's Manual.) Adjust ground speed to conditions. (See "Performance Variables" on page 362.)

3. Is the correct number of blades used for conditions?

Yes: Go to next step.

No: Install reel with correct number of blades. (See "Performance Variables" on page 362.)

4. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See "Backlapping Procedure" on page 366. See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

5. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

No: Perform reel-to-bed knife adjustment. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

Tests and Adjustments

Backlapping and Reel-to-Bed Knife

It is best to think of backlapping and reel-to-bed knife adjustments as one procedure. Although backlapping removes only a small amount of metal, the clearance between the reel and bed knife will be increased and must be readjusted.

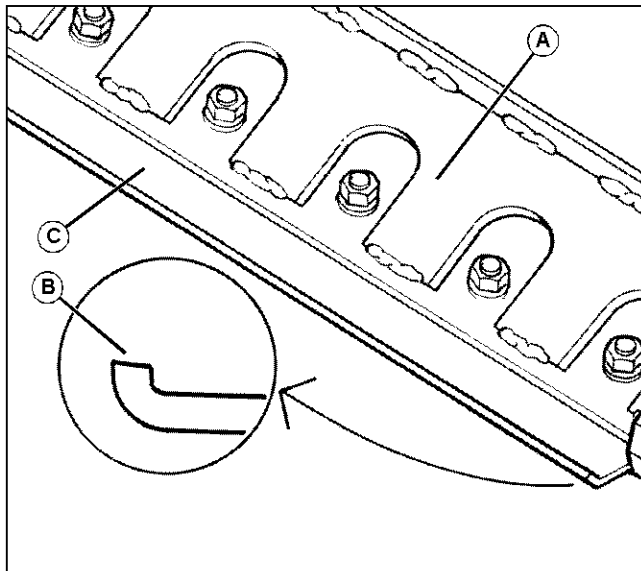
Another very important point to remember is that adjustments can be successful only if the frame integrity (straightness and strength) is maintained. Attaching bolts must be secure and bearings must be well lubricated and not worn.

Inspect Reel and Bed Knife



Caution: Avoid Injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.



M56519

A- Bed Knife Support

B- Land

C- Bed Knife

1. Visually inspect cutting unit for damage. Chipped paint, dents, or gouges may indicate the need for a closer look at the frame for distortion, broken weldments, or other

damage that could prevent proper adjustment. Repair or replace parts as necessary.

2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.

3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge for nicks, gouges, or distortion. Ensure that the cutting edge land (B) does not exceed $\frac{3}{4}$ of the blade thickness. Restore the relief angle and cutting edge before continuing with this procedure. (See "Reel and Bed Knife Grinding" on page 360, and "Grinding the Bed Knife and Reel" on page 383.)

4. Inspect the bed knife (C) cutting edge for nicks, gouges, or distortion.

5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure that the cutting edge land does not exceed $\frac{3}{4}$ of the cutting edge. Replace the bed knife if the cutting edge extends below 1.45 mm (0.057 in.) from the mounting surface.

ATTACHMENTS TESTS AND ADJUSTMENTS

Backlapping Procedure

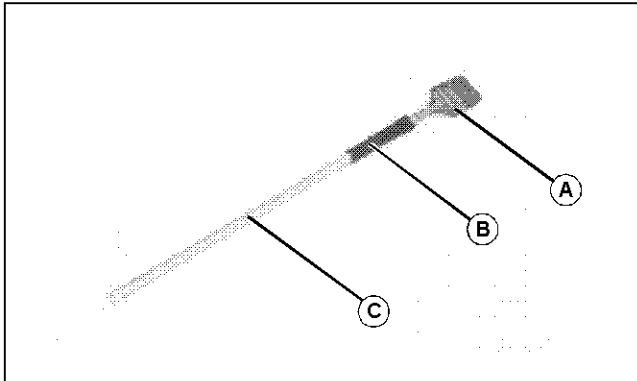
Reason

To provide a consistent cutting action and prolong reel life.

Other Material

Part No.	Part Name	Part Use
N/A	Lapping Compound	Used in backlapping procedure.

Dealer Fabricated Tools



M32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

Procedure



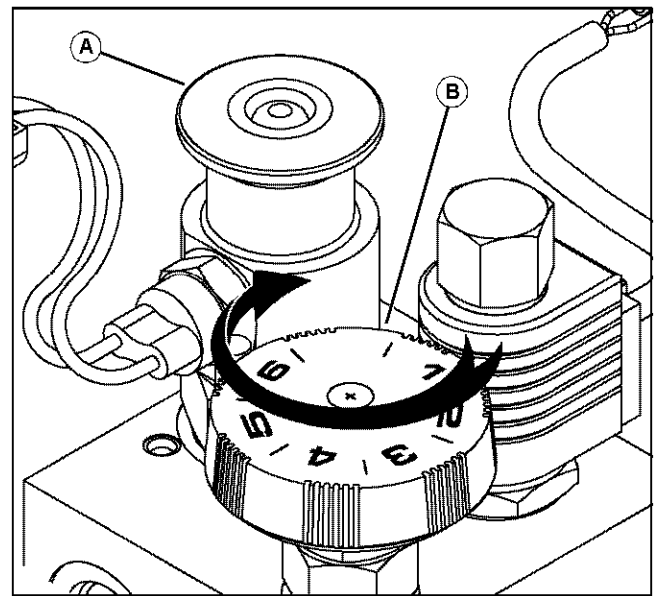
Caution: Avoid Injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running.

Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

Note: Perform reel-to-bed knife adjustment before performing backlapping procedure.

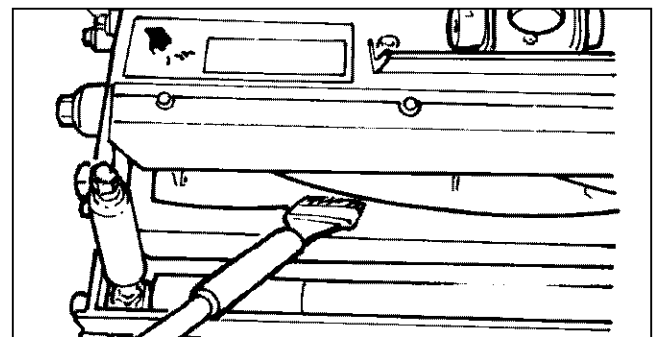
1. Prior to starting, ensure reel-to-bed knife clearance is adjusted to 0.051 mm (0.002 in.).
2. Set the park brake and start the engine. Lower the cutting units to the ground.



MX23253

3. Lift the hood to expose the backlapping valve. Pull up the forward-reverse knob (A).
4. Move the mow-transport lever to the mow position. (The reels should now be rotating in the reverse direction.)
5. Using the flow control knob (B), adjust machine speed to rotate reels at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.

Note: Apply 60- to 80-grit compound for units with extended service time, and 120-grit compound for new, newly ground reels or when applied on a weekly basis.



M56482

6. Apply lapping compound to the rotating reel evenly from one side to the other and back again using a long-handled brush.
7. Allow the reel to spin until quiet. If desired, follow with a 120-grit compound to achieve a smoother finish.

ATTACHMENTS TESTS AND ADJUSTMENTS



Caution: Avoid Injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running.

Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

Important: Avoid Damage! Never operate cutting unit in the forward direction until abrasive compounds are removed from the cutting unit. The abrasive compound will dull the cutting edge.

8. Rinse the lapping compound completely off the cutting unit with water.

9. Move the mow-transport lever to the transport position and shut off the engine. Turn the flow control knob fully counterclockwise.

10. Push forward-reverse knob down.

11. Check reel-to-bed knife clearance. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Reel-to-Bed Knife Clearance



Caution: Avoid Injury! Blades are sharp. Always wear gloves when handling blades or working near blades.

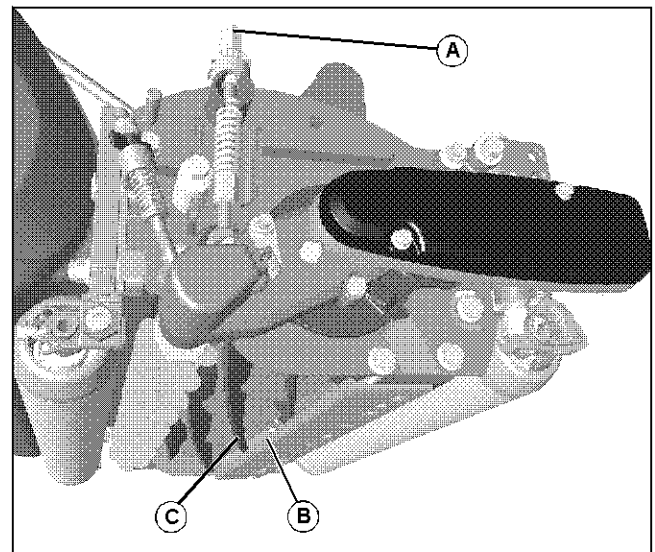
Important: Avoid Damage! Adjust reel to bed knife clearance by lowering and raising the reel evenly.

Do not adjust more than one notch on the adjuster bolt at a time, and alternate side to side.

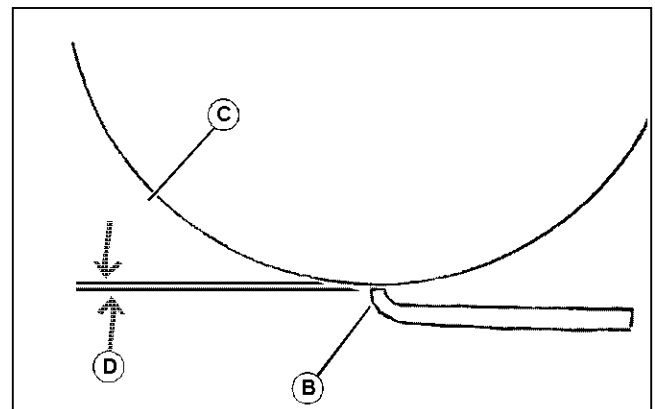
1. Raise reels slightly off the ground to gain access to underside of each reel.

2. Park machine safely. (See "Park Machine Safely" in the Safety section.)

Note: Each notch on the adjustment bolt (A) represents 0.025 mm (0.001 in.) movement of the reel (C).



MX41221



E35559

3. With the use of a feeler gauge in the center of the reel, alternately turn adjustment bolts (A) (one on each side) evenly (no more than one notch at a time) until bed knife

ATTACHMENTS TESTS AND ADJUSTMENTS

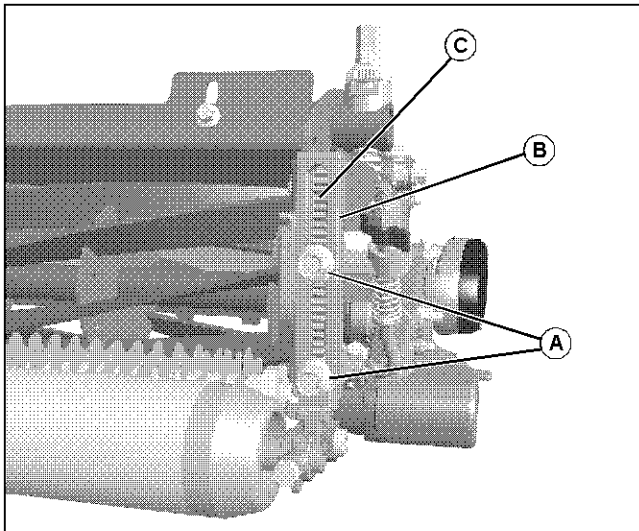
(B) to reel (C) clearance (D) measures 0.050 mm (0.002 in.).

4. Check the bed knife-to-reel clearance (D) on the outer left and outer right side of the reel.
5. If clearances do not match, you will need to grind the reel and bed knife. (See "Grinding the Bed Knife and Reel" on page 383.)

Adjust Height-of-Cut Range

Adjust front roller brackets for the height of cut (HOC) range desired.

1. Select height-of-cut (HOC) adjustment range by adjusting the position of both front roller brackets.



MX41280

2. Loosen nuts (A) on each roller bracket.
3. Align desired mark on roller bracket (C) and cutting unit frame marks (B) on each side of the cutting unit to determine the HOC adjustment range. Each mark represents approximately 5 mm (0.2 in.) change in height. Make sure brackets on each side are on the same mark. Tighten nuts.
4. Adjust front roller brackets for the height of cut (HOC) range desired. Refer to chart for desired setting.

Adjust Height-of-Cut (HOC)



Caution: Avoid Injury! Do not service or adjust cutting units while the engine is running. Shut off engine prior to making any adjustments.

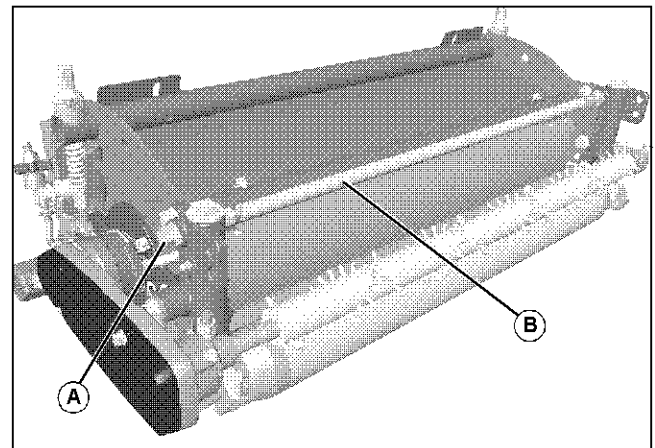
Always wear protective gloves when working on or near the reel or bed knife.

Never allow more than one person at a time to work on any one cutting unit. Never allow adjustments to be made on more than one cutting unit at the same time.

Important: Avoid Damage! All cutting units must be set at the same height to obtain an even cut. Never adjust rollers so that there is more than 1.6 mm (1/16 in.), or one notch, difference between front and back rollers or cutting geometry will be affected. Floating units will not provide a quality cut in grass over approximately 38 mm (1-1/2 in.) tall.

1. Raise cutting units.
2. Shut off engine and lock park brake.

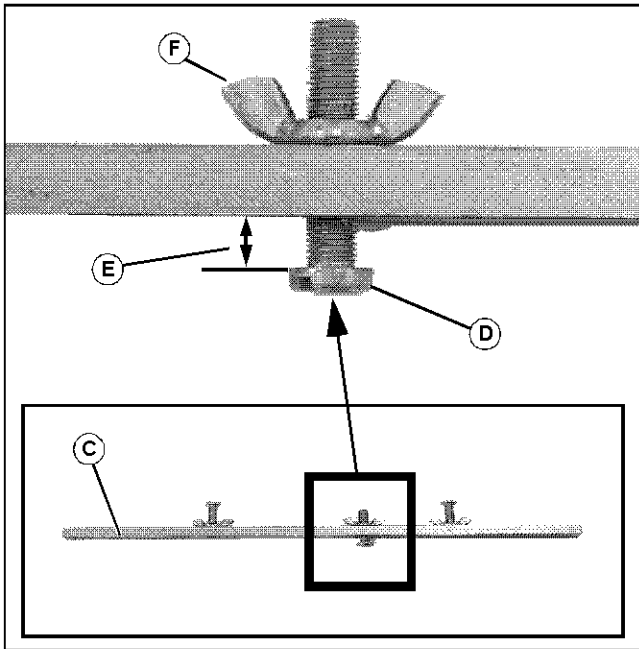
NOTE: Adjusters (A) are connected with cross shaft (B) so turning one side simultaneously turns the other.



MX41226

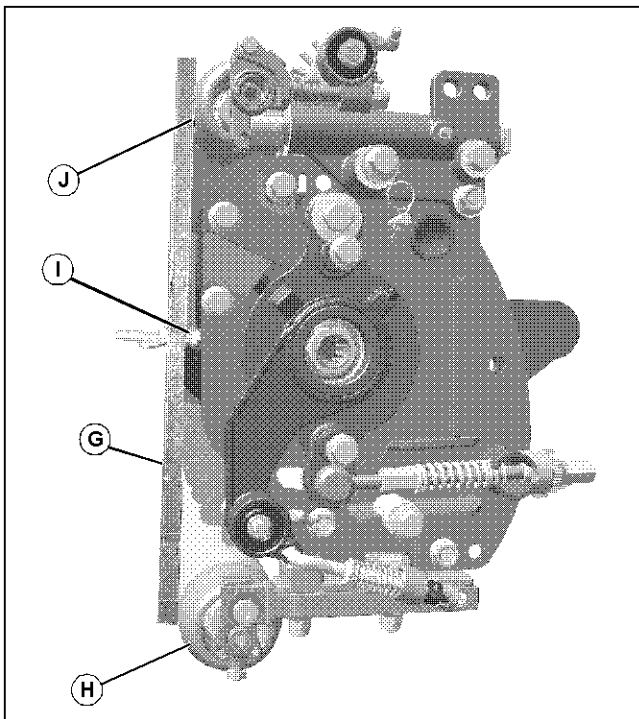
3. Adjust reel-to-bed knife before adjusting HOC.

ATTACHMENTS TESTS AND ADJUSTMENTS



M97423, M97422

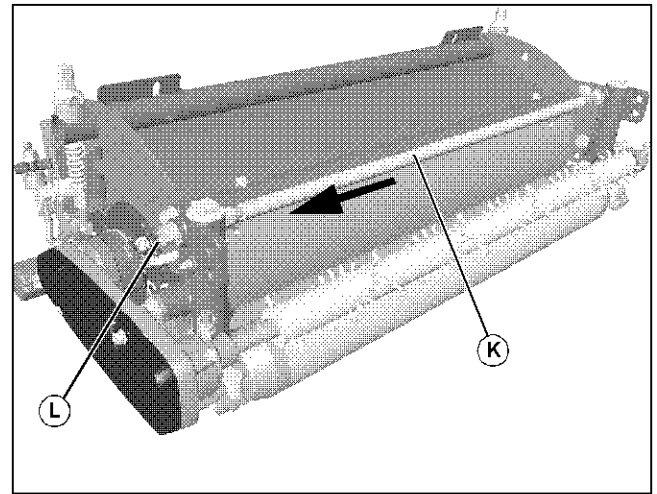
4. On the height-of-cut (HOC) gauge bar (C), set center adjustment bolt head (D) at the desired height of cut (E). Lock wing nut (F).
5. Back out or remove outside adjustment bolts so they do not interfere with adjustment.



MX41227b

6. Rest HOC gauge bar (G) against front roller (H) approximately 51 mm (2 in.) from the end of the bed knife. Set the inside of the bolt head (I) against the edge of the bed knife.

7. Turn HOC adjuster until the rear roller (J) contacts the HOC gauge bar. Repeat for the other side of the cutting reel.
8. Check HOC adjustment setting from side to side and adjust if necessary.



MX41226

9. If side to side HOC adjustment is necessary, pull against spring tension on cross shaft (K) to disconnect it from hex coupling. Remove the cross shaft.
10. Turn adjuster (L) until side to side HOC is equal, and then reinstall cross shaft (K).

ATTACHMENTS TESTS AND ADJUSTMENTS

Adjust Front Roller Parallel to Bed Knife

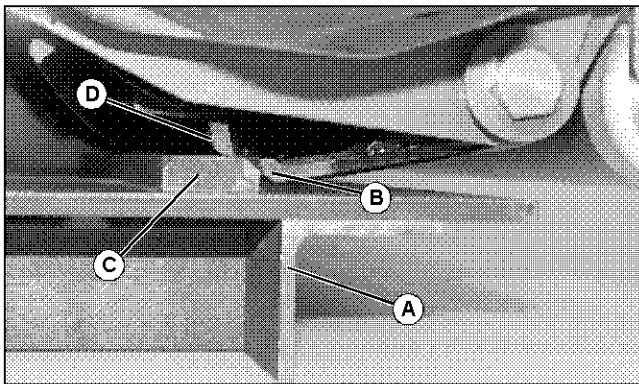
Parallelism Adjustment with Bench Plate



Caution: Avoid Injury! Rotating blades are dangerous. Before adjusting or servicing mower:

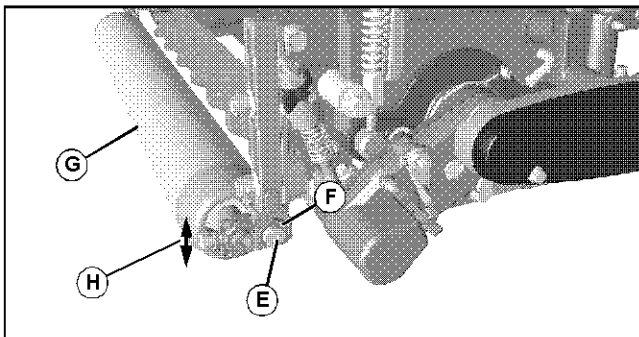
- Disconnect spark plug wire(s) or battery negative (-) cable to prevent engine from accidentally starting.
- Always wear gloves when handling mower blades or working near blades.

1. Position cutting unit upright on flat surface or workbench.



M97254

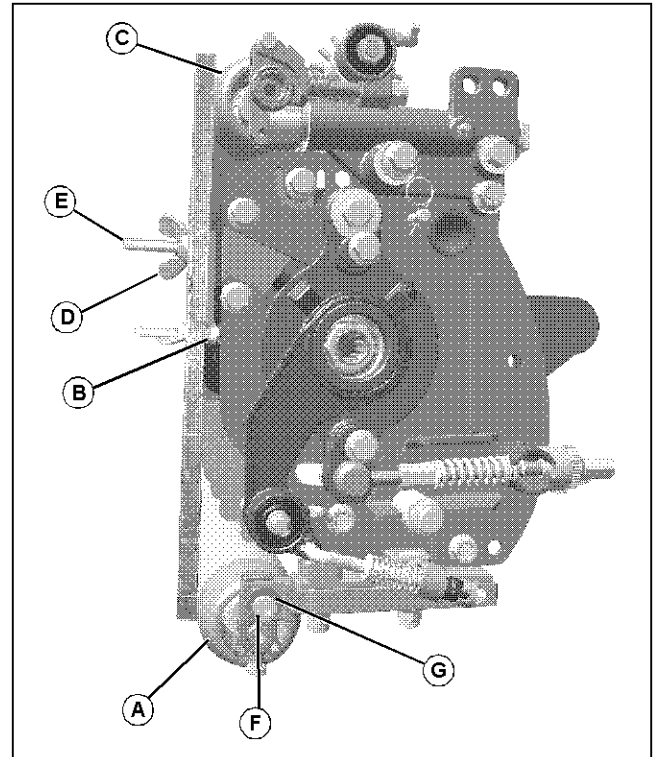
2. Set bench plate on a level surface. Set cutting unit on top of bench plate (A). Bed knife (B) must rest firmly against plate stop (C) with cutting reel blade (D) on top of plate stop.



MX41220

3. Loosen socket head cap screw (E) on one of the roller brackets.
4. Rotate eccentric adjuster (F) until the front roller (G) sits flat and parallel with the bench plate. Gap (H) should not exceed 0.050 mm (0.002 in.) maximum.
5. Hold roller eccentric adjuster (F) and tighten socket head cap screw (E).

Parallelism Adjustment with HOC Gauge Bar



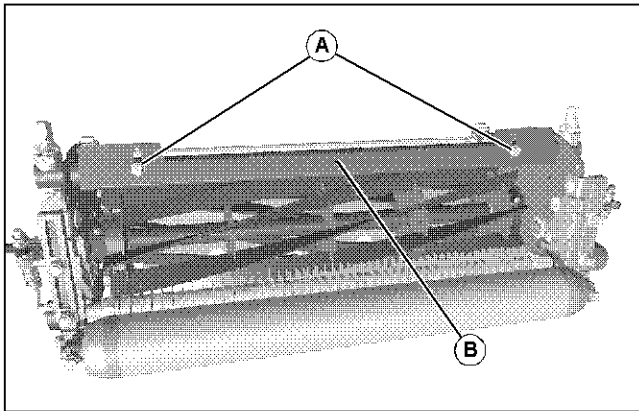
MX41227a

1. Position cutting unit upright on flat surface or workbench.
2. Rest HOC gauge bar against front roller (A) approximately 51 mm (2 in.) from the end of the bed knife. Set the inside of the bolt head (B) against the edge of the bed knife.
3. Loosen wing nut (D). Turn lower gauge screw (E) clockwise until top of screw makes contact with flat edge of bed knife.
4. Tighten wing nut (D).
5. Hold end of gauge bar against the bottom of front roller (C).
6. Adjust position of front roller:
 - Loosen socket head cap screw (F) and rotate eccentric adjuster (G) until top of lower gauge screw (E) makes contact with the bed knife.
7. Repeat procedure for opposite side.

ATTACHMENTS TESTS AND ADJUSTMENTS

Adjust Cutting Unit Shield

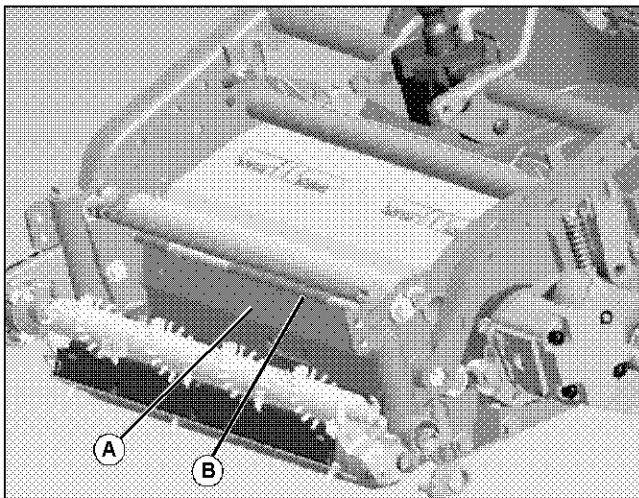
NOTE: Keeping the shield close to the cutting blades improves the performance of the grass catcher in most conditions.



MX41274

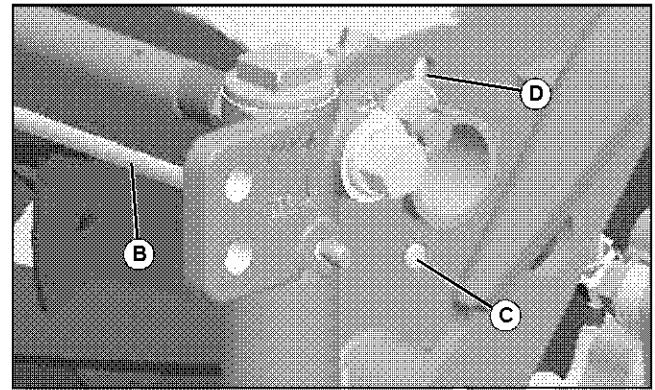
1. Loosen two bolts (A) and locknuts on each side of cutting unit.
2. Raise or lower shield (B) to desired position.
 - Maintain an approximate 1.5 mm (0.06 in.) clearance between the bottom of the shield and the top of the cutting blades.
3. Tighten bolts.

Adjusting Grass Deflector



MX26095B

1. To change deflector position slide deflector (A) to one side and opposite side rod (B) will slide out.



MX26094A

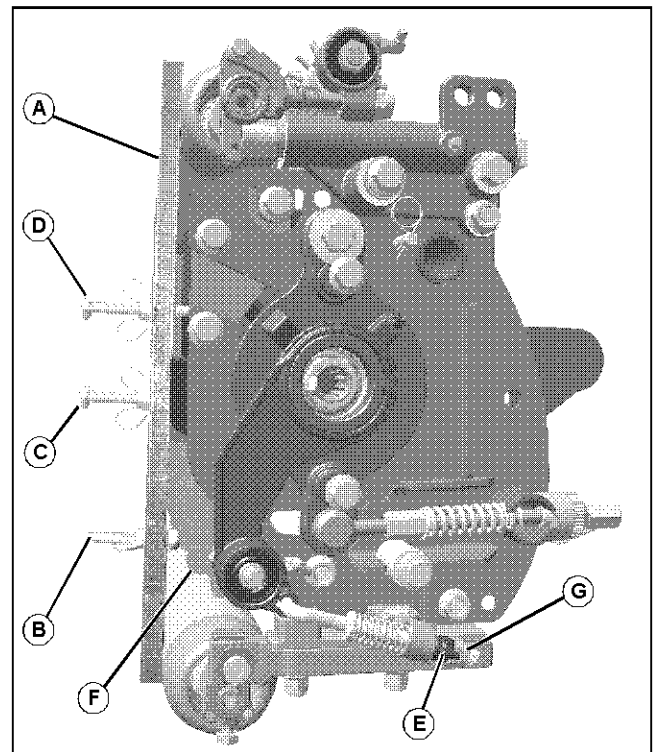
2. There are three positions for the deflector, completely closed, partially open, and completely open. For completely closed and partially open positions rod (B) needs to be in position (C). For completely open position place rod (B) into position (D).

3. When deflector is in the completely closed position make sure the deflector clips onto the bed knife shoe so no discharge will occur.

Adjusting (Optional) Fairway Tender Conditioner [FTC]

NOTE: Height Of Cut must be adjusted prior to adjusting the FTC.

1. Position cutting unit on bench to make height of cut adjustment.



MX41545

ATTACHMENTS REPAIR

2. Using a gauge bar (A), set adjustment screw (B) on the gauge bar to the desired operating height.

- Adjustment screw (C) may need to be loosened so that the gauge bar can rest on both the front and rear rollers.

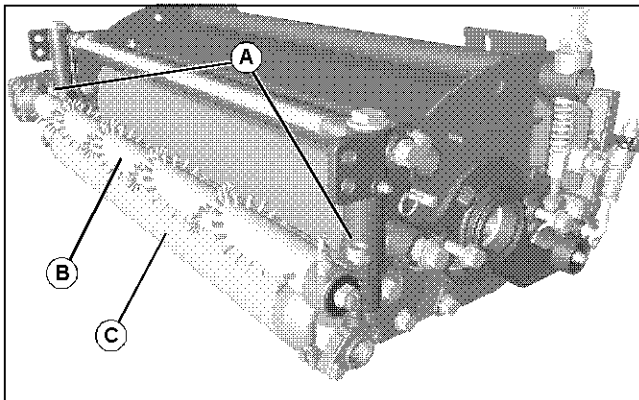
3. Place preset gauge bar on cutting unit. Hook height of cut screw (D) on bed knife. The ends should rest firmly on the front and rear rollers.

4. Make certain wing nut (E) is turned so conditioner (F) is lowered (engaged).

5. Turn adjuster locknut (G) equally on both ends of the cutting unit clockwise or counterclockwise to raise or lower conditioner (F) until teeth on conditioner touch the screw (B) on the gauge bar.

Adjust (Optional) Rear Roller Power Brush

Note: The brush bristles should just barely clear the full length of the roller. The gap between the brush bristle tips and the roller should be approximately 1 mm (1/32 in.).



MX41219

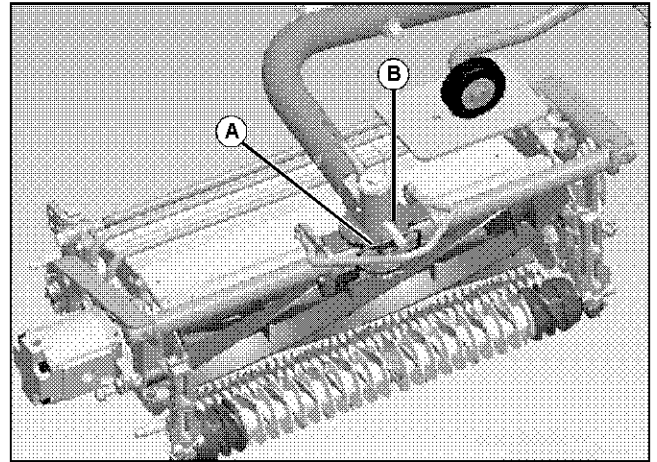
1. Loosen or tighten locknuts (A), evenly on both sides to adjust the roller brush (B) bristle tips approximately 1 mm (1/32 in.) away from roller (C).

Repair

Remove and Install Cutting Unit

Removing and Installing Cutting Units

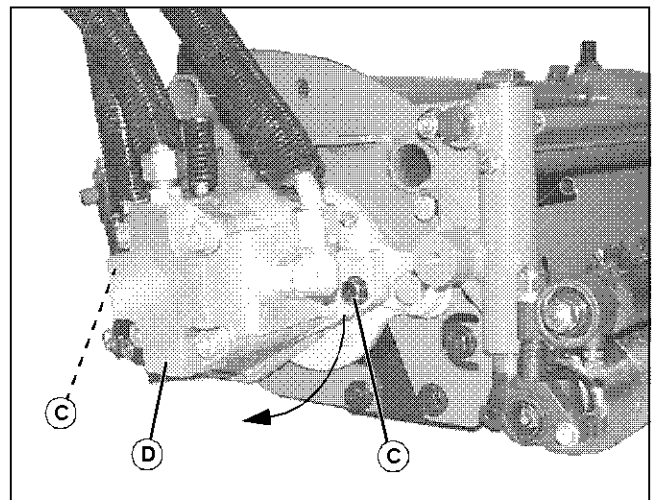
1. Park the machine safely.
2. Lower reels to the ground.



MX42126

3. Push spring (A) down and remove front pin (B).
4. Pull unit away from the mower.

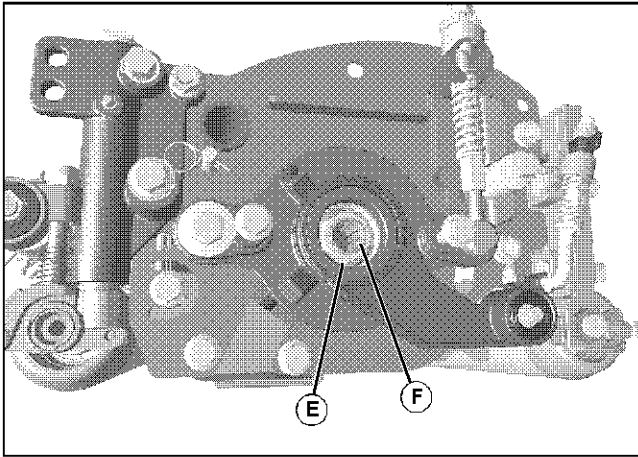
Note: Disconnect hydraulic hoses only if hydraulic motor is being replaced.



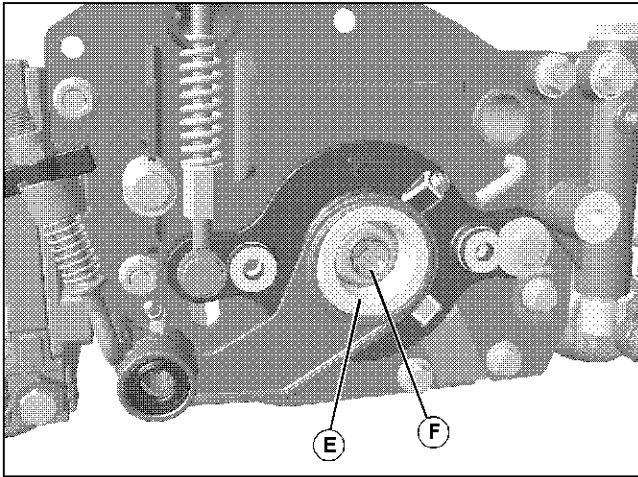
MX41260

5. Loosen two bolts (C), and rotate and remove hydraulic motor (D) from bolts.

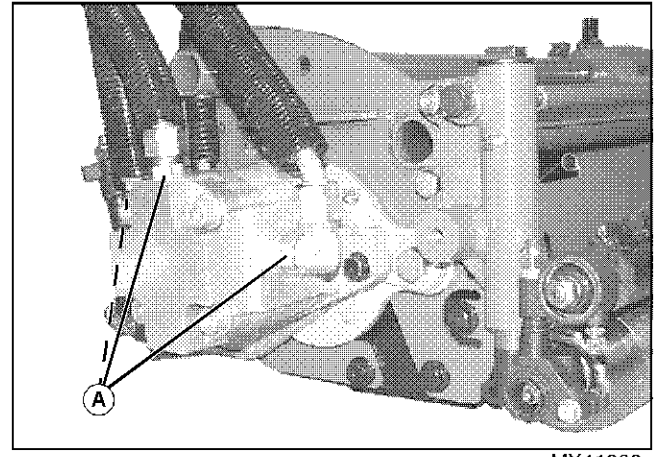
ATTACHMENTS REPAIR



MX41261

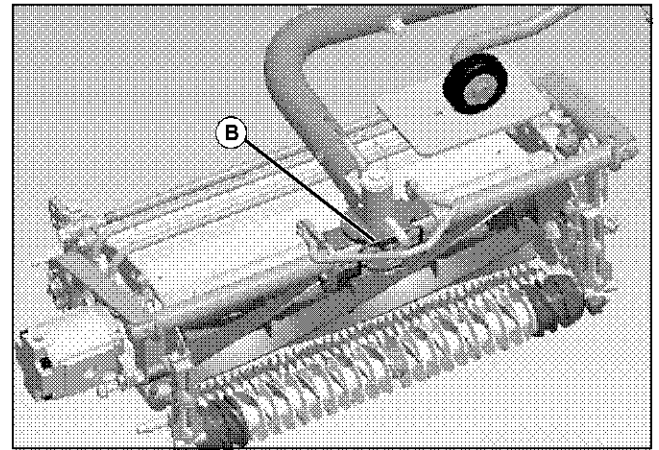


MX41713



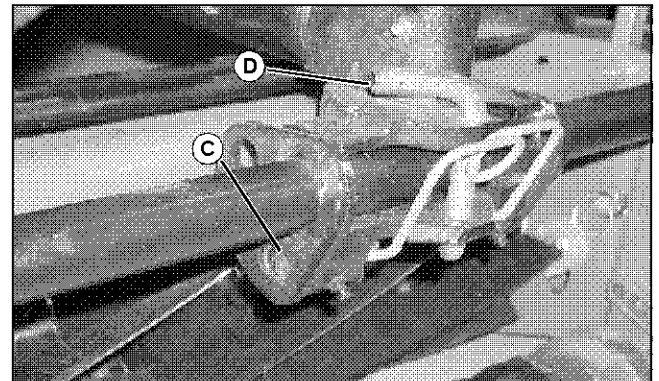
MX41260

3. If the motor was replaced, install three hose hydraulic fittings (A).



MX42036

4. Pull spring (B) down and roll cutting unit into place.



MX18955

5. Align locking pins (C) and release spring (B), to allow locking pins to engage.
6. Insert front pin (D) into place.

6. Inspect inside of reel bearing housing (E) for grease. Add John Deere Special Purpose HD Cornhead Grease to housing if additional lubrication is needed.

7. Check splines (F) for wear. Replace reel if splines are excessively worn and can't effectively engage motor splines. Make sure splines are lubricated with grease.

8. Repeat procedure for other cutting units.

Installing Cutting Units

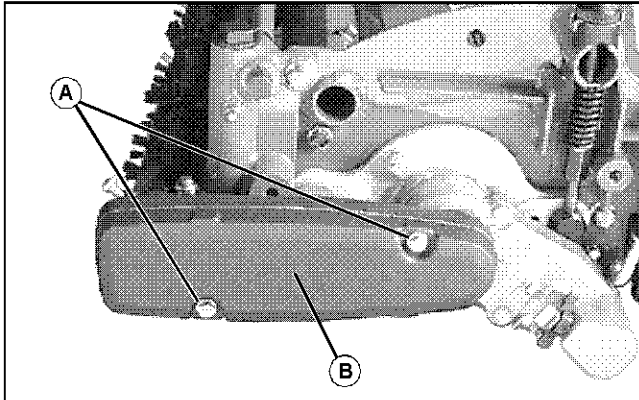
Note: Center cutting unit has two upstop brackets.
Right front cutting unit has the steering limiter bracket.

1. Align reel spline with motor drive shaft, and install motor onto the reel bearing housing.
2. Secure assembly with cap screws.

ATTACHMENTS REPAIR

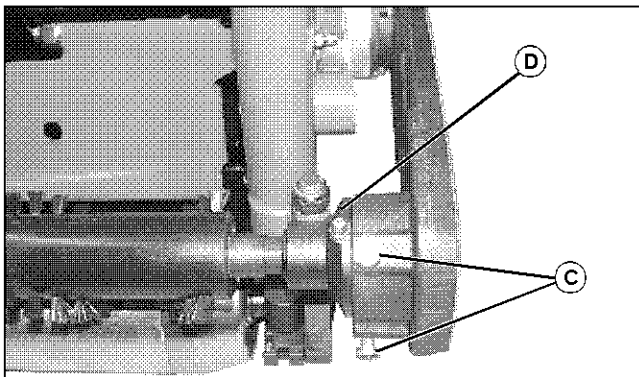
Remove and Install Power Brush

Remove Power Brush



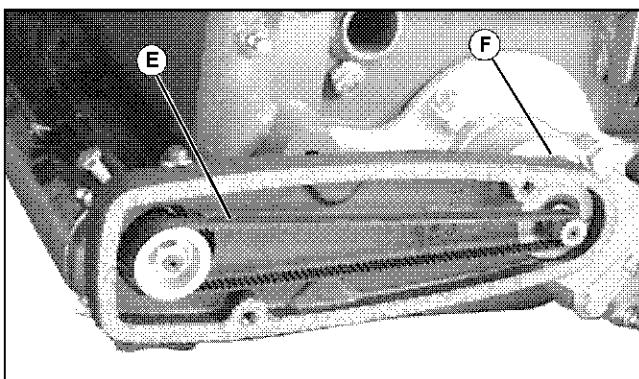
MX41529

1. Remove both hex head bolts (A).
2. Remove drive housing cover (B).



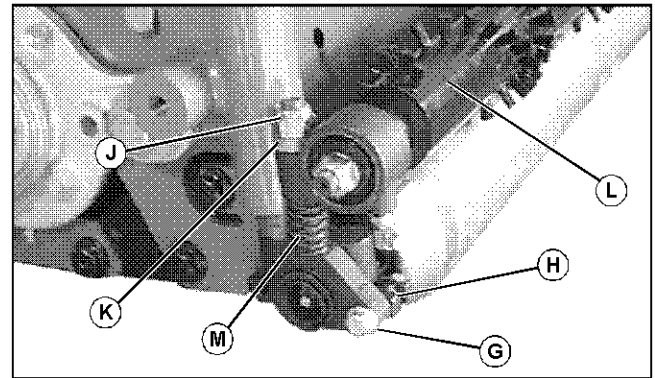
MX41538

3. Loosen two cap screws (C) and rotate top of eccentric housing (D) toward front of reel to loosen drive belt.



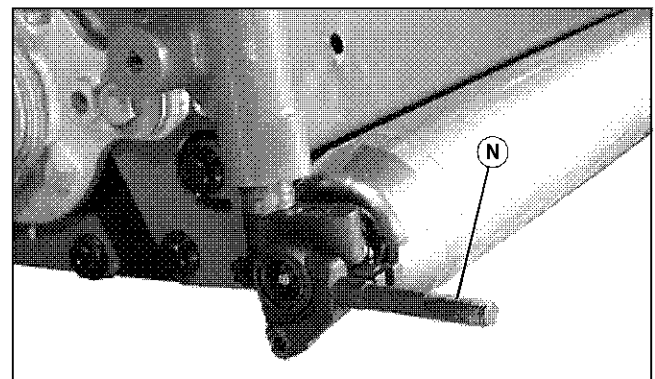
MX41530

4. Remove belt (E) from pulley and drive shaft.
5. Remove lock pin (F) from housing.
6. Remove inner drive housing from reel assembly.



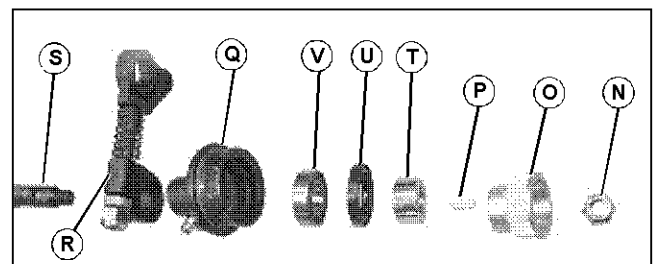
MX41531

7. Remove cap screw (G) and lock nut (H) from non-driven side of brush assembly.
8. Remove lock nut (J) and spacer (K) from both brush support brackets.
9. Lift brush assembly (L) and remove from reel.
10. Remove wave spring (M) from stud on both brush support brackets.



MX41532

11. Rotate and remove brush support bracket (N) from non-driven side of reel.

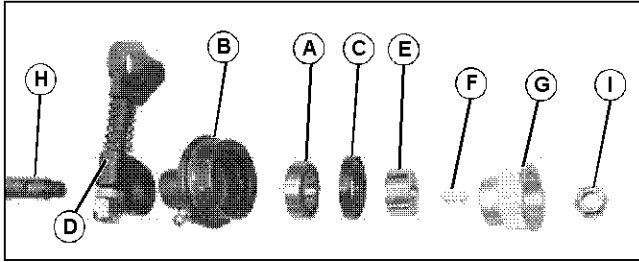


MX41623

12. Remove nut (N), gear (O), key (P), housing (Q) and shaft support bracket (R) from shaft (S).
13. Remove spacer (T), seal (U) and bearing (V) from housing (Q).

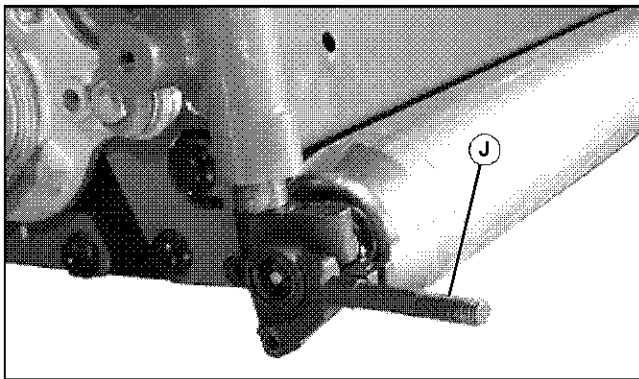
ATTACHMENTS REPAIR

Install Power Brush



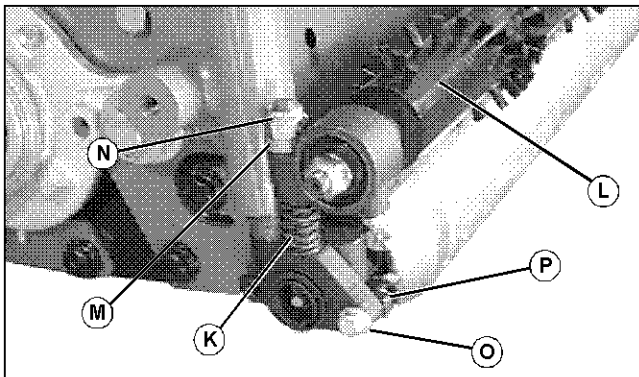
MX41623

1. Install bearing (A) in housing (B).
2. Install seal (C) in housing (B) with lip facing out.
3. Install brush support bracket (D), spacer (E), key (F) and gear (G) onto shaft (H), and secure with lock nut (I).



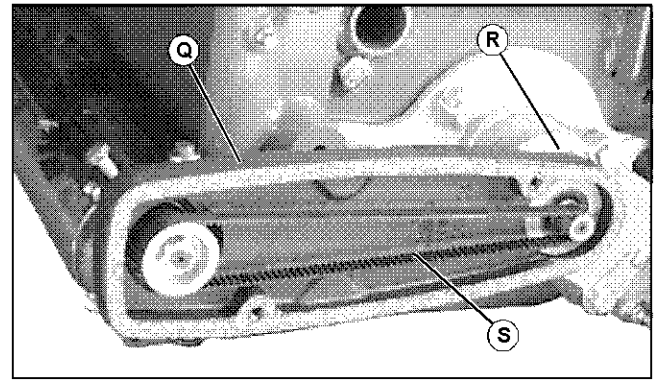
MX41532

1. Install brush support bracket on non-driven side (J) and rotate to a vertical position.



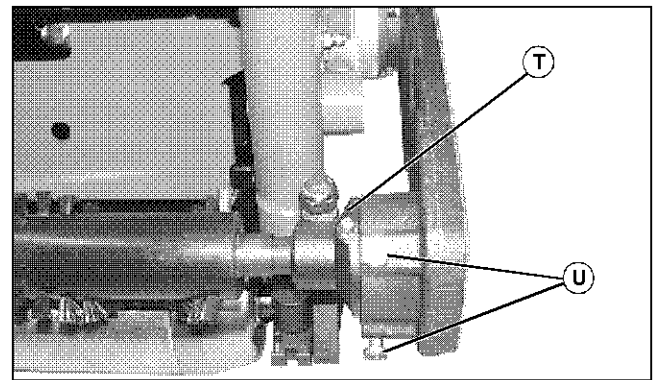
MX41531

2. Install wave spring (K) on stud on both brush support brackets.
3. Install brush assembly (L) on both brush support brackets.
4. Install spacer (M) and lock nut (N) on both brush support brackets. Adjust nut on each side to obtain brush to roller clearance of 0-1 mm (0-0.039 in.).
5. Install cap screw (O) and lock nut (P) on support bracket on non-driven side only.



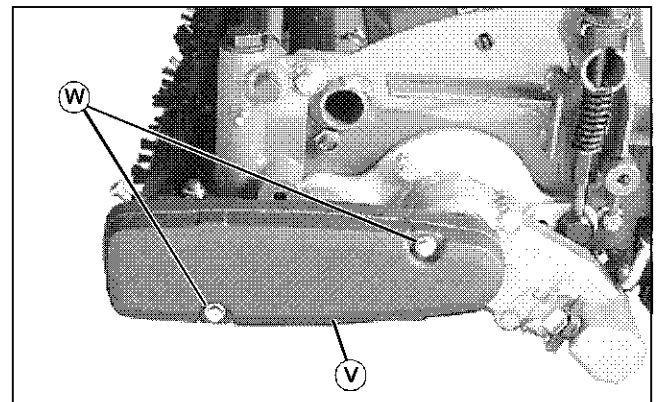
MX41530

6. Install inner drive housing (Q) on reel assembly.
7. Install lock pin (R) in housing and install belt (S) on pulley and drive shaft.



MX41538

8. Rotate top of eccentric housing (T) toward rear of reel to tension drive belt. Tighten cap screws (U) securely.
9. Install new gasket on housing.



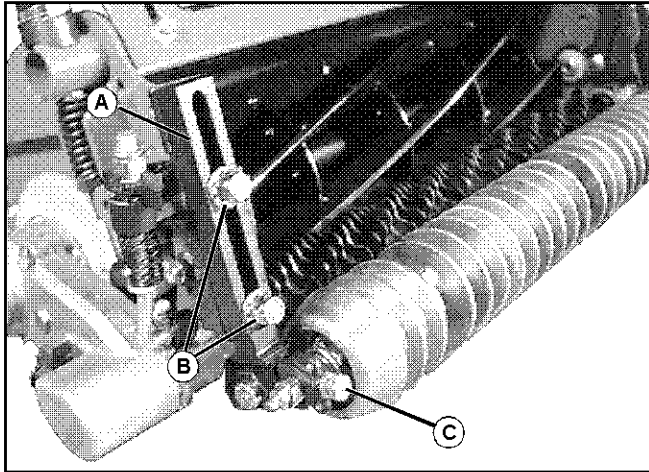
MX41529

10. Install drive housing cover (V) with hex head bolts (W) and tighten securely.

ATTACHMENTS REPAIR

Remove and Install Front Roller

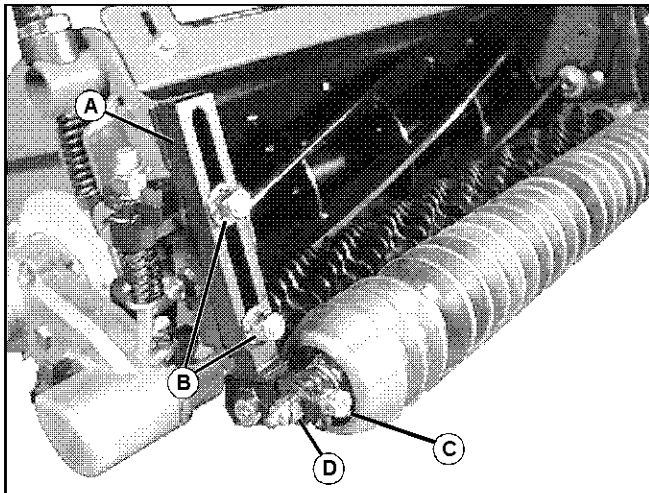
Removal



MX41534

1. Mark the position of the roller adjustment brackets (A) on each side and remove the nuts (B) securing the brackets to the cutter frame. Remove roller with brackets from cutting unit.
2. Loosen jam nuts and set screws (C). Slide the roller adjustment brackets off the roller.
3. Remove grease fittings from each end of roller.

Installation



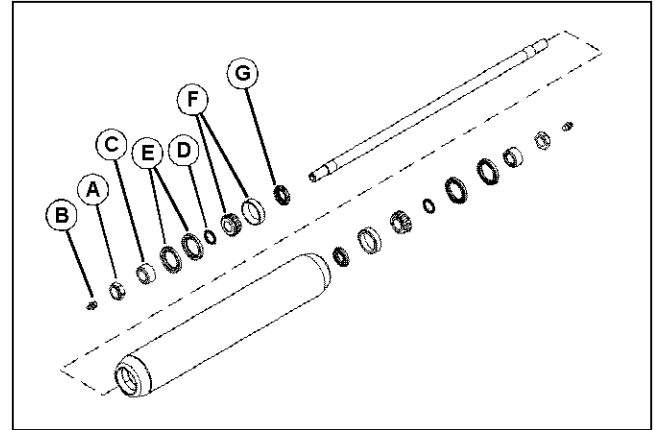
MX41534

1. Slide adjustment brackets (A) onto roller shaft.
2. Secure each bracket to frame in its original position with nuts (B).
3. Center the roller between the brackets with flat side of shaft (D) facing toward set screw. Tighten set screws and jam nuts (C).
4. Adjust height-of-cut. (See "Adjust Height-of-Cut (HOC)" on page 368.)

Repair Front Roller

Disassembly

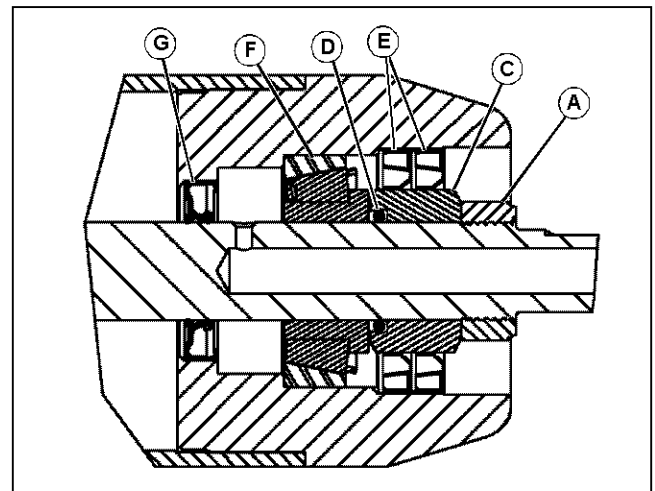
1. Remove front roller assembly from reel housing. (See "Remove and Install Front Roller" on page 376.)



MX20405

2. Remove locknut (A) from both ends of shaft.
3. Remove grease fitting (B) from both ends of shaft.
4. Push shaft through roller to remove.
5. If spacer (C) and O-ring (D) do not come out with shaft, pull out to remove.
6. Remove outer seals (E).
7. Remove bearing and race (F).
8. Remove inner seal (G).
9. Repeat for opposite end of roller if needed.
10. Inspect all components and replace as necessary.

Assembly



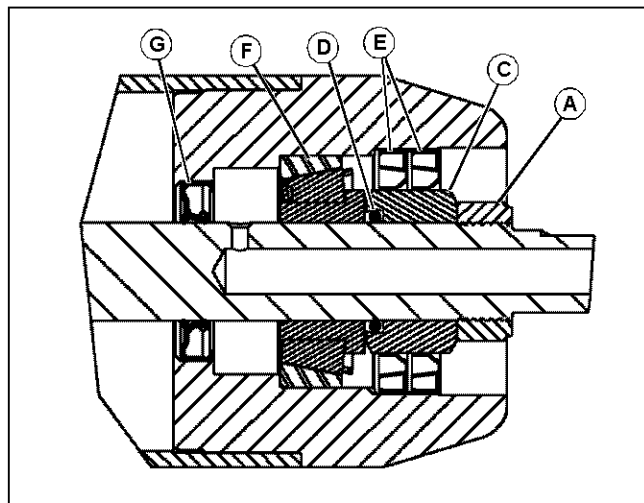
MX41948

1. Install inner seal (G) with lip facing out.
2. Pack bearing (F) with TY25083 Golf and Turf Cutting

ATTACHMENTS REPAIR

8. Remove inner seal (G).
9. Repeat for opposite end of roller if needed.
10. Inspect all components and replace as necessary.

Assembly - Roller



MX41948

1. Install inner seal (G) with lip facing out.
2. Pack bearing (F) with TY25083 Golf and Turf Cutting Unit Grease. Install bearing.

Important: Avoid Damage! Install outer seals with lips facing in.

3. Apply TY25083 Golf and Turf Cutting Unit Grease between lips of outer seals. Press outer seals (E) into place.

4. Install shaft in roller and approximately center it lengthwise.

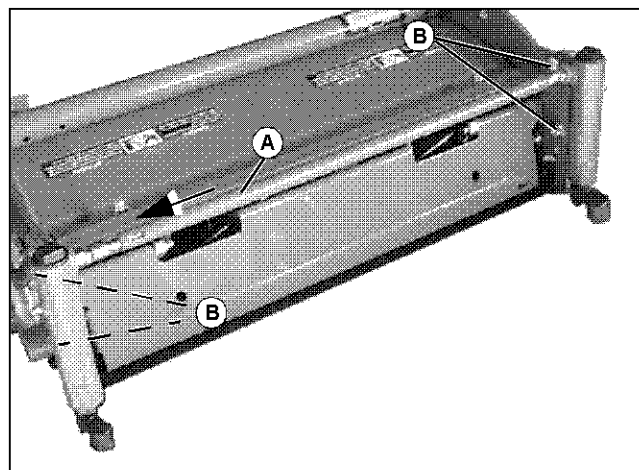
Important: Avoid Damage! Use care not to catch seal lips when installing spacer.

5. Install new O-ring (D) in spacer (C). Apply a light coat of grease to bore of spacer and install with O-ring next to bearing.
6. Repeat for opposite end of roller.
7. Install both locknuts (A) and tighten until end play is gone, yet roller rotates freely.
8. Install front roller assembly onto reel housing. (See "Remove and Install Rear Roller" on page 377.)

Rear Roller Adjuster

Removal:

1. Remove rear roller assembly from reel housing. (See "Remove and Install Rear Roller" on page 377.)

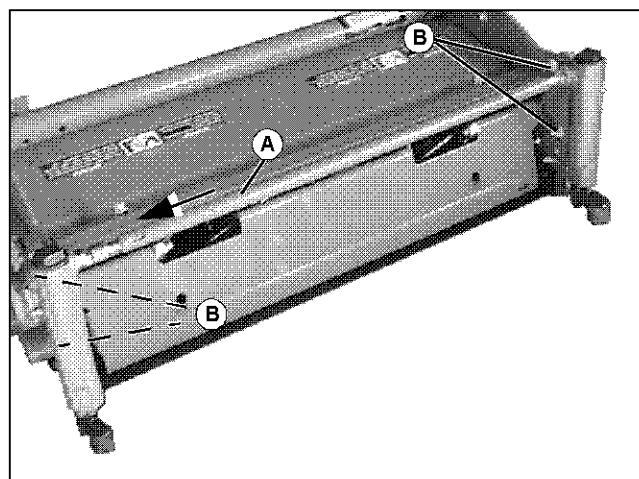


MX41533A

2. Push adjuster shaft (A) toward slotted end and disconnect from adjusters.
3. Remove cap screws and nuts (B) from adjusters and remove adjusters from reel.

Installation:

1. Install adjuster assemblies onto reel frame and secure with cap screws and nuts (B).



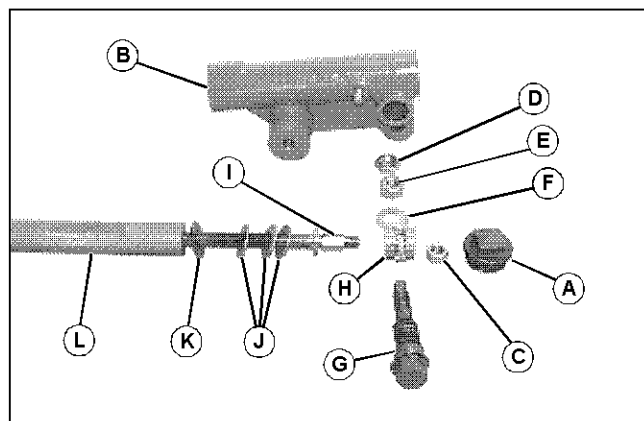
MX41533A

2. Install adjuster shaft (A).
3. Install rear roller. See "Remove and Install Rear Roller" on page 377.
4. Check height of cut and adjust if necessary. (See "Adjust Height-of-Cut (HOC)" on page 368)

ATTACHMENTS REPAIR

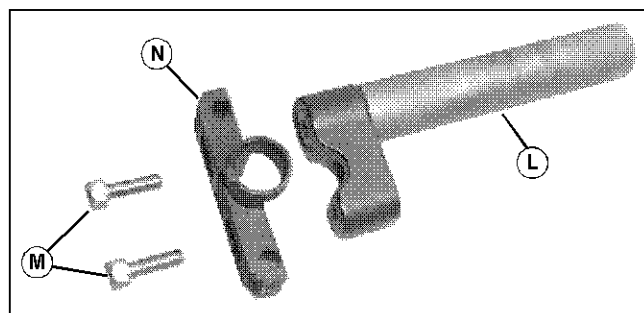
Disassembly - Roller Adjuster

1. Remove rear roller assembly from reel housing. (See "Remove and Install Rear Roller" on page 377.)



MX41624

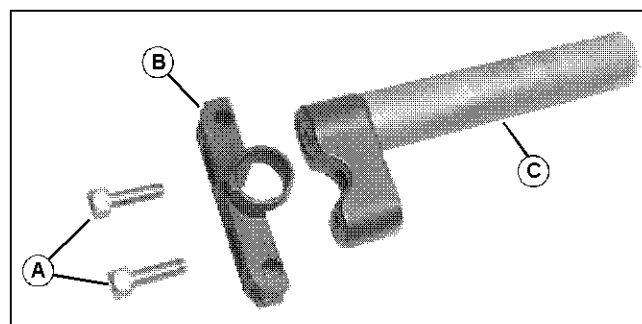
2. Remove plug (A) from housing (B).
3. Remove nut (C).
4. Remove lock nut (D), nut (E), convex washer (F) and adjustment bolt (G) from the housing (B).
5. Remove gear (H) from the housing (B).
6. Remove threaded shaft (I), three convex washers (J) and flat washer (K) from shaft (L).
7. Remove shaft (L) from housing (B).



MX41625

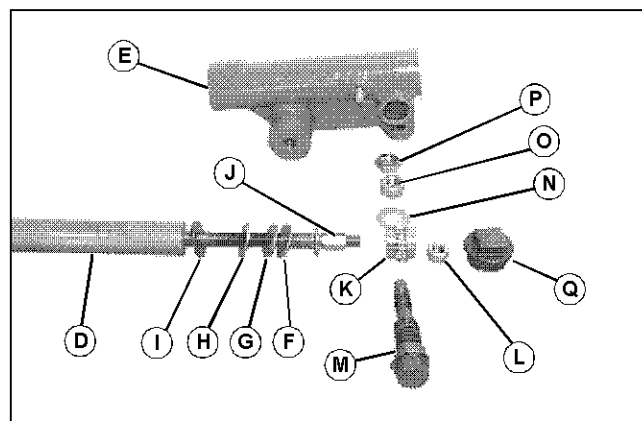
8. Remove hex head cap screws (M) and bracket (N) from shaft (L).
9. Repeat steps for opposite adjuster if needed.
10. Inspect all components and replace as necessary.

Assembly - Roller Adjuster



MX41625

1. Install hex head cap screws (A) and bracket (B) to shaft (C).



MX41624

2. Install shaft (D) in housing (E).
3. Install convex washer (F), concave washer (G), convex washer (H) and flat washer (I) on threaded shaft (J).
4. Insert threaded shaft (J) in housing (E) and hand thread it fully into shaft (D).
5. Insert gear (K) on threaded shaft (J) and secure with nut (L).
6. Install adjustment bolt (M) in housing (E). Install convex washer (N) and nut (O). Tighten nut to slightly preload the washer (N).
7. Add lock nut (P) to bolt (M) and tighten securely.
8. Install plug (Q) in housing.
9. Install rear roller adjusters and roller onto reel housing. (See "Remove and Install Rear Roller" on page 377.)

ATTACHMENTS REPAIR

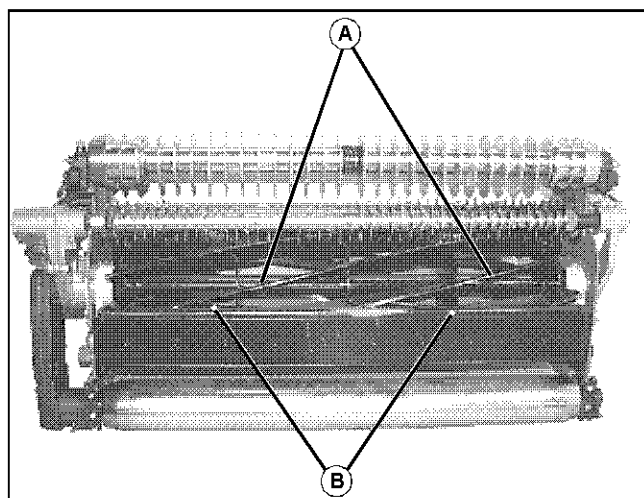
Inspect Bed Knife and Reel



Caution: Avoid Injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running. Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

1. Visually inspect cutting unit for damage. Chipped paint, dents or gouges may indicate the need for a closer look at the frame for distortion, broken weldments or other damage that could prevent proper adjustment. Repair or replace parts as necessary.
2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.



MX41551

3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge (A) for nicks, gouges or distortion. Ensure the cutting edge land does not exceed more than 3/4 of the blade thickness. Restore the relief angle and cutting edge before continuing with this procedure. (See "Grinding the Bed Knife and Reel" on page 383.)
4. Inspect the bed knife cutting edge (B) for nicks, gouges or distortion.
5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure the cutting edge land does not exceed 3/4 of the cutting edge. Replace the bed knife if the cutting edge

extends below 1.45 mm (0.057 in.) from the mounting surface.

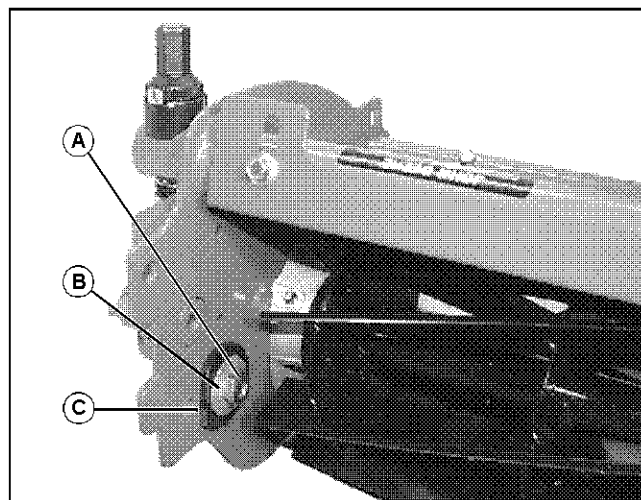
Remove and Install Reel

Remove Reel



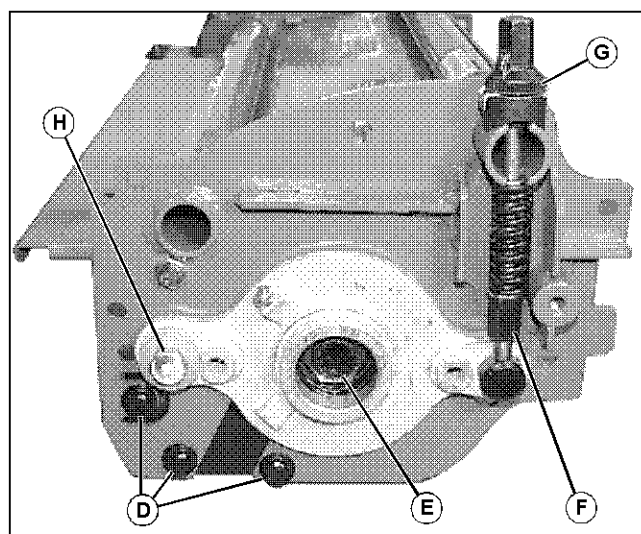
Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.

1. Remove front roller assembly from reel housing. (See "Repair Front Roller" on page 376.)



MX41539

2. Remove shoulder nut (A), spring washer (B) and spacer (C) from both sides of reel housing.

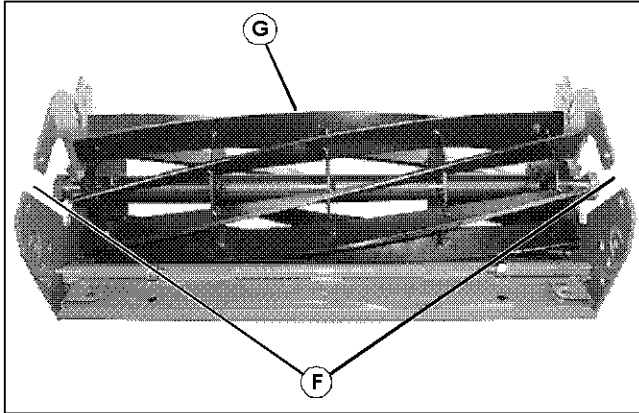


MX41543

3. Remove three cap screws (D) from each side of reel housing and remove bed knife assembly.
4. Remove nut (E) from both reel bearing retainers.

ATTACHMENTS REPAIR

5. Mark position of nuts (F) to aid in reassembling to the same position. Loosen nuts to release spring tension and remove adjuster (G) on both sides of reel housing.
6. Remove shouldered cap screw, two spring washers (H) and lock nut, and remove both reel bearing retainers from reel and housing.



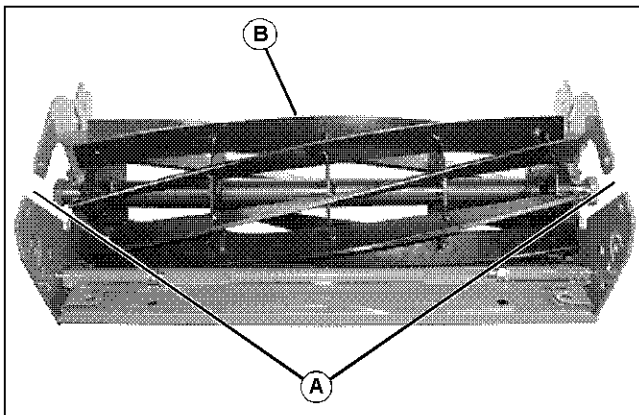
MX41544

7. Invert reel housing (G) and remove reel through slots on each end of housing.

Install Reel

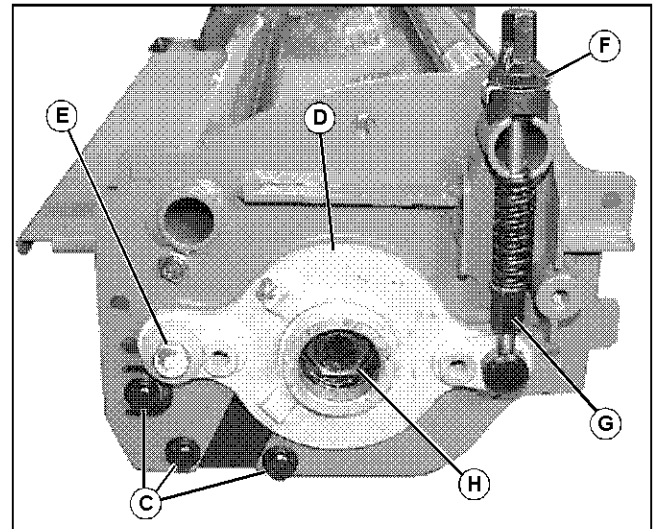


Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.



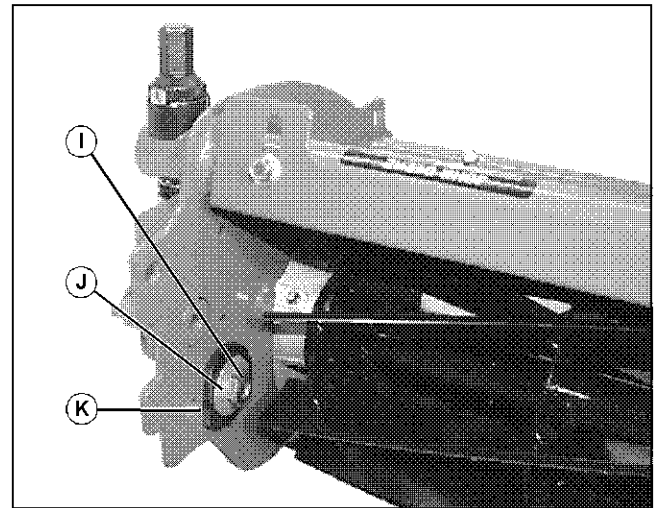
MX41544

1. Routing the reel shaft ends through the slots (A) in the housing, place the reel (B) in the housing.



MX41543

2. Install the bed knife assembly and secure with three cap screws (C) on each side of reel housing assembly.
3. Install a reel bearing retainer (D) on the reel shaft and housing and secure with a shouldered cap screw, two spring washers (E) and lock nut.
4. Repeat step 3 for the second bearing retainer.
5. Loosely install the height adjuster assembly (F) in the bearing retainer and reel housing. Tighten nuts (G) in equal increments to marks made during disassembly.
6. Install nut (H) on both ends of the reel shaft in the bearing retainers and tighten securely.



MX41539

7. Install shoulder nut (I), spring washer (J) and spacer (K) on both sides of reel housing and tighten securely.
8. Install front roller assembly onto reel housing. (See "Remove and Install Front Roller" on page 376.)
9. Adjust reel-to-bed knife clearance. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)

ATTACHMENTS REPAIR

Removing and Installing Bed Knife and Shoe

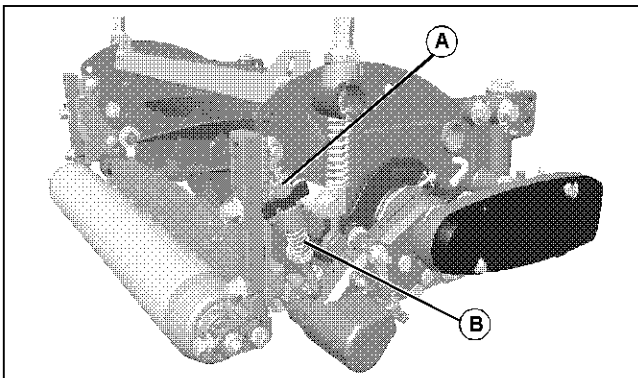


Caution: Avoid Injury! Blades are sharp and rotate quickly:

- Keeps hands and feet away from cutting reels while machine is running.
- Always wear gloves while working on cutting reels.
- Watch for rotation of cutting reels. Rotating one cutting reel can cause another blade or cutting reel to rotate.

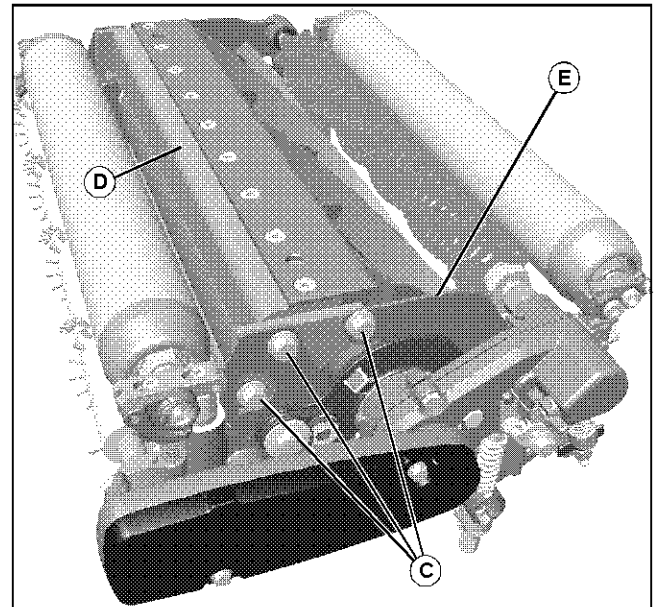
Removing Bed Knife and Shoe

1. Remove the cutting unit from machine.
2. Position cutting unit with the bottom side down on a flat surface or workbench.
3. Relieve tension from bed knife tension springs on both sides of cutting unit.



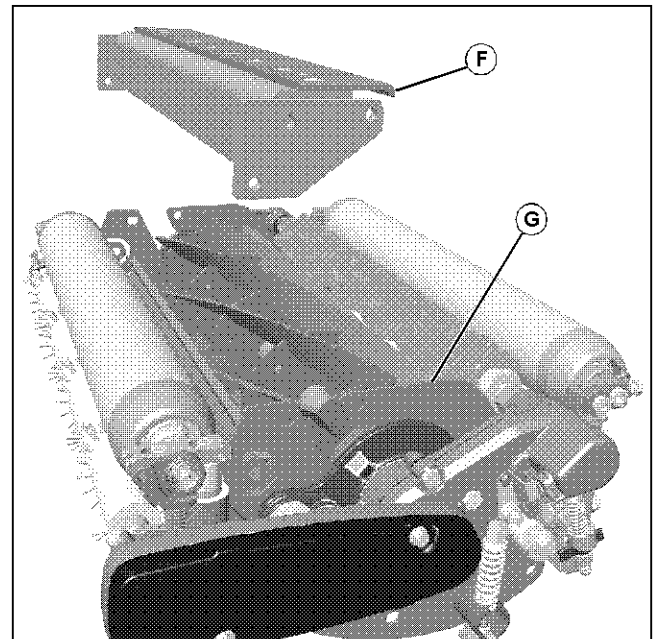
MX41502

- Turn hex head bolt (A) counterclockwise until spring (B) is completely relaxed. Repeat on opposite side.



MX41503

4. Rotate cutting unit and position with bottom side up on flat surface or workbench as shown.
5. Remove three bolts (C) holding bed knife and shoe assembly (D) to reel frame (E). Repeat on opposite side.

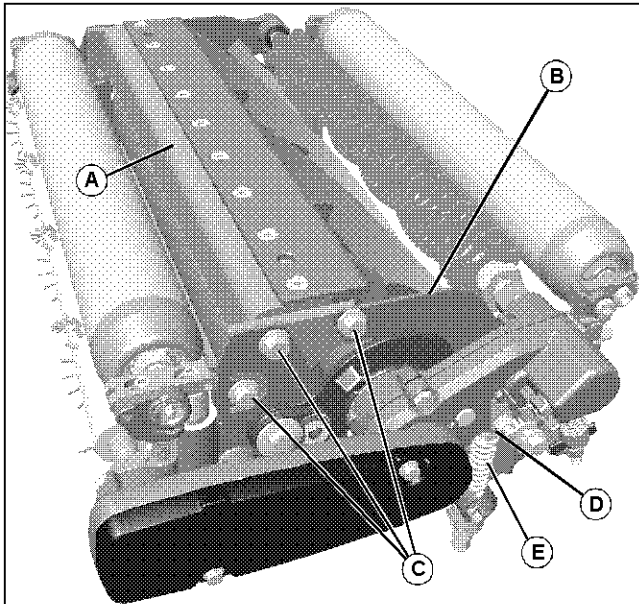


MX41504

6. Remove bed knife and shoe assembly (F) from reel frame (G).
7. Inspect bed knife for wear or damage. Replace bed knife, if necessary.
8. If original bed knife is to be used again, grind the bed knife. (See "Grinding the Bed Knife and Reel" on page 383.)

ATTACHMENTS REPAIR

Installing Bed Knife and Shoe



MX41503

1. Install bed knife assembly (A) onto reel frame (B), and secure with three bolts (C). Repeat on opposite side. Tighten hardware to 55 N•m (40 lb-ft).
2. Tighten nut (D) to compress spring (E) on adjuster. Repeat on opposite side.
3. Adjust reel-to-bed knife. (See "Adjust Reel-to-Bed Knife Clearance" on page 367.)
4. Set height-of-cut. (See "Adjust Height-of-Cut (HOC)" on page 368.)
5. Backlap reel. (See "Backlapping Procedure" on page 366.)
6. Check height-of-cut and adjust as necessary.

Grinding the Bed Knife and Reel

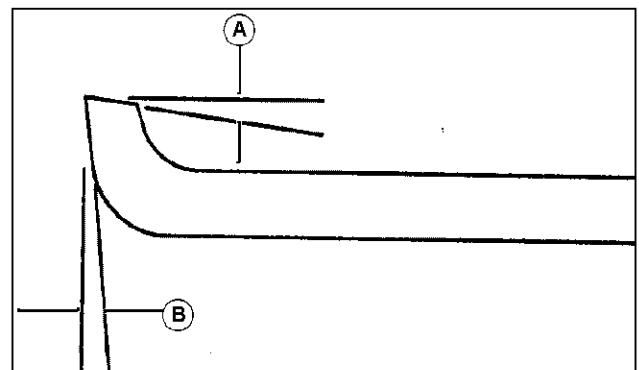
Grinding the Bed Knife



Caution: Avoid Injury! Rotating blades are dangerous. Before adjusting or servicing mower:

- Disconnect spark plug wire(s) or battery negative (-) cable to prevent engine from accidentally starting.
- Always wear gloves when handling mower blades or working near blades.

Note: Bed knife and support assembly must be ground as a complete unit.

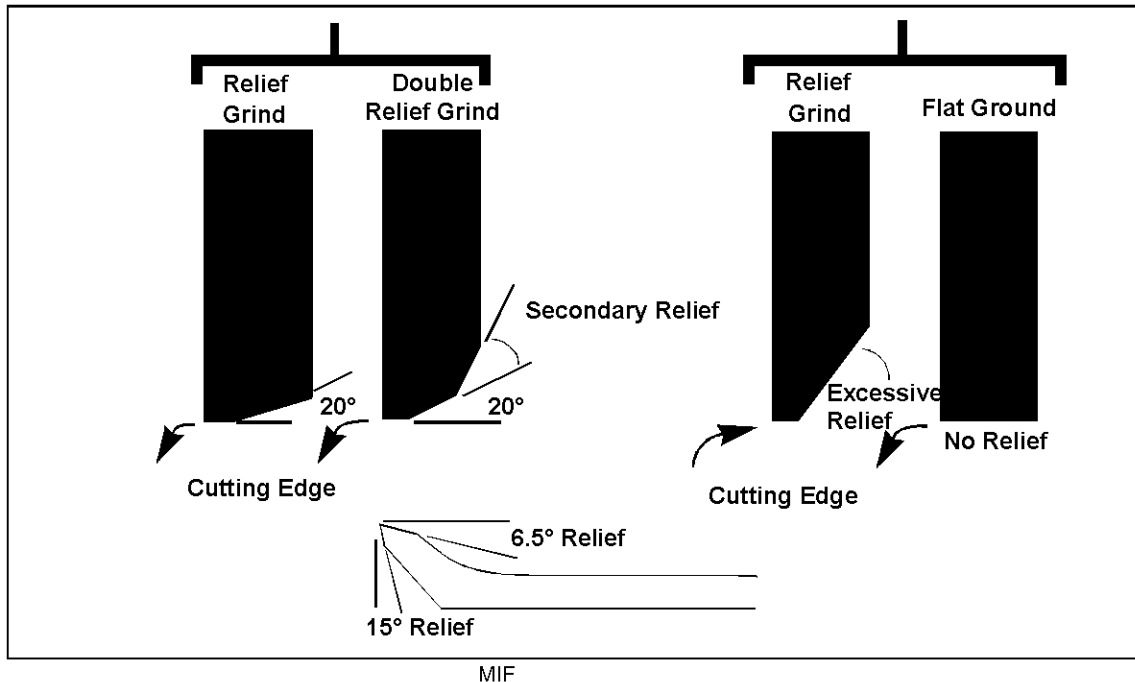


M47199

1. When grinding the bed knife, it is important to have a 6.5° relief angle on the top surface (A) and a 15° relief angle on the front surface (B).
2. Put entire bed knife support and bed knife in a suitable grinder and grind until material is consistently removed from the entire length of the top and front surfaces of the bed knife.

ATTACHMENTS REPAIR

Grinding the Reel



John Deere recommends relief grinding the reels before spin grinding for these reasons:

- Reduced blade contact area results in less friction, requiring less horsepower to drive the reel and increases fuel efficiency.
- Ensures longer wear life.
- Less time is required to backlap.
- Reduces pulling and tearing of the grass as the unit gets dull by use.
- Provides an area for backlapping compound to be trapped to more effectively backlap reels.
- Relief grinding removes metal from the trailing edge of the blade, forming an angle (relief angle) to reduce the contact area of the cutting edges.
- Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is 0.025-0.050 mm (0.001-0.002 in.) out of round.

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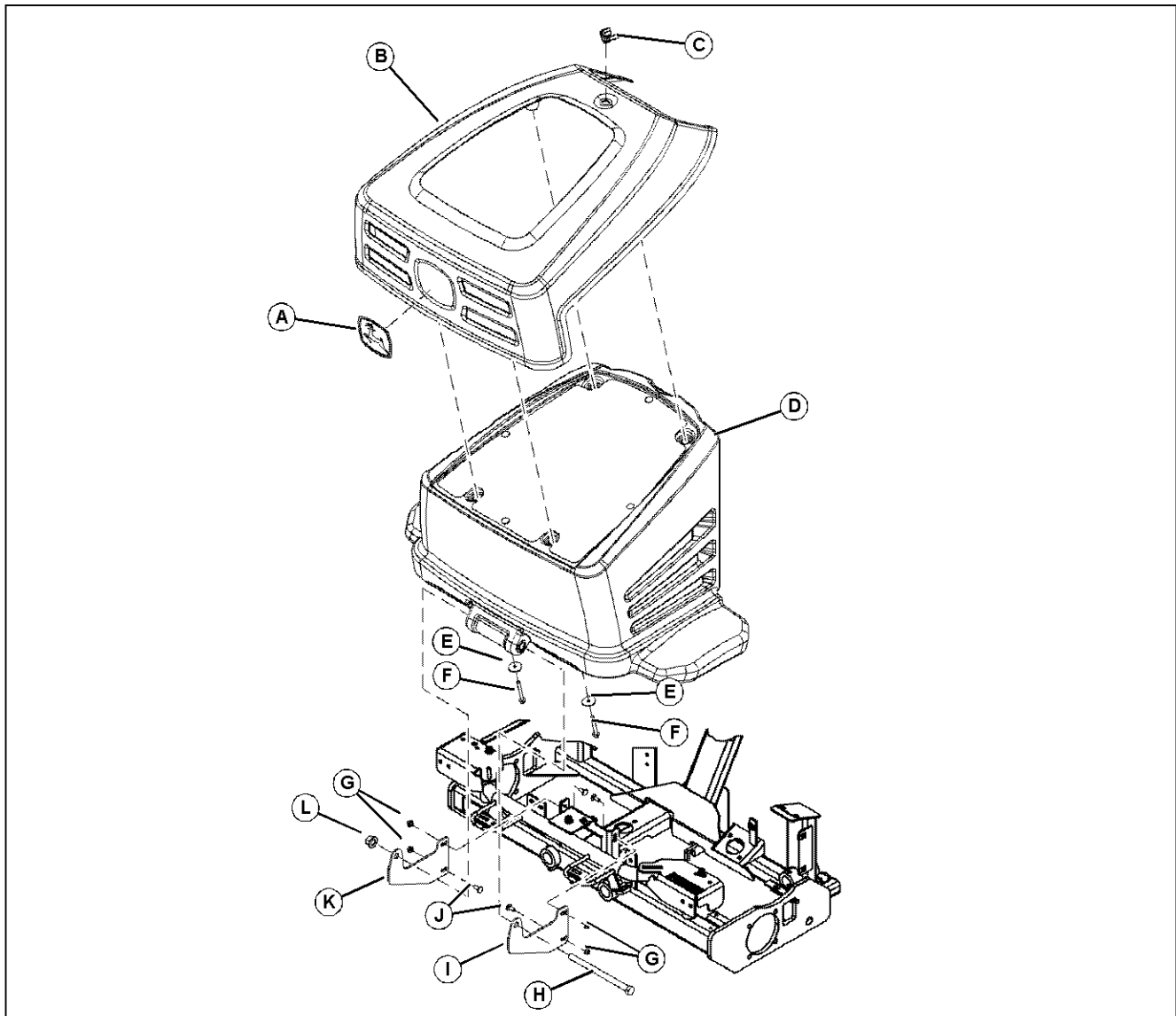
Torque Specifications

Roll-Over Protective Structure (ROPS) Cap Screw.....	108 N•m (80 lb-ft)
Front Wheel Bolt.....	81-95 N•m (60-70 lb-ft)
Rear Wheel Bolt	81-95 N•m (60-70 lb-ft)
Fuel Tank Mounting Cap Screw	20 N•m (177 lb-in.)

MISCELLANEOUS COMPONENT LOCATION

Component Location

Hood

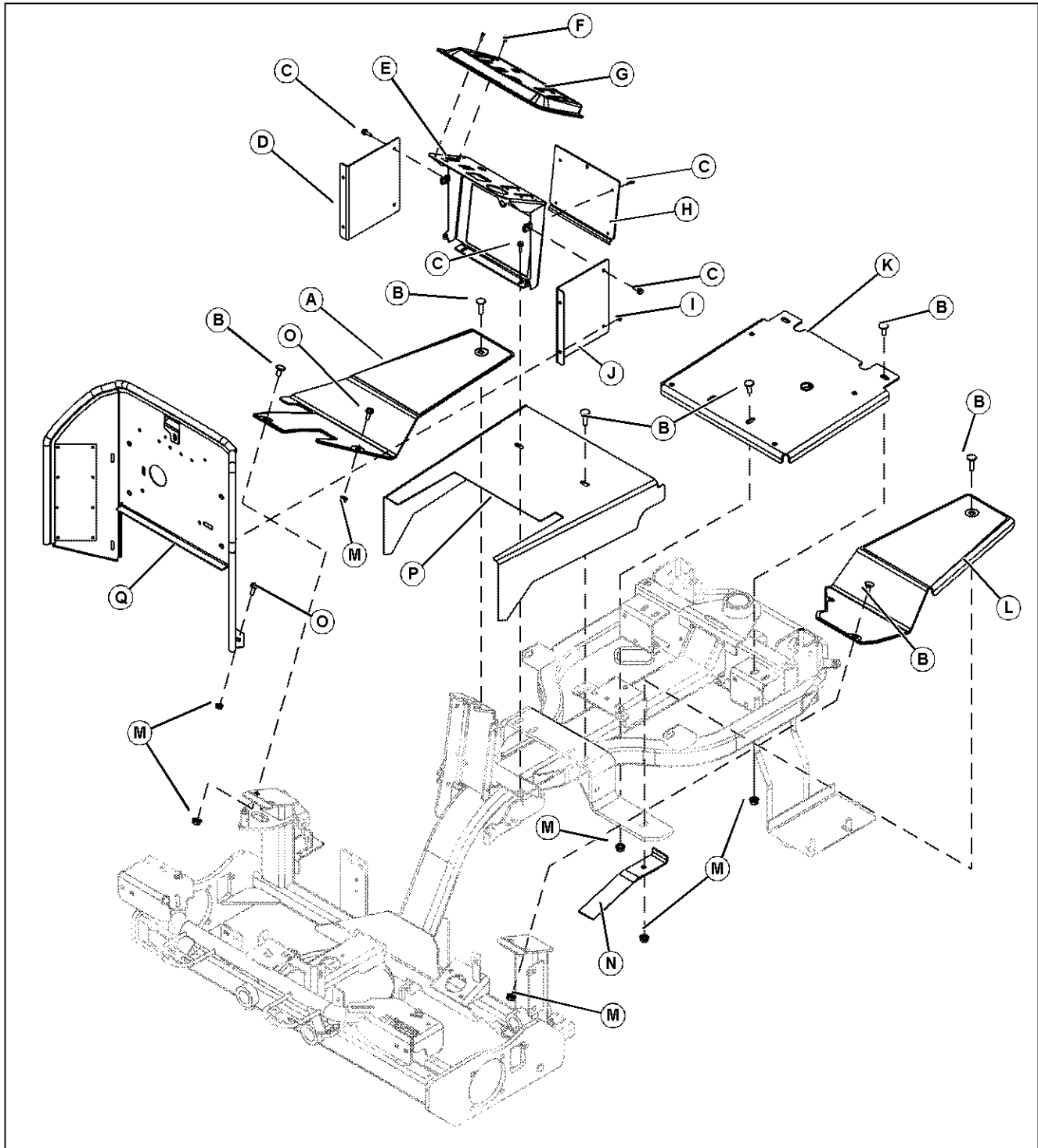


MX23562

- A- Decal
- B- Hood
- C- Hood Latch Assembly
- D- Cowl
- E- Washer
- F- Flange Bolt
- G- Locknut
- H- Hinge Bolt
- I- LH Hinge
- J- Carriage Bolt
- K- RH Hinge
- L- Locknut

MISCELLANEOUS COMPONENT LOCATION

Body Panels



MX23563

- A- RH Footrest
- B- Carriage Bolt
- C- Cap Screw
- D- RH Access Panel
- E- Pedestal
- F- Screw

- G- Control Panel
- H- Center Access Panel
- I- Locknut
- J- LH Access Panel
- K- Seat Base Plate
- L- LH Footrest
- M- Locknut

MISCELLANEOUS COMPONENT LOCATION

N- Leaf Support
O- Flange Bolt
P- Center Floor Panel
Q- Firewall

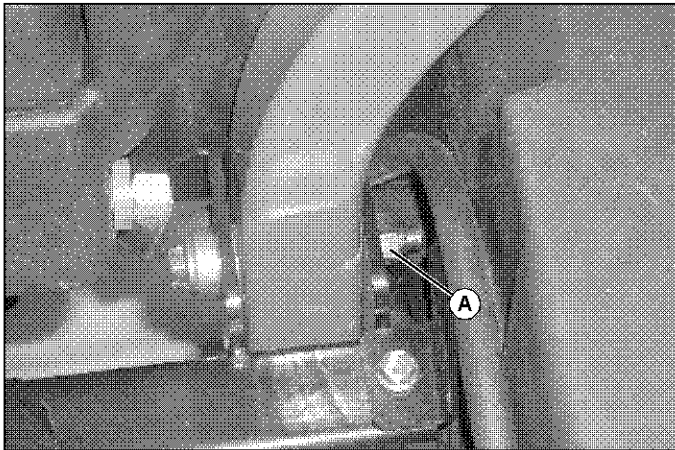
MISCELLANEOUS REPAIR

Repair

Remove and Install Roll-Over Protective Structure (ROPS)

Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.



MX23561

6. Remove four locknuts (A), bolts, and bushings.
7. Remove ROPS.

Installation

Installation is done in the reverse order of removal.

- Tighten hardware to specifications.

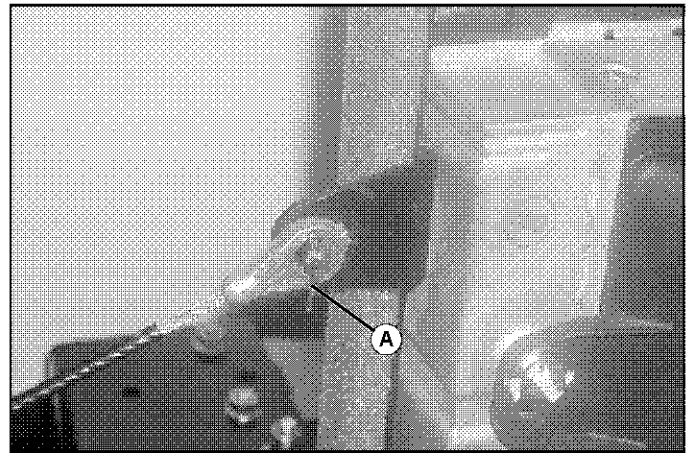
Specifications

ROPS Hardware Torque 108 N•m (80 lb-ft)

Remove and Install Hood

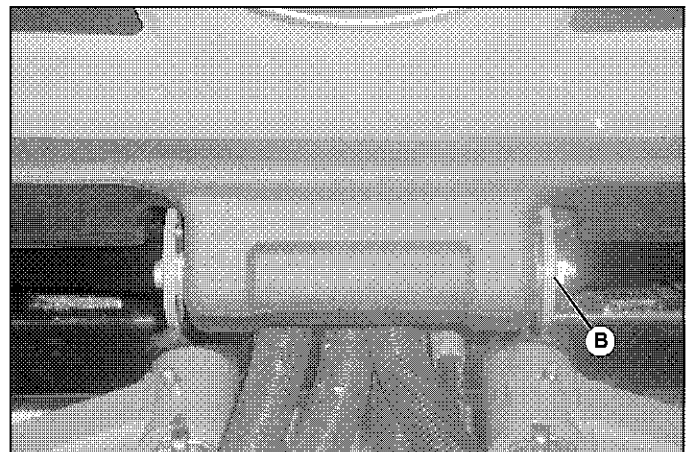
Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.
6. Raise hood.



MX23567

7. Remove cotter pin (A) and pin fastener from lanyard.



MX23568

8. Remove locknut (B) and carriage bolt.
9. Remove hood.

Installation

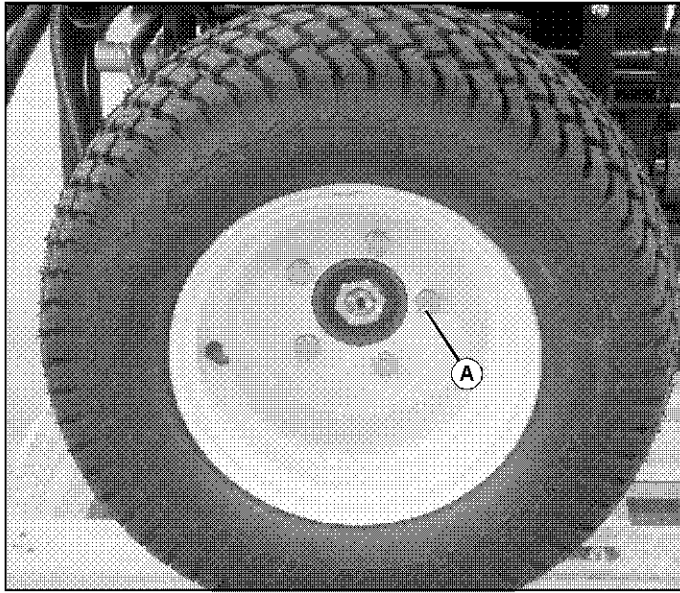
Installation is done in the reverse order of removal.

Remove and Install Front Wheels

Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.
6. Lift and support front of machine with jack stands.

MISCELLANEOUS REPAIR



MX23566

7. Remove five wheel bolts (A).
8. Remove wheel.

Installation

Installation is done in the reverse order of removal.

- Tighten wheel bolts evenly in an alternate pattern to specifications.

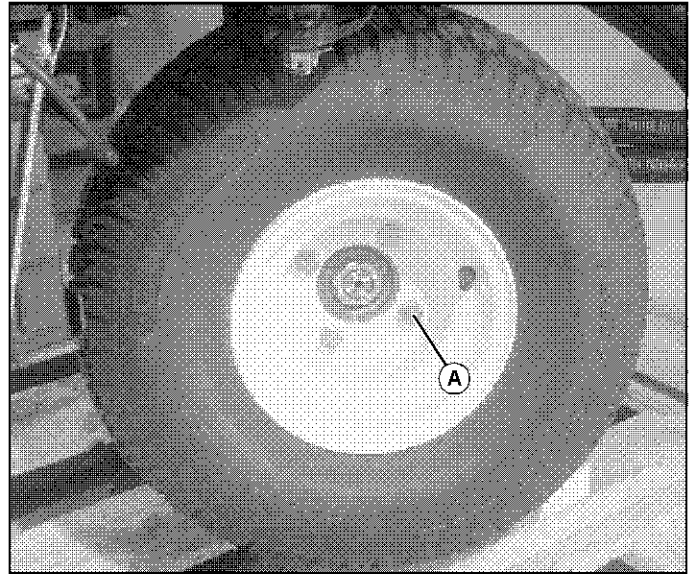
Specifications

Wheel Bolts Torque 81-95 N•m (60-70 lb-ft)

Remove and Install Rear Wheel

Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground
4. Turn key switch to the stop position.
5. Lock the park brake.
6. Lift and support rear of machine with jack stands.



MX23565

7. Remove four wheel bolts (A).
8. Remove wheel.

Installation

Installation is done in the reverse order of removal.

- Tighten wheel bolts evenly in an alternate pattern to specifications.

Specifications

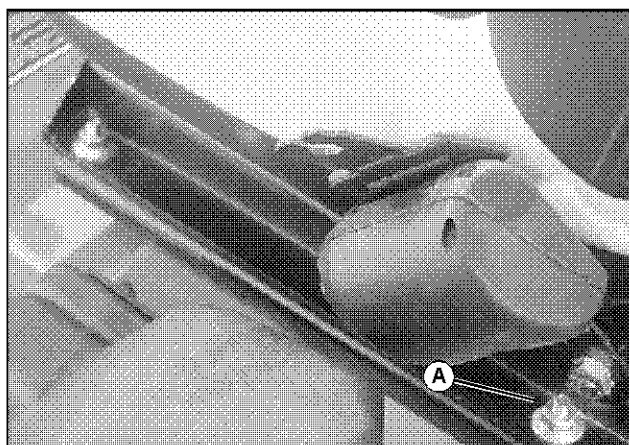
Wheel Bolts Torque 81-95 N•m (60-70 lb-ft)

Remove and Install Seat

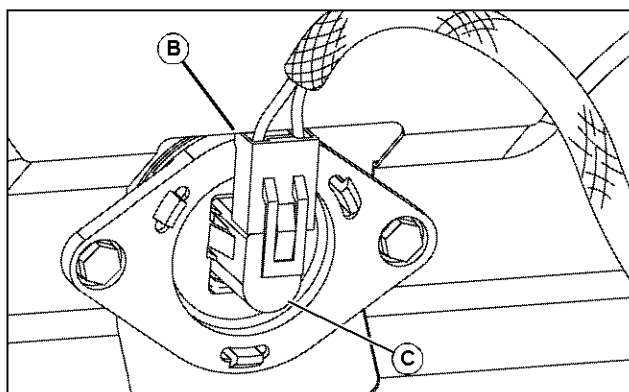
Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.

MISCELLANEOUS REPAIR



6. Remove four locknuts (A).



7. Tilt seat back to gain access to connector.
8. Disconnect wire harness (B) from operator presence switch (C).
9. Remove seat from machine.

Installation

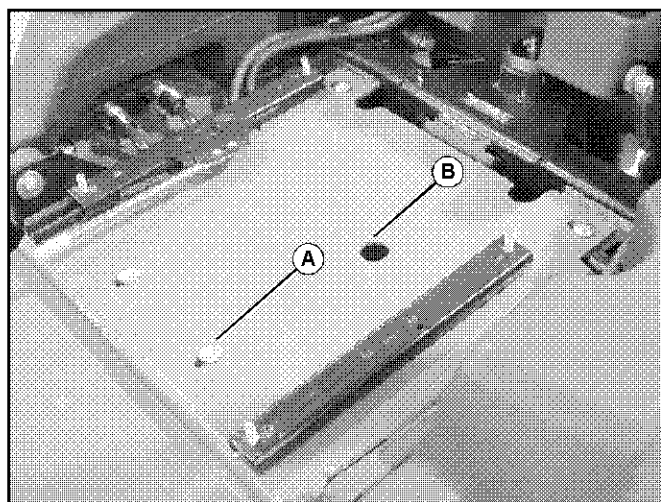
Note: For maximum operator comfort, use forward seat pan mounting holes when installing the seat.

Installation is done in the reverse order of removal.

Remove and Install Seat Base Plate

Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.
6. Remove seat. (See "Remove and Install Seat" on page 392.)



7. Remove four serrated locknuts securing carriage bolts (A) from the bottom of the machine and remove carriage bolts.

Note: Carefully route operator presence switch wire harness through hole (B) before removing seat base plate.

8. Remove seat base plate.

Installation

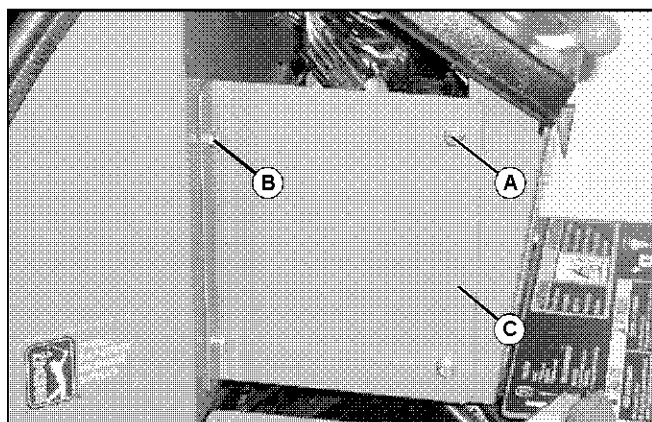
Installation is done in the reverse order of removal.

Disassemble and Assemble Control Console

Removal

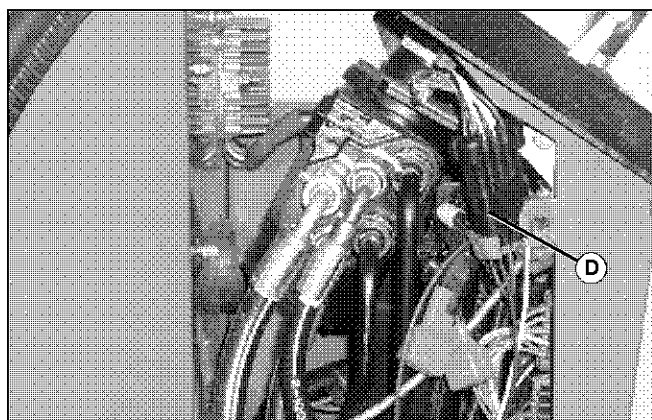
1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.
6. Chock front wheels to prevent inadvertent movement of the machine.
7. Raise hood and secure in the upright position.
8. Disconnect negative (-) battery cable.
9. Remove steering wheel. (See "Remove and Install Steering Wheel" on page 341.)

MISCELLANEOUS REPAIR



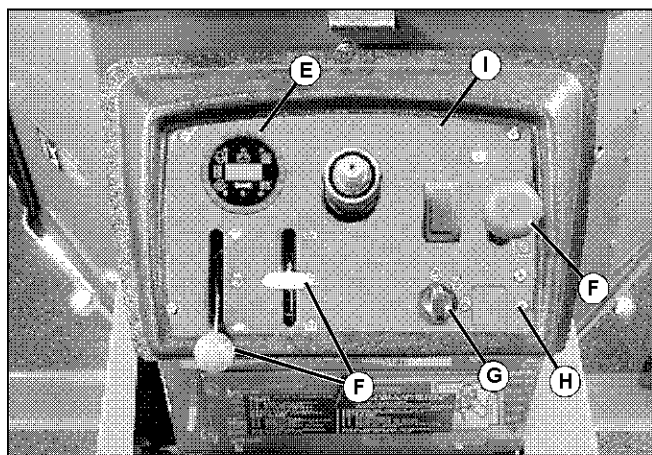
MX23256

10. Remove two cap screws (A), two flange nuts (B), and access panel (C).



MX23257

11. Disconnect indicator light-hour meter module connector (D).



MX23511A

12. Remove indicator light-hour meter module (E).

13. Remove three control handle knobs (F) and start switch retaining ring (G).

14. Remove six screws (H) securing control panel (I).

15. Remove control panel.

Installation

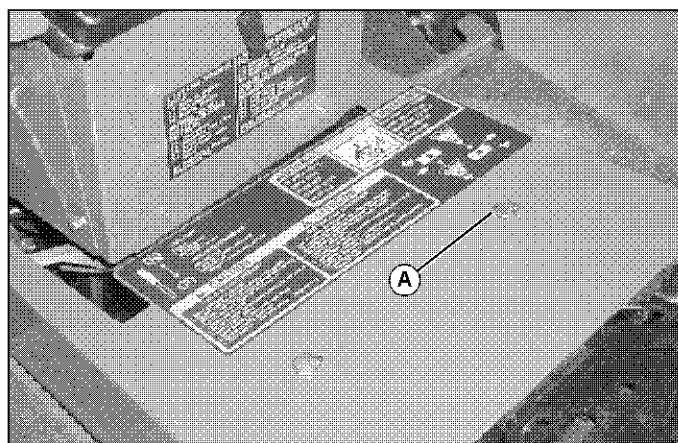
Installation is done in the reverse order of removal.

- Connect battery negative terminal last.

Remove and Install Center Floor Panel

Removal

1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.
6. Chock front wheels to prevent inadvertent movement of the machine.
7. Remove seat. (See "Remove and Install Seat" on page 392.)
8. Remove seat base plate. (See "Remove and Install Seat Base Plate" on page 393.)



MX23672

9. Remove two serrated locknuts securing carriage bolts (A) from the bottom of the machine and remove carriage bolts.

10. Unlock the park brake.

11. Remove center floor panel.

Installation

Installation is done in the reverse order of removal.

MISCELLANEOUS REPAIR

Remove and Install Fuel Tank

Removal

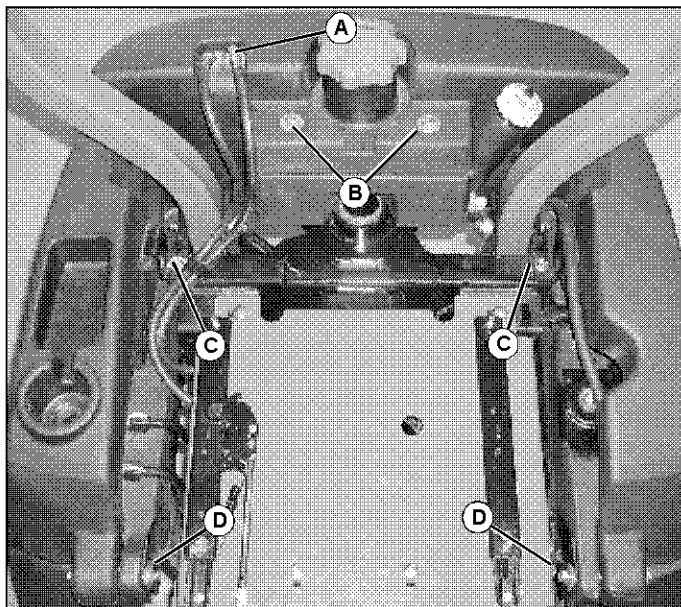
1. Park machine on a level surface.
2. Move mow-transport lever to the transport position.
3. Lower cutting units to the ground.
4. Turn key switch to the stop position.
5. Lock the park brake.



Caution: Avoid Injury! Fuel vapors are explosive and flammable:

- Shut engine off and allow to cool before draining and removing fuel tank.
- Do not smoke while handling fuel.
- Drain fuel tank outdoors or in well ventilated area.
- Keep fuel away from flames or sparks.
- Clean up spilled fuel immediately.

6. Drain fuel tank using a suitable container.



MX23569

Seat shown removed for picture clarity.

7. Remove two fuel lines (A).
8. Remove cap screws (B) and washers.
9. Remove cap screws (C) and hose clamp.
10. Remove locknuts (D), cap screws, and washers.
11. Remove fuel tank from machine.

Installation

Installation is done in the reverse order of removal.

- Tighten all cap screws to specifications.



Caution: Avoid Injury! Fuel vapors are explosive and flammable:

- Shut engine off before filling fuel tank.
- Do not smoke while handling fuel.
- Keep fuel away from flames or sparks.
- Fill fuel tank outdoors or in well ventilated area.
- Clean up spilled fuel immediately.
- Use clean approved non-metal container to prevent static electric discharge.
- Use clean approved plastic funnel without screen or filter to prevent static electric discharge.

- Fill fuel tank.

Specifications

Fuel Tank Cap Screws Torque 20 N•m (177 lb-in.)

MISCELLANEOUS REPAIR



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