JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Lightweight Fairway Mower
3225C, 3235C and 3245C

TM2105 DEC05

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

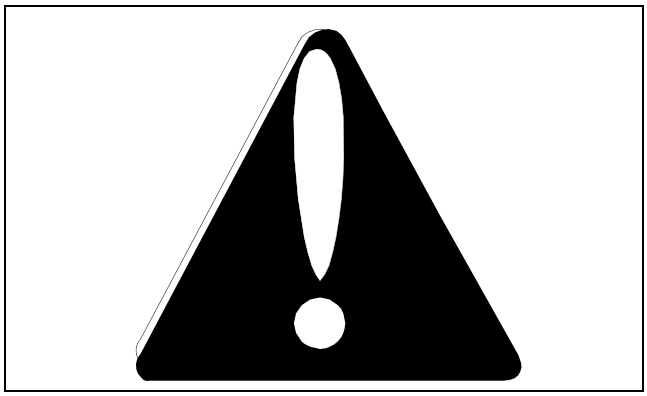
Steering

Brakes

Attachments

INTRODUCTION

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.

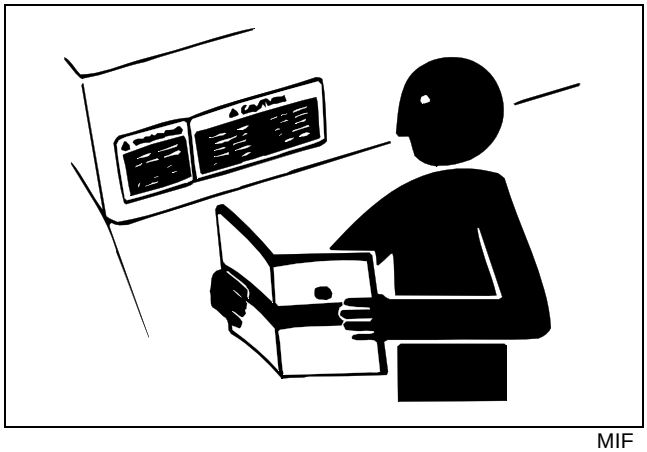
Follow recommended precautions and safe servicing practices.

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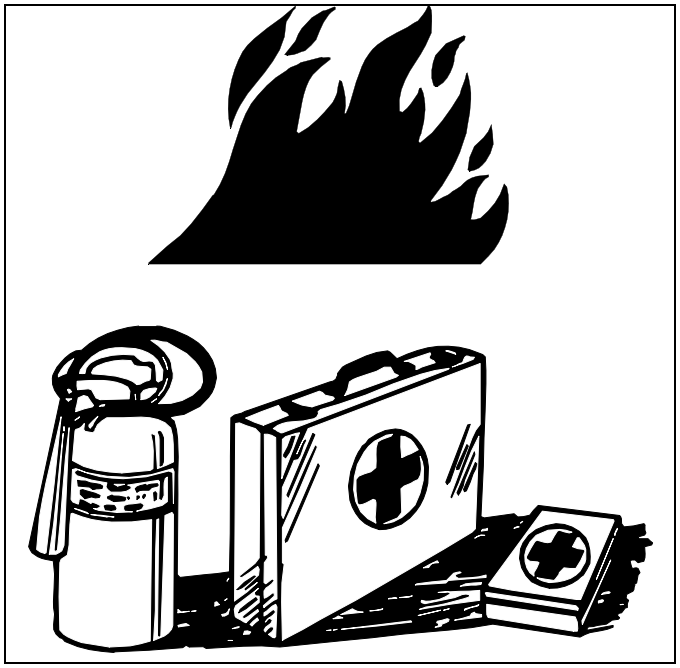
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



MIF

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.

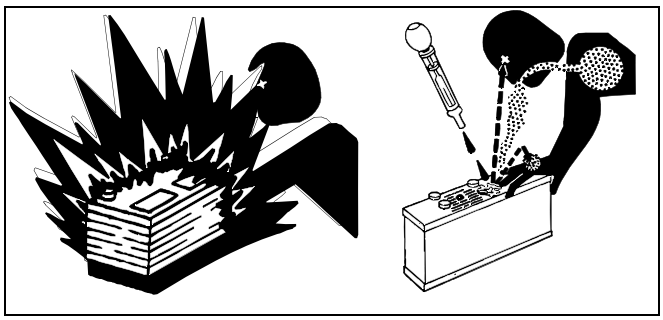
Do not store oily rags; they can ignite and burn spontaneously.

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



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Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away 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:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10-15 minutes.
4. Get medical attention immediately.

If acid is swallowed:

1. Drink large amounts of water or milk.
2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.

Use Care Around High-Pressure Fluid Lines

Avoid High-Pressure Fluids

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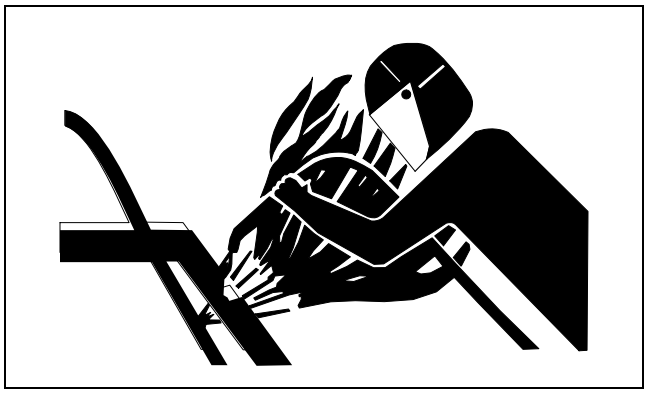
Escaping fluid under pressure can penetrate the skin causing serious injury.

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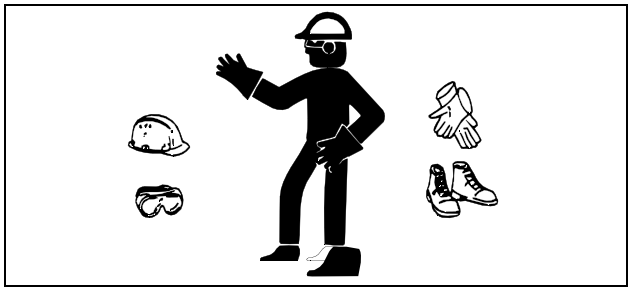
Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond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

Use Safe Service Procedures

Wear Protective Clothing



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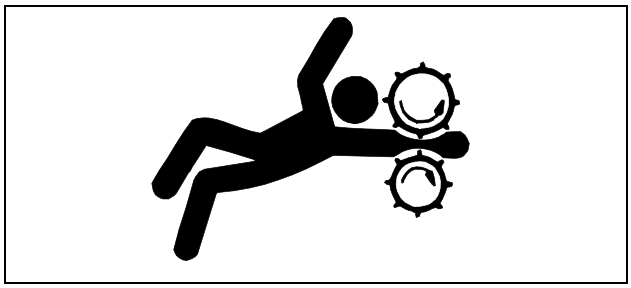
Wear close-fitting clothing and safety equipment appropriate to the job.

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.

Service Machines Safely



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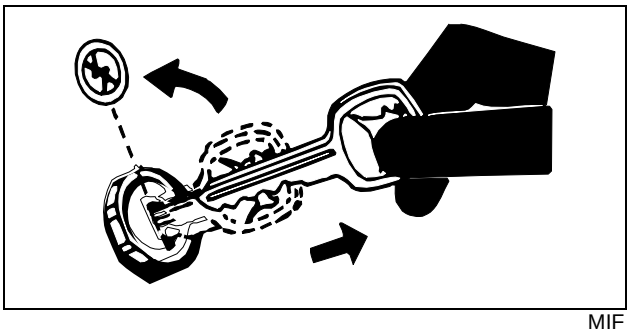
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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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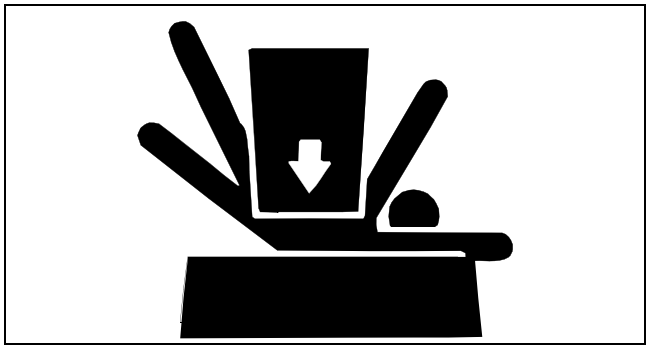
Before working on the machine:

1. Lower all equipment to the ground.
2. Stop the engine and remove the key.
3. Disconnect the battery ground strap.
4. Hang a “DO NOT OPERATE” tag in operator station.

Support Machine Properly and Use Proper Lifting Equipment



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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:

1. Clean work area and machine.
2. Make sure you have all necessary tools to do your job.
3. Have the right parts on hand.
4. Read all instructions thoroughly; do not attempt shortcuts.

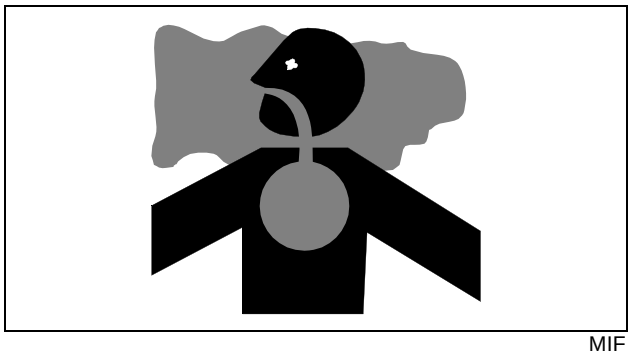
Using High-Pressure Washers

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.

Work in Ventilated Area



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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.

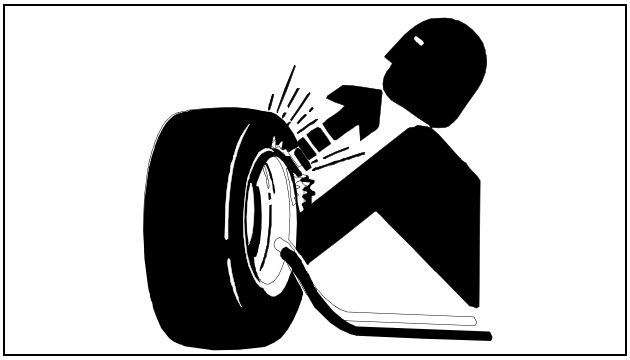
Avoid Harmful Asbestos Dust

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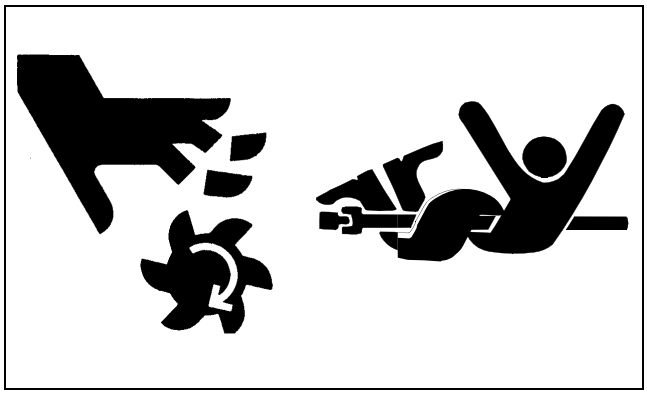
Explosive separation of a tire and rim parts can cause serious injury or death.

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.

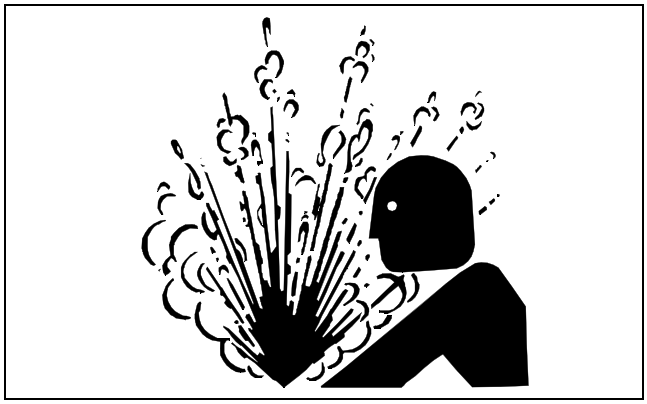
Avoid Injury from Rotating Blades and Drive Shafts



TS283 MIF

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

Service Cooling System Safely



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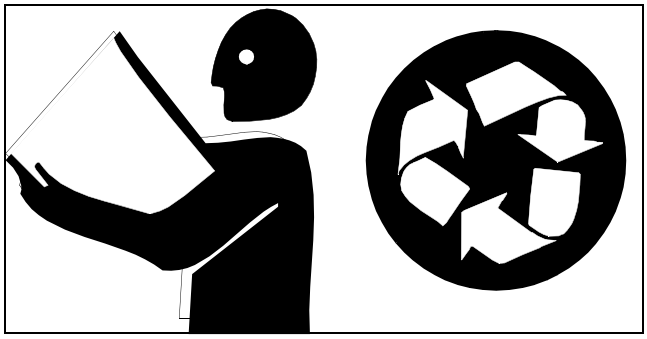
Explosive release of fluids from pressurized cooling system can cause serious burns.

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



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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

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

Table of Contents

Specifications

General Specifications

Engine Specifications

Make	Yanmar
Model	3TNV84(T)
Type	4-cycle diesel
Output Power 3225C (3TNV84)	23.9 kW (32 hp)
Output Power 3235C and 3245C (3TNV84T)	30.2 kW (40.5 hp)
Cylinders	3
Bore	84 mm (3.31 in.)
Stroke	90 mm (3.54 in.)
Displacement	1.496 L (91.3 cu. in.)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Direct injection type
Compression Ratio	18:1
Cooling	Liquid
Governor	Centrifugal
RPM at Slow Idle	1400 ± 50
RPM at Fast Idle (No-Load)	3000 ± 50
Rated RPM	2800
Torque Rise	20 percent minimum

Electrical Specifications

Battery Voltage	12
Starter Type	Solenoid shift
Alternator	Nippondenso

Power Train

Triple Pump (Front Gear Set) Make	Danfoss

Hydrostatic Transmission (3225C)

Make	Eaton
Model	70145
Type	Rotating piston, variable flow

Hydrostatic Transmission (3235C and 3245C)

Make	Eaton
Model	72400
Type	Servo-controlled piston pump

Front Wheel Motors

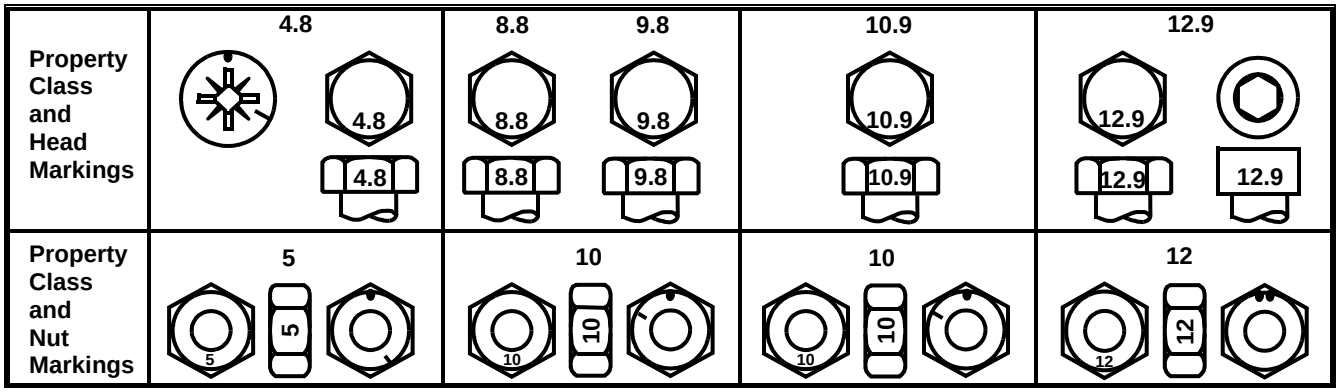
Make	Eaton
Model - 3225C	167-0035-001
Model - 3235C and 3245C	167-0036-001

Rear Wheel Motors (3235C and 3245C)

Make	**Parker**
Model	**MB10020BAAGW**
Brake Type	**Mechanical**

General Information

Metric Fastener Torque Values



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 ±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.

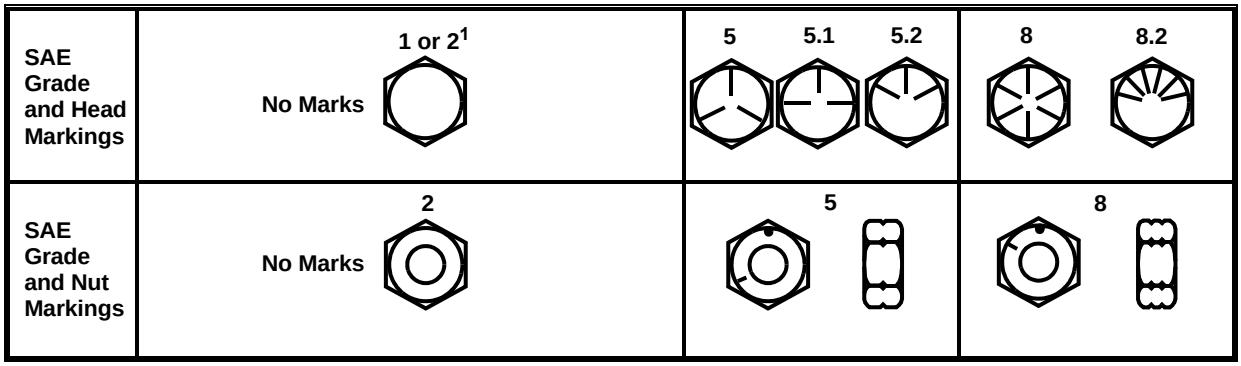
Tighten toothed or serrated-type locknuts to the full torque value.

Reference: JDS-G200.

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

Inch Fastener Torque Values



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	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 ±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.

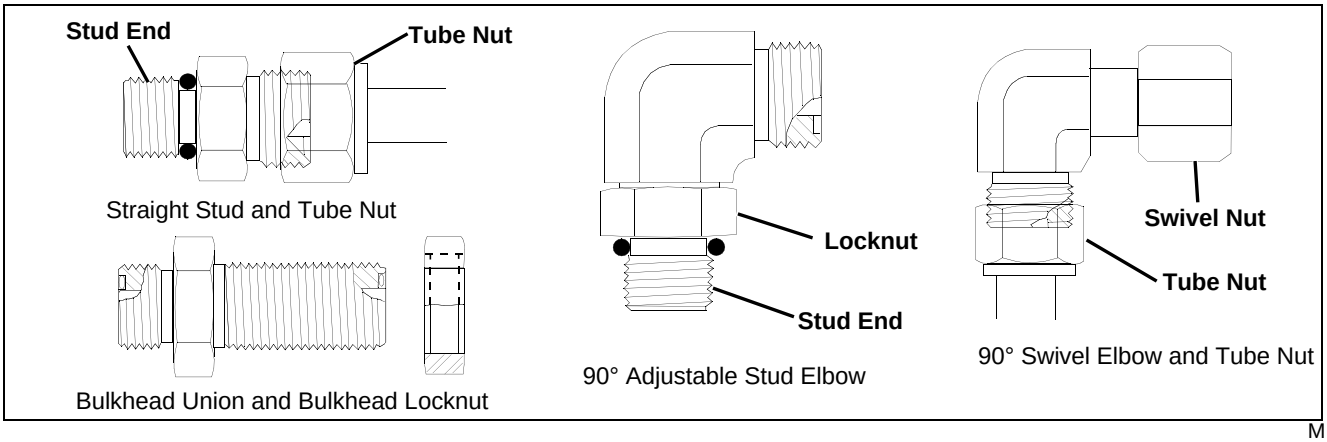
Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

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 locknuts to the full torque value.

Reference: JDS-G200.

Face Seal Fittings with Inch Stud Ends Torque



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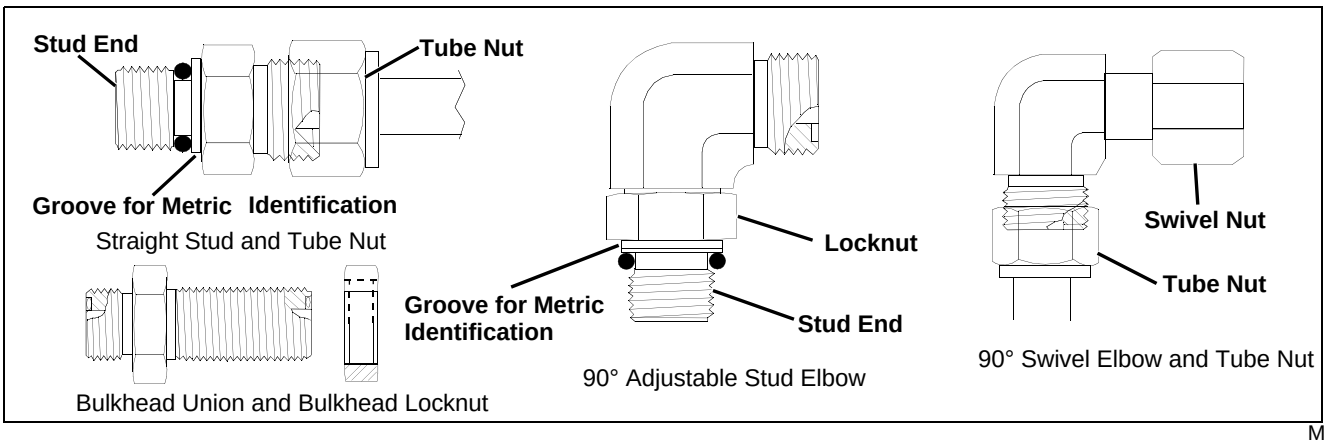
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Straight Fitting or Locknut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24	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%.

Face Seal Fittings with Metric Stud Ends Torque



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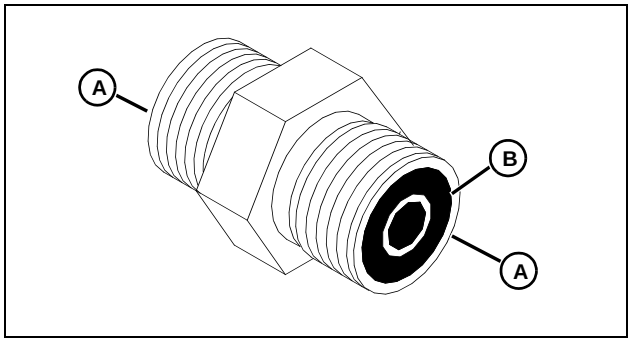
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Locknut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	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



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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-rings 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.

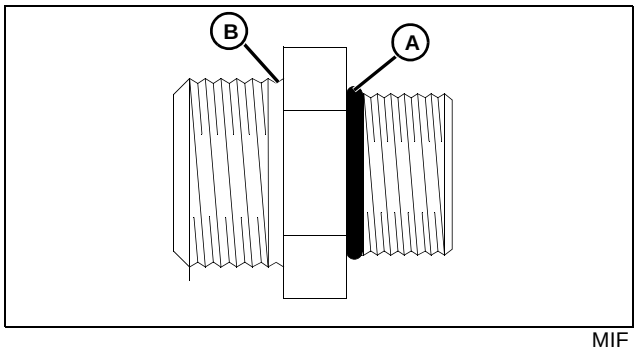
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

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.



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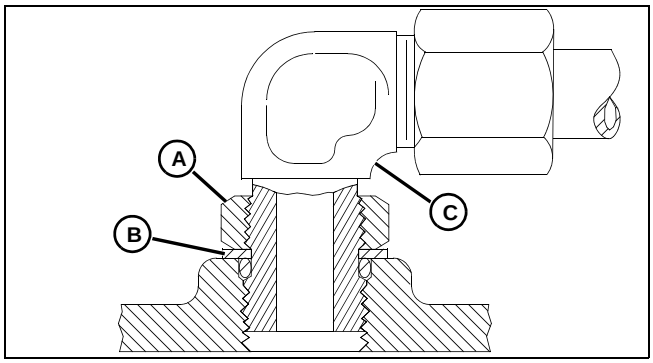
2. Put hydraulic oil or petroleum jelly on the O-ring (A). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (B) of fitting. Remove tape.



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3. For angle fittings, loosen special nut (A) and push special washer (B) 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 (C), 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 on the chart while holding body of fitting with a wrench.

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.

Service Recommendations for STC Fittings

Special or Required Tools:

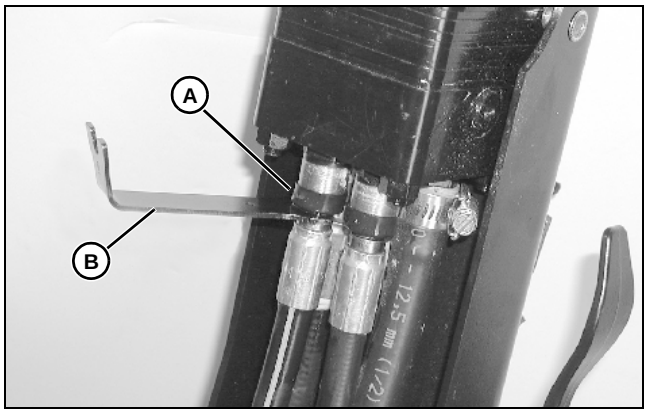
Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1518	Used to disconnect hoses.

Seal Tight Connector (STC)® Fittings:

STC fittings are used on this machine. The fittings are designed for quick leak-proof connections.

Compact swivel-type connections can be made easily. Fittings are available in -06, -08, -10, -12, and -16 sizes.

Fittings are easily disconnected using JDG1518 Hose Removal Tool. To connect fittings, simply push both fitting halves together.



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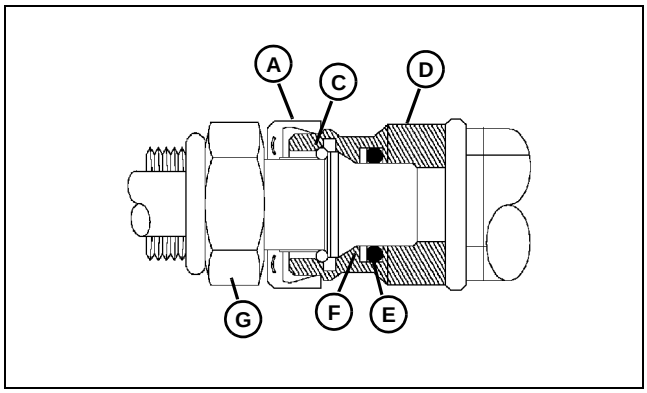

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A - Release Sleeve
B - Hose Removal Tool
C - Retaining Ring
D - Female Half of STC Fitting
E - O-Ring
F - Backup Ring
G - Male Half of STC Fitting

IMPORTANT: Avoid damage! Do not pry against release sleeve (1) or damage to fitting may result.

Do not force release sleeve beyond normal range of travel, or release sleeve may fall off when hose is disconnected. If this happens and fitting is connected without the release sleeve installed, fitting will not be able to be disconnected again.

1. Disconnect STC-type fittings:

   a. Clean area around fitting, especially around the release sleeve (A).

   b. While keeping JDG1518 Hose Removal Tool (B) perpendicular to the fitting, insert tool under release sleeve until tool stops.

   c. Pull hose away from fitting to disconnect.

2. Inspect STC fittings:

   a. Check seal mating surfaces for nicks, scratches, or flat spots.

   b. Check O-ring (E), backup ring (F), and retaining ring (3) for wear or damage. Replace if damaged or if fittings look good but connection leaks.

   c. O-ring, backup ring, and retaining ring must be in position before connecting fitting halves. Install backup ring first, then the O-ring behind the backup ring.

3. Connect STC fittings:

   a. Make sure fitting halves are clean and free of contaminants.

IMPORTANT: Avoid damage! If release sleeve is not on fitting when connection is made, fitting will not be able to be disconnected.

   b. Make sure release sleeve (A) is on male half of fitting before connecting fitting halves together.

   c. Push fitting halves together until definite, solid stop is felt.

   d. Pull back on hose to make sure fitting halves are locked together.

   e. To prevent hoses from binding, move component into position before pressurizing hydraulic system.

Using Proper Fuel (Diesel) - North America

Use the proper diesel fuel to help prevent decreased engine performance and increased exhaust emissions. Failure to follow the fuel requirements listed below can void your engine warranty.

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

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

Diesel fuels specified to EN 590 or ASTM D975 are recommended.

Required fuel properties

In all cases, the fuel shall meet the following properties:

Cetane number of 45 minimum. Cetane number greater than 50 is preferred, especially when temperatures are below -20°C (-4°F) or elevations above 1500 m (5000 ft).

Cold Filter Plugging Point (CFPP) below the expected low temperature OR **Cloud Point** at least 5°C (9°F) below the expected low temperature.

Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078 or maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

If a fuel of low or unknown lubricity is used, addition of John Deere PREMIUM DIESEL FUEL CONDITIONER at the specified concentration is recommended.

Sulfur content

- Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.
- Sulfur content less that 0.05% (500 ppm) is recommended for best performance.
- Diesel fuel sulfur content greater than 0.5% (5000 ppm) should not be used.

IMPORTANT: Avoid damage! Do not mix diesel engine oil or any other type of lubricating oil with diesel fuel.

Handling and Storing Diesel Fuel

CAUTION: Avoid injury! Handle fuel carefully. Do not fill the fuel tank when engine is running.

Do not smoke while you fill the fuel tank or service the fuel system.

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.

- Fill fuel tank at end of each day's operation to prevent water condensation and freezing during cold weather.

IMPORTANT: Avoid damage! The fuel tank is vented through the filler cap. If a new cap is required, always replace it with an original vented cap.

- When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and to prevent water condensation. Contact your fuel supplier for recommendations.

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 five different classes or six 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 0.05%, 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 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.**

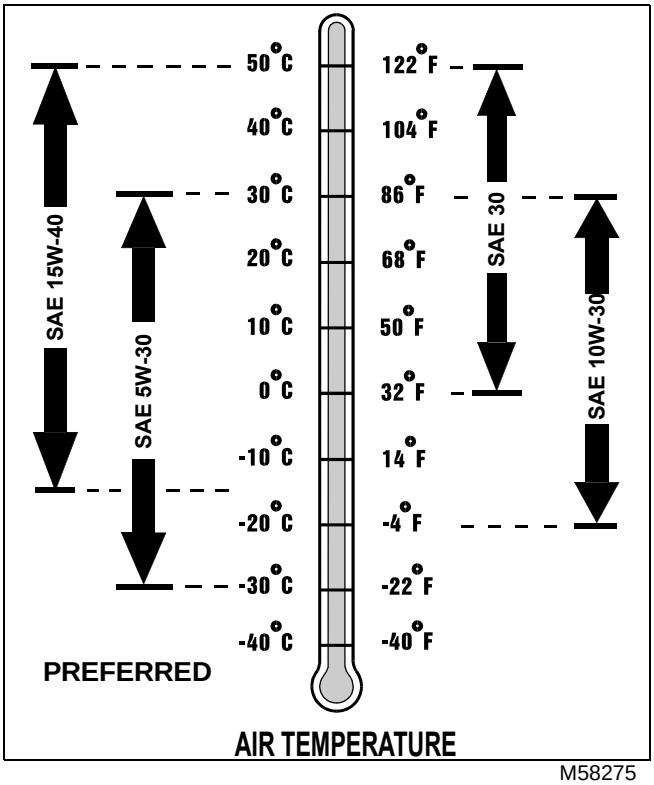
The following John Deere oils are also recommended, based on their specified temperature range:

- **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 0.05% is used, reduce the service interval for oil and filter by 50%.



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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.**

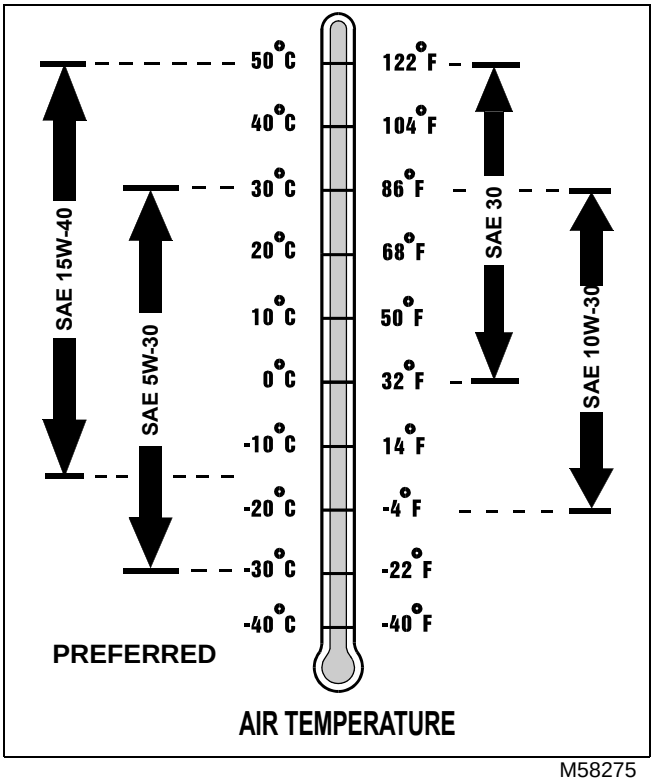
The following John Deere oils are also recommended, based on their specified temperature range:

- **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 0.05% is used, reduce the service interval for oil and filter by 50%.



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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

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.

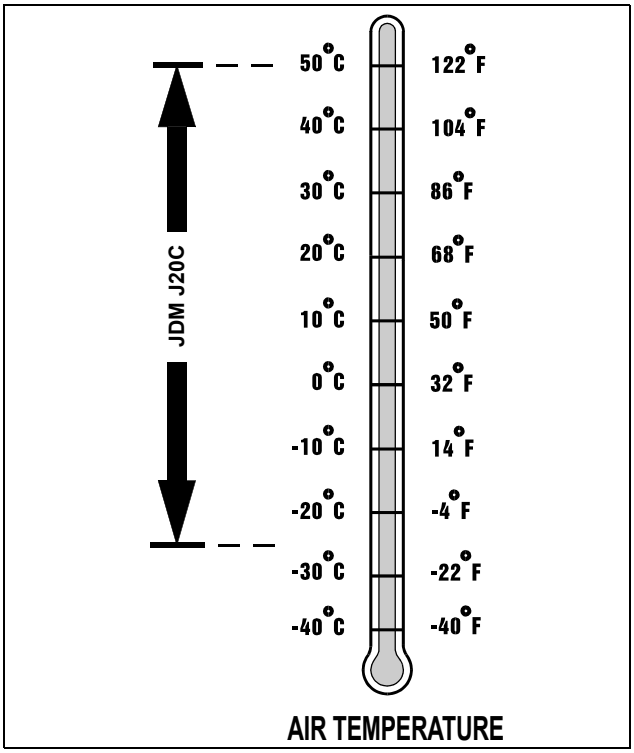
IMPORTANT: Avoid damage! DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission. DO NOT mix any other oils in this transmission.

The following John Deere transmission and hydraulic oil is PREFERRED:

- **HY-GARD™ - JDM J20C.**

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.



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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).

BIO HY-GARD should be used only in cases where the benefits of its use offset the extra initial cost, the increased oil change cost and the potential increasing maintenance costs for hydraulic systems with high temperatures and heavy loads.

- 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.

Cold Weather Operation

Precautions should be taken if BIO HY-GARD containers or equipment are stored for long periods of time in extremely cold temperatures. Freezing should be expected if BIO HY-GARD is subjected to the following temperatures:

- Stored for six months at -18° to -23°C (-1° to -10°F)
- Stored for seven days at -23° to -26°C (-10° to -15°F)
- Stored for three days at -26° to -29°C (-15° to -20°F)
- Stored for two days at -29° to -34°C (-20° to -30°F)
- Stored for one day at -34°C (-30°F) and below.

IMPORTANT: Avoid damage! Equipment should not be started or any operation attempted until BIO HY-GARD has reached a safe operating viscosity.

If freezing of BIO HY-GARD is suspected, the container or equipment MUST be warmed to at least 0°C (32°F) and maintained for 24-48 hours to ensure the fluid has reached a safe operating viscosity.

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 1-7.
11. Follow recommended maintenance schedules.

Anti-Corrosion Grease

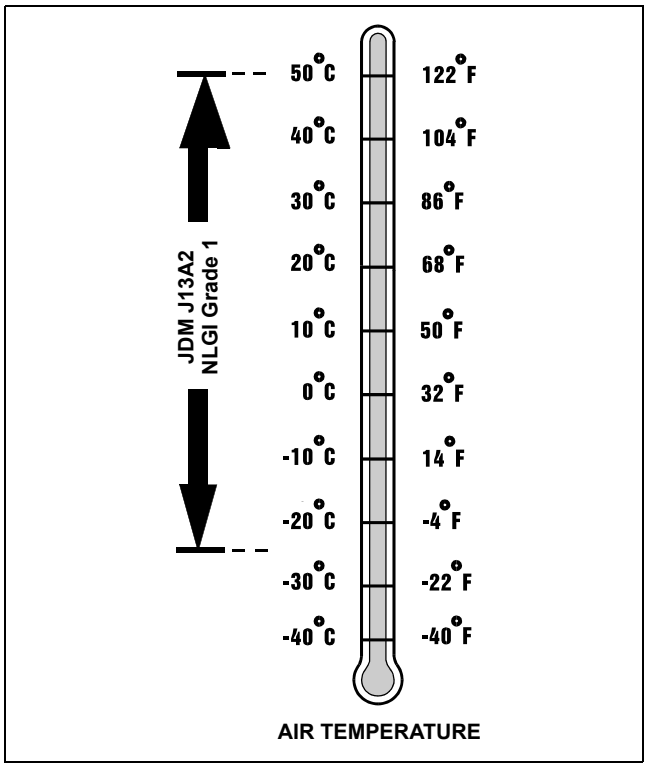
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

The following anti-corrosion grease is PREFERRED:

- DuBois MPG-2® - Multi-Purpose Polymer Grease-M79292.

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

- John Deere Standard JDM J13A2, NLGI Grade 1.



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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.

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.

IMPORTANT: Avoid damage! ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO-GREASE in this application.

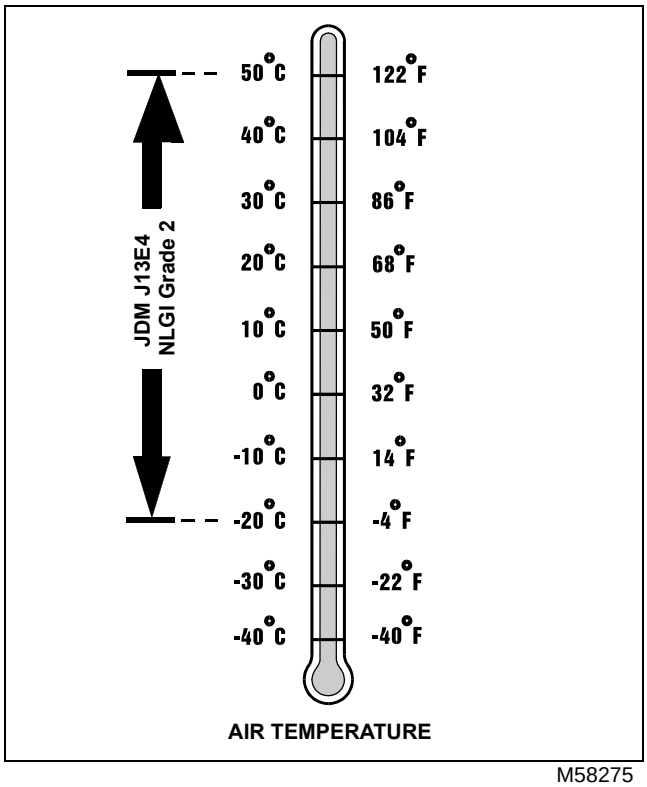
The following John Deere greases are PREFERRED:

- **Multi-Purpose SD Polyurea (TY6341).**
- **Special-Purpose HD Moly (TY6333).**
- **Reel Support Grease - Special Purpose Golf and Turf Cutting Unit Grease (TY25083).**

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

Reel Support Grease Applications:

- Polyurea Grease - NLGI Grade 0.
- Calcium Complex Grease - NLGI Grade 0.
- Lithium Complex Grease - NLGI Grade 0.
- John Deere Standard JDM J13E4 - NLGI Grade 2.



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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.

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.

IMPORTANT: Avoid damage! ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO-GREASE in this application.

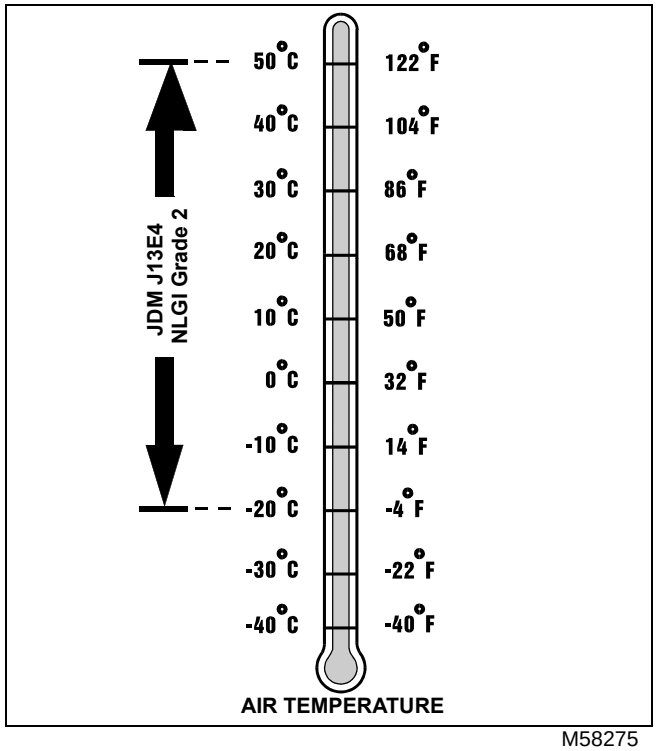
The following John Deere greases are PREFERRED:

- **GREASE-GARD™ - JDM J13E4, NLGI Grade 2.**
- **Reel Support Grease - JDM J13E6, NLGI Grade 0.**

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

Reel Support Grease Applications:

- Polyurea Grease - NLGI Grade 0.
- Calcium Complex Grease - Grade 0.
- Lithium Complex Grease - NLGI Grade 0.
- John Deere Standard JDM J13E4 - NLGI Grade 2.



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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.

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.

Mixing of Lubricants

In general, avoid mixing different brands or types of lubricants. Manufacturers blend additives in their lubricants to meet certain specifications and performance requirements. Mixing different lubricants can interfere with the proper functioning of these additives and lubricant properties which will downgrade their intended specified performance.

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.

Diesel Engine Coolant - North America

The engine cooling system, when filled with a proper dilution mixture of anti-freeze and deionized or distilled water, provides year-round protection against corrosion, cylinder or liner pitting, and winter freeze protection down to -37°C (-34°F).

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

- **PRE-DILUTED DIESEL ENGINE ANTI-FREEZE/ SUMMER COOLANT (TY16036).**

This coolant satisfies specifications for “Automobile and Light Duty Engine Service” and is safe for use in John Deere Lawn and Grounds Care/Golf and Turf Division equipment, including aluminum block gasoline engines and cooling systems.

The above preferred pre-diluted anti-freeze provides:

- adequate heat transfer
- corrosion-resistant chemicals for the cooling system
- compatibility with cooling system hose and seal material
- protection during extreme cold and extreme hot weather operations
- chemically pure water for better service life
- compliance with ASTM D4656 (JDM H24C2) specifications

If above preferred pre-diluted coolant is not available, the following John Deere concentrate is recommended:

- **DIESEL ENGINE ANTI-FREEZE/SUMMER COOLANT CONCENTRATE (TY16034).**

If either of above recommended engine coolants are not available, use any Automobile and Light Duty Engine Service ethylene glycol base coolant meeting the following specification:

- ASTM D3306 (JDM H24C1).

Read container label completely before using and follow instructions as stated.

IMPORTANT: Avoid damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze mixture in the cooling system. DO NOT mix or add any additives/conditioners to the cooling system in Lawn and Grounds Care/Golf and Turf Division equipment. Water used to dilute engine coolant concentrate must be of high quality - clean, clear, potable water (low in chloride and hardness - Table 1) is generally acceptable. DO NOT use salt water. Deionized or distilled water is ideal to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Water Quality	
Property	**Requirements**
Total Solids (Max)	340 ppm (20 grns/gal)
Total Hardness (Max)	170 ppm (10 grns/gal)
Chloride (as Cl) (Max)	40 ppm (2.5 grns/gal)
Sulfate (as SO_4) (Max)	100 ppm (5.8 grns/gal)

Mix 50 percent anti-freeze concentrate with 50 percent distilled or deionized water. This mixture and the pre-diluted mixture (TY16036) will protect the cooling system down to a temperature of -37°C (-34°F) and up to 108°C (226°F).

Certain geographical areas may require lower air temperature protection. See the label on your anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Diesel Engine Coolant Drain Interval - North America

When using John Deere Pre-Diluted (TY16036) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 36 months or 3,000 hours of operation, whichever comes first.

When using John Deere Concentrate (TY16034) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 24 months or 2,000 hours of operation, whichever comes first.

If above John Deere Automobile and Light Duty Engine Service coolants are not being used, drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

Diesel Engine Coolant - Europe

The engine cooling system, when filled with a proper dilution mixture of anti-freeze and deionized or distilled water, provides year-round protection against corrosion, cylinder liner pitting, and winter freeze protection down to -37°C (-34°F).

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

- **COOL-GARD™ COOLANT CONCENTRATE.**

If above preferred coolant is not available, use any Automobile and Light Duty Engine Service ethylene glycol base coolant meeting the following specification:

- ASTM D3306 (JDM H24C1).

Read container label completely before using and follow instructions as stated.

IMPORTANT: Avoid damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze mixture in the cooling system. DO NOT mix or add any additives/conditioners to the cooling system in Lawn and Grounds Care/Golf and Turf Division equipment. Water used to dilute engine coolant concentrate must be of high quality - clean, clear, potable water (low in chloride and hardness - Table 1) is generally acceptable. DO NOT use salt water. Deionized or distilled water is best to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Water Quality	
Property	**Requirements**
Total Solids (Max)	340 ppm (20 grns/gal)
Total Hardness (Max)	170 ppm (10 grns/gal)
Chloride (as Cl) (Max)	40 ppm (2.5 grns/gal)
Sulfate (as SO_4) (Max)	100 ppm (5.8 grns/gal)

Mix 50 percent anti-freeze concentrate with 50 percent distilled or deionized water. This mixture will protect the cooling system down to -37°C (-34°F) and up to 108°C (226°F).

Certain geographical areas may require lower air temperature protection. See the label on your anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Diesel Engine Coolant Drain Interval - Europe

When using John Deere COOL-GARD Coolant Concentrate for Automobile and Light Duty Engine Service, drain and flush the cooling system and refill with fresh coolant mixture every 24 months or 2,000 hours of operation, whichever comes first.

If above John Deere Automobile and Light Duty Engine Service coolant is not being used, drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

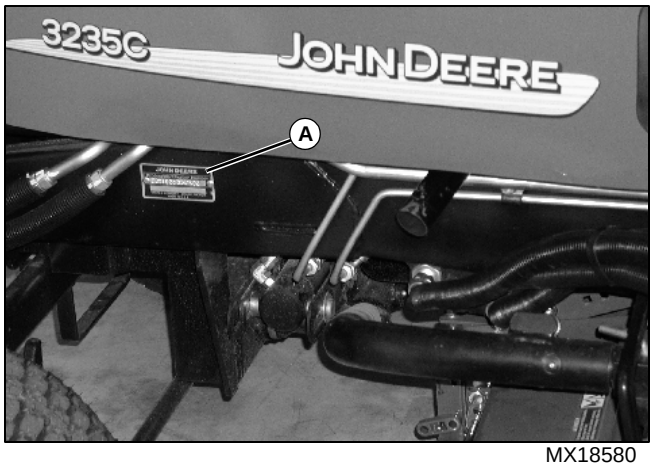
Identification Numbers

Serial Number Location

When ordering parts or submitting a warranty claim, it is IMPORTANT that you include the mower product identification number and the component serial numbers.

The locations of mower identification number and component serial numbers are shown.

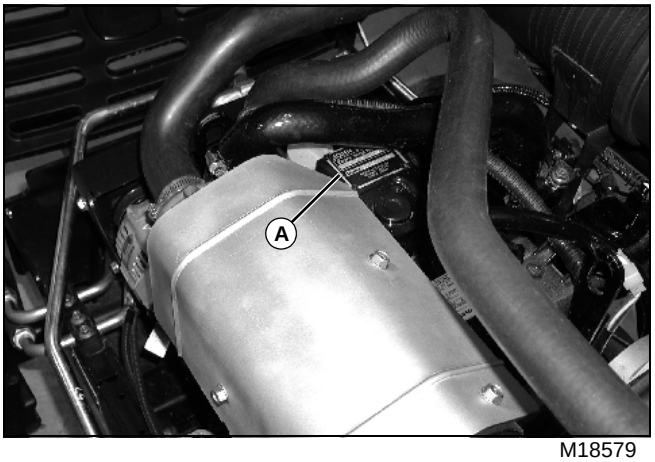
Machine Identification Number



MX18580

The mower identification number plate (A) is located on the right-hand frame under the engine compartment.

Engine Serial Number

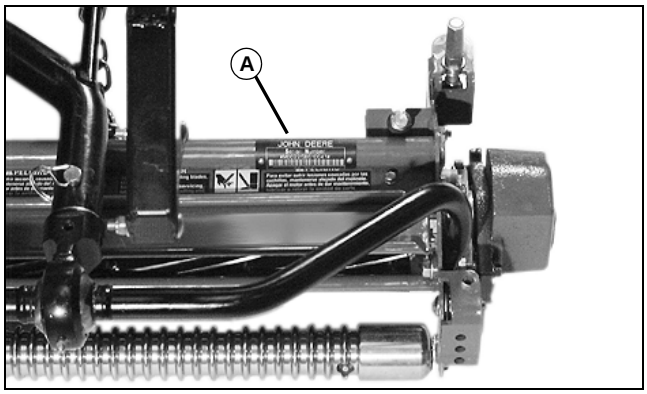


M18579

The engine serial number plate (A) is located on the top of the valve cover.

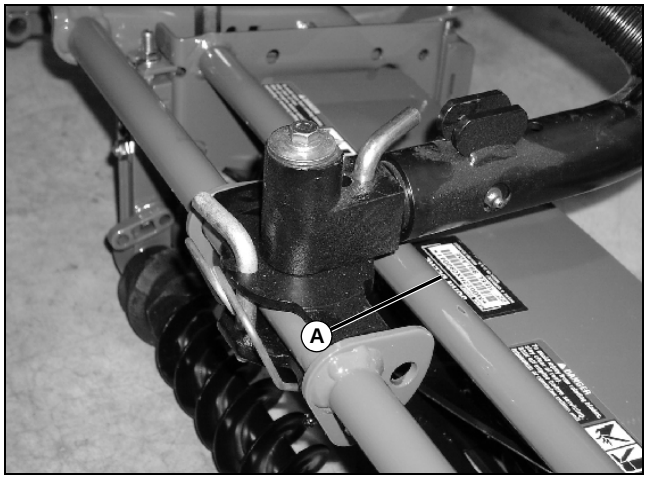
Cutting Unit Serial Numbers

NOTE: The rotary cutting units do not have serial number plates.



M84563

Picture Note: 2500M Cutting Unit



MX18036

Picture Note: 22 In. Heavy Duty

The cutting unit serial number plate (A) is located on top of the cutting unit.

ENGINE - DIESEL TABLE OF CONTENTS

Table of Contents

Specifications

3TNV84(T) Engine

General Specifications

Make	Yanmar
Model	3TNV84(T)
Type	4-cycle diesel
Output Power 3225C (3TNV84)	23.9 kW (32 hp)
Output Power 3235C and 3245C (3TNV84T)	30.2 kW (40.5 hp)
Cylinders	3
Bore	84 mm (3.31 in.)
Stroke	90 mm (3.54 in.)
Displacement	1.496 L (91.3 cu. in.)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Direct injection type
Compression Ratio	18:1
Cooling	Liquid
Governor	Centrifugal
RPM at Slow Idle	1400 ± 50
RPM at Fast Idle (No-Load)	3000 ± 50
Rated RPM	2800
Torque Rise	20 percent minimum

Startability

W/O Block Heater	-17.8°C (0°F)
W/ Block Heater	-28.9°C (-20°F)

Repair Specifications

Alternator

Belt Deflection @ 98 N (22 lb-force)	8-13 mm (0.4-0.6 in.)
Slip Ring Diameter (Minimum)	14 mm (0.55 in.)
Exposed Brush Length (Minimum)	4.5 mm (0.17 in.)
Exposed Brush Length (Maximum)	10.5 mm (0.41 in.)
Output	40 amp

Cam Follower Bore

Bore ID	12.00-12.02 mm (0.472-0.473 in.)
Wear Limit	11.96 mm (0.474 in.)
Clearance	0.010-0.043 mm (0.0.001-0.002 in.)

Cam Follower Stem

Stem OD	11.98-11.99 mm (0.471-0.472 in.)
Wear Limit	11.93 mm (0.470 in.)

Camshaft

Camshaft End Play	**0.05-0.20 mm (0.002-0.010 in.)**
Wear Limit	**0.03 mm (0.012 in.)**
Camshaft Bend (Maximum)	**0.03 mm (0.0021 in.)**
Camshaft Lobe Height	**38.64-38.77 mm (1.521-1.526 in.)**
Wear Limit	**38.40 mm (01.512 in.)**

Camshaft Bushings

Camshaft Bushing ID at Gear Housing	**44.990-45.055 mm (1.771-1.774 in.)**
Camshaft Bushing ID at Intermediate and Flywheel End	**45.00-45.025 mm (1.772-1.773 in.)**
Wear Limit	**45.10 mm (1.776 in.)**
Camshaft Bushing-to-Journal Clearance	**0.23 mm (0.009 in.)**

Camshaft Journals

Gear Housing and Flywheel End Camshaft Journals OD	**44.93-44.95 mm (1.769-1.770 in.)**
Intermediate Camshaft Journals	**44.91-44.94 mm (1.768-1.769 in.)**
Wear Limit	**44.85 mm (1.766 in.)**

Connecting Rod Bearing

Bearing ID	**47.952-47.962 mm (1.888-1.891 in.)**
Wear Limit	**48.07 mm (1.893 in.)**
Bearing Oil Clearance	**0.038-0.074 mm (0.001-0.003 in.)**
Wear Limit	**0.150 mm (0.006 in.)**

Crankshaft and Main Bearings

Crankshaft Bend Variation	**0.02 mm (0.001 in.)**
Connecting Rod Journal OD	**47.95-47.96 mm (1.8878-1.8882 in.)**
Wear Limit	**47.91 mm (1.886 in.)**
Main Bearing Journal OD	**53.95-53.96 mm (2.1240-2.1244 in.)**
Wear Limit	**53.91 mm (2.122 in.)**
Main Bearing Oil Clearance	**0.038-0.074 mm (0.001-0.003 in.)**
Wear Limit	**0.15 mm (0.006 in.)**

Cylinder Bore

Standard Cylinder Bore ID	**84.00-84.03 mm (3.307-3.308 in.)**
Wear Limit	**84.20 mm (3.315 in.)**
Oversize Cylinder Bore ID	**84.25-84.28 mm (3.317-3.318 in.)**
Wear Limit	**84.45 mm (3.325 in.)**
Piston-to-Cylinder Bore Clearance	**0.040-0.070 mm (0.001-0.003 in.)**
Cylinder Roundness	**0.00-0.01 mm (0.00-0.0004 in.)**
Wear Limit	**0.03 mm (0.001 in.)**
Cylinder Taper	**0.00-0.01 mm (0.00-0.0004 in.)**
Wear Limit	**0.03 mm (0.001 in.)**

Cylinder Head

Cylinder Head Flatness (Maximum Distortion)	**0.15 mm (0.006 in.)**
Cylinder Head Flatness (Resurface Range)	**0.00-0.05 mm (0.000-0.002 in.)**
Wear Limit	**0.15 mm (0.006 in.)**

Flywheel

Flatness	**0.02 mm (0.001 in.)**

Fuel Injection Nozzles

Nozzle Contact Surface	**0.10 mm (0.004 in.)**

Idler Gear

Shaft OD	**45.950-45.975 mm (1.809-1.810 in.)**
Wear Limit	**45.93 mm (1.808 in.)**
Bushing ID	**46.00-46.025 mm (1.811-1.812 in.)**
Wear Limit	**46.08 mm (1.814 in.)**
Shaft and Bushing Clearance	**0.18 mm (0.006 in.)**

Oil Pressure Regulating Valve

Spring Free Length	**46 mm (1.810 in.)**
Spring Compressed Length (at 20.5 N (4.6 lb-force))	**27.5 mm (1.080 in.)**

Oil Pump Gear Backlash	**0.12 mm (0.005 in.)**
Rotor Shaft OD-to-Backing Plate ID Clearance	**0.013-0.043 mm (0.001-0.002 in.)**
Wear Limit	**0.20 mm (0.008 in.)**
Rotor Recess	**0.03-0.09 mm (0.001-0.002 in.)**
Wear Limit	**0.15 mm (0.006 in.)**
Outer Rotor-to-Pump Body Clearance	**0.10-0.16 mm (0.004-0.006 in.)**
Wear Limit	**0.25 mm (0.010 in.)**
Inner-to-Outer Rotor Clearance	**0.02-0.07 mm (0.001-0.003 in.)**
Wear Limit	**0.12 mm (0.006 in.)**

Piston

Standard Piston OD	**83.95-83.98 mm (3.305-3.306 in.)**
Wear Limit	**83.90 mm (3.303 in.)**
Oversize Piston OD	**84.20-84.23 mm (3.315-3.316 in.)**
Wear Limit	**84.10 mm (3.311 in.)**

Piston-to-Cylinder Head

Clearance	**0.72 ± 0.06 mm (0.025 ± 0.002 in.)**

Piston Pin Bore

Piston Pin Bore ID	**26.00-26.01 mm (1.0236-1.0240 in.)**
Wear Limit	**26.04 mm (1.0252 in.)**
Piston Pin-to-Piston Oil Clearance	**0.00-0.02 mm (0.00-0.001 in.)**
Wear Limit	**0.12 mm (0.005 in.)**

Piston Pin Bushing

Piston Pin Bushing ID	**26.025-26.038 mm (1.0246--1.0251 in.)**
Wear Limit	**26.07 mm (1.026 in.)**
Piston Pin-to-Rod Bore Oil Clearance	**0.03-0.05 mm (0.001-0.002 in.)**
Wear Limit	**0.10 mm (0.004 in.)**

Piston Pin Diameter

Piston Pin OD	25.99-26.00 mm (1.023-1.024 in.)
Wear Limit	25.97 mm (1.022 in.)

Piston Ring End Gap

Piston Ring End Gap	0.20-0.40 mm (0.008-0.016 in.)
Wear Limit	1.50 mm (0.059 in.)

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance	0.075-0.11 mm (0.003-0.004 in.)
Wear Limit	0.025 mm (0.010 in.)
Second Compression Ring Groove Side Clearance	0.045-0.080 mm (0.002-0.003 in.)
Wear Limit	0.025 mm (0.010 in.)
Oil Control Ring Groove Side Clearance	0.025-0.060 mm (0.001-0.002 in.)
Wear Limit	0.020 mm (0.008 in.)

Push Rods

Maximum Bend	0.03 mm (0.001 in.)
Length	178.25-178.75 mm (7.018-7.037 in.)

Rocker Arm Shaft

Rocker Arm Shaft OD	15.97-15.98 mm (0.628-0.629 in.)
Rocker Arm Shaft Wear Limit	15.94 mm (0.628 in.)

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance	0.02-0.05 mm (0.001-0.002 in.)
Oil Clearance Wear Limit	0.13 mm (0.005 in.)

Rocker Arms and Supports

Rocker Arm and Support ID	16.00-16.02 mm (0.630-0.631 in.)
Rocker Arm and Support Wear Limit	16.07 mm (0.633 in.)

Springs

Valve Spring Free Length	44.4 mm (1.748 in.)
Wear Limit	43.9 mm (1.730 in.)
Spring Inclination (3TNV84)	1.20 mm (0.047 in.)
Spring Inclination (3TNV84T)	1.40 mm (0.055 in.)

Valve Guides

Valve Guide ID	8.010-8.025 mm (0.3154-0.3160 in.)
Wear Limit	8.10 mm (0.319 in.)
Oil Clearance	0.035-0.070 mm (0.001-0.003 in.)
Valve Guide Projection	15 mm (0.591 in.)

Valve Seats

Intake Valve Seat Width	1.77 mm (0.070 in.)
Wear Limit	2.27 mm (0.089 in.)
Exhaust Valve Seat Width	1.34 mm (0.053 in.)
Wear Limit	1.84 mm (0.072 in.)

Valve Recession

Valve Recession	0.30-0.50 mm (0.012-0.020 in.)
Wear Limit	0.80 mm (0.031 in.)

Valves

Valve Head (Minimum Thickness)	0.50 mm (0.020 in.)
Intake and Exhaust Valve Stem OD	7.96-7.97 mm (0.3134-0.3138 in.)
Wear Limit	7.90 mm (0.311 in.)

Test and Adjustment Specifications

Camshaft

End Play	0.05-0.20 mm (0.002-0.010 in.)
Wear Limit	0.30 mm (0.012 in.)

Connecting Rod

Side Play	0.2-0.4 mm (0.008-0.016 in.)
Connecting Rod-to-Crankshaft Journal Clearance	0.038-0.074 mm (0.001-0.003 in.)

Cooling System

Maximum Pressure	97 kPa (14 psi)
Minimum Pressure (After 15 Seconds)	88 ± 15 kPa (12.8 ± 2.2 psi)
Radiator Cap Pressure	88 kPa (12.8 psi)
Temperature Switch (Contact Closing Temperature)	107-113°C (225-235°F)

Crankshaft

End Play	0.13-0.23 mm (0.005-0.009 in.)
Wear Limit	0.28 mm (0.011 in.)
Main Bearing-to-Crankshaft Journal Oil Clearance	0.038-0.068 mm (0.001-0.003 in.)
Wear Limit	0.150 mm (0.006 in.)

Cylinder Compression Pressure @ 250 RPM

Model 3225C	3234 ± 103 kPa (469 ± 15 psi)
Model 3225C (Minimum)	2551 ± 103 kPa (370 ± 15 psi)
Model 3235C and 3245C	2937 ± 103 kPa (426 ± 15 psi)
Model 3235C and 3245C (Minimum)	2448 ± 103 kPa (355 ± 15 psi)
Difference Between Cylinders @ 250 RPM (Maximum)	296 kPa (43 psi)

Fan/Alternator Belt

Deflection @ 98 N (22 lb-force)	8-13 mm (0.315-0.512 in.)

Fuel Injection Nozzles

Opening Pressure	21 600—22 600 kPa (3133—3278 psi)

Oil Pressure

Engine Oil Pressure	345 ± 48 kPa (50 ± 7.0 psi)

Thermostat

Begins to Open	**70°C (158°F)**
Fully Open	**85°C (184°F)**
Lift Height	**8 mm (0.310 in.)**

Timing Gear

Backlash	**0.04-0.12 mm (0.001-0.005 in.)**

Throttle Lever

Friction	**36-53 N (8-12 lb-force)**

Rotor Shaft Axial Play

Standard	**0.022-0.053 mm (0.009-0.0021 in.)**
Wear Limit	**0.07 mm (0.0028 in.)**

Rotor Shaft Radial Play

Standard	**0.061-0.093 mm (0.0024-0.0037 in.)**
Wear Limit	**0.12 mm (0.0047 in.)**

Valve Adjustment

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

Valve Lift

Valve Lift	**8.8 mm (0.350 in.)**

Torque Specifications (All Engines)

Alternator

Pulley Nut Torque	**69 N•m (51 lb-ft)**

Camshaft

Thrust Plate Mounting Cap Screw Torque	**26 N•m (226 lb-in.)**

Crankshaft

Main Bearing Cap Screw Torque	**98 N•m (72 lb-ft)**
Connecting Rod Cap Screw Torque	**47 N•m (35 lb-ft)**

Cylinder Head Cap Screw Torque[1]

Initial Torque	**44 N•m (33 lb-ft)**
Second Torque	**62 N•m (45 lb-ft)**
Final Torque	**88 N•m (65 lb-ft)**

Exhaust Manifold

Cap Screws and Nuts Torque	**26 N•m (19 lb-ft)**

1. Cylinder head cap screw torque must be checked for proper torque after 50 hours of engine operation.

Fuel Injection Pump

Gear Nut Torque	**90 N•m (66 lb-ft)**
Injection Pump Nut Torque	**27 N•m (20 lb-ft)**
Lube LIne Mounting Bolt Torque	**25 N•m (217 lb-in.)**

Fuel Injectors

Retaining Nut Torque	**8 N•m (70 lb-in.)**

Intake Manifold

Cap Screw Torque	**26 N•m (19 lb-ft)**

Oil Pressure Regulating Valve

Housing Cap Screw Torque	**27 N•m (20 lb-ft)**

Rocker Arm Assembly

Support Cap Screw Torque	**26 N•m (19 lb-ft)**

Rocker Arm Cover

Rocker Arm Cover Nut Torque	**18 N•m (160 lb-in.)**
Breather Cover Cap Screw Torque	**22 N•m (16 lb-ft)**
Engine Mounting Cap Screws	**80 N•m (60 lb-ft)**
Drive Shaft Cap Screws	**80 N•m (60 lb-ft)**

Tools and Materials

Tools

Special or Required Tools

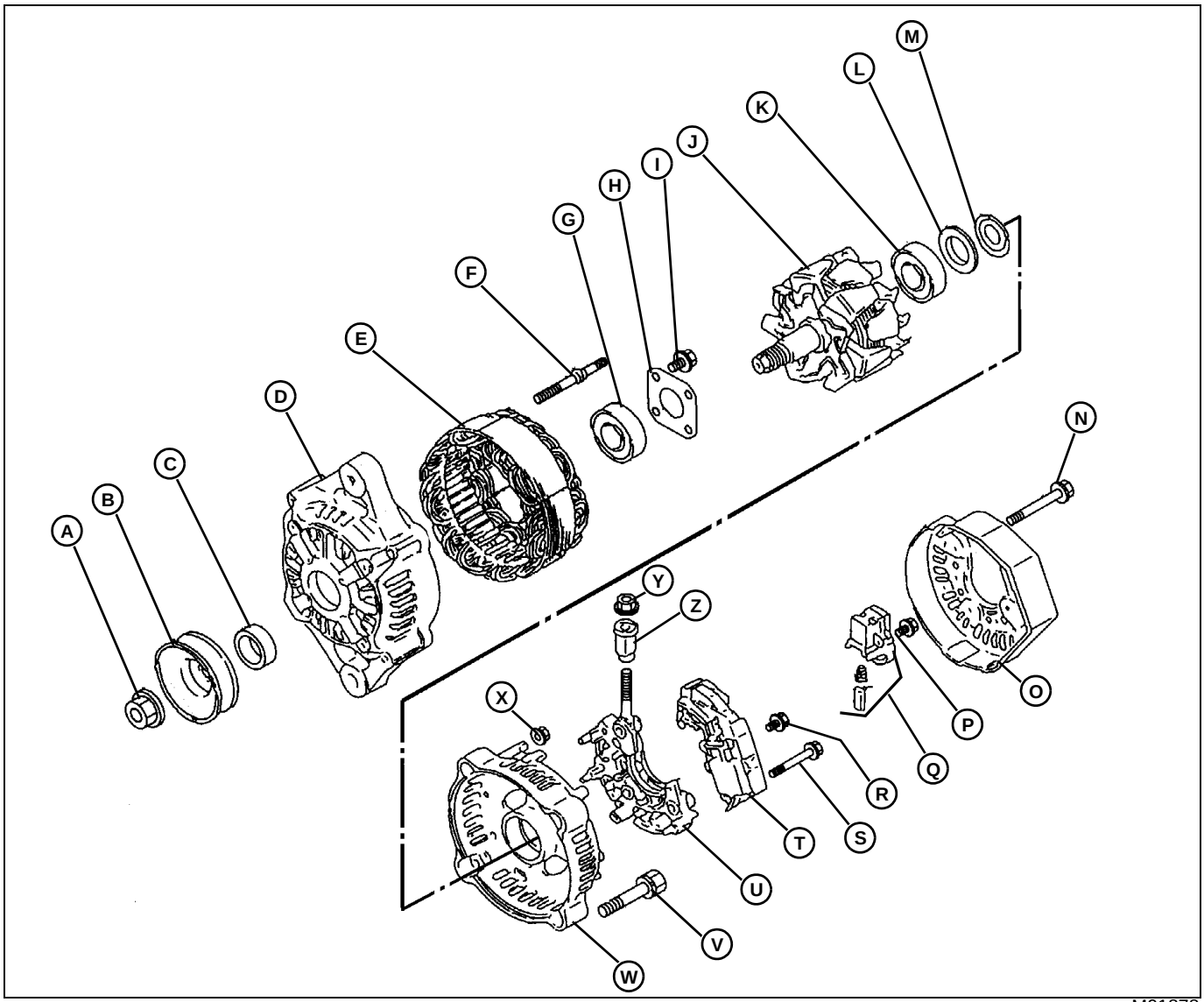
Tool Name	Tool No.	Tool Use
Straight Adapter	23622	Used to test fuel injection nozzles.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzles.
Adapter Set	D01110AA	Used to test fuel injection nozzles.
Cooling System Pressure Pump	D05104ST	Used to test cooling system and radiator cap pressure.
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Valve Guide Knurler	D-20019WI	Used to knurl valve guides.
Valve Guide Reamer	D-20021WI	Used to ream valve guides.
Valve Guide Driver	JDE118	Used to install new valve guides.
Fuel Injection Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.
Belt Tension Gage	JDG529 or JDST28	Used to adjust belt tension.
Adapter	JDG560	Used to measure cylinder compression and pressurize cylinder with compressed air for cylinder leakdown test.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test cooling system and radiator cap pressure.
Compression Gage Assembly	JT01682	Used to measure cylinder compression.
Hose Assembly	JT03017	Used to test engine oil pressure.
Connector 1/8” Male BSP x 7/16” Male 37° Flare	JT03349	Used to test engine oil pressure.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Elbow 7/16” Male 37° Flare x 7/16” Male 37° Flare	JT05483	Used to test engine oil pressure.
Inductive Electronic Tachometer	JT05801	Used to check engine rpm when setting slow idle speeds.
Pressure Gage 689 kPa (100 psi)	JT07034	Used to test engine oil pressure.
Heating Unit	NA	Used to check coolant temperature switch.
Dial Indicator	NA	Used to measure valve lift, to check crankshaft-to-engine block side clearance, to check camshaft gear end journal-to-thrust plate side clearance, and to check wear between meshing gears.
Glass Container	NA	Used to check coolant temperature switch.
Ohmmeter	NA	Used to check coolant temperature switch.
PLASTIGAGE®	NA	Used to measure oil clearance between connecting rod and crankshaft journal. Also used to check main bearing-to-crankshaft journal clearance.
Straightedge	NA	Used to adjust belt tension.
Thermometer	NA	Used to check thermostat opening temperature and coolant temperature switch.
Volt-Ohm-Amp Meter	NA	Used to test alternator components.

Component Location

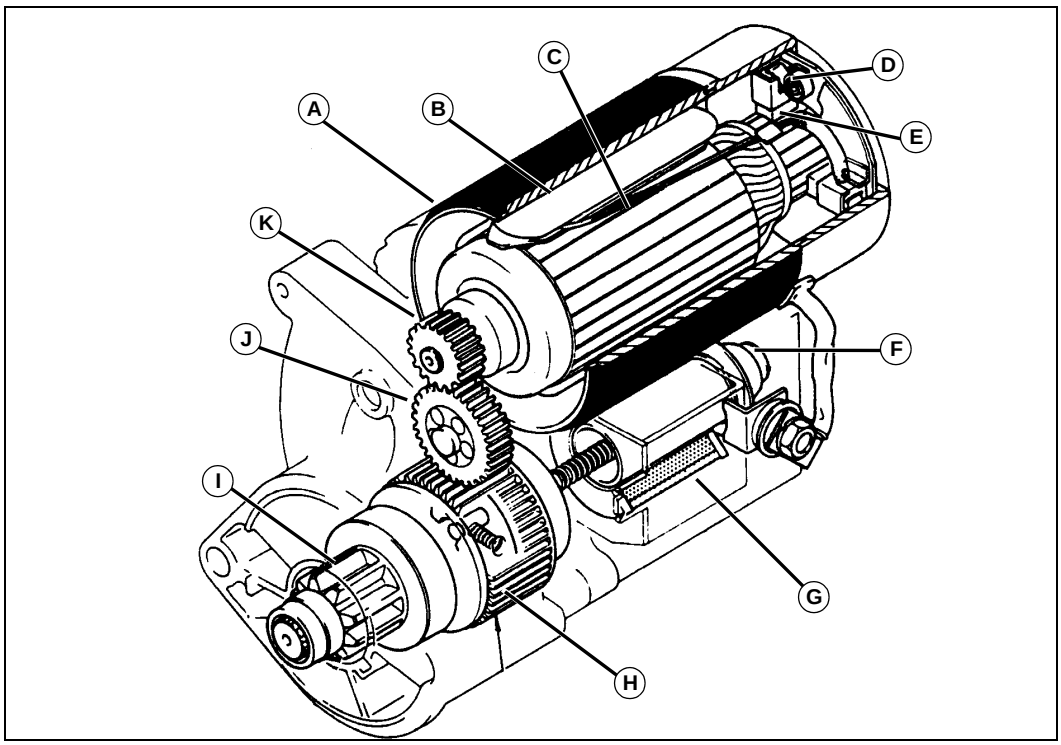
Alternator Components



M91878

A - Nut
B - Pulley
C - Spacer (40 Amp Only)
D - Front Frame
E - Stator
F - Stud
G - Bearing
H - Cover
I - Screw
J - Rotor
K - Bearing
L - Cover
M - Thrust Washer (40 Amp)
N - Cap Screw
O - Cover
P - Screw
Q - Brush Assembly
R - Screw
S - Screw
T - Regulator
U - Diode Assembly
V - Cap Screw
W - Rear Frame
X - Nut
Y - Nut
Z - Insulator Bushing

Starter Components



MX2734

A - Motor
B - Field Coil
C - Armature
D - Brush Spring
E - Brush
F - Plunger
G - Solenoid
H - Overrunning Clutch
I - Pinion
J - Idler Gear
K - Drive Gear

Theory of Operation

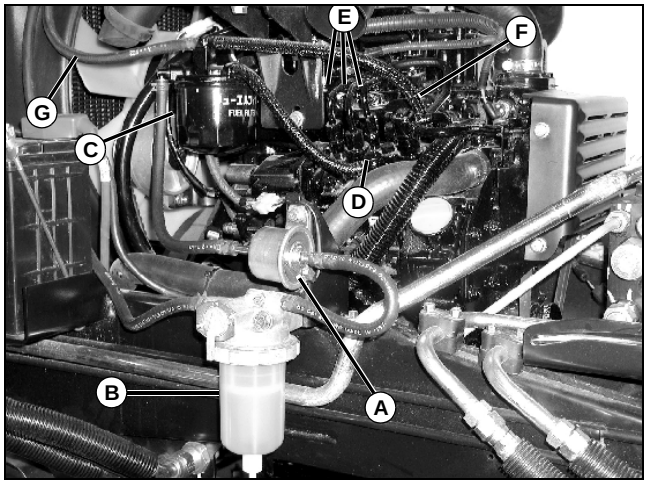
Fuel and Air System Operation

Function

Fuel system supplies fuel to injection nozzles.

The air intake system filters and supplies air needed for combustion.

Theory of Operation



MX17927

Fuel System

An electric fuel transfer pump (A) draws fuel through the water separator (B) from the tank outlet. The low-pressure fuel from the fuel pump flows through the filter (C) to the fuel injection pump inlet (D). The injection pump then directs high-pressure fuel through the injection lines (E) to the injectors where it is injected into the cylinders for combustion. Excess fuel from the injectors and the injection pump is returned by line (F) to the filter where, if needed, it can be sent back to the injection pump. If not needed, the fuel is sent back to the tank by line (G).

If the unit 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 (key in the START or ON position), the engine can be started. When the key 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 reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines contain 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.

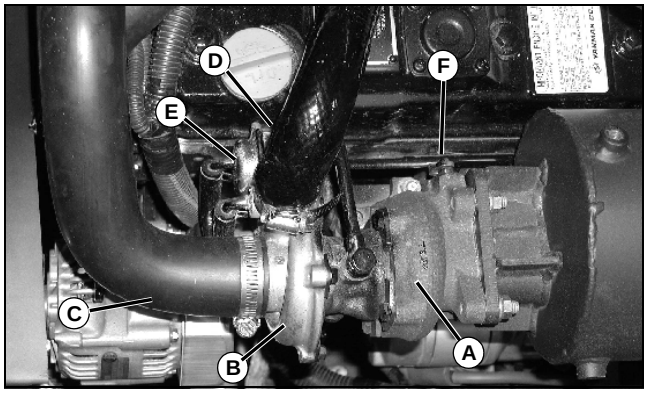
A fuel float gauge is mounted in the fuel tank to inform the operator of the fuel level.

Air Intake System

Air enters the air filter through the perforated side holes. The primary and secondary elements filter the air before entering the intake manifold.

An air filter restriction switch informs the operator when the air filter needs servicing. The air filter restriction switch closes when the vacuum reaches a specified level and lights a lamp. 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.

Turbocharger (Models 3235C and 3245C)



MX17928

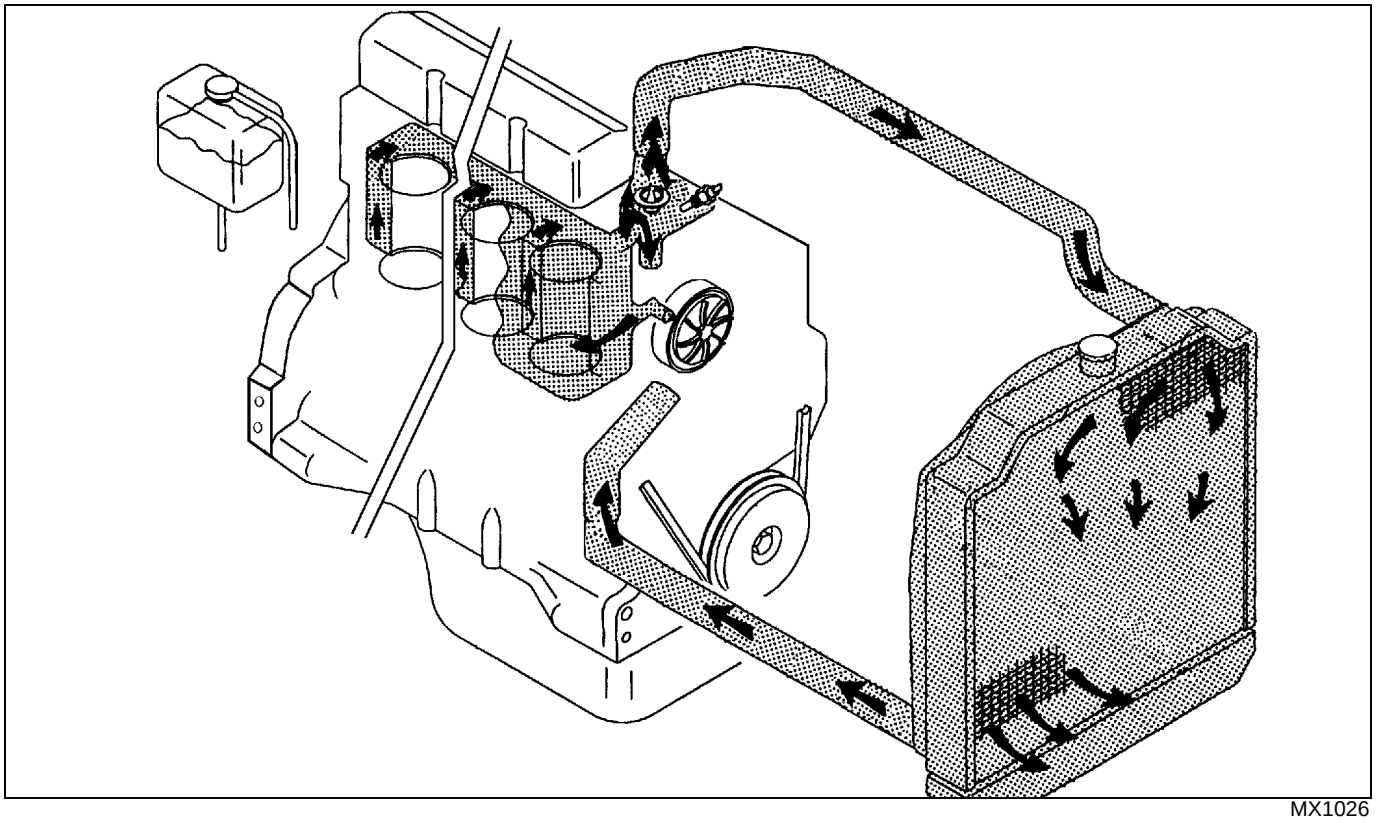
The turbocharger provides additional air, to burn more fuel and produce more power without increasing the size of the engine. The turbine in the turbocharger may spin as fast as 150,000 rpm.

The turbine is on a shaft inside the turbine housing (A). The shaft is connected to the compressor wheel, which is inside the compressor housing (B). The shaft is supported by two floating bearings, which are located between the turbine and compressor housings.

Exhaust gases from the engine pass through the turbine housing, causing the turbine to rotate before the exhaust gas is discharged. The compressor wheel also begins to rotate in the compressor housing. Air from the air cleaner is supplied to the inlet side of the compressor housing by hose (C). The air is compressed inside the housing and delivered to the intake manifold by hose (D).

The turbocharger is equipped with a waste gate (F). If the turbocharger goes above a specified pressure, a diaphragm (E), sensing inlet pressure from the compressor, opens a waste a gate valve (F) to allow excess exhaust gases to bypass the turbine. The waste gate valve limits boost pressure at high engine rpm to prevent damage to the engine.

Cooling System Operation



MX1026

Function

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

Theory of Operation

The pressurized cooling system includes the radiator, coolant 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.

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 the thermostat housing. With the thermostat open, 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 88.3 kPa (12.8 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 switch 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 filtered oil.

Theory of Operation

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

The pump draws lubrication oil from the oil pan through a strainer and a suction tube. The oil is then pumped through an oil passage to the oil filter and through the engine block main oil galley.

From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals and idler gear shaft. 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 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, cam followers and valves.

Lubrication oil is supplied to the fuel injection pump from the main oil galley through external oil lines.

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

Turbocharger Lubrication

Engine oil under pressure from the engine lubrication system is pumped through passages into the center housing of the turbocharger and directed to the bearings.

The turbocharger contains two floating bearings that have clearance between the bearing OD and the housing wall, as well as clearance between the bearing ID and the shaft OD.

These clearances are lubricated by the pressurized oil supply which allows the bearings to be protected by a cushion of oil.

The pressure-free oil drains by gravity from the center housing to the engine crankcase.

Diagnostics

Diesel Engine Troubleshooting

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

(1) Proper starting procedure being used is correct for conditions?

Yes - Go to step (2).

No - Use correct procedure for conditions. (See the Operator's Manual.)

(2) Battery 12.7 VDC or higher?

Yes - Go to step (3).

No - Charge and check battery.

(3) No open circuits in wiring?

Yes - Go to step (4).

No - Repair or replace as needed.

(4) Starting motor functioning properly?

Yes - Go to step (5).

No - Repair or replace starting motor. (See "Disassemble and Assemble Starting Motor" on page 114.)

(5) Engine oil of correct viscosity and type?

Yes - Go to step (6).

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

(6) No water in fuel?

Yes - Go to step (7).

No - Drain and replace fuel.

(7) Fuel filter not clogged?

Yes - Go to step (8).

No - Replace fuel filter.

(8) No air leak in fuel system?

Yes - Go to step (9).

No - Repair fuel system.

Symptom: Engine Will Not Start

(9) Fuel lines not plugged, pinched or cracked?

Yes - Go to step (10).

No - Repair or replace fuel lines as needed.

(10) Correct volume of fuel supplied to injection pump?

Yes - Go to step (11).

No - Replace fuel transfer pump.

(11) Intake and/or exhaust valve clearance correct?

Yes - Go to step (12).

No - Adjust valve clearance. (See "Adjust Valve Clearance" on page 54.)

(12) Is injection pump timing correct?

Yes - Go to step (13).

No - Correctly time injection pump.

(13) Intake and/or exhaust valve not seized?

Yes - Go to step (14).

No - Replace valve and check valve guide. (See "Disassemble and Assemble Cylinder Head and Valves" on page 80.)

(14) Piston rings not broken or seized?

Yes - Go to step (15).

No - Replace rings. Check piston and cylinder. (See "Inspect Piston and Connecting Rod" on page 88. See "Inspect Cylinder Bore" on page 91.)

(15) Piston rings, piston or cylinder not worn?

Yes - Go to step (16).

No - Replace piston and/or rings; bore or hone cylinder. (See "Inspect Piston and Connecting Rod" on page 88. See "Inspect Cylinder Bore" on page 91.)

(16) Crankshaft pin or bearing not seized?

No - Regrind crankshaft and replace bearings. (See "Inspect Crankshaft and Main Bearings" on page 95.)

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

(1) Engine oil of proper viscosity and type?

Yes - Go to step (2).

No - Replace engine oil filter and oil of proper viscosity and type.

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

(2) Fuel filter not clogged?

Yes - Go to step (3).

No - Replace fuel filter.

(3) No air leak in fuel system?

Yes - Go to step (4).

No - Repair fuel system.

(4) Fuel lines not plugged, pinched or cracked?

Yes - Go to step (5).

No - Repair or replace fuel lines as needed.

(5) Correct volume of fuel supplied to injection pump?

Yes - Go to step (6).

No - Replace fuel transfer pump.

(6) Valve clearance proper?

Yes - Go to step (7).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 54.)

(7) Crankshaft pin or bearing not seized?

No - Regrind crankshaft and replace bearings. (See “Inspect Crankshaft and Main Bearings” on page 95.)

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

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) Fuel filter not clogged?

Yes - Go to step (3).

No - Replace fuel filter.

(3) Intake and/or exhaust valve not seized?

Yes - Go to step (4).

No - Replace valve and check valve guide. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

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

(4) Piston rings not broken or seized?

Yes - Go to step (5).

No - Replace rings. Check piston and cylinder. (See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 91.)

(5) Piston rings, piston or cylinder not worn?

No - Replace piston and/or rings; bore or hone cylinder. (See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 91.)

Symptom: Low Engine Output - Exhaust Color NORMAL

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) Proper type and viscosity of oil being used?

Yes - Go to step (3).

No - Replace engine oil and filter.

(3) Fuel filter not clogged?

Yes - Go to step (4).

No - Replace fuel filter.

(4) Fuel lines not clogged, cracked or pinched?

Yes - Go to step (5).

No - Clean or replace fuel lines.

(5) No air leakage into fuel system?

Yes - Go to step (6).

No - Repair fuel supply system.

(6) Proper volume of fuel to injection pump?

Yes - Go to step (7).

No - Check or replace fuel transfer pump.

(7) Intake and exhaust valve clearance correct?

Yes - Go to step (8).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 54.)

Symptom: Low Engine Output - Exhaust Color NORMAL

(8) Intake or exhaust valves not leaking compression?

Yes - Go to step (9).

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

(9) Intake or exhaust valves not seized?

Yes - Go to step (10).

No - Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 80.)

(10) Cylinder head gasket not leaking compression?

No - Replace head gasket. (See “Remove and Install Cylinder Head and Valves” on page 79.) Resurface head and block if necessary. (See “Inspect Cylinder Head and Valves” on page 80.)

Symptom: Low Engine Output - Exhaust Color WHITE

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Even volume of fuel being injected?

Yes - Go to step (4).

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

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injection nozzles. (See “Remove and Install Fuel Injection Nozzles” on page 111.)

(5) Intake or exhaust valve stems not worn?

Yes - Go to step (6).

No - Replace valve guides and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

Symptom: Low Engine Output - Exhaust Color WHITE

(6) Is injection pump timing correct?

Yes - Go to step (7).

No - Correctly time injection pump.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 87.)

(8) Piston ring ends staggered?

Yes - Go to step (9).

No - Stagger piston ring ends. (See “Disassemble and Assemble Piston and Connecting Rod” on page 87.)

(9) Piston, rings, or cylinder not worn?

Yes - Go to step (10).

No - Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 91.)

(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 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Low Engine Output - Exhaust Color BLACK

(1) Is engine NOT being run under high altitude or high temperature conditions?

Yes - Go to step (2).

No - Reduce load.

(2) Correct type of fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Air filter elements not clogged?

Yes - Go to step (4).

No - Clean or replace air filter elements.

(4) Exhaust pipe not clogged?

Yes - Go to step (5).

No - Clean exhaust pipe.

Symptom: Low Engine Output - Exhaust Color BLACK

(5) Engine running cool enough?

Yes - Go to step (6).

No - Check thermostat. (See “Test Thermostat Opening” on page 62.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

(6) Cooling system filled to correct level?

Yes - Go to step (7).

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

(7) Correct volume of fuel being injected?

Yes - Go to step (8).

No - Replace faulty fuel injection pump or fuel injectors.

(8) Correct pattern from fuel injectors?

Yes - Go to step (9).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(9) Is injection pump timing correct?

Yes - Go to step (10).

No - Correctly time injection pump.

(10) Intake or exhaust valves not leaking compression?

Yes - Go to step (11).

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

(11) Intake or exhaust valve not seized?

No - Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 80.)

Symptom: Exhaust Color WHITE Under Load

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

Symptom: Exhaust Color WHITE Under Load

(3) Engine not running too cool?

Yes - Go to step (4).

No - Check thermostat. (See “Test Thermostat Opening” on page 62.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

(4) Correct volume of fuel being injected?

Yes - Go to step (5).

No - Replace faulty fuel injection pump.

(5) Correct pattern from fuel injectors?

Yes - Go to step (6).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(6) Is injection pump timing correct?

Yes - Go to step (7).

No - Adjust injection pump timing.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 87.)

(8) Pistons, rings or cylinders not worn?

Yes - Go to step (9).

No - Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 91.)

(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 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Exhaust Color BLACK Under Load

(1) Is engine NOT being run under high altitude or high temperature conditions?

Yes - Go to step (2).

No - Reduce load.

(2) Correct type of fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

Symptom: Exhaust Color BLACK Under Load

(3) Air filter elements not clogged?

Yes - Go to step (4).

No - Clean or replace air filter elements.

(4) Exhaust pipe not clogged?

Yes - Go to step (5).

No - Clean exhaust pipe.

(5) Even volume of fuel being injected?

Yes - Go to step (6).

No - Replace faulty fuel injection pump or fuel injectors.

(6) Correct volume of fuel being injected?

Yes - Go to step (7).

No - Replace faulty fuel injection pump or fuel injectors.

(7) Proper spray pattern from injectors?

Yes - Go to step (8).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(8) Is injection pump timing correct?

Yes - Go to step (9).

No - See injection pump timing.

(9) Intake or exhaust valves not leaking compression?

Yes - Go to step (10).

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

(10) Intake or exhaust valves not seized?

No - Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 80.)

Symptom: Exhaust Temperature Too High

(1) Cooling system filled to correct level?

Yes - Go to step (2).

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

(2) Engine running cool enough?

Yes - Go to step (3).

No - Check thermostat. (See “Test Thermostat Opening” on page 62.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

(3) Exhaust pipe not clogged?

Yes - Go to step (4).

No - Clean exhaust pipe.

(4) Correct volume of fuel being injected?

Yes - Go to step (5).

No - Replace faulty fuel injection pump or fuel injectors.

(5) Intake or exhaust valve clearance correct?

Yes - Go to step (6).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 54.)

(6) Intake or exhaust valves not leaking compression?

Yes - Go to step (7).

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

(7) 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 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Engine Runs Rough - Misfiring

(1) Intake or exhaust valve clearance correct?

Yes - Go to step (2).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 54.)

(2) Correct volume of fuel being injected?

Yes - Go to step (3).

No - Replace faulty fuel injection pump or fuel injectors.

Symptom: Engine Runs Rough - Misfiring

(3) Is injection pump timing correct?

Yes - Go to step (4).

No - See “Adjust Injection Pump Timing”.

(4) Backlash of timing gear not excessive?

Yes - Go to step (5).

No - Repair gears as needed. (See “Check Timing Gear Backlash” on page 60.)

(5) Combustion chambers clean of foreign matter?

Yes - Go to step (6).

No - Clean combustion chambers. (See “Remove and Install Cylinder Head and Valves” on page 79.)

(6) Intake or exhaust valves not leaking compression?

Yes - Go to step (7).

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

(7) Intake or exhaust valves not seized?

Yes - Go to step (8).

No - Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 80.)

(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 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Engine Runs Rough - Uneven Combustion Sound

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel. Check fuel filter.

(3) Even volume of fuel being injected?

Yes - Go to step (4).

No - Replace faulty fuel injection pump or fuel injectors.

Symptom: Engine Runs Rough - Uneven Combustion Sound

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(5) Air filter elements not clogged?

Yes - Go to step (6).

No - Clean or replace air filter elements.

(6) Exhaust pipe not clogged?

No - Clean exhaust pipe.

Symptom: Engine Runs Rough - Engine Surges DURING IDLING

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Check fuel filter.

(2) Even volume of fuel injected?

Yes - Go to step (3).

No - Replace faulty fuel injection pump or fuel injectors.

(3) Proper spray pattern from injectors?

Yes - Go to step (4).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(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 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Engine Runs Rough - Engine Surges UNDER LOAD

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Check fuel filters.

(2) Even volume of fuel injected?

Yes - Go to step (3).

No - Replace faulty fuel injection pump or fuel injectors.

Symptom: Engine Runs Rough - Engine Surges UNDER LOAD

(3) Proper spray pattern from injectors?

Yes - Go to step (4).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(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 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Engine Runs Rough - Excessive Engine Vibration

(1) Even volume of fuel injected?

Yes - Go to step (2).

No - Replace faulty fuel injection pump or fuel injectors.

(2) Proper spray pattern from injectors?

Yes - Go to step (3).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(3) Piston rings not broken or seized?

Yes - Go to step (4).

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 91.)

(4) Crankshaft pin or bearing not worn or seized?

Yes - Go to step (5).

No - Regrind crankshaft and replace bearings. (See “Inspect Crankshaft and Main Bearings” on page 95.)

(5) Connecting rod bolts torqued properly?

No - Replace damaged components. Tighten to correct specification. (See “Remove and Install Cylinder Head and Valves” on page 79.)

Symptom: Excessive Fuel Consumption

(1) Engine not running too cool?

Yes - Go to step (2).

No - Check thermostat. (See “Test Thermostat Opening” on page 62.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

Symptom: Excessive Fuel Consumption

(2) Correct volume of fuel being injected?

Yes - Go to step (3).

No - Replace faulty fuel injection pump or fuel injectors.

(3) Correct pattern from fuel injectors?

Yes - Go to step (4).

No - Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

(4) Intake or exhaust valves not leaking compression?

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

Symptom: Excessive Oil Consumption

(1) Engine oil of correct viscosity and type?

Yes - Go to step (2).

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

(2) No external or internal oil leak?

Yes - Go to step (3).

No - Repair as needed.

(3) Intake or exhaust valve stems not worn?

Yes - Go to step (4).

No - Replace valve guides and valves. (See “Remove and Install Cylinder Head and Valves” on page 79.)

(4) Piston rings installed correctly and properly staggered?

Yes - Go to step (5).

No - Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 87.)

(5) Pistons, rings or cylinders not worn?

Yes - Go to step (6).

No - Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Excessive Oil Consumption

(6) Piston rings not broken or seized?

Yes - Go to step (7).

No - Replace rings. Check piston and cylinder. (See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 91.)

(7) No foreign matter in combustion chamber?

No - Clean head and top of piston. Check for damage.

Symptom: Fuel Oil in Crankcase

(1) Correct volume of fuel being injected”

Yes - Go to step (2).

No - Replace faulty fuel injection pump or fuel injectors.

(2) Intake or exhaust valve not seized or broken?

Yes - Go to step (3).

No - Replace valve and check valve guide. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

(3) Piston rings not broken or seized?

Yes - Go to step (4).

No - Replace rings. Check piston and cylinder. (See “Inspect Piston and Connecting Rod” on page 88. See “Inspect Cylinder Bore” on page 91.)

(4) Piston rings, pistons or cylinders not worn?

No - Replace pistons and rings, bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 91.)

Symptom: Coolant in Crankcase

(1) Cylinder head gasket not leaking?

Yes - Go to step (2).

No - Replace head gasket. Resurface head and block if necessary. (See “Remove and Install Cylinder Head and Valves” on page 79. See “Inspect Cylinder Head and Valves” on page 80.)

(2) Is cylinder block not cracked?

No - Replace cylinder block.

Symptom: Low Oil Pressure

(1) Oil at correct level?

Yes - Go to step (2).

No - Add oil.

(2) Engine oil of correct viscosity and type?

Yes - Go to step (3).

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

(3) No external or internal oil leak?

Yes - Go to step (4).

No - Repair as needed.

(4) Oil pressure relief valve not worn or damaged?

Yes - Go to step (5).

No - Clean or replace relief valve. (See “Remove, Inspect, and Install Oil Pump” on page 103.)

(5) Crankshaft pin or bearing not worn?

Yes - Go to step (6).

No - Regrind crankshaft and replace bearings. (See “Inspect Crankshaft and Main Bearings” on page 95.)

(6) Connecting rod bolts torqued properly?

Yes - Go to step (7).

No - Replace damaged components. Tighten to correct specification.

(7) Is engine not worn excessively?

No - Replace oil pump. (See “Remove, Inspect, and Install Oil Pump” on page 103.)

Symptom: Engine Is Overheating

(1) Is engine NOT being run under high altitude or high temperature conditions?

Yes - Go to step (2).

No - Reduce load on engine.

(2) Cooling system filled to correct level?

Yes - Go to step (3).

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

(3) Is radiator clear of debris?

Yes - Go to step (4).

No - Clean radiator fins.

Symptom: Engine Is Overheating

(4) Is radiator core free from blockage?

Yes - Go to step (5).

No - Clean or replace radiator.

(5) Is thermostat operating correctly?

Yes - Go to step (6).

No - Check thermostat. (See “Test Thermostat Opening” on page 62.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

(6) Is cylinder head gasket not leaking?

Yes - Go to step (7).

No - Replace head gasket. Resurface head and block if necessary. (See “Remove and Install Cylinder Head and Valves” on page 79. See “Inspect Cylinder Head and Valves” on page 80.)

(7) Is cylinder block not cracked?

No - Replace cylinder block.

Symptom: Low Engine Coolant Temperature

(1) Is thermostat operating correctly?

No - Check thermostat. (See “Test Thermostat Opening” on page 62.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

Symptom: Low Compression

(1) Engine oil of correct viscosity and type?

Yes - Go to step (2).

No - Replace engine oil with oil of correct viscosity and type. Replace oil filter.

(2) Intake or exhaust valves not leaking compression?

Yes - Go to step (3).

No - Grind valves and seats. (See “Grind Valve Seats” on page 84. See “Inspect Cylinder Head and Valves” on page 80.)

(3) Intake or exhaust valve stems not worn?

Yes - Go to step (4).

No - Replace valve guides and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

Symptom: Low Compression

(4) Intake or exhaust valve not seized?

Yes - Go to step (5).

No - Replace valve guides and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

(5) Pistons, rings or cylinders not worn or seized?

Yes - Go to step (6).

No - Replace pistons and rings, bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 85. See “Inspect Cylinder Bore” on page 91.)

(6) Piston rings installed correctly and properly staggered?

No - Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 87.)

Tests and Adjustments

Test Cylinder Compression

Reason

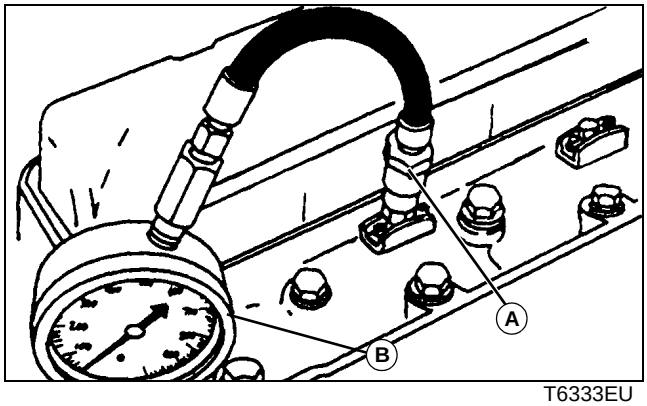
To determine the condition of the pistons, rings, cylinder walls and valves.

Special or Required Tools

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

Procedure

1. Remove the injection nozzles.



T6333EU

2. Install heat protector on end of injector and install on JDG560 Adapter (A).

3. Install JT01682 Compression Gauge Assembly (B) and adapter.

4. Disconnect fuel control solenoid connector.

IMPORTANT: Avoid damage! DO NOT overheat starting motor during test.

5. Crank the engine for five seconds with the starting motor. Minimum cranking speed is 250 rpm.

6. Record the pressure reading for each cylinder.

Results

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

Specifications

Cylinder Compression Pressure @ 250 RPM

Model 3225C . . . . . 3234 ± 103 kPa (469 ± 15 psi)
Model 3225C (Minimum) . 2551 ± 103 kPa (370 ± 15 psi)
Model 3235C and 3245C 2937 ± 103 kPa (426 ± 15 psi)
Model 3235C and 3245C (Minimum) . . . 2448 ± 103 kPa (355 ± 15 psi)
Difference Between Cylinders @ 250 RPM (Maximum) . 296 kPa (43 psi)

Adjust Slow Idle

Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Inductive Electronic Tachometer	JT05801	Used to check engine rpm when setting slow idle speed.

Procedure

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

1. Place a small piece of reflective tape on the crankshaft pulley.

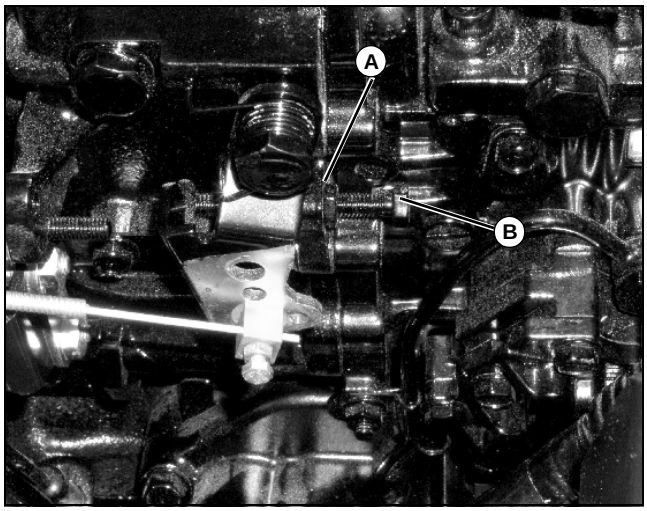
2. Start the engine and run for 5 minutes to attain operating temperature.

3. Move the throttle lever to slow idle position.

4. Use JT05801 Hand Held Digital Tachometer to check engine speed at the crankshaft pulley.

5. Visually check that the injection pump throttle lever is against slow idle stop screw.

Results



MX20068

• If the slow idle rpm is not according to specifications, loosen the nut (A) and turn the slow idle stop screw (B) clockwise to increase the engine speed, or counterclockwise to decrease the engine speed, until the slow idle speed is correct. After adjustment, tighten the nut.

Specifications

Slow Idle Speed . . . . . 1400 ± 50 rpm

Adjust Torque Capsule

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 preset by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable ONLY by authorized diesel service facilities.

Because the FAST idle speed and torque capsule are NOT adjustable, the throttle cable adjustment becomes very critical to proper engine operation. Therefore, first MAKE SURE that the throttle cable obtains its full range of motion, stop-to-stop, before performing any diagnostic procedures.

Adjust Injection Pump Static Timing

IMPORTANT: Avoid damage! DO NOT attempt to adjust the fuel injection pump timing. For most engine problems, the fuel injection pump timing will not have to be adjusted. If the engine performed well at one time, then the performance dropped, the fuel injection timing is NOT the problem. Fuel injection timing, once set by the engine manufacturer, must NOT change during the life of the engine.

Fuel injection pump timing should NOT change during the life of the engine unless the pump has been altered illegally, or there is excessive wear to the camshaft injection pump cam lobes and lifters.

First check the fuel quality, fuel supply, fuel injection nozzles, air intake system and engine compression in all cylinders before considering fuel injection timing problems.

If all other possibilities have been ruled out and it is determined that the fuel injection pump and governor assembly are in need of repair, they must be replaced ONLY as complete assemblies.

Only an authorized factory trained technician is allowed to remove and install these assemblies.

Adjust Valve Clearance

Reason

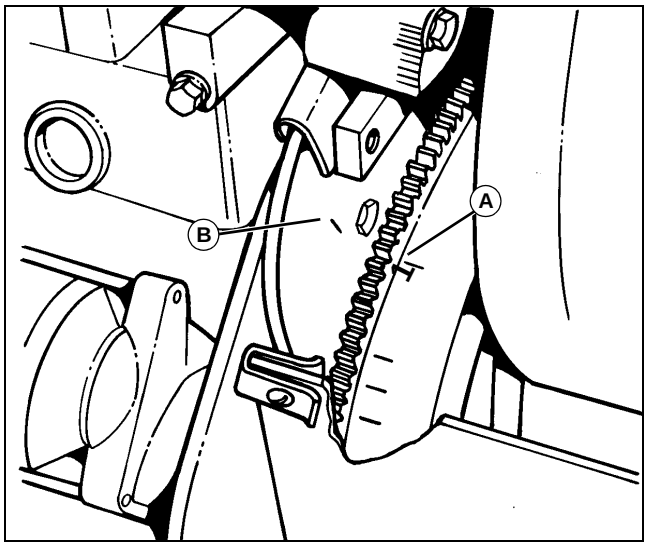
To set valve clearance for proper engine operation.

Procedure

CAUTION: Avoid injury! Be sure ignition key is OFF before attempting to turn engine by hand.

NOTE: The engine must be cool (room temperature) before the valve clearance is checked.

1. Remove battery.
2. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 76.)
3. Remove flywheel cover from starter side of engine.

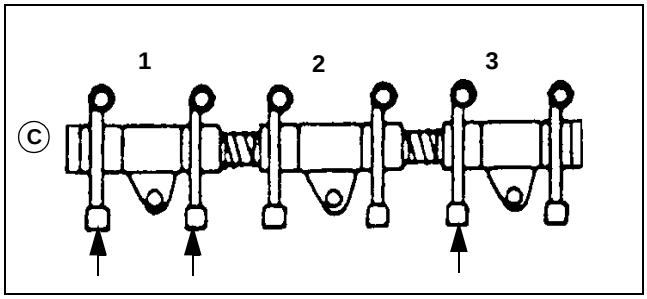


M76565

4. Turn crankshaft pulley clockwise, as viewed from flywheel end, until No 1 cylinder top dead center (TDC) mark (A) on flywheel aligns with index mark (B) on flywheel plate.

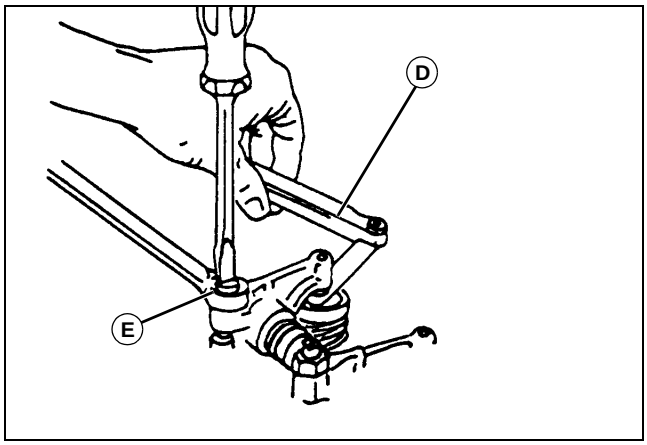
5. Try to move rocker arms and/or push rods for No. 1 cylinder:

- If the rocker arms and push rods are loose, the piston is at TDC on the compression stroke. Go to step 8.
- If the rocker arms and/or push rods are not loose, rotate the flywheel one revolution (360°), and recheck the rocker arms and push rods.



M82327A

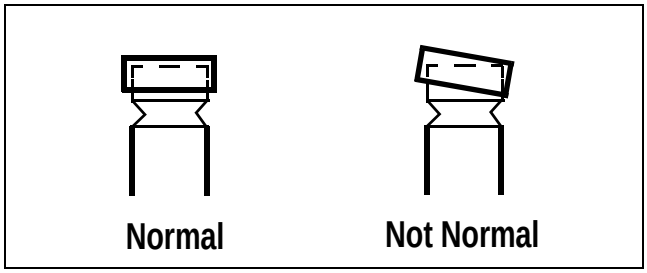
6. Measure and adjust valve clearance (if necessary) on the valves (arrows) with No 1 piston at TDC. No 1 piston is at the flywheel end (C). Valve clearance should be at specifications.



T6105BF

7. If valve clearance is not at specifications, loosen the locknut and turn the adjusting screw (E) until the blade of the feeler gauge (D) can be inserted between the rocker arm and valve cap. Hold the adjusting screw while tightening the locknut.

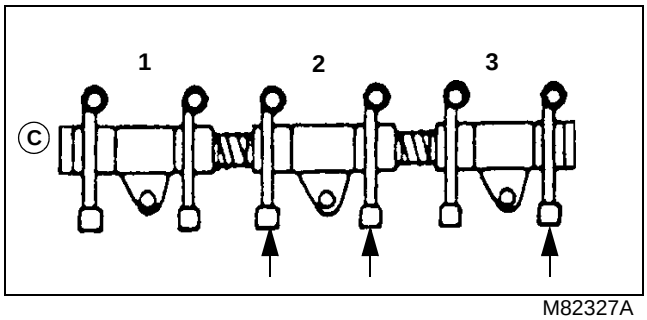
8. Recheck the valve clearance after tightening the locknut.



MIF

9. Check that the valve cap on the valve stem remained seated on the valve and inside the valve spring retainer.

10. Turn crankshaft pulley one revolution (360°). This puts the piston in No 2 cylinder at TDC compression stroke.



M82327A

11. Measure and adjust valve clearance (if necessary) on the valves (arrows) with No. 2 piston at TDC.

12. Install flywheel cover.

13. Install rocker arm cover. Tighten rocker arm cover nuts to specifications.

Results

If valve clearance cannot be adjusted to specification, check rocker arm assembly for wear or damage.

Specifications

Valve Clearance . . . . . 0.15-0.25 mm (0.006-0.010 in.)
Rocker Arm Cover Nuts . . . . . 18 N•m (160 lb-in.)

Check Valve Lift

Reason

Check wear on cam lobes, followers, and/or push rods.

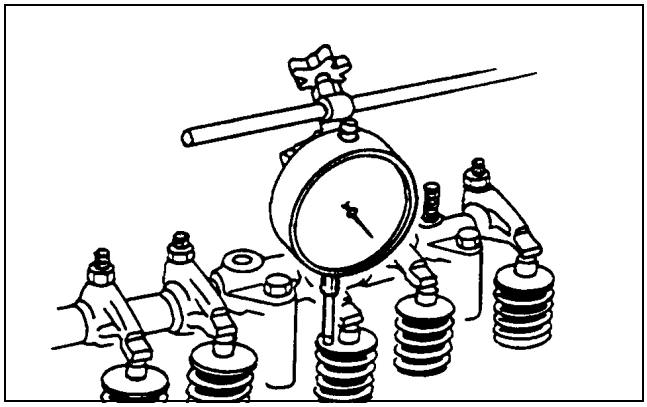
Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to measure valve lift.

Procedure

1. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 76.)

2. Adjust the valve clearance. (See “Adjust Valve Clearance” on page 54.)



T6333DT

3. Fasten the dial indicator to the engine and position the indicator tip on the valve retainer. The valve must be fully closed and the rocker arm must move freely.

4. Zero the dial indicator.

5. Manually turn the crankshaft pulley clockwise (viewed from flywheel end).

6. Observe the dial indicator as the valve is moved to the full open position and compare with specification. 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 and Install Camshaft” on page 97.) If the camshaft, followers and push rods are within specification remove and inspect the cylinder head. (See “Remove and Install Cylinder Head and Valves” on page 79.)

Specifications

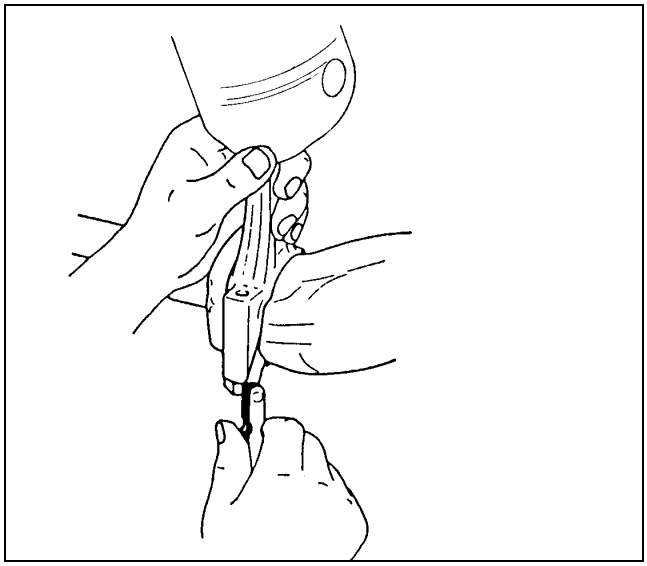
Valve Lift . . . . . 8.8 mm (0.350 in.)

Check Connecting Rod Side Play

Reason

To determine proper side clearance between the crankshaft and the connecting rod.

Procedure



M82116A

1. Insert a feeler gauge, according to specifications, between the connecting rod cap and the crankshaft.

Results

- If the side play exceeds specification, replace the bearing inserts or the connecting rod.

Specifications

Connecting Rod Side Play 0.2-0.4 mm (0.008-0.016 in.)

Check Connecting Rod Bearing Clearance

Reason

To measure oil clearance between connecting rod bearing and crankshaft journal.

Special or Required Tools

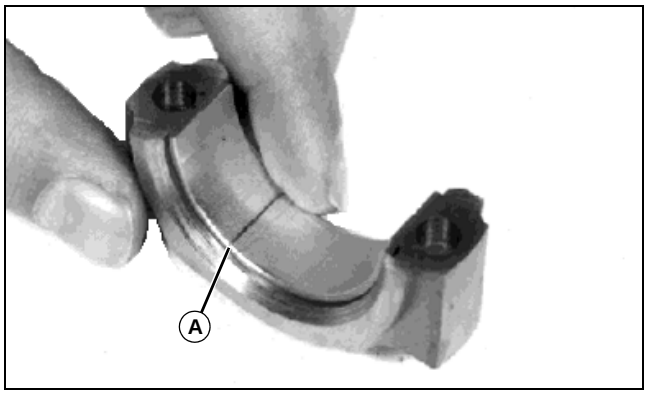
Tool Name	Tool No.	Tool Use
PLASTIGAGE®	NA	Used to measure oil clearance between connecting rod and crankshaft journal.

Procedure

IMPORTANT: Avoid damage! The 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 the connecting rod cap.

2. Wipe oil from the bearing insert and the crankshaft journal.



M35351

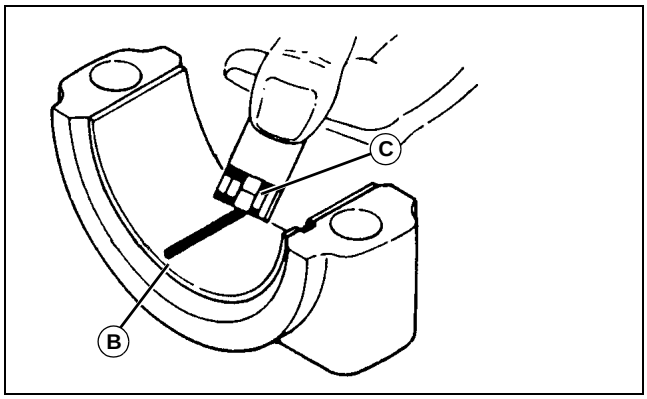
3. Put a piece of PLASTIGAGE (A), or an equivalent, along the width of the bearing insert approximately 6 mm (0.25 in.) off center.

4. Turn the crankshaft approximately 30° from bottom dead center.

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

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

6. Remove the rod end cap screws and the connecting rod cap.



M82117A

7. Use the graduation marks on the envelope (C) to compare the width of the flattened PLASTIGAGE (B) 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. Measure the connecting rod bearing oil clearance.

9. Remove the PLASTIGAGE.

Results

- If the clearance exceeds the wear limit specification, replace the bearing inserts.

Specifications

Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)

Connecting Rod-to-Crankshaft Journal Clearance. . . . . 0.038-0.074 mm (0.001-0.003 in.)

Check Crankshaft End Play

Reason

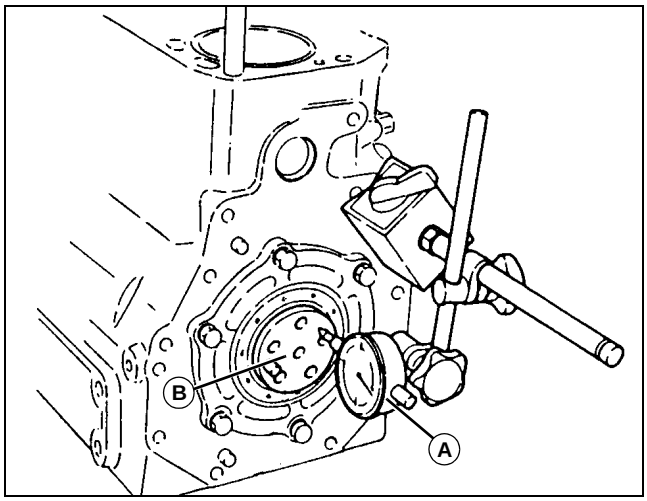
To determine proper side clearance between the crankshaft and the engine block.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to check crankshaft-to-engine block side clearance.

Procedure

NOTE: Crankshaft end play can be measured at front end or rear end of crankshaft. Procedure is performed from the rear end. The flywheel is removed to show detail.



M82118A

1. Fasten the dial indicator (A) to engine and position indicator tip on end of crankshaft (B).

IMPORTANT: Avoid damage! Do not use excessive force when moving crankshaft to avoid damaging bearings.

2. Push the crankshaft toward rear as far as possible.
3. Zero the dial indicator.
4. Using a bar, gently pry the crankshaft as far forward as possible.

Results

- If the end play exceeds specifications, replace the thrust bearings.

Specifications

Crankshaft End Play. . . . 0.13-0.23 mm (0.005-0.009 in.)

Check Crankshaft Main Bearing Clearance

Reason

To measure oil clearance between main bearing and crankshaft journal.

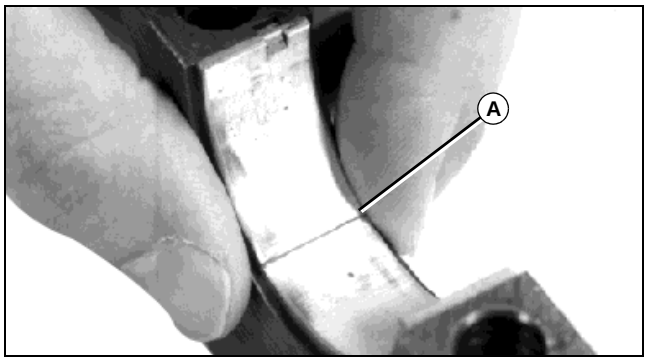
Special or Required Tools

Tool Name	Tool No.	Tool Use
PLASTIGAGE®	NA	Used to check main bearing-to-crankshaft journal clearance.

Procedure

IMPORTANT: Avoid damage! Main bearing caps must be installed on the same main bearing and in the same direction to prevent crankshaft and main bearing damage.

1. Remove the main bearing cap.
2. Wipe oil from the bearing insert and the crankshaft journal.

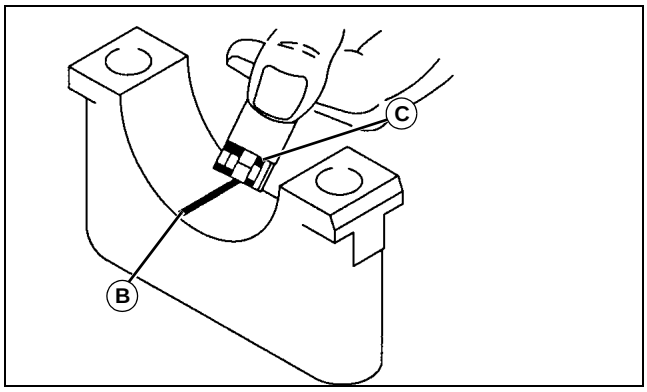


M35382

3. Put a piece of PLASTIGAGE (A), or an equivalent, along the width of the bearing insert approximately 6 mm (0.25 in.) off center.
4. Install the main bearing cap and cap screws. Tighten the cap screws to specification.

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

5. Remove the cap screws and main bearing caps.



M82119A

6. Use the graduation marks (C) on the envelope to compare the width of the flattened PLASTIGAGE (B) 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.

7. Remove PLASTIGAGE.

Results

- If the clearance exceeds the wear limit specification, replace the bearing inserts.

Specifications

Main Bearing Cap Screw Torque. . . . . 98 N•m (72 lb-ft)
Main Bearing-to-Crankshaft Journal Oil Clearance . . . 0.038-0.068 mm (0.001-0.003 in.)
Wear Limit . . . . . 0.150 mm (0.006 in.)

Check Camshaft End Play

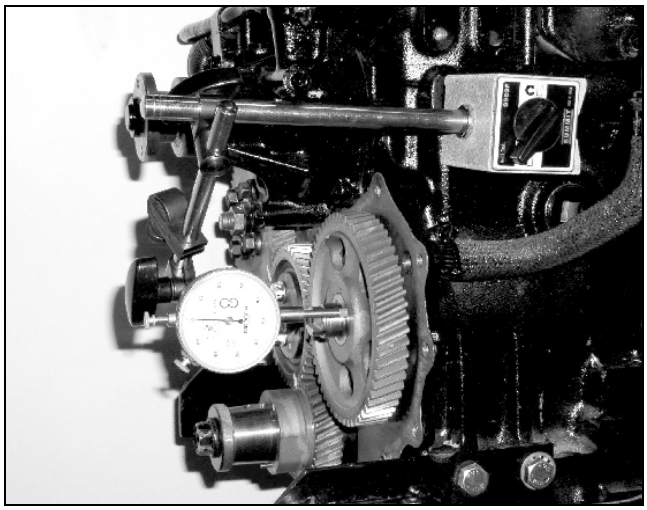
Reason

To determine proper side clearance between camshaft gear end journal and thrust plate.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to check camshaft gear end journal-to-thrust plate side clearance.

Procedure



MX20063

1. Remove the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 101.)

2. Fasten the dial indicator to the engine and position indicator tip on end of camshaft.

3. Push the camshaft toward the rear as far as possible.

4. Zero the dial indicator.

5. Pull the camshaft forward as far as possible.

Results

- If the end play exceeds specifications, remove the camshaft and replace the thrust plate. (See “Remove and Install Camshaft” on page 97.)

Specifications

Camshaft End Play. . . . . 0.05-0.20 mm (0.002-0.010 in.)
Wear Limit. . . . . 0.30 mm (0.012 in.)

Check Timing Gear Backlash

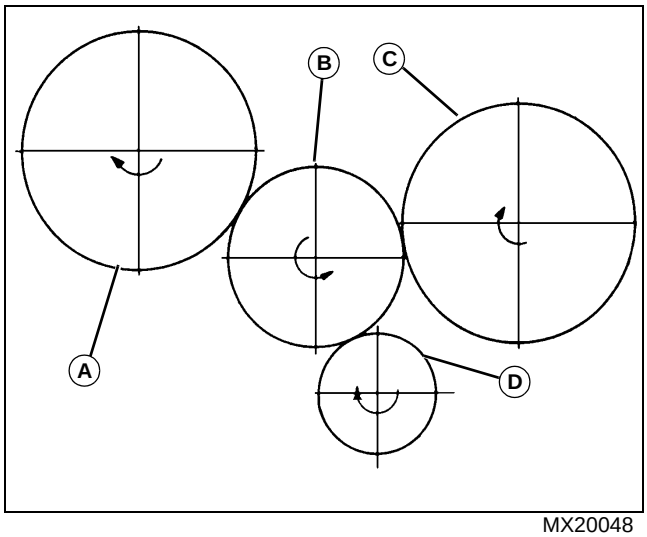
Reason

To check for wear between meshing gears, resulting in excessive noise and poor engine performance.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to check wear between meshing gears.

Procedure



MX20048

1. Measure the backlash between meshing gears.

Results

If the backlash exceeds specifications, replace meshing gears as a set:

- Fuel Injection Pump Gear (A)
- Idler Gear (B)
- Camshaft Gear (C)
- Crankshaft Gear (D)

Specifications

Gear Backlash. . . . . 0.07-0.15 mm (0.002-0.006 in.)

Test Fuel Injection Nozzles

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

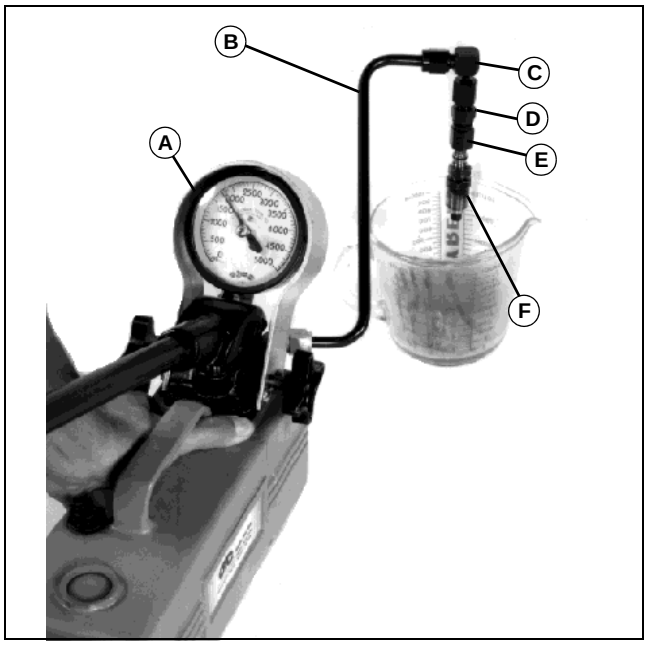
Reason

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter Set	D01110AA	Used to test fuel injection nozzles.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzles.
Straight Adapter	23622	Used to test fuel injection nozzles.

Connections



M35913

1. Connect the fuel injection nozzle (F) to D01109AA Diesel Fuel Injection Nozzle Tester (A) using parts 36352 (B), 23617 (C) and 23621 (D) from D01110AA Adapter Set, and 23622 Straight Adapter (E).

IMPORTANT: Avoid damage! Use clean filtered diesel fuel when testing injection nozzles to get best test results.

Procedure 1

Test the fuel injection nozzle opening pressure following the nozzle tester manufacturer's instructions. The opening pressure should be at specifications.

Results

- If the pressure reading does not meet specifications, disassemble the injection nozzle and inspect for contamination or a stuck valve. If necessary, add or remove shims to change opening pressure.

Procedure 2

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

1. Dry the nozzle completely using a lint-free cloth.

2. Pressurize injection nozzle to 19 400 kPa (2814 psi).

3. Watch for leakage from nozzle spray orifice for a minimum of five seconds.

Results

- Fuel should not leak from the nozzle when the nozzle is pressurized.

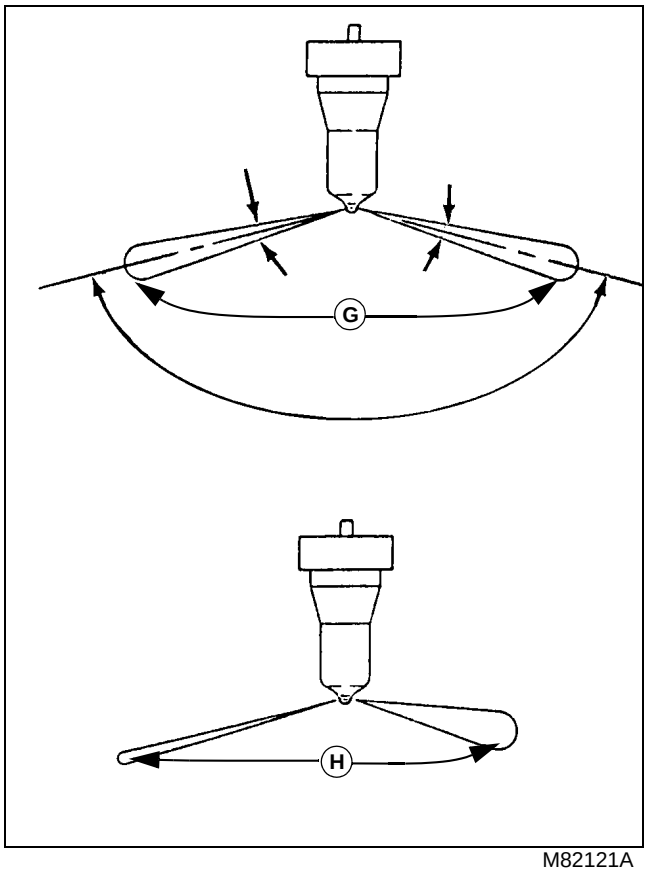
- If the injection nozzle leaks fuel, disassemble and inspect the nozzle assembly for contamination. Inspect the valve seating surface. Replace the nozzle assembly if necessary.

Procedure 3

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

1. Pressurize injection nozzle to 21 600—22 600 kPa (3133—3278 psi).

2. Listen for chatter sound and watch spray pattern.



M82121A

3. With slow hand lever movement there should be a “chatter” sound and a fine stream spray pattern.

4. With fast hand lever movement the nozzle should exhibit an even, fine atomized spray pattern (G), unlike spray pattern (H).

5. Place a sheet of white paper 30 cm (12 in.) below the nozzle. The injection spray should form a perfect circle on the paper.

Results

• If nozzle chatter or the spray pattern do not meet specifications, disassemble the injection nozzle and inspect the nozzle assembly for contamination. Inspect the valve seating surface. Replace the nozzle assembly if necessary.

• If there is excessive difference in the spray angle or injection angle, incomplete atomizing or sluggish starting/stopping of injection (H), disassemble the injection nozzle and inspect the nozzle assembly for contamination. Replace the nozzle assembly if necessary.

Specifications

Fuel Injection Nozzle Opening Pressure 21 600—22 600 kPa (3133—3278 psi)

Test Thermostat Opening

Reason

To determine opening temperature of thermostat.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	NA	Used to check thermostat opening temperature.

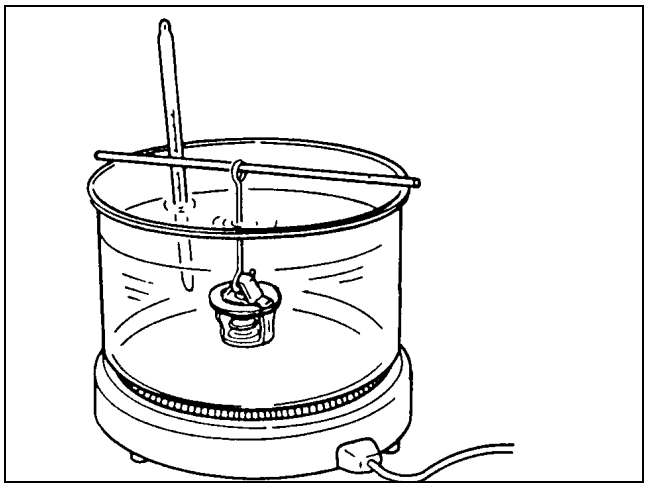
Procedure

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.

1. Suspend the thermostat and a thermometer in a container of water.

2. Heat and stir the water. Observe the opening action of the thermostat as the water heats up.

3. Remove the thermostat and observe the closing action as it cools.



M82122A

Results

Thermostat opening temperature, fully open temperature and lift height should meet specifications.

Specifications

Thermostat Begins to Open . . . . . 70°C (158°F)
Thermostat Fully Open . . . . . 85°C (184°F)
Thermostat Lift Height. . . . . 8 mm (0.310 in.)

Adjust Fan/Alternator Drive Belt

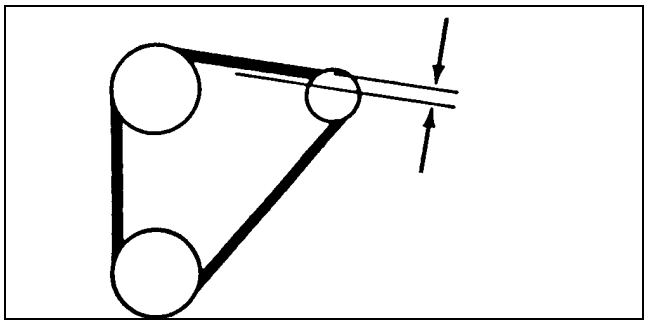
Reason

To keep proper tension on the belt to drive the coolant pump and the alternator. To prevent shortened belt and bearing life.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Belt Tension Gage	JDG529 or JDST28	Used to adjust belt tension.
Straightedge	NA	Used to adjust belt tension.

Procedure (Check Belt Tension)



M54014

1. Check belt tension between coolant pump and alternator using a belt tension gage and a straightedge. Belt deflection should be at specification. If not, adjust belt.

2. Check belt tension between fan and crankshaft pulley using belt tension gage and a straightedge. Belt deflection should be at specifications. If not, adjust fan belt.

Procedure (Adjust Alternator Belt)

1. Loosen both alternator mounting cap screws/nuts.

2. Apply force to FRONT alternator housing only (near the belt) until tension is to specifications.

3. Tighten cap screws/nuts.

Procedure (Adjust Fan Belt)

1. Loosen idler pulley mounting cap screws/nuts.

2. Apply force to pulley (near belt) until tension is correct.

3. Tighten cap screws/nuts.

Results

Both belts should meet specifications.

Specifications

Fan/Alternator Belt Deflection @ 98 N (22 lb-force) 8-13 mm (0.315-0.512 in.)

Test Cylinder Leakdown

Reason

To determine if compression pressure is leaking from cylinder.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter	JDG560	Used to pressurize cylinder with compressed air for cylinder leakdown test.

Procedure

1. With the coolant at the proper level and the radiator cap tight, run the engine for 5 minutes to bring it to operating temperature.

2. Remove the recovery tank cap.

3. Check for bubbles coming from the overflow hose at the bottom of the tank.

4. If bubbles are present, isolate the source of the compression leak.

   a. Remove the injection nozzles.

   b. Install JDG560 Adapter in the injection port of the cylinder to be tested.

   c. Move the piston to the bottom of the stroke with intake and exhaust valves closed.

   d. Connect the hose from a compressed air source to the adapter.

   e. Apply shop air pressure into the cylinder.

   f. Check for bubbles in the recovery tank or air escaping from the muffler, air cleaner or oil fill opening.

   g. Repeat for each cylinder.

Results

- If bubbles are present in the recovery tank, check for cracks in the cylinder head and block. Check for a damaged head gasket.
- If air escapes from the muffler, check for a worn exhaust valve.
- If air escapes from the air cleaner, check for a worn intake valve.
- If air escapes from the engine oil fill, check for worn piston rings.

Test Cooling System Pressure

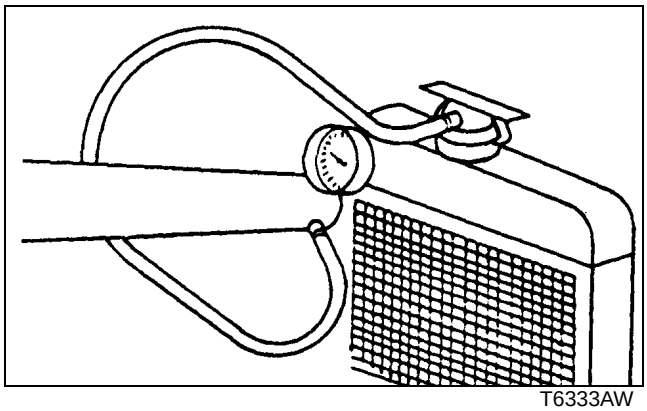
Reason

Inspect the cooling system for leaks.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to test cooling system pressure.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test cooling system pressure.

Procedure



T6333AW

1. Remove cap and attach pressure pump to radiator.
2. Apply pressure according to specifications. DO NOT exceed maximum pressure specification.
3. Check for leaks throughout the cooling system. The pressure should not go below the minimum pressure specification for at least 15 seconds.

Results

- 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, cracked block, or cylinder head may be the cause. (See “Test Cylinder Leakdown” on page 63.)

Specifications

Maximum Pressure. . . . . 97 kPa (14 psi)
Minimum Pressure (After 15 Seconds). . . . 88 ± 15 kPa (12.8 ± 2.2 psi)

Test Radiator Pressure Cap

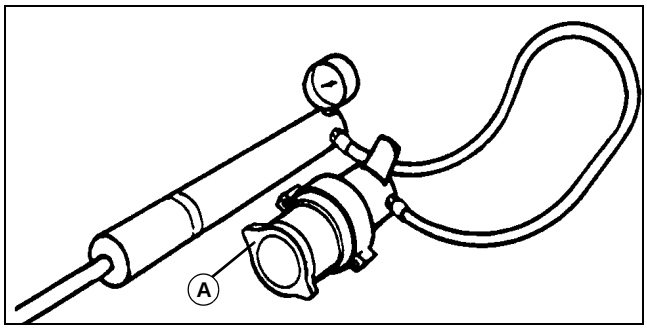
Reason

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 test radiator cap pressure.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test radiator cap pressure.

Procedure



T6333AX

1. Install the radiator cap (A) on the pressure pump.
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 Pressure . . . . . 88 kPa (12.8 psi)

Test Engine Oil Pressure

Reason

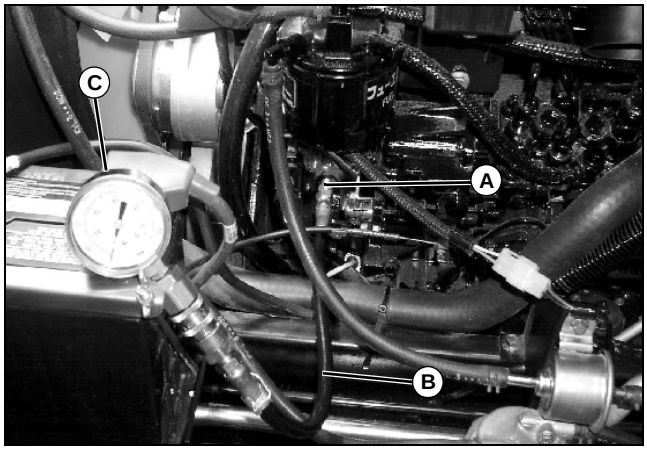
To determine if engine bearings or lubrication system components are worn.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Assembly Gage	JT03017	Used to test engine oil pressure.
Pressure Gauge 689 kPa (100 psi)	JT07034	Used to test engine oil pressure.
Connector 1/8 in. Male BSP x 7/16 in. Male 37° Flare	JT03349	Used to test engine oil pressure.

Procedure

1. Remove oil pressure sender.



MX17937

2. Install JT03349 Connector (A).

3. Connect JT03017 Hose Assembly (B) and JT07034 Pressure Gage (C).

IMPORTANT: Avoid damage! DO NOT run engine if there is insufficient oil pressure!

4. Start engine. If pressure reading is below 69 kPa (10 psi), STOP engine and discontinue this procedure.

5. Run engine approximately five minutes to heat oil, then check oil pressure at fast idle.

Results

- If the oil pressure is not within specifications, inspect the oil pump.
- Inspect oil pressure regulating valve for wear or damage. Add or remove shims as necessary.

Specifications

Engine Oil Pressure . . . . . 345 ± 48 kPa (50 ± 7.0 psi)
Fast Idle Speed. . . . . 3210 ± 25 rpm

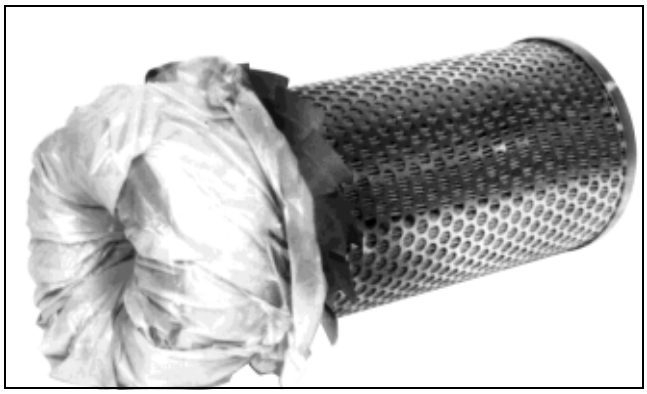
Test Air Intake System Leakage

Reason

Check for leaks in air intake system.

Procedure

1. Remove air filter restriction switch.
2. Remove air cleaner cover and main filter element.


M82124

3. Put plastic bag into and over end of main filter element. Install main filter element and cover.

4. Apply 34-69 kPa (5-10 psi) air pressure to air intake system. If air intake system cannot be pressurized, turn engine slightly to close valves.

5. Spray soap solution over all connections from air cleaner to intake manifold and check for leaks.

Results

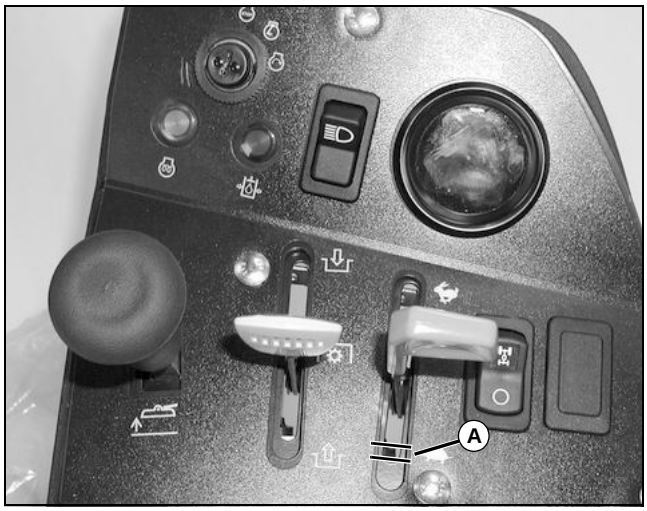
- Find leaks and repair or replace parts as necessary.

Adjust Throttle Cable

Reason

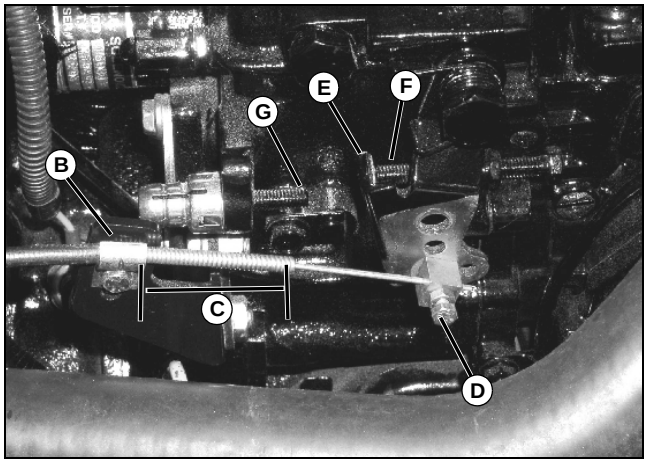
To make sure that throttle lever and cable move governor lever fully from slow idle to fast idle position.

Procedure



MX20824

1. Move throttle lever on instrument panel to within approximately 7 mm (0.275 in.) from slow idle end of slot (A).



MX20067

2. Loosen throttle cable clamp (B). Outer cable measurement (C) should be aproximately 41 mm (1.625 in.). Tighten clamp.

3. Loosen screw and jam nut (D). Throttle arm (E) should be against slow idle stop screw (F).

4. Tighten screw and jam nut.

Results

Throttle lever should move governor linkage throughout full range of travel, touching slow idle stop screw (F) and fast idle stop screw (G).

Test Fuel System Leakage

Reason

Tests 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. Disconnect fuel lines from fuel filter.

2. Place fuel line from fuel pump to fuel filter 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.

3. Apply 34-69 kPa (5-10 psi) air pressure to fuel supply hose until all fuel is drained from the system. DO NOT exceed maximum pressure of 103 kPa (15 psi).

4. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

Results

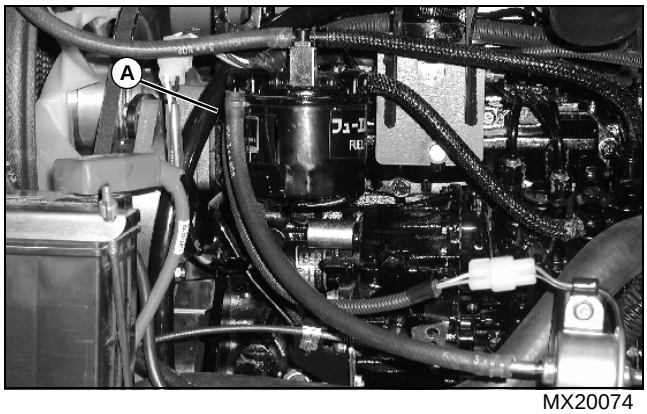
- Find leaks and repair or replace parts as necessary.

Fuel Transfer Pump Pressure Test

Reason

To determine fuel transfer pump operating pressure.

Procedure



MX20074

1. Disconnect transfer pump hose (A) from outlet side of pump at fuel filter.

2. Install the hose and gage to outlet-side hose of pump.

3. Turn key switch to ON position for 15 seconds.

4. Record fuel pressure reading on gage.

Results

• If the pressure is below specification, replace the fuel transfer pump.

Specifications

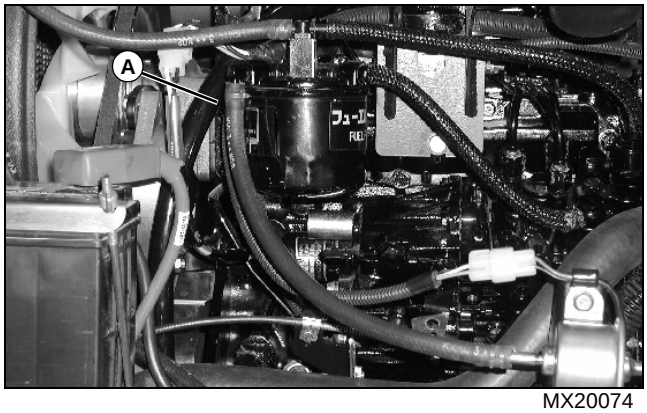
Fuel Transfer Pump Pressure . . . . . 37.3 kPa (5.4 psi)

Fuel Transfer Pump Flow Test

Reason

To determine fuel transfer pump flow..

Procedure



MX20074

1. Disconnect transfer pump hose (A) from outlet side of pump at fuel filter.
2. Place hose in a graduated container.
3. Turn key switch to ON position for 15 seconds.
4. Compare fuel amount to specification.

Results

• If the pressure is below specification, replace the fuel transfer pump.

Specifications

Fuel Transfer Pump Flow. . . . . 400 mL (13.5 oz)

Bleed Fuel System

CAUTION: Avoid injury! Be careful of moving fan blades, alternator pulley and belts when engine is running. Engine may also be hot.

IMPORTANT: Avoid damage! Modification or alteration of the injection pump, pump timing or the injection nozzles in any way not approved by the manufacturer will terminate the warranty obligation.

All engines are equipped with an automatic air venting system that makes the fuel system self-bleeding.

1. Ensure that all fuel line connections are securely tightened.
2. Add fuel to the fuel tank.
3. Crank engine to allow fuel system to bleed itself.

Test Coolant Temperature Switch

Reason

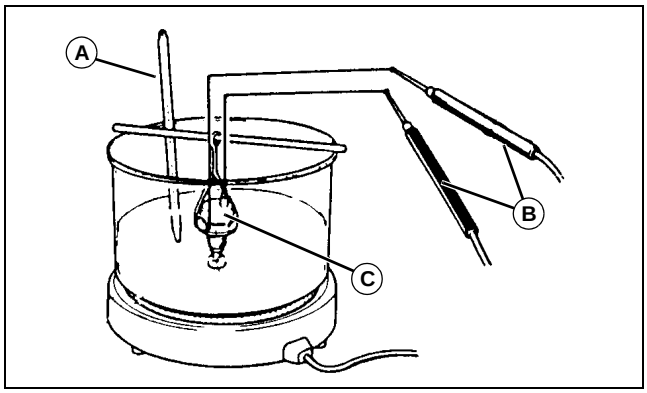
To determine operating temperature of sender.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	NA	Used to check coolant temperature switch.
Glass Container	NA	Used to check coolant temperature switch.
Heating Unit	NA	Used to check coolant temperature switch.
Ohmmeter	NA	Used to check coolant temperature switch.

Procedure

IMPORTANT: Avoid damage! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



M82123A

1. Connect lead wires from ohmmeter probes (B) to sender terminal and body.

2. Suspend sender (C) and a thermometer (A) in a container of water.

3. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be at specifications.

Results

- If continuity does not occur within temperature listed, replace sender.

Specifications

Coolant Temperature Switch (Contact Closing Temperature). . . . . 107-113°C (225-235°F)

Extending Turbocharger Life

Turbochargers are designed to last the life of the engine, but, because they operate at such high speeds (100,000 rpm or more), a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failure are:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

Lack of Lube Oil

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds) seals, shaft, turbine and compressor wheels can also be damaged.

The principle causes of turbocharger bearing lubrication problems are low pressure; a bent, plugged, or undersized oil lube supply line; plugged or restricted oil galleries in the turbocharger; or improper machine start-up and shutdown procedure.

Oil levels and pressure should always be closely monitored and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent and it should always be replaced with a line of equal size, length, and strength.

IMPORTANT: Avoid damage! Allow engine to idle for two minutes before shutting down after running under load to avoid damage to turbocharger.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least two minutes (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat to build up and possible bearing damage. It can also cause carbon and varnish deposits to form.

Oil Contamination

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc., from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Ingestion of Foreign Objects

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

IMPORTANT: Avoid damage! Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

Restricted Oil Drainage

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage:

- A blocked drain tube, due to either damage or a buildup of sludged oil.
- High crankcase pressure, due to restricted crankcase breather or excessive engine blow-by.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

Low Oil Level

Check engine oil level periodically according to your operator's manual. Proper oil level will prevent turbocharger failure.

Operation on Excessive Side Slopes

Operating equipment on excessive side slopes will prevent oil from being transferred up to the turbocharger, causing overheating wear of moving parts.

Abnormally High Exhaust Temperatures

A fifth cause of turbocharger damage is abnormally high exhaust temperatures. This can cause coking of oil which can lead to bearing failure. Extreme over-temperature operation can cause wheel burst.

There are two basic causes of over-temperature:

- Restricted air flow
- Overpowering the engine

In either case, the engine has more fuel than available air for proper combustion. This over-fueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include:

- Damaged inlet piping
- Clogged air filters
- Excessive exhaust restriction
- Operation at extreme altitudes

Overpowering generally is due to improper fuel delivery or injection timing. If over-temperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

Turbocharger Seven-Step Inspection

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed, so the primary cause of failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons.

1. Identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

2. Proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

NOTE: To enhance the turbocharger inspection, use an inspection sheet (Form No. DS-2280 available from Distribution Service Center) to list the inspection steps in the proper order and show potential failure modes for each step. Check off each step of the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

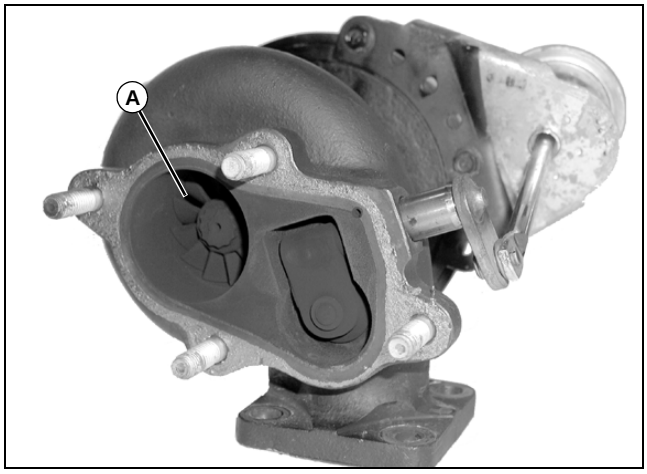
The seven recommended inspection steps, which are explained in detail on the following pages, are:

- Compressor Housing Inlet and Compressor Wheel
- Compressor Housing Outlet
- Turbine Housing Inlet
- Turbine Housing Outlet and Turbine Wheel
- External Center Housing and Joints
- Internal Center Housing
- Turbo Bench Test

Compressor Housing Inlet and Compressor Wheel

NOTE: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate future damages.

Use a good light source for this check.



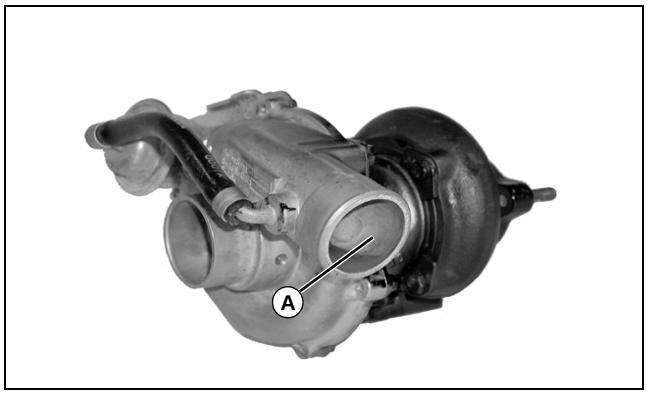
MX14541

1. Check compressor inlet and blade (A) for foreign object damage.

2. Check compressor inlet for wheel rub on the housing. Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.

3. Mark findings on your checklist and continue the inspection.

Compressor Housing Outlet

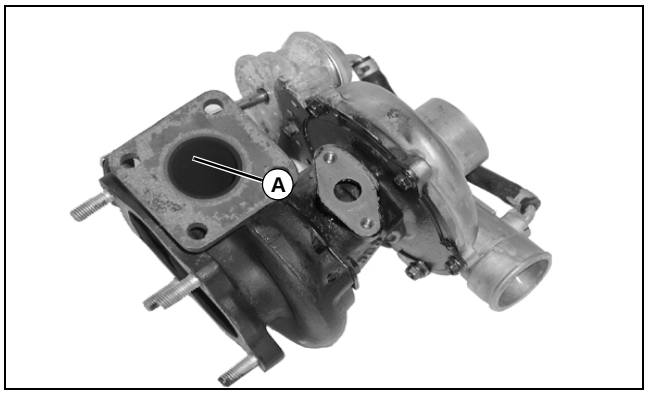


MX14539

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark the checklist if dirt or oil is found and continue the inspection.

Turbine Housing Inlet

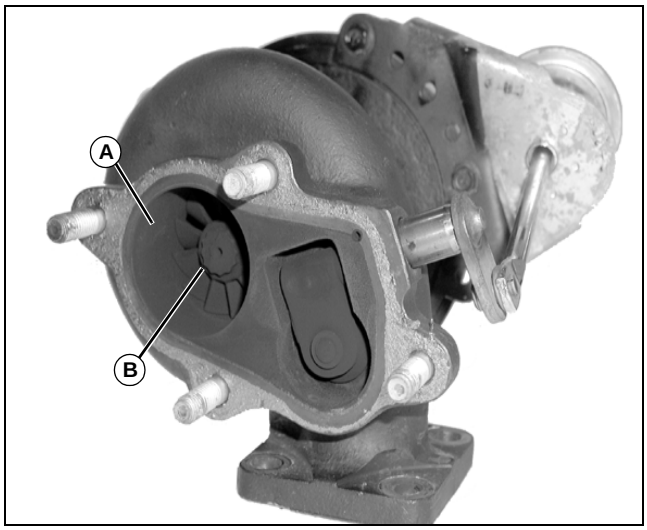


MX14540

Check the turbine housing inlet port (A) for oil in housing, excessive carbon deposit, or erosion of walls.

NOTE: If the inlet is wet with oil or has excessive carbon deposits, an engine problem is likely. Wall erosion (cracking or missing pieces) indicates excessive exhaust temperature.

Turbine Housing Outlet and Turbine Wheel

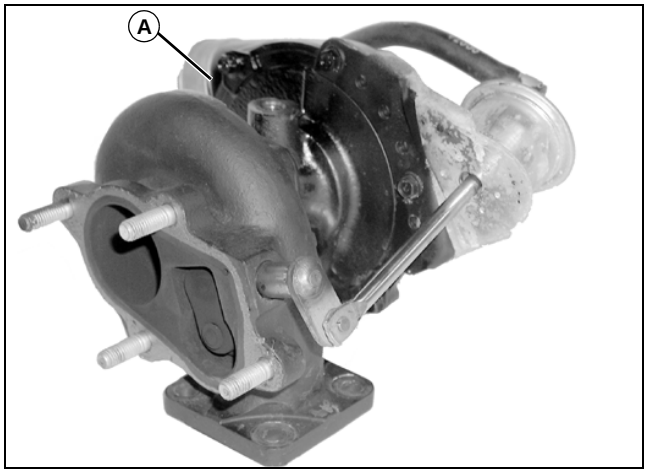


MX14541

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.

2. Inspect the wheel blades and housing for evidence of wheel rub. Wheel rub can bend the tips of the blades with the housing showing wear or damage.

External Center Housing and Joints

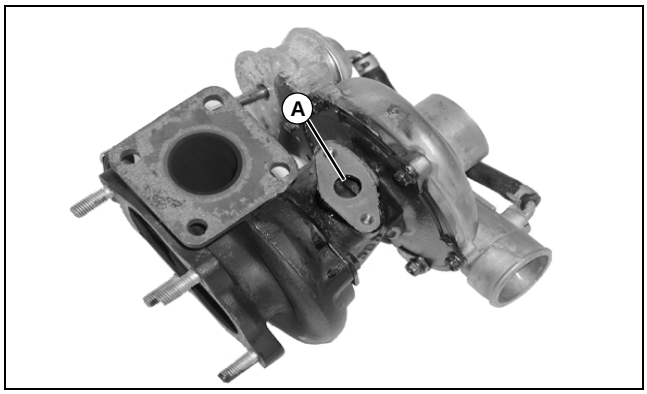


MX14564

Visually check the outside of the center housing (A), all connections to the compressor housing, and turbine housing for oil.

NOTE: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

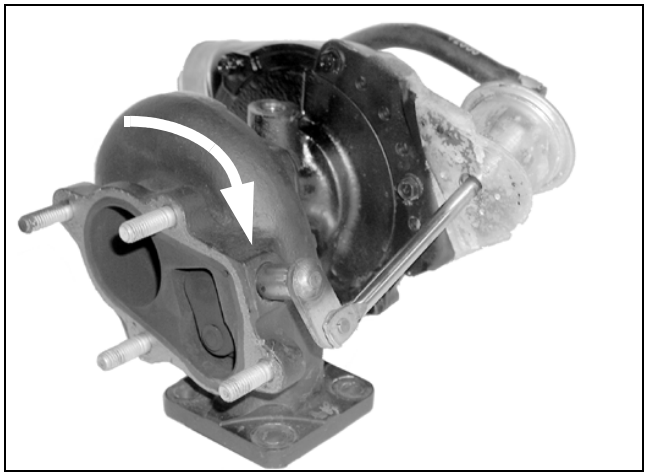
Internal Center Housing



MX14540

Using a flashlight, look through the oil return hole (A) to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.

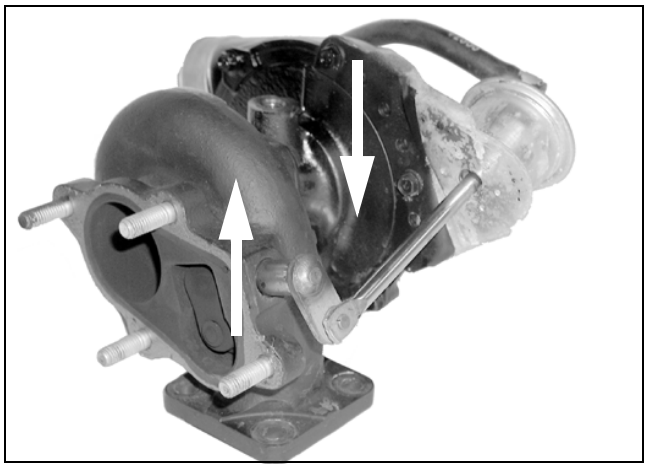
Turbo Bench Test



MX14564

1. Mount the turbocharger in a vise.

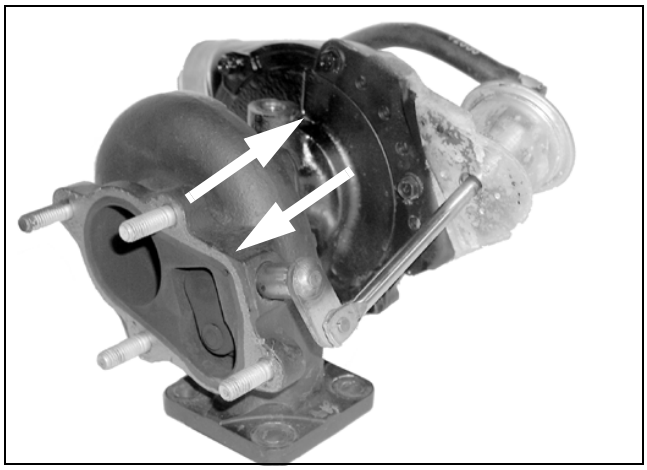
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely, however, there may be a slight amount of drag.



MX14564

3. Pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel not the turbine wheel should contact the housing at any point.

NOTE: There will be some "play" because the bearings inside the center housing are free floating.



MX14564

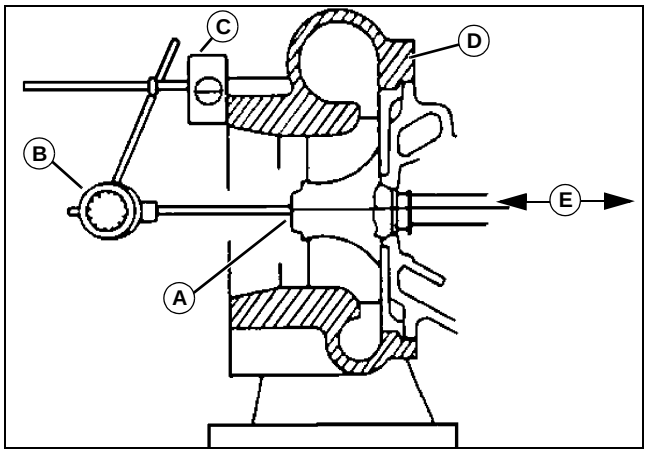
4. Check shaft end play by moving the shaft back and forth while rotating. There will be some end play, but not to the extent that the wheels contact the housing.

IMPORTANT: Avoid damage! Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended to check rotor shaft axial and radial play. (See procedures later in this group.) These procedures are not required if a failure mode has already been identified.

NOTE: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure. It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.

Check Turbocharger Rotor Shaft Axial Play

This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.



MX14542

A - Shaft End
B - Dial Indicator
C - Magnetic Base
D - Turbine Housing
E - Axial Direction

1. Mount magnetic base (C) so that indicator tip rests on end of shaft (A). Preload indicator tip and zero dial on indicator (B).
2. Move shaft axially back and forth by hand.
3. Observe and record total dial indicator movement.

If axial play is not within specification, replace turbocharger.

Specifications

Rotor Shaft Axial Play

Standard . . . . . 0.022-0.053 mm (0.009-0.0021 in.)
Wear Limit . . . . . 0.07 mm (0.0028 in.)

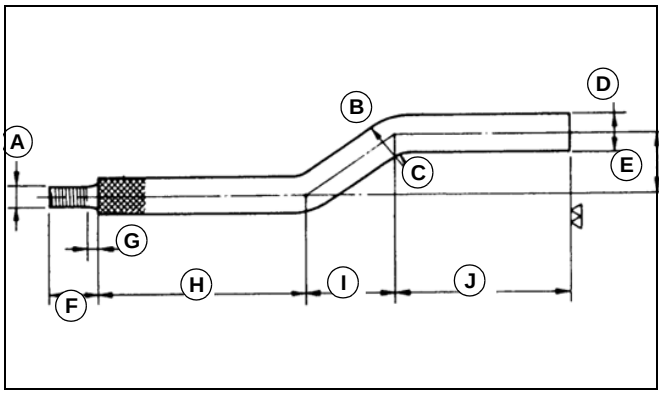
Check Turbocharger Rotor Shaft Radial Play

This test will give an indication of the condition of the radial bearing within the center housing and rotation assembly.

NOTE: Prelube center housing bearing prior to performing radial play test. (See "Prelube Turbocharger" on page 123.)

1. Purchase an extended indicator tip from a local supplier with the following approximate dimensions:

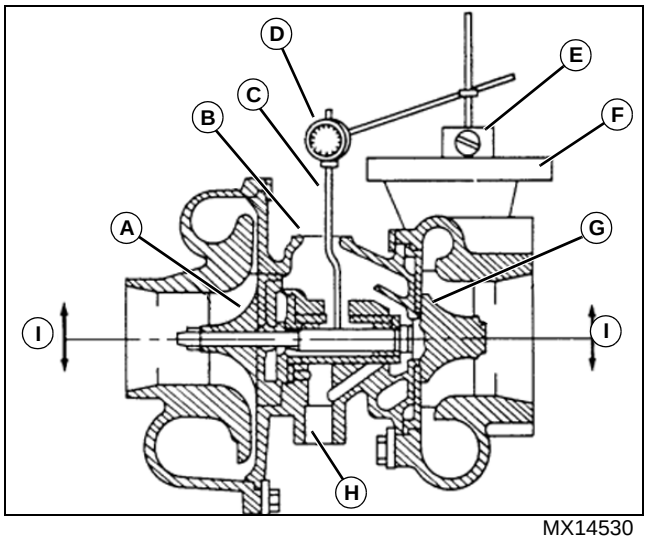
- Length: 76 mm (3.0 in.)
- Diameter: 5.0 mm (0.197 in.)



MX14531

A - M2.6, P0.45
B - Radius: 10 mm (0.3937 in.)
C - Radius: 5 mm (0.1968 in.)
D - Diameter: 5 mm (0.1968 in.)
E - Distance: 7 mm (0.2755 in.)
F - Length: 8 mm (0.3149 in.)
G - Length: 1 mm (0.0393 in.)
H - Length: 40 mm (1.5748 in.)
I - Length: 10 mm (0.3937 in.)
J - Length: 15 mm (0.5905 in.)

2. Heat and bend to size as shown.



MX14530

A - Compressor Wheel
B - Oil Return Cavity
C - Extension Adapter
D - Dial Indicator
E - Magnetic Base
F - Turbocharger Mounting Flange
G - Turbine Wheel
H - Oil Inlet
I - Radial Direction

3. Position dial indicator (D) with extension adapter (C) onto turbocharger mounting flange (F), so that tip rests on shaft by extending through oil return cavity (B).

4. Grasp rotation shaft at both ends and move the shaft toward the indicator then away from the indicator (arrows) by applying moderate force.

5. Observe and record total indicator movement.

6. If total indicator reading is not within specification, replace turbocharger.

Specifications

Rotor Shaft Radial Play

Standard . . . . . 0.061-0.093 mm (0.0024-0.0037 in.)
Wear Limit . . . . . 0.12 mm (0.0047 in.)

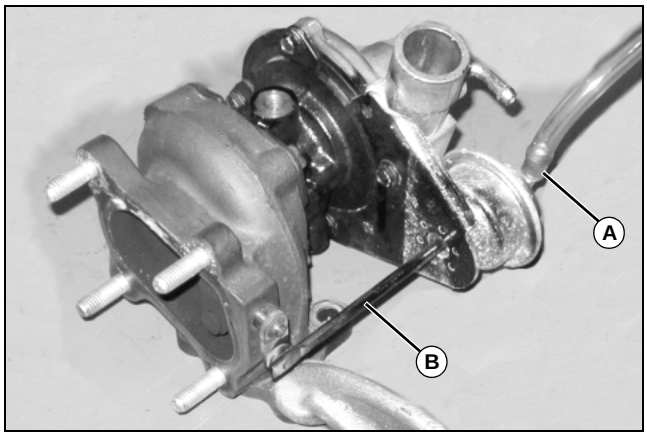
Turbocharger Waste Gate Test

Equipment:

- Pressure regulating valve - Allowing gradual adjustment in a range from 0 to 200 kPa (0 to 29 psi).

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise hood.
4. Check hose to waste gate actuator for kinks or cracks. Replace if damaged.



MX34308

5. Disconnect hose from waste gate actuator (A).
6. Connect a regulated air source to actuator fitting.

IMPORTANT: Avoid damage! Do not apply more than 400 kPa (58 psi) to the actuator.

7. Vary pressure to wastegate actuator from 0 - 193 kPa (0 - 20 psi). Check results below.
8. Apply 117 kPa (17 psi) to actuator, shut off and seal air supply. Wait one minute and measure pressure in actuator.

Results:

- Actuator rod (B) should move in and out freely as pressure is varied.
- If rod does not move freely, disconnect turbocharger wastegate linkage. Check for movement and repair or replace components as necessary.
- After 117 kPa (17 psi) is applied, the pressure should not drop below 103 kPa (15 psi) after one minute. Replace actuator if pressure drop exceeds specification.

Repair

Remove and Install Engine

Remove

1. Disconnect negative (-) cable from battery.

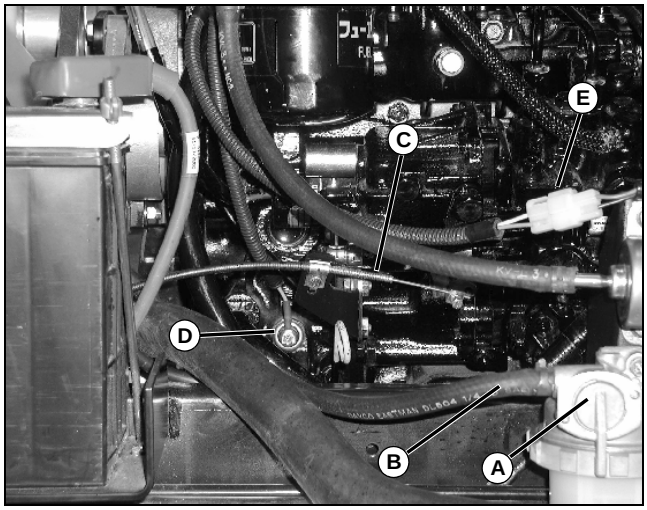
2. Remove starter. (See “Remove and Install Starter” on page 114.)

3. Drain coolant. Disconnect upper and lower hoses from radiator.

4. Remove three cap screws attaching driveshaft to flex plate. Loosen cap screws holding driveshaft to pump input shaft and slide driveshaft toward pump.

5. Remove two cap screws and clamps securing positive battery cable to bottom of engine.

6. Remove air cleaner assembly.



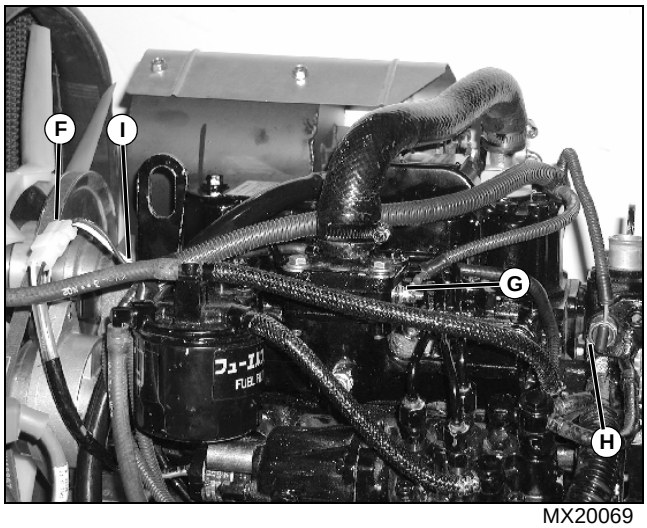
MX17938

7. Close fuel shutoff (A) at fuel filter.

8. Disconnect and plug fuel line (B).

9. Disconnect throttle cable (C).

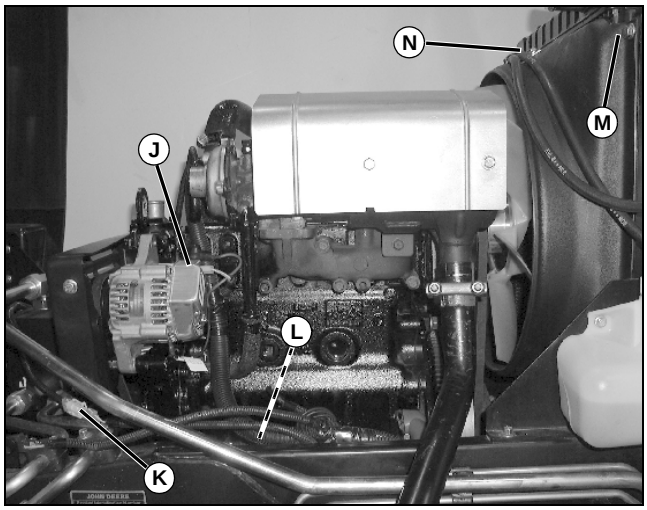
10. Disconnect wire connectors at oil pressure sender (D) and fuel pump (E).



MX20069

11. Disconnect engine wiring harness at fuel shutoff solenoid (F), air intake preheater (G), and water temperature sender (H).

12. Disconnect and plug fuel line (I).

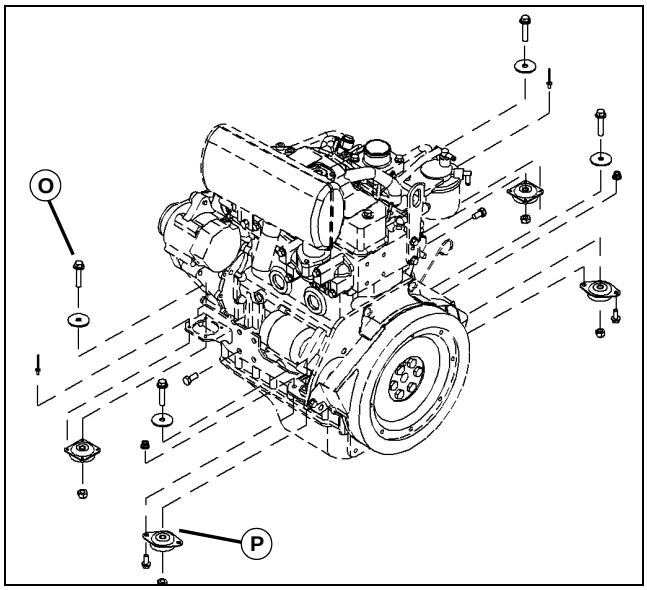


MX17939

13. Disconnect four-wheel drive solenoid wire connector (K) and wires from alternator (J).

14. Disconnect engine ground strap (L).

15. Remove the four cap screws (M) securing the fan shroud to the radiator, and cap screw and clamp (N) securing fuel lines to shroud. Position the shroud over the fan for removal with the engine and lay fuel lines on radiator, clear of shroud.



MX20070

16.Attach suitable hoist to engine lifting eyes.

17.Remove mounting cap screws and nuts (O). Remove engine

18.Inspect rubber isolators (P) for wear. Replace if required.

Install

1. Loosely install engine mounting screws and nuts. Do not tighten.

2. Install driveshaft to engine. Tighten cap screws to specification.

3. Tighten cap screws on pump input shaft yoke.

4. Tighten engine mounting screws to specification.

5. Install positive battery cable clamps to bottom of engine.

6. Install fan shroud cap screws and fuel line clamp.

7. Connect engine ground strap.

8. Connect wire harness.

9. Install and adjust throttle cable. (See “Adjust Throttle Cable” on page 66.)

10.Install fuel lines and open fuel shutoff at fuel filter.

11.Install air cleaner assembly.

12.Connect radiator hoses and fill radiator with coolant.

13.Install starter. (See “Remove and Install Starter” on page 114.)

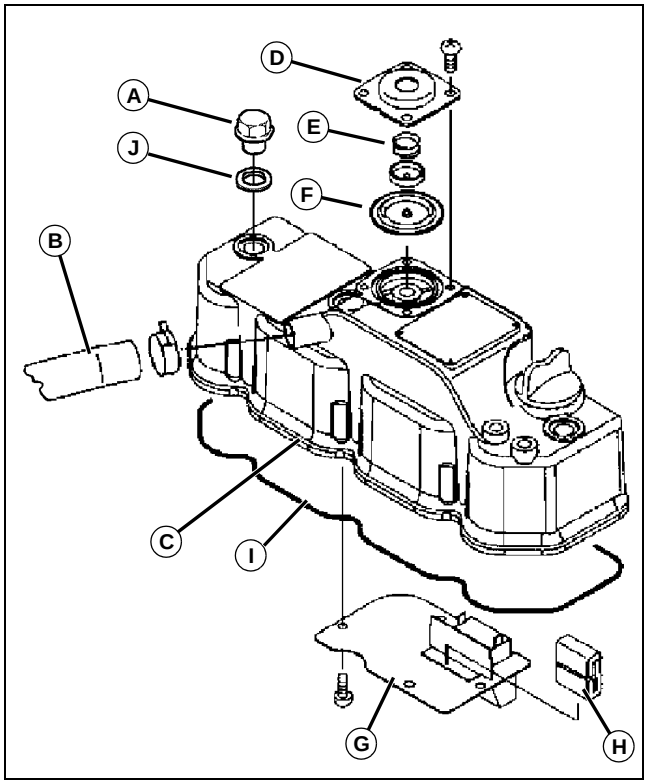
14.Connect battery.

Specifications

Engine Mounting Cap Screws . . . . . 80 N•m (60 lb-ft)
Drive Shaft Cap Screws . . . . . 80 N•m (60 lb-ft)

Remove and Install Rocker Arm Cover

Remove



MX17960

1. Remove three rocker cover nuts (A).

2. Remove breather hose (B).

3. Remove rocker cover (C) from the cylinder head.

4. Remove diaphragm cover (D).

5. Remove and inspect spring (E) and diaphragm (F). Replace as needed.

6. Remove baffle plate (G) and baffle (H).

7. Wash the baffle in a safe solvent and blow dry with air. Replace the baffle if it comes apart or is deteriorated.

Install

1. Install baffle and baffle plate.

2. Install diaphragm, plate, spring and diaphragm cover.

3. Inspect the rocker cover gasket (I) and O-rings (J). Replace if damaged.

4. Clean the cylinder head surface and install rocker cover to cylinder head. Tighten rocker cover nuts to specification.

5. Install breather hose.

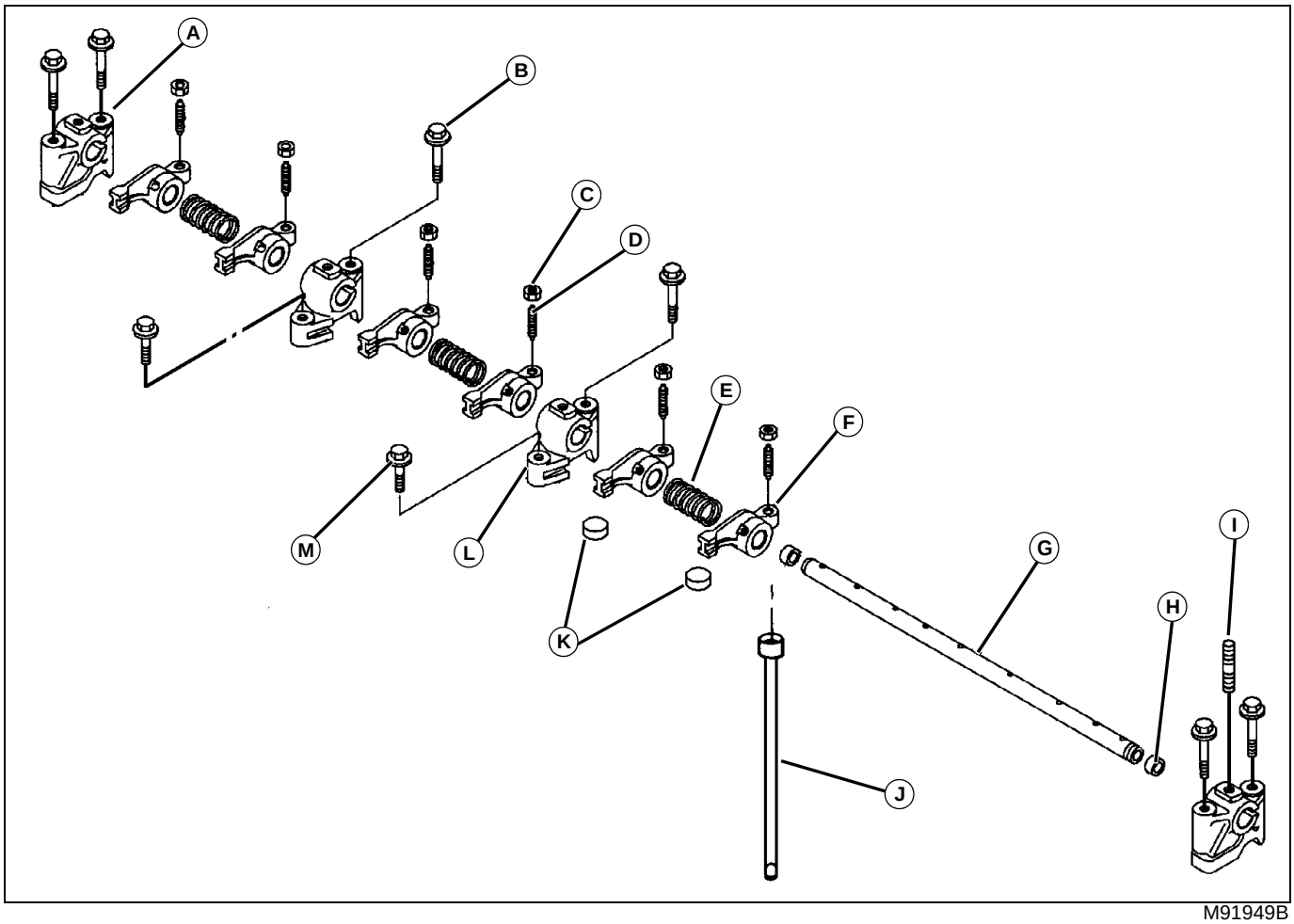
Specifications

Rocker Arm Cover Nut Torque . . . . . 18 N•m (13 lb-ft)

Remove and Install Rocker Arm Assembly

Removal

1. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 76.)



M91949B

A - Shaft End Support (2)
B - Cap Screw, M8 x 50 (6)
C - Jam Nut (6)
D - Adjuster Screw (6)
E - Spring (3)
F - Rocker Arm
G - Rocker Arm Shaft
H - Plug (2)
I - Stud
J - Push Rod (6)
K - Valve Caps (6)
L - Center Support (2)
M - Cap Screw, M8 x 25 (2)

2. Remove the rocker arm end supports (A) and rocker arm center support mounting cap screws (B and M).

3. Lift the rocker arm assembly from the cylinder head and set the assembly on a bench.

NOTE: If the rocker arm shaft assembly is to be disassembled, replace components in same location on the rocker arm shaft they were removed from.

4. Note the positions of the rocker arm assembly components. Slide the components off the rocker arm shaft.

5. Lift the push rods from the cylinder head and note the order of removal for reassembly.

6. Inspect the rocker arm components and push rods.

Installation

1. Reinstall the push rods to their original location in the cylinder head, with the ball shaped end down in head.

2. Lubricate all parts with clean oil during assembly.

3. Assemble the rocker arm assembly components in the reverse order of removal.

4. Place the rocker arm assembly on the cylinder head.
   - Align the rocker arms with the valves and push rods.
   - Align the rocker arm end supports and center supports with the corresponding holes in the head.

5. Install the rocker arm support cap screws. Tighten the cap screws to specification.

6. Adjust the valve clearance. (See “Adjust Valve Clearance” on page 54.)

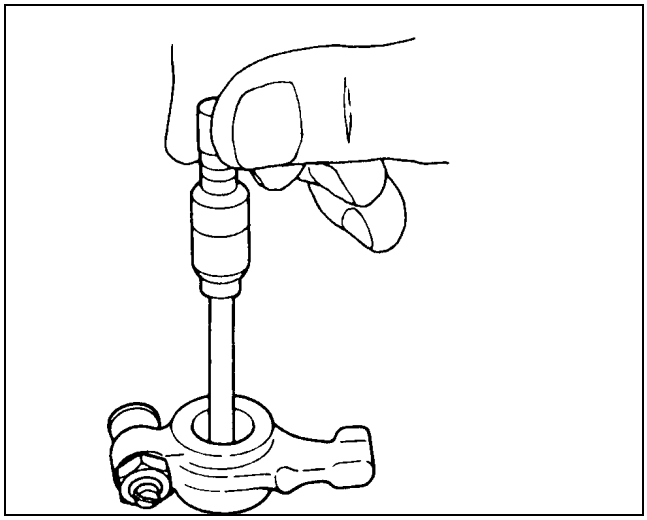
Specifications

Rocker Arm Support Cap Screws Torque 26 N•m (19 lb-ft)

Inspect Rocker Arm Assembly

M35262

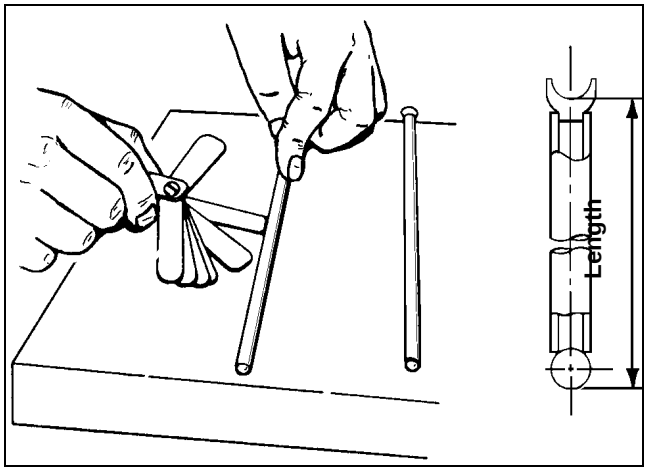
1. Measure the rocker arm shaft OD and compare with specifications. Replace rocker arm shaft if below wear limit.



M82022A

2. Measure the inner diameters of the rocker arms and supports. Compare with specifications. Replace rocker arms or supports if greater than wear limit.

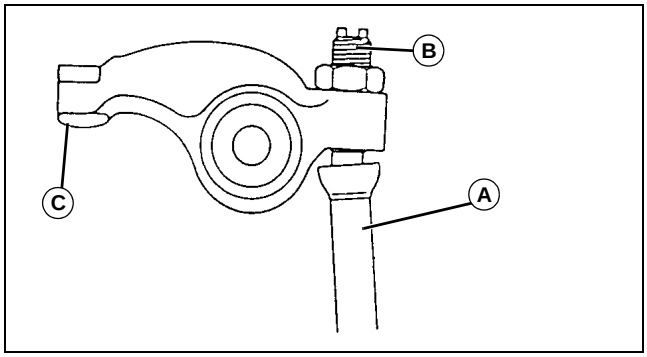
3. Measure the rocker arm shaft to rocker arm bushing oil clearance. Oil clearance is the difference between the OD of the rocker arm shaft and the ID of the rocker arms. If oil clearance is not within specifications, replace parts as necessary.



M82023A

4. Place the push rod on a flat surface. Use a feeler gauge to measure any gaps between the push rod and flat surface. Replace push rod(s) if not within specification.

5. Measure push rod length. If not within specification, replace push rod.



M76398

6. Check the surface of the adjusting screw that contacts the push rod (A) for wear. Replace the adjusting screw (B) if it is worn or damaged.

7. Check the surface (C) of the rocker arm that comes in contact with the valve cap for wear. Replace rocker arm if necessary.

8. Check the socket portion of the push rod where the valve clearance adjusting screw contacts the push rod. Replace the push rod if it is worn or damaged.

Specifications

Rocker Arm Shaft

Rocker Arm Shaft OD 15.97-15.98 mm (0.628-0.629 in.)
Rocker Arm Shaft Wear Limit . . . . 15.94 mm (0.628 in.)

Rocker Arms and Supports

Rocker Arm and Support ID . . 16.00-16.02 mm (0.630-0.631 in.)

Rocker Arm and Support Wear Limit . 16.07 mm (0.633 in.)

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance. . . . . 0.02-0.05 mm (0.001-0.002 in.)

Oil Clearance Wear Limit . . . . . 0.13 mm (0.006 in.)

Push Rods

Maximum Bend . . . . . 0.03 mm (0.001 in.)

Length . . . . . 178.25-178.75 mm (7.018-7.037 in.)

Remove and Install Cylinder Head and Valves

Removal

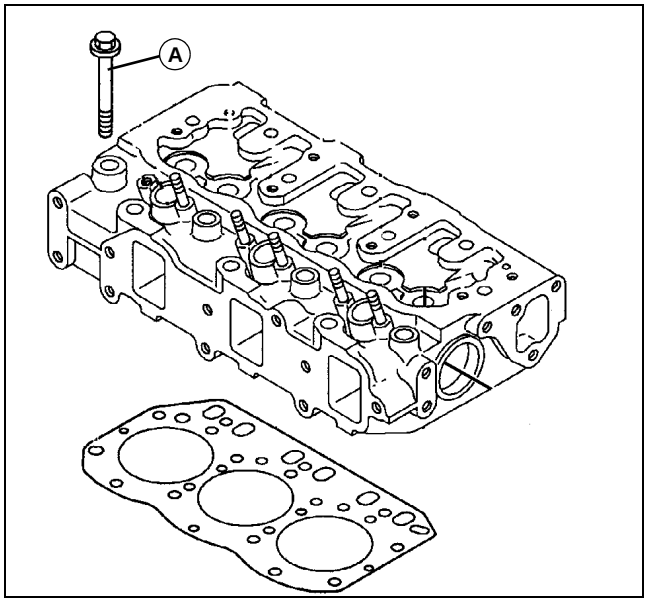
1. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 76.)

2. Remove the rocker arm assembly, push rods and valve caps. (See “Remove and Install Rocker Arm Assembly” on page 77.)

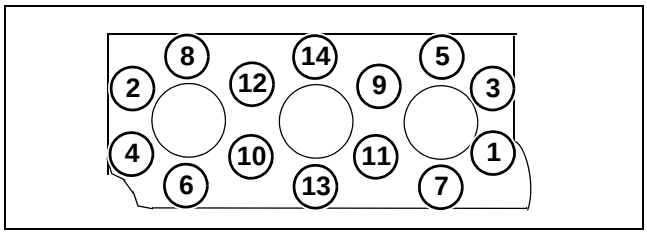
3. Remove the exhaust and intake manifolds. (See “Remove and Install Exhaust Manifold” on page 83. See “Remove and Install Intake Manifold” on page 83.)

4. Remove the coolant pump. (See “Remove and Install Coolant Pump” on page 107.)

5. Remove the fuel injection nozzles. (See “Remove and Install Fuel Injection Nozzles” on page 111.)



M91949A



MIF

6. Remove the cylinder head cap screws (A) in the order shown.

7. Remove the cylinder head from the engine block.

8. Disassemble and inspect the cylinder head and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

Installation

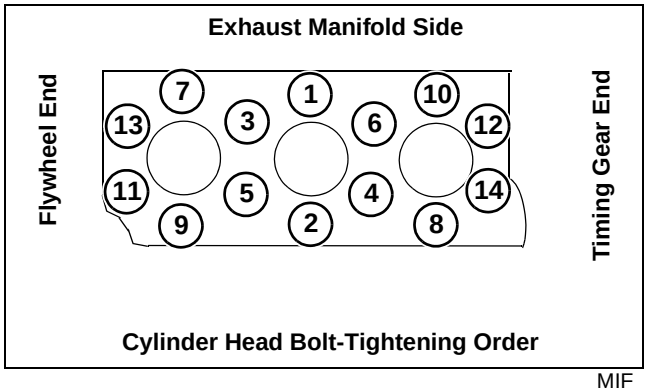
1. Reassemble cylinder head and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 80.)

IMPORTANT: Avoid damage! The oil passage in the gasket must be located over the oil passage in cylinder block.

2. Place a new cylinder head gasket on the engine block. Dowels in the engine block will assist in aligning the gasket.

3. Place the cylinder head on the engine block. Dowels in the engine block will again assist in alignment.

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



MIF

4. Dip the cylinder head cap screws in clean engine oil. Install and tighten in the sequence shown, using the three stages of torque values listed in specifications.

5. Install the fuel injection nozzles.

6. Install the coolant pump.

7. Install the exhaust and intake manifolds.

8. Install rocker arm assembly, push rods and valve caps.

9. Install rocker arm cover.

Specifications

Engine Cylinder Head Cap Screw Torque

Initial Torque . . . . . 44 N•m (33 lb-ft)
Second Torque . . . . . 62 N•m (45 lb-ft)
Final Torque . . . . . 88 N•m (65 lb-ft)

Disassemble and Assemble Cylinder Head and Valves

Removal

1. Remove the valve caps from the valves. The valve caps should be installed on the valves they were removed from.

2. Compress the valve spring using a valve spring compressor and remove the collet halves, retainer, valve spring and valve stem seal for each valve.

3. The intake and exhaust valve guides are press fit. Remove the guides only if necessary.

Installation

IMPORTANT: Avoid damage! Do not reuse stem seals if removed. Used seals will leak.

1. Install new valve stem seals over the valve guides.

2. Apply clean engine oil on intake and exhaust valve stems during assembly.

3. Install the valve springs with smaller pitch end or paint mark toward cylinder head.

4. Compress the valve springs and retainer until the collet halves are able to be installed in the grooves of the valve stem.

5. Carefully release the tension on the spring compressor.

6. Tap on the end of the valve with a plastic hammer to ensure the collet halves have seated properly on the valve stem.

7. Repeat for the remaining valves.

8. Measure valve recession if new valves were installed. (See “Inspect Cylinder Head and Valves” on page 80.)

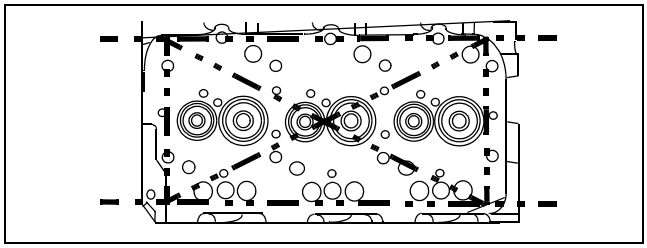
Inspect Cylinder Head and Valves

Special or Required Tools

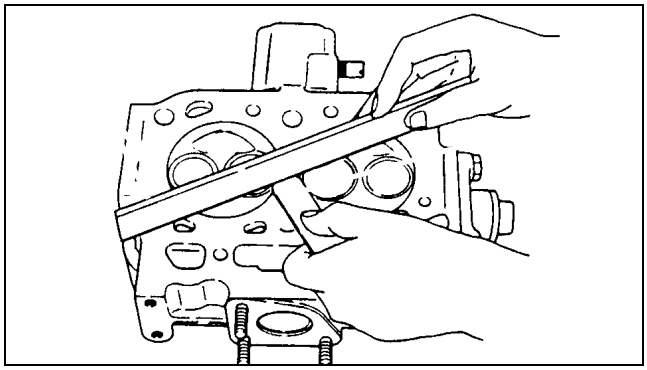
Tool Name	Tool No.	Tool Use
Valve Guide Knurler	D-20019WI	Used to knurl valve guides.
Valve Guide Reamer	D-20021WI	Used to ream valve guides.
Valve Guide Driver	JDE118	Used to install new valve guides.

IMPORTANT: Avoid damage! Before inspection, thoroughly clean all components of carbon or dirt.

Cylinder Head



MIF



M82028A

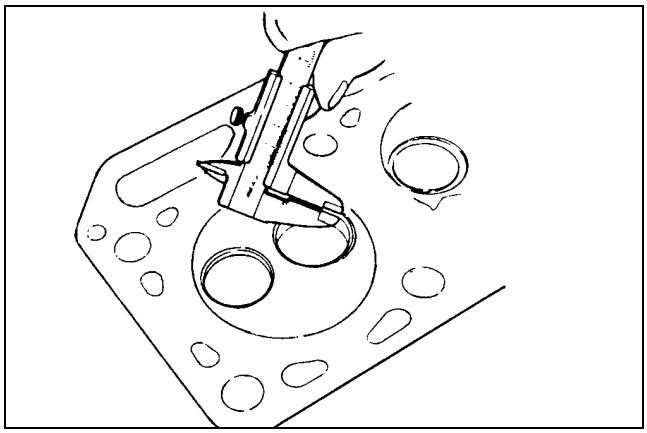
1. To measure cylinder head flatness, place a straightedge along each of the four sides and each diagonal. Measure clearance between straightedge and combustion surface with a feeler gauge and compare with specifications.

2. If the cylinder head was resurfaced:

   - Measure piston-to-cylinder head clearance. (See “Measure Piston-to-Cylinder Head Clearance” on page 85.)
   - Measure valve recession. (See “Inspect Cylinder Head and Valves” on page 80.)
   - Measure valve seat width in this procedure.

Valve Seats

NOTE: The valve seats are not replaceable. If inspection of the cylinder head reveals valve seats that are damaged or worn beyond repair, the cylinder head must be replaced.

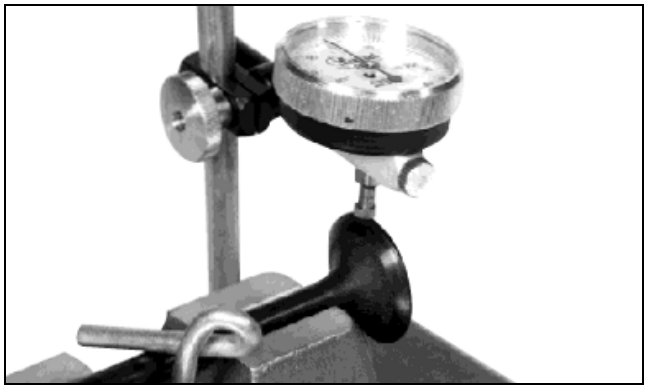


M82029A

1. Measure the valve seat widths and compare with specifications.

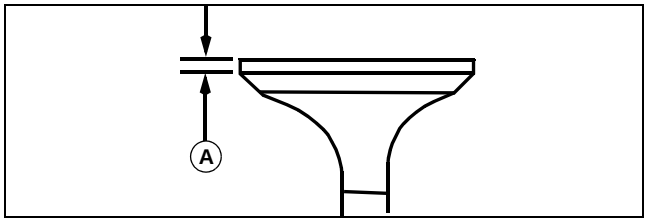
2. If necessary, grind the valve seats to meet specifications. (See “Grind Valve Seats” on page 84.)

Valves



M35307

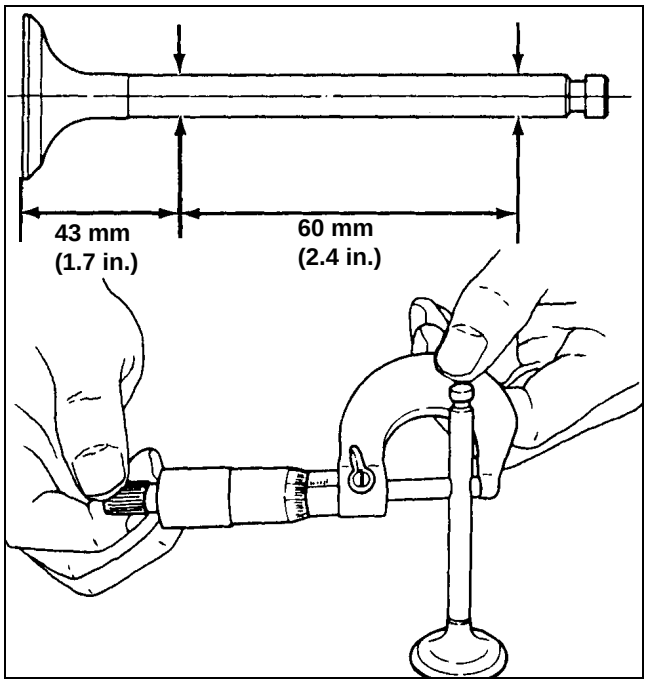
1. Check valves for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



MIF

2. If the valve faces are worn, burned or pitted, grind valves to proper face angle.

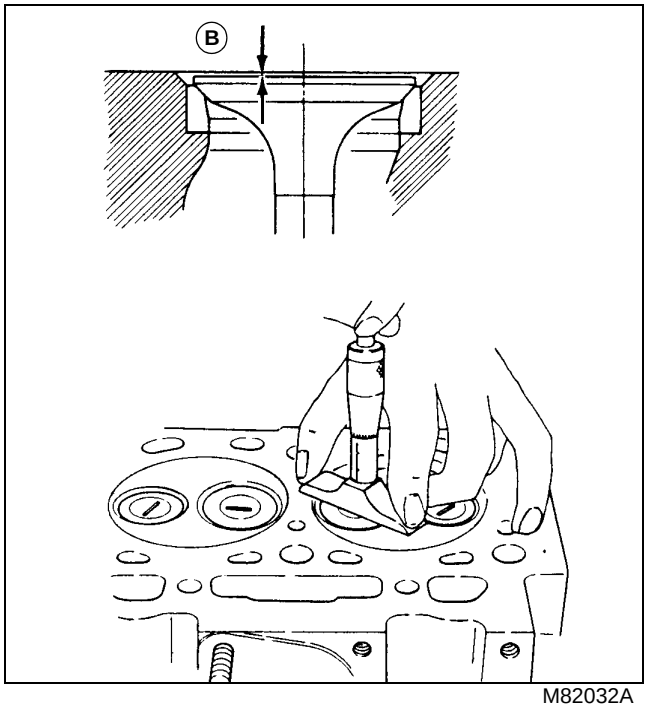
3. Measure valve head thickness (A). If measurement is less than specifications after grinding, replace valve.



M82031A

4. Measure the valve stem diameter at two locations, as shown. If valve stem diameter is less than specifications, replace the valve.

Valve Recession



M82032A

1. Measure valve recession (B) using a depth gauge. If recession is not within specifications, repair or replace parts as needed.

Valve Guides

1. Clean the valve guides using a valve guide brush.

2. Measure the valve guide inside diameter and compare with specifications.

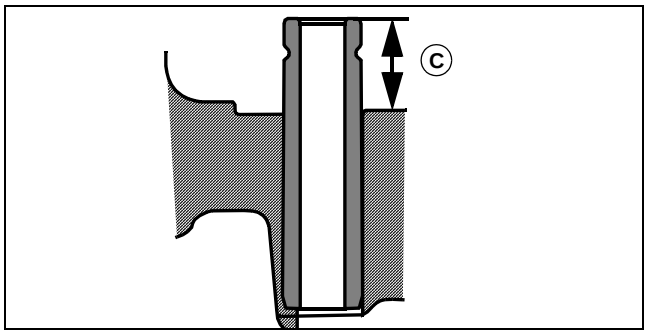
3. Subtract the valve stem OD from the valve guide ID to obtain the oil clearance and compare with specifications.

4. Determine the guide-to-stem oil clearance (guide diameter minus stem diameter).

- If the oil clearance exceeds 0.15 mm (0.006 in.) but is less than 0.20 mm (0.008 in.), knurl the valve guides using D-20019WI Valve Guide Knurler.
- If clearance exceeds 0.20 mm (0.008 in.), replace valve guides using JDE118 Valve Guide Driver.

IMPORTANT: Avoid damage! New valve guides must be cooled in a container of liquid nitrogen, or equivalent, before driving into cylinder head.

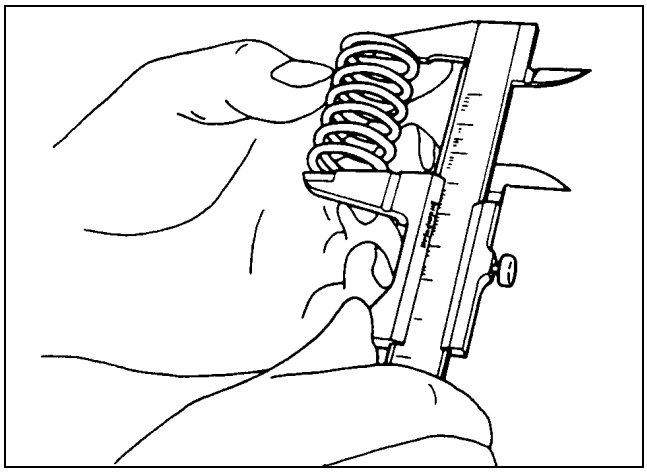
The intake and exhaust valve guides are different. The exhaust valve guide has one groove and the intake valve guide has none.



5. If replacing valve guide, install the valve guides with the tapered ends down. Push the valve guides into the cylinder head until the valve guide projection (C) is within specification.

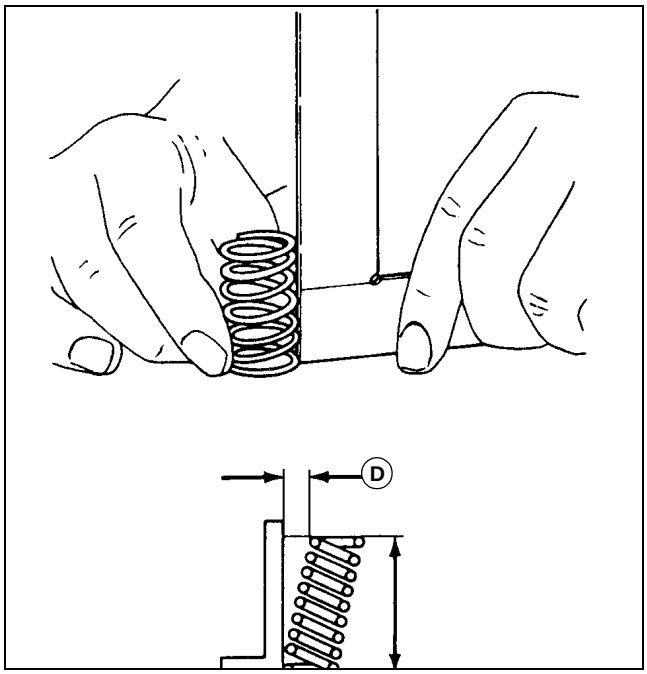
6. Ream the inside diameter of valve guides using D20021WI Valve Guide Reamer.

Springs



M82034A

1. Measure the valve spring free length and compare with specifications.



M82035A

2. Measure the spring inclination (D) and compare with specifications.

Specifications

Cylinder Head

Cylinder Head Flatness (Allowable Distortion Without Resurfacing) . . . . . 0.05 mm (0.002 in.)

Cylinder Head Flatness (Resurface Range). . . 0.00-0.05 mm (0.000-0.002 in.)

Wear Limit . . . . . 0.15 mm (0.006 in.)

Cylinder Head Flatness (Maximum Distortion) 0.15 mm (0.006 in.)

Valve Seats

Intake Valve Seat Width . . . . . 1.77 mm (0.070 in.)
Wear Limit . . . . . 2.27 mm (0.089 in.
Exhaust Valve Seat Width . . . . . 1.34 mm (0.053 in.)
Wear Limit . . . . . 1.84 mm (0.072 in.)

Valves

Valve Head (Minimum Thickness) . . 0.50 mm (0.020 in.)
Intake and Exhaust Valve Stem OD . . . . . 7.96-7.97 mm (0.3134-0.3138 in.)
Wear Limit . . . . . 7.90 mm (0.311 in.)

Valve Recession

Valve Recession . . . . . 0.30-0.50 mm (0.012-0.020 in.)
Wear Limit . . . . . 0.08 mm (0.039 in.)

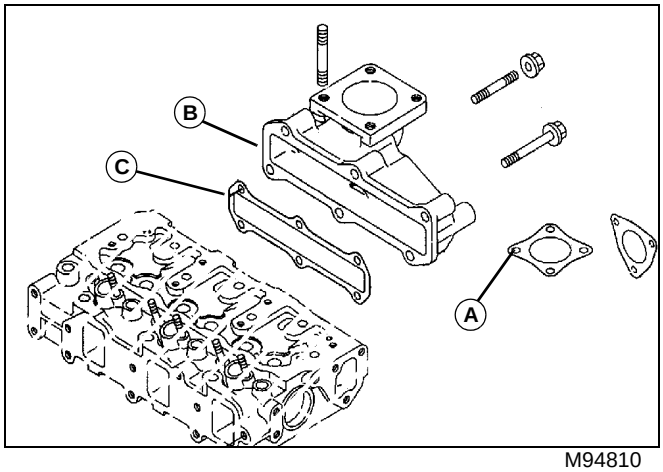
Valve Guides

Valve Guide ID. . . . . 8.010-8.025 mm (0.3154-0.3160 in.)
Wear Limit . . . . . 8.10 mm (0.319 in.)
Oil Clearance. . . . . 0.035-0.070 mm (0.001-0.003 in.)
Valve Guide Projection. . . . . 15 mm (0.591 in.)

Springs

Valve Spring Free Length . . . . . 44.4 mm (1.748 in.)
Wear Limit . . . . . 43.90 mm (1.730 in.)
Spring Inclination (3TNV84). . . . . 1.20 mm (0.047 in.)
Spring Inclination (3TNV84T) . . . . . 1.40 mm (0.055 in.)

Remove and Install Exhaust Manifold



M94810

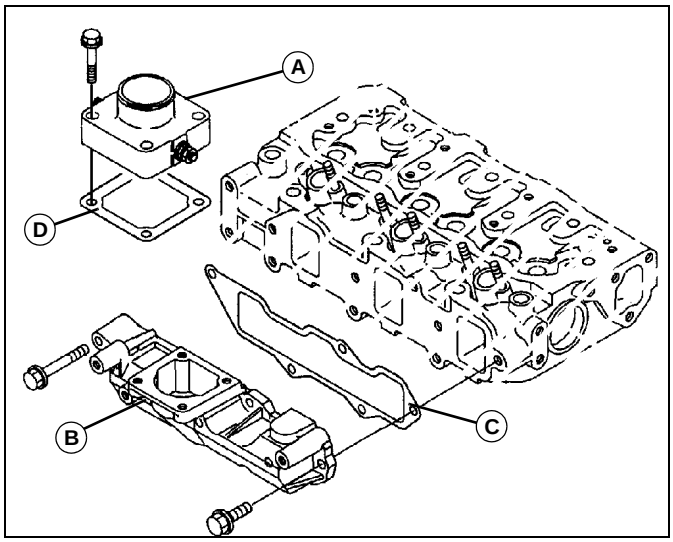
Picture Note: Model 3235C Shown

1. Remove the muffler and gasket (A).
2. Remove the exhaust manifold (B) and gasket (C).
3. Clean the mating surfaces and replace the exhaust manifold gasket.
4. Install the exhaust manifold. Tighten all fasteners to specification.

Specifications

Exhaust Manifold Cap Screws and Nuts . . . . . 26 N•m (19 lb-ft)

Remove and Install Intake Manifold



M94811

Picture Note: Model 3235C Shown

1. Remove the fuel filter bracket (not shown).
2. Remove the intake air heater (A).
3. Remove the fuel injection lines (not shown).
4. Remove the intake manifold (B).
5. Clean the mating surfaces and replace the intake manifold gasket (C).
6. Install the intake manifold.
7. Replace the intake air heater gasket (D), and install the intake air heater.
8. Install the fuel injection lines.
9. Tighten all fasteners to specification.

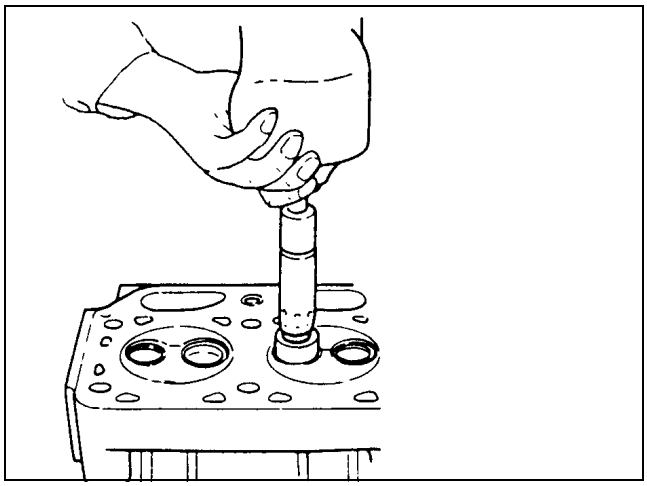
Specifications

Intake Manifold Cap Screws . . . . . 26 N•m (19 lb-ft)

Grind Valve Seats

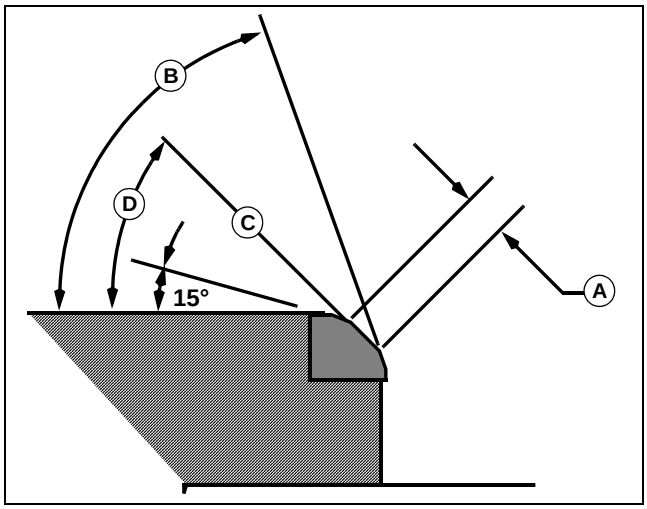
NOTE: LIGHTLY grind the valve seats for only a few seconds to avoid excessive valve seat width.

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



M82039A

2. Measure the valve seat width after grinding and compare with specifications.



MIF

3. If the seat width (A) is too wide after grinding, grind the lower seat surface (B) using a 70° seat grinder until the seat width is close to specifications.

4. Grind the upper seat surface (C) using a 15° seat grinder until the seat width is narrowed to specifications.

5. If the valve seats (D) are ground, measure valve recession. (See "Inspect Cylinder Head and Valves" on page 80.) Check the contact pattern between the seat and valve with bluing dye.

6. Lap the valves. (See "Lap Valves" on page 84.)

If the valve recession exceeds the maximum specifications or the seats cannot be reconditioned, replace the valves or the cylinder head.

Specifications

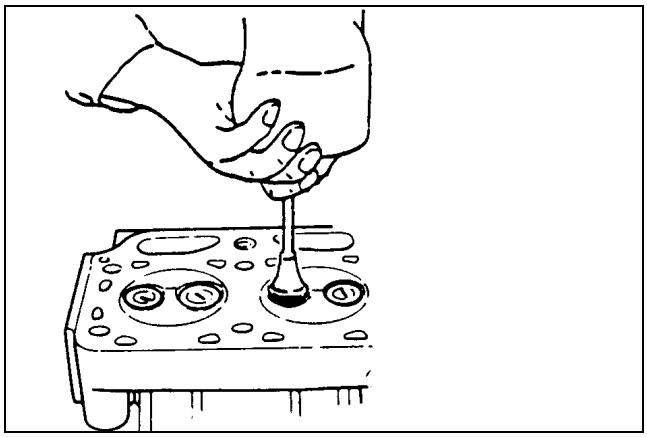
Valve Seats

Intake Valve Seat Width	**1.77 mm (0.070 in.)**
Wear Limit	**2.27 mm (0.089 in.)**
Exhaust Valve Seat Width	**1.34 mm (0.053 in.)**
Wear Limit	**1.84 mm (0.072 in.)**

Lap Valves

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

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



M82041A

1. Apply a small amount of fine lapping compound to the face of the valve.

2. Turn the valve to lap the valve to the seat.

3. Lift the valve from the seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.

4. Wash all parts in solvent to remove lapping compound. Dry all parts.

5. Check the position of the lap mark on the valve face. Lap marks must be on or near the center of the valve face.

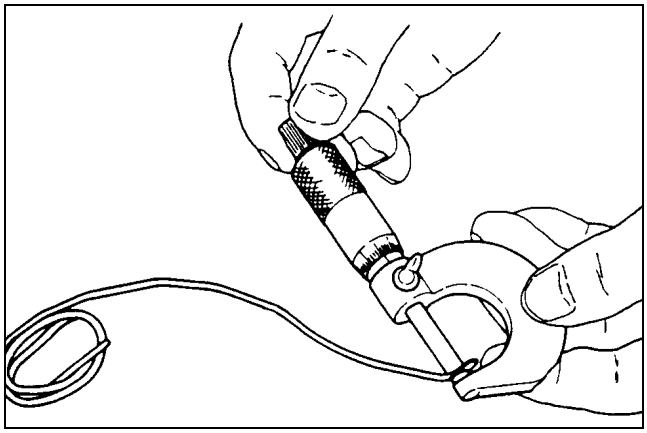
Measure Piston-to-Cylinder Head Clearance

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 bolts and tighten in proper sequence. (See “Remove and Install Cylinder Head and Valves” on page 79.)

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.

- If the clearance is less than specification, replace cylinder head.

Specifications

Piston-to-Cylinder Head Clearance . . . 0.72 ± 0.06 mm (0.025 ± 0.002 in.)

Remove and Install Piston and Connecting Rod

Removal

1. Remove the oil pan and oil pickup tube.

2. Remove the cylinder head. (See “Remove and Install Cylinder Head and Valves” on page 79.)

3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.

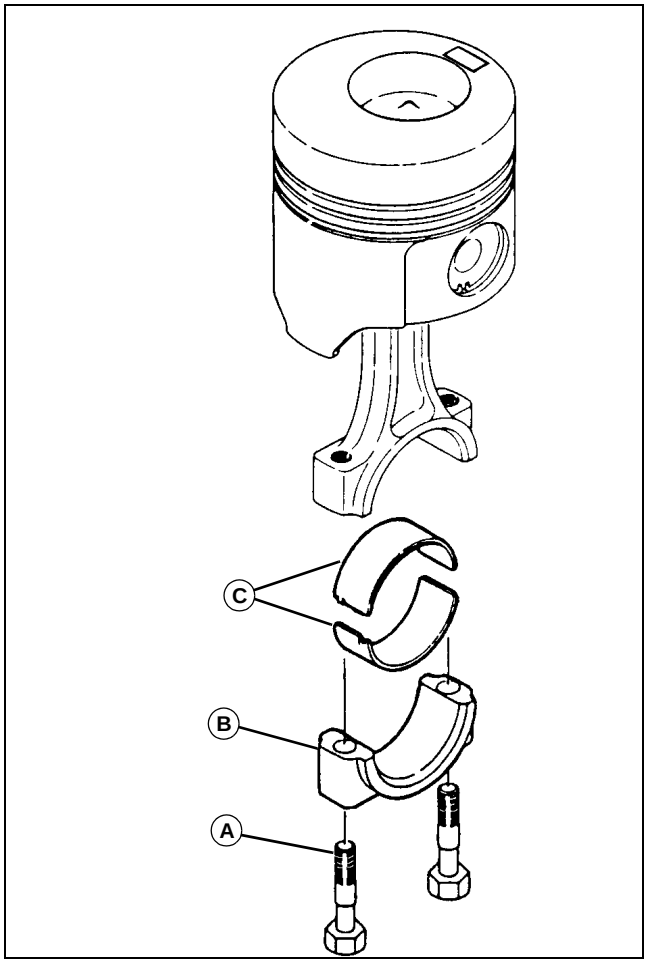
4. If necessary, remove any ridge from the top of the cylinder bore using a ridge reamer.

5. Measure the connecting rod side play. (See “Check Connecting Rod Side Play” on page 56.)

6. Measure the crankshaft end play. (See “Check Crankshaft End Play” on page 58.)

7. Measure the connecting rod bearing clearance. (See “Check Connecting Rod Bearing Clearance” on page 57.)

IMPORTANT: Avoid damage! Keep the connecting rods and rod caps together. Rods and caps are a matched set. Note the alignment marks on each part.



M82196AB

8. 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 were removed.

9. Note the connecting rod alignment mark in relation to the cylinders. Starting at the flywheel end with cylinder No. 1, then No. 2, etc.

10. Push the piston and connecting rod out of the cylinder bore using a wooden dowel.

11. Disassemble and inspect all parts for wear or damage.

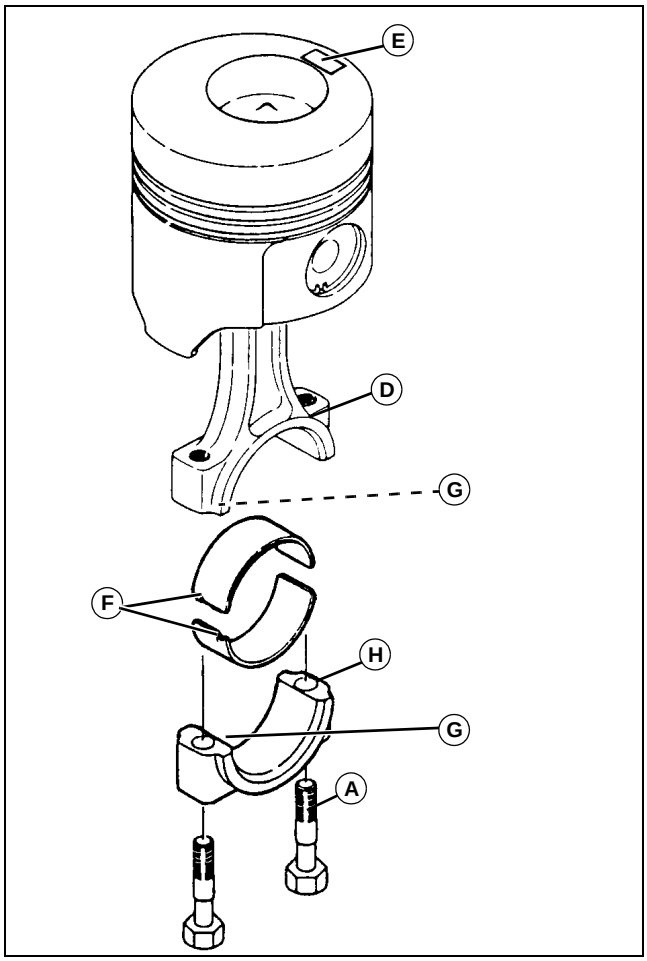
12. Inspect the cylinder bore. (See “Inspect Cylinder Bore” on page 91. See “Inspect Cylinder Bore Taper and Out-of-Round” on page 92.)

Installation

- Apply clean engine oil to all parts during installation.
- Always replace the connecting rod cap screws. DO NOT reuse the cap screws.

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.

1. Assemble the piston and connecting rod. (See "Disassemble and Assemble Piston and Connecting Rod" on page 87.)



M82196AB

2. Install the piston and connecting rod into the cylinder from which it was removed. The alignment mark on the connecting rod (D) and/or the piston size mark (E) 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.

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

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

4. Match the connecting rods to caps using alignment marks (H). Install the rod caps.

5. Dip the entire connecting rod cap screw in clean engine oil. Install new cap screws (A) and tighten to specification.

6. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.

7. Install the cylinder head.

8. Install oil pan and oil pickup tube.

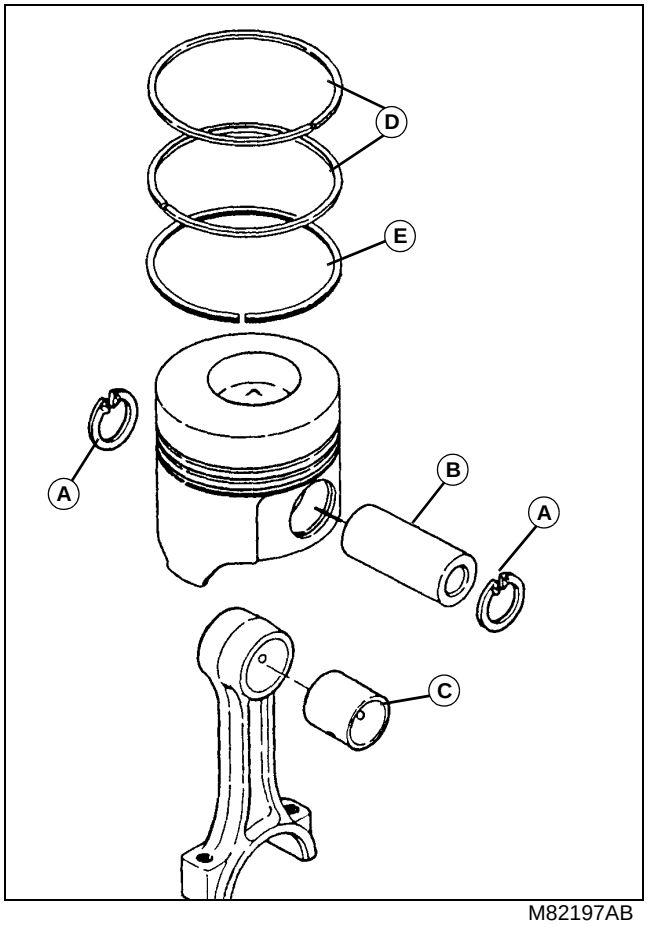
Specifications

Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)

Disassemble and Assemble Piston and Connecting Rod

Disassemble

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



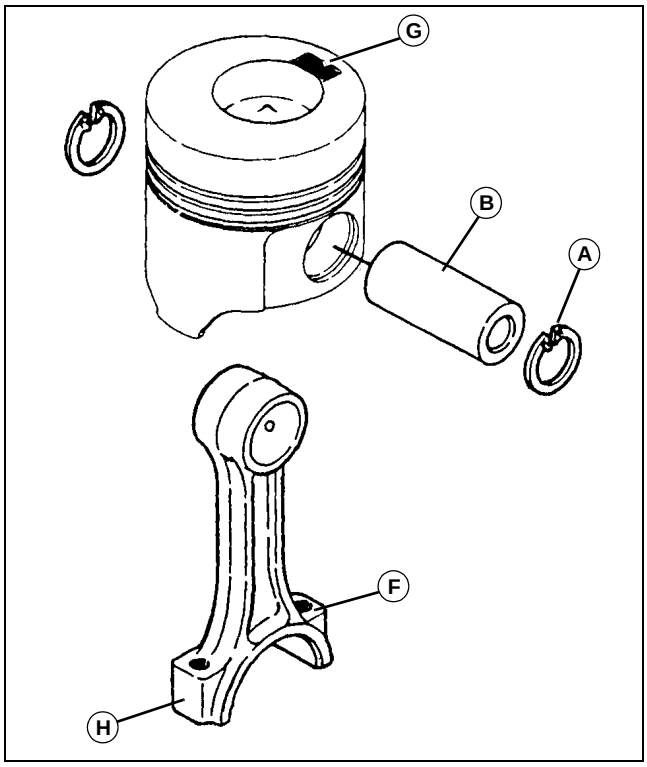
M82197AB

- Put a mark on each piston and connecting rod to aid in assembly.
- Remove snap rings (A) from piston pin (B) and remove pin.
- The piston pin bushing (C) is a press fit in the connecting rod. Remove the bushing only if replacement is necessary.
- Inspect all parts for wear or damage. Replace as necessary.
- Remove the 1st and 2nd compression rings (D) and oil ring with expander (E).

Assemble

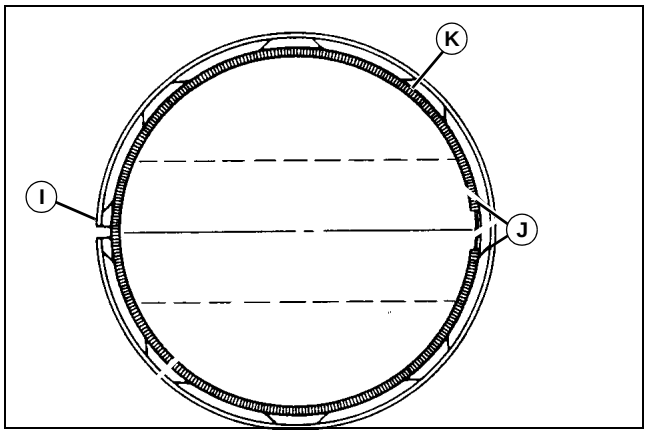
- Apply clean engine oil to all parts during assembly.

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



M82198AB

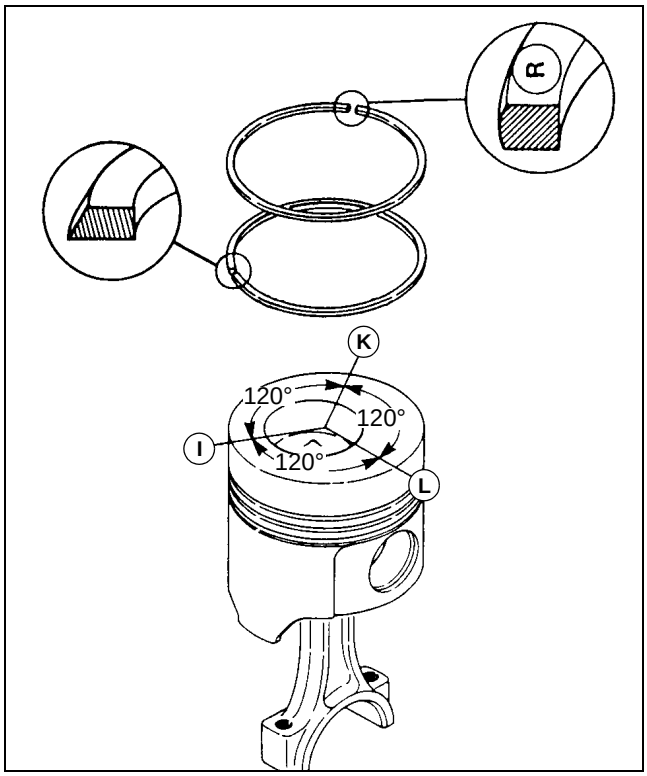
1. Assemble the piston to the connecting rod with piston mark (G) on the same side as the connecting rod stamped mark (F). If a new connecting rod is used, assemble the piston to the connecting rod with piston mark opposite the connecting rod bearing insert groove (H). Be sure the oil hole in the piston pin bushing is aligned with the hole in the connecting rod.
2. Install the piston pin (B) and retaining rings (A).
3. Install an oil ring expander (E) in the bottom ring groove of the piston, with the ends above either end of the piston pin.



M82046A

4. Install the oil ring over the expander with the ring gap (I) opposite (180°) of the expander ends (J).

5. Install the second compression ring, with the small diameter of taper toward top of piston, in the middle groove. Turn the ring until the gap (K) is 120° away from the oil ring gap (I).



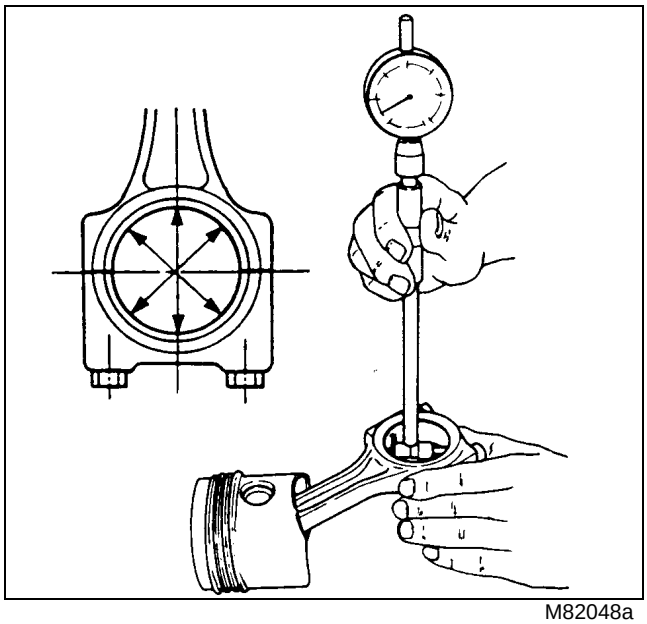
M82199A

6. Install the first compression ring (chrome plated), with the manufacturer's mark “R”, “T” or “RN” (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the gap (L) is 120° away from the second ring gap (K) and 120° away from the oil ring gap (I).

Inspect Piston and Connecting Rod

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.



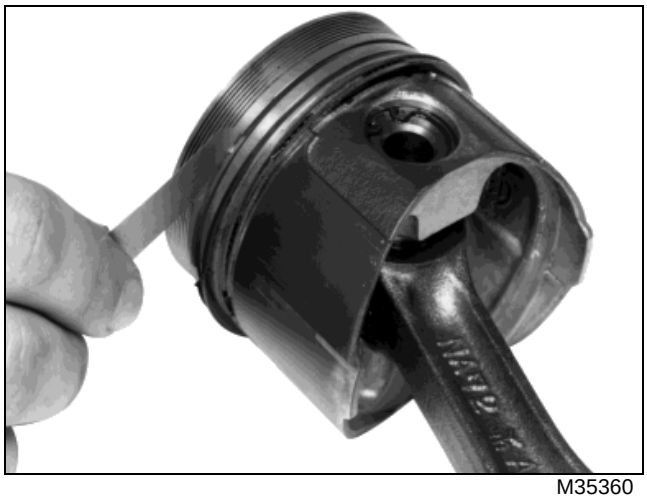
M82048a

2. Measure the connecting rod bearing inside diameter and compare with specifications. Replace bearing if bearing ID is greater than wear limit.

3. Measure the oil clearance between the bearing inserts and the crankshaft. Compare measurement with 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.

Piston Ring Groove Clearance

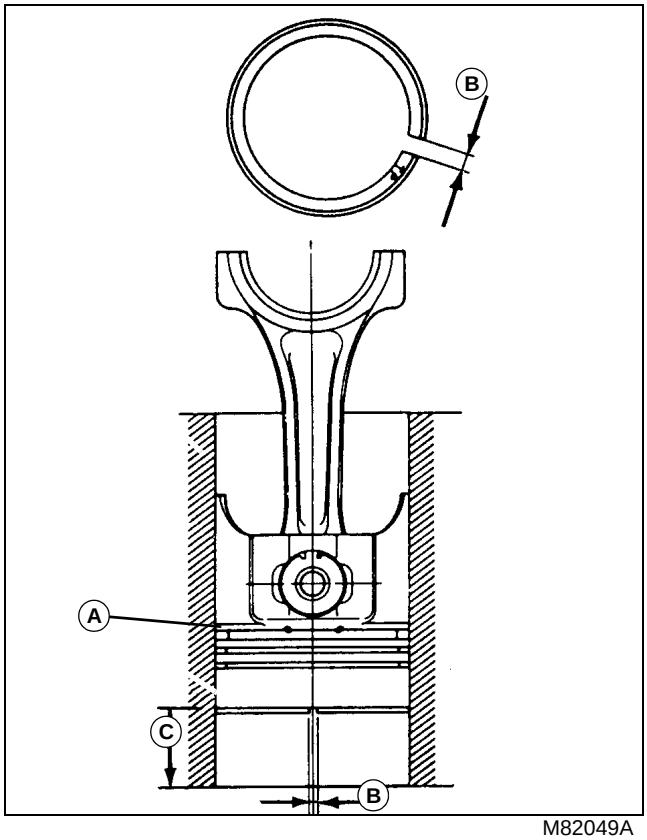


M35360

1. With the rings installed on the piston, measure the piston ring groove side clearance. Measure at several places around each piston and compare with specification.

2. Replace the rings or the piston if the clearances exceed specification.

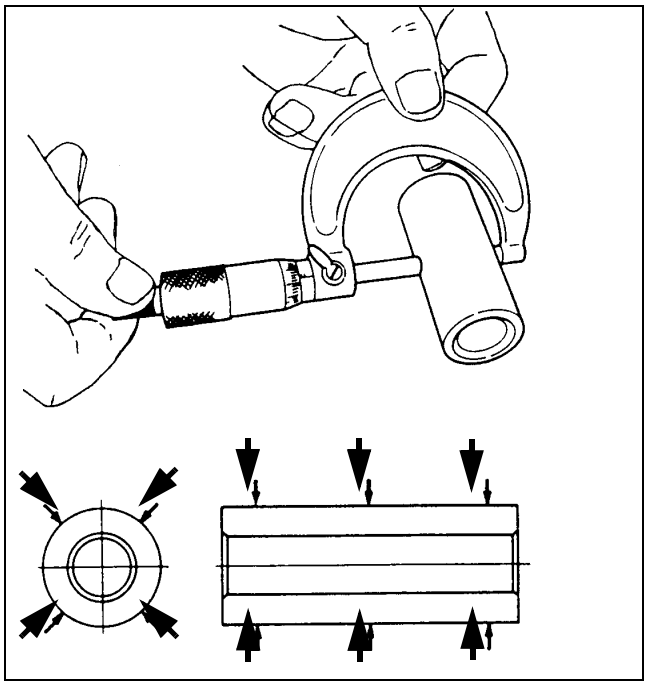
Piston Ring End Gap



M82049A

1. Use a piston to push the ring (A) approximately 30 mm (1.18 in.) (C) from the bottom of the cylinder bore. Measure the piston ring end gap (B) and compare with specifications.

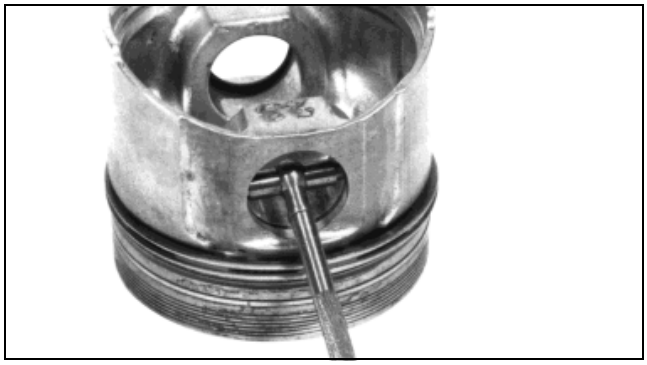
Piston Pin Diameter



M82050A

1. Measure the piston pin diameter at six places and compare with specifications. Replace any pin that is not within specification.

Piston Pin Bore



M37683

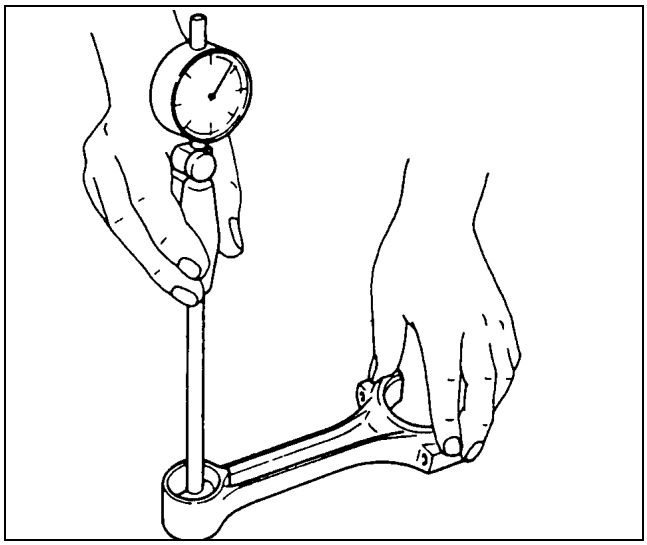
1. Measure the pin bore diameter in the piston and compare with specifications.

2. Piston pin-to-piston oil clearance is the bore ID minus the pin OD. Compare piston pin-to-piston clearance with specifications.

- If the piston pin bore exceeds the wear limit, replace the piston.
- If the piston pin is less than the wear limit, replace the piston pin.
- If the bore clearance 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.



M82051A

1. Measure the piston pin bushing diameter in the connecting rod and compare with specifications.

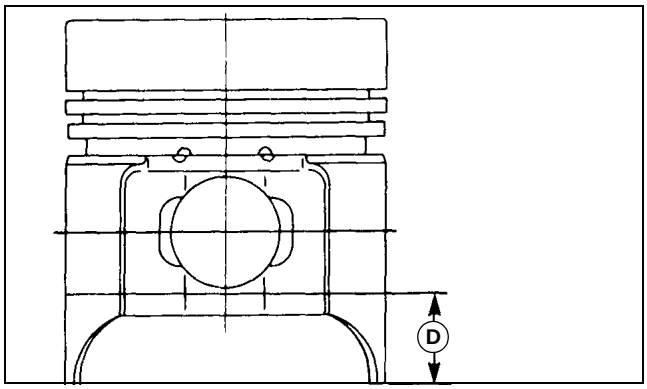
   • If the bushing diameter exceeds the wear limit, replace bushing.

2. Piston pin-to-rod bore oil clearance is the bore ID minus the pin OD.

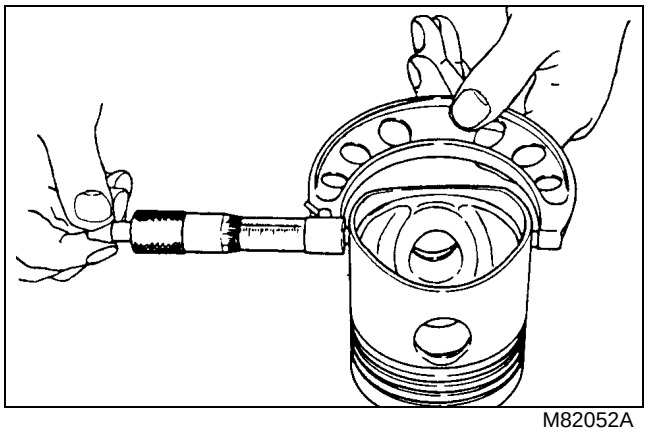
   • If the bushing clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

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.



M82200A



M82052A

1. Measure the piston diameter perpendicular to the piston pin bore 23 mm (0.905 in.) (D) from the bottom of the piston skirt and compare with specifications.

• If piston diameter is less than wear limit, install a new piston.

Specifications

Connecting Rod Bearing

Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)
Bearing ID . . . . . 47.95-47.96 mm (1.888-1.891 in.)
Wear Limit . . . . . 48.07 mm (1.893 in.)
Bearing Oil Clearance 0.038-0.074 mm (0.001-0.003 in.)

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance 0.075-0.11 mm (0.003-0.004 in.)
Wear Limit . . . . . 0.025 mm (0.010 in.)
Second Compression Ring Groove Side Clearance . . . . 0.045-0.080 mm (0.002-0.003 in.)
Wear Limit . . . . . 0.025 mm (0.010 in.)
Oil Control Ring Groove Side Clearance . . . 0.025-0.060 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.020 mm (0.008 in.)

Piston Ring End Gap

Piston Ring End Gap . . . 0.20-0.40 mm (0.008-0.016 in.)
Wear Limit . . . . . 1.50 mm (0.059 in.)

Piston Pin Diameter

Wear Limit . . . . . 22.90 mm (0.902 in.)
Piston Pin OD . . . . . 25.99-26.00 mm (1.023-1.024 in.)
Wear Limit . . . . . 25.97 mm (1.022 in.)

Piston Pin Bore

Piston Pin Bore ID . 26.00-26.01 mm (1.0236-1.0240 in.)
Wear Limit . . . . . 26.04 mm (1.025 in.)
Piston Pin-to-Piston Oil Clearance 0.00-0.02 mm (0.00-0.001 in.)
Wear Limit . . . . . 0.12 mm (0.005 in.)

Piston Pin Bushing

Piston Pin Bushing ID . . . . 26.025-26.038 mm (1.0246-1.0251 in.)
Wear Limit . . . . . 26.07 mm (1.026 in.)
Piston Pin-to-Rod Bore Oil Clearance . . . 0.03-0.05 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.10 mm (0.004 in.)

Piston

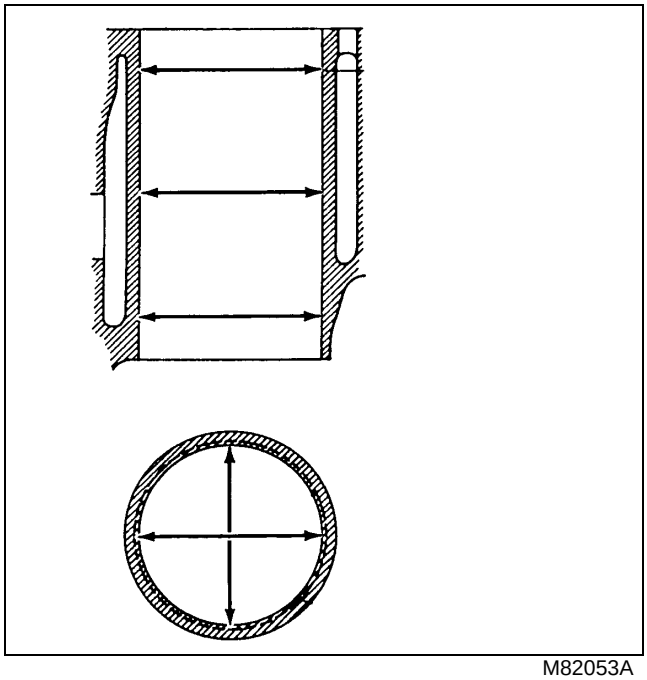
Standard Piston OD . . 83.95-83.98 mm (3.305-3.306 in.)
Wear Limit . . . . . 83.90 mm (3.303 in.)
Oversize Piston OD . . 84.20-84.23 mm (3.315-3.316 in.)
Wear Limit . . . . . 84.10 mm (3.311 in.)

Inspect Cylinder Bore

NOTE: If the 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.

Cylinder Bore Diameter

NOTE: Slight uneven wear, flaws, or minor damage may be corrected by deglazing.



M82053A

1. Measure the cylinder bore diameter at three positions: top, middle and bottom. At these three positions, measure in both directions: along the crankshaft centerline and the direction of the crankshaft rotation. Compare measurements with specifications.

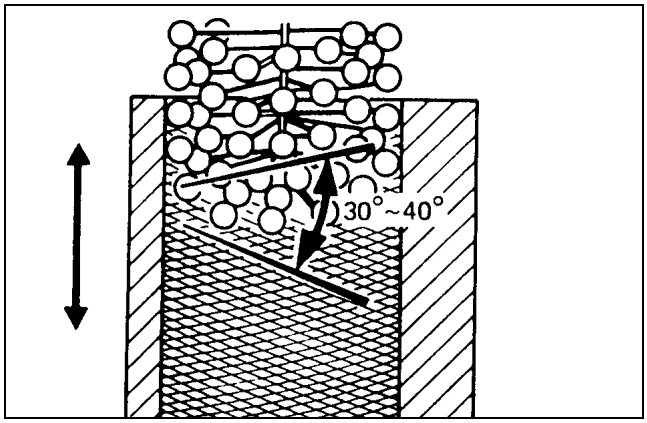
- If the cylinder bore standard ID exceeds the wear limit, have the cylinder rebored.
- If the cylinder is rebored, oversize pistons and rings must be installed.
- If the cylinder bore exceeds the oversize bore ID, replace the cylinder block.

2. Determine piston-to-cylinder bore clearance (cylinder bore ID minus piston OD). If piston-to-cylinder bore clearance exceeds specifications, replace the cylinder block, piston, or both, or rebore cylinder and install oversize piston and rings.

Deglazing

IMPORTANT: Avoid damage! If the 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 the cylinder bores using a flex-hone with 180 grit stones.



M82054A

2. Use the flex-hone as instructed by the 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 the cylinder walls using a clean dry rag. Clean the cylinder walls using clean white rags and warm soapy water. Continue to clean the 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.

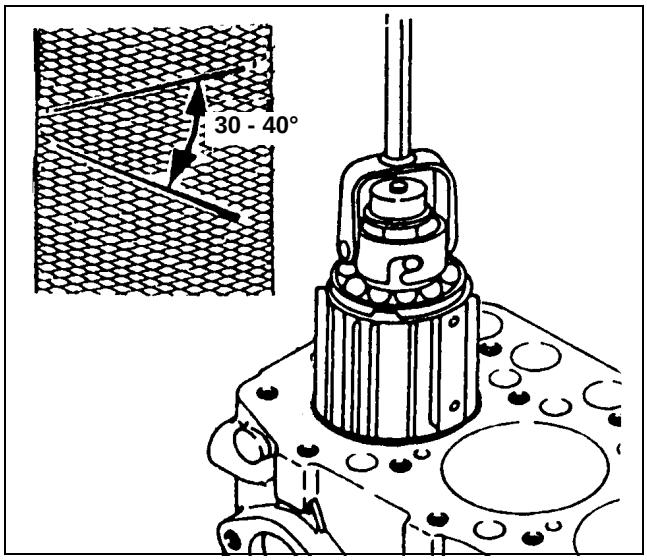
1. Align the center of bore to the drill press center.

IMPORTANT: Avoid damage! Check stone for wear or damage. Use a rigid hone with 300-grit stones.

2. Adjust the hone so the lower end is even with the lower end of cylinder bore.

3. Adjust the rigid hone stones until they contact the narrowest point of the cylinder.

4. Coat the cylinder with honing oil. The hone should turn by hand. Adjust the hone if it is too tight.



M52959

5. Run the drill press at about 250 rpm. Move the hone up and down in order to obtain a 30-40° crosshatch pattern.

NOTE: Measure the bore when the cylinder is cool.

6. Stop the press and check the cylinder diameter.

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

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

8. Use a flex-hone with 180-grit stones for honing to final size.

9. Check the bore for size.

10.Check bore for taper and out-of-round. (See “Inspect Cylinder Bore Taper and Out-of-Round” on page 92.)

IMPORTANT: Avoid damage! Do not use solvents to clean the cylinder bores. Solvents will not remove all the metal particles and abrasives produced during honing.

11.Clean the cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

12.Dry the cylinder and apply engine oil.

Specifications

Cylinder Bore

Standard Cylinder Bore ID 84.00-84.03 mm (3.307-3.308 in.)
Wear Limit. . . . . 84.20 mm (3.315 in.)
Oversize Cylinder Bore ID 84.25-84.28 mm (3.317-3.318 in.)
Wear Limit. . . . . 84.45 mm (3.325 in.)
Piston-to-Cylinder Bore Clearance. . . . 0.040-0.070 mm (0.001-0.003 in.)

Inspect Cylinder Bore Taper and Out-of-Round

1. Use a cylinder dial gauge and inside micrometer, or a telescope gage and outside micrometer, to measure cylinder bore.

2. Measure the bore parallel to the crankshaft at the top end of the ring travel zone.

3. Measure the bore in the same position at the bottom end of the ring travel zone.

4. Measure the bore at right angles to the crankshaft at the top end of the ring travel zone.

5. Measure the bore in the same position at the bottom end of the ring travel zone.

6. Compare measurements from steps 2 and 4 to find the out-of-round wear at the top end of the bore.

7. Compare measurements from steps 3 and 5 to find the out-of-round wear at the bottom end of the bore.

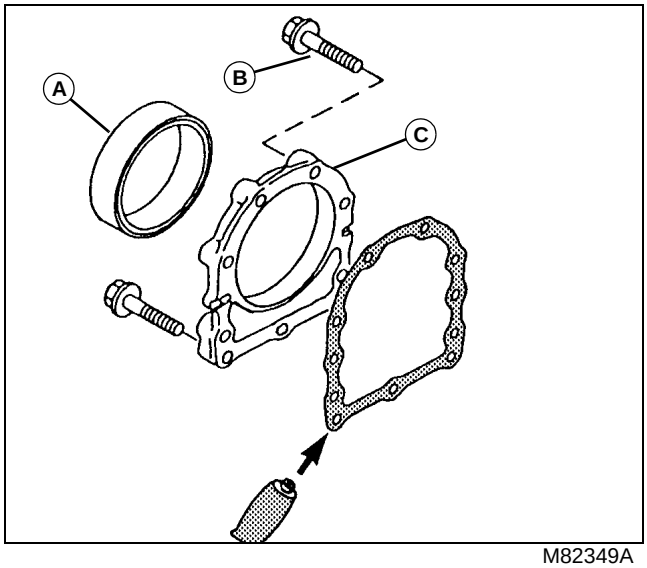
8. Compare results of measurements from steps 2, 3, 4 and 5 to find out whether or not the bore has worn tapered.

Specifications

Cylinder Roundness . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit. . . . . 0.03 mm (0.001 in.)
Cylinder Taper . . . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit. . . . . 0.03 mm (0.001 in.)

Replace Crankshaft Rear Oil Seal

1. Remove flywheel. (See “Remove and Install Flywheel” on page 96.)



M82349A

2. Remove the rear oil seal (A), case-to-crankcase extension cap screws and the oil seal case-to-crankcase cap screws (B).

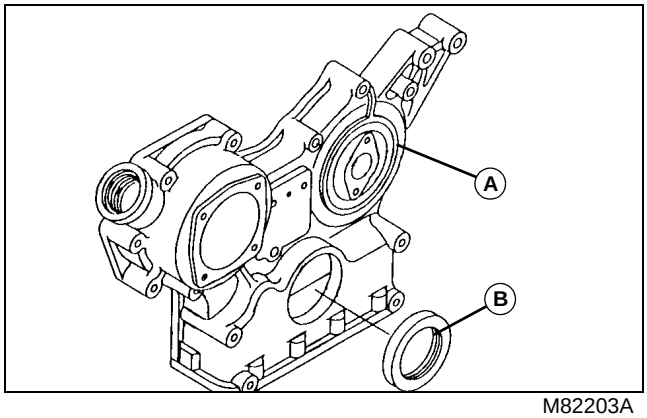
3. Remove the rear oil seal case (C).

4. Replace the oil seal using an appropriate seal driver, with the lip toward the cylinder block, flush with the surface of the oil seal case.

NOTE: If the crankshaft is grooved at the oil seal contact point, the seal can be installed 3 mm (0.12 in.) farther into the oil seal case.

5. Install the oil seal case to the crankcase and crankcase extension.

Replace Crankshaft Front Oil Seal



M82203A

1. Remove the timing gear cover (A). (See “Remove and Install Timing Gear Cover” on page 101.)

2. Replace the oil seal (B). Install new seal with the lip toward inside of gear housing cover, flush with the surface of the cover.

Remove and Install Crankshaft and Main Bearings

Removal

1. Check the crankshaft end play. (See “Check Crankshaft End Play” on page 58.)

2. Remove the cylinder head. (See “Remove and Install Cylinder Head and Valves” on page 79.)

3. Remove rear oil seal. (See “Replace Crankshaft Rear Oil Seal” on page 93.)

4. Remove timing gear cover mounting plate. (See “Remove and Install Timing Gear Cover Mounting Plate” on page 103.)

5. Check the crankshaft rod bearing clearance. (See “Check Connecting Rod Bearing Clearance” on page 57.)

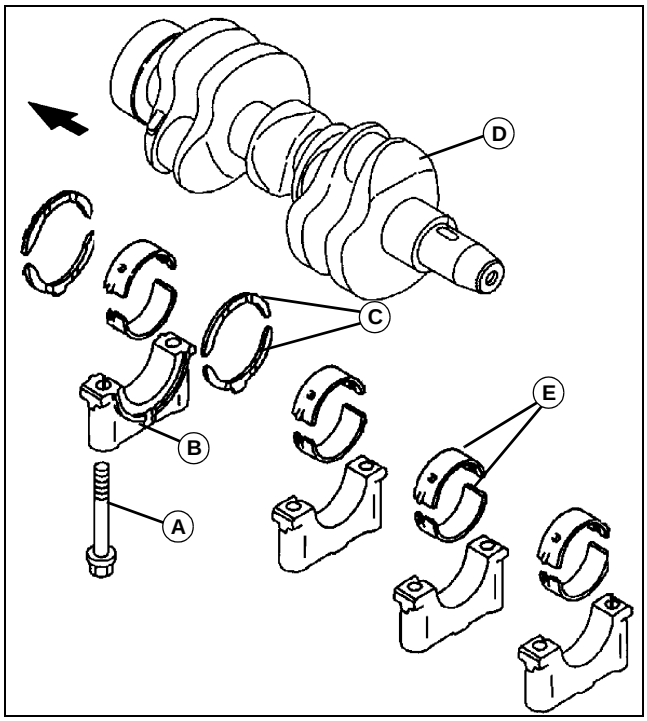
IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rods from which they were removed. Note the alignment marks on the caps and rods.

6. Check the crankshaft main bearing clearance. (See “Check Crankshaft Main Bearing Clearance” on page 58.)

IMPORTANT: Avoid damage! Main bearing caps must be installed on the same main bearings from which they were removed.

7. Remove the connecting rod cap screws and rod caps. Discard the connecting rod cap screws.

8. Push the pistons and connecting rods away from crankshaft.



M91948C

9. Remove the main bearing cap screws (A), main bearing caps (B) and thrust bearings (C).

10.Remove the crankshaft (D).

11.Remove the block thrust bearings and main bearing inserts (E).

12.Inspect all parts for wear or damage.

Installing

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

1. Apply clean engine oil to all parts during installation.

2. Install the grooved bearing inserts in the crankshaft bearing bores, aligning the tangs with the slots in the bores.

3. Install the thrust bearings with the oil grooves facing away from the engine block.

4. Install the crankshaft.

5. Install the bearing inserts in the main bearing caps, aligning the tangs with the slots in the caps.

NOTE: The main bearing caps have raised arrows that are stamped with numbers. Both correspond to their location on the engine block. Install all bearing caps with the arrow toward the flywheel end of the engine. Install the bearing caps, beginning with the thrust bearing cap (no number), number 1, then 2, etc. The main bearing cap at the gear train end does not have a number.

6. Install the thrust bearings, with the oil grooves facing away from the cap, in the number 1 main bearing cap.

7. Install the main bearing caps in their original locations with arrows pointing toward the flywheel side of the engine.

IMPORTANT: Avoid damage! DO NOT use high-speed power tools or air wrenches to tighten main bearing cap screws.

8. Dip each main bearing cap screw entirely in clean engine oil. Install the cap screws but do not tighten.

9. Using a soft-faced hammer, tap the front end of the crankshaft, then the rear end of the crankshaft, to align the thrust bearings.

10.Tighten the main bearing cap screws to specification. When tightening, start at the center main bearing cap and work your way out, alternating to the ends. Turn the 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 they were removed from.
Never reuse connecting rod cap screws; replace with new.

11.Match the connecting rod caps to the rods using alignment marks. Install the caps to the rods.

12.Dip entire connecting rod cap screw in clean engine oil. Install new cap screws and tighten to specification. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

13.Install the timing gear cover mounting plate.

14.Install the rear oil seal.

15.Install the flywheel.

16.Install the timing gear cover.

17.Install the front oil seal.

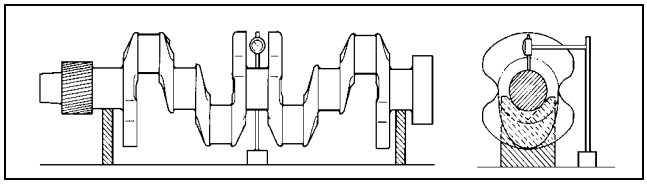
18.Install the oil pan.

Specifications

Main Bearing Cap Screw Torque . . . . . 98 N•m (72 lb-ft)
Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)

Inspect Crankshaft and Main Bearings

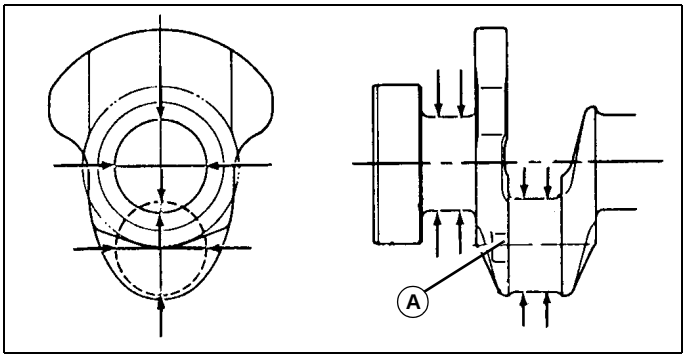
1. Inspect the crankshaft gear for chipped or broken teeth. Replace if necessary.



M82061A

2. Inspect the crankshaft for bend using V-blocks and a dial indicator. Turn the crankshaft slowly and read variations on the indicator. If the variation is greater than specification, replace the crankshaft.

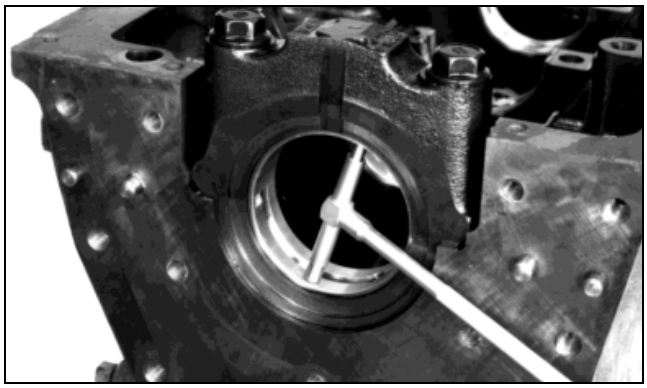
3. Measure the crankshaft connecting rod journal and main bearing journal diameters at several places around each journal.



M82062A

- If the journal diameter (A) is less than the specification, but greater than the wear limit, have the journals ground undersize by a qualified machine shop.
- If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.
- If the journal diameter is less than the wear limit, replace the crankshaft.

4. Install the bearing inserts and main bearing caps on the main bearings. Tighten the main bearing cap screws to specification.



M82063

5. Measure the main bearing inner diameter.

6. Subtract the main bearing journal OD of the crankshaft from the main bearing ID to obtain the main bearing oil clearance.

- If the crankshaft is within specification, but the main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
- If the crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.
- If the crankshaft is worn past the wear limit, replace the crankshaft.

7. Clean and inspect the oil passages in the main bearing journals, connecting rod journals and main bearing bores in cylinder block.

8. Inspect the crankshaft for cracks or damage. Replace if necessary.

Specifications

Crankshaft Bend Variation . . . . . 0.02 mm (0.001 in.)

Connecting Rod Journal OD . . 47.95-47.96 mm (1.8878-1.8882 in.)

Wear Limit . . . . . 47.91 mm (1.886 in.)

Main Bearing Journal OD . . . . 53.95-53.96 mm (2.1240-2.1244 in.)

Wear Limit . . . . . 53.91 mm (2.122 in.)

Main Bearing Cap Screw Torque 96-100 N•m (71-74 lb-ft)

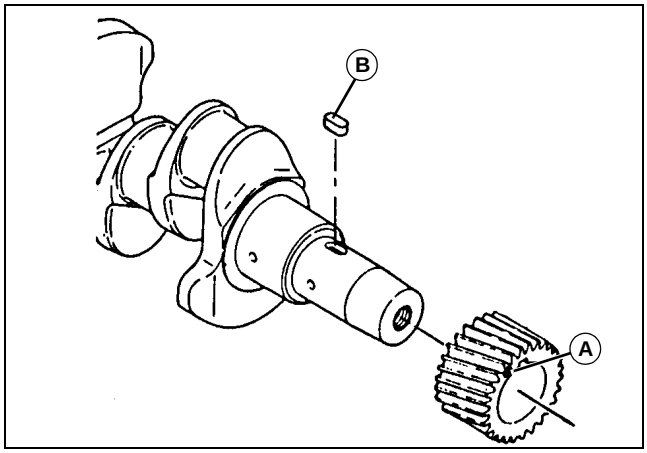
Main Bearing Oil Clearance . . . . 0.038-0.074 mm (0.001-0.003 in.)

Wear Limit . . . . . 0.15 mm (0.006 in.)

Remove and Install Crankshaft Gear

1. Remove the 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.

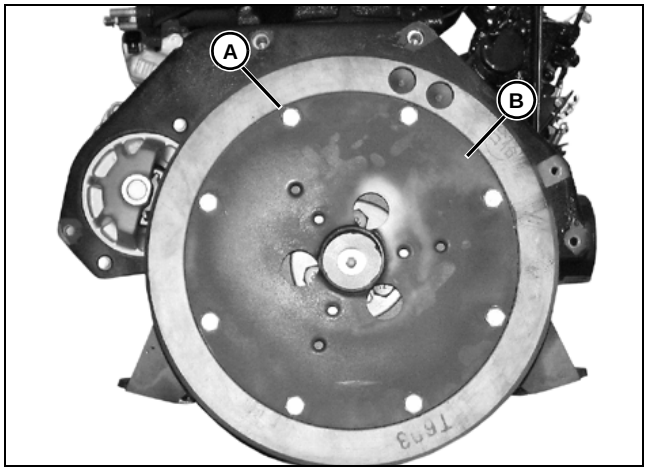


M82060A

2. Heat new gear to approximately 150°C (302°F). Install gear with timing mark (A) toward press table. Align slot in gear with key (B) in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.

Remove and Install Flywheel

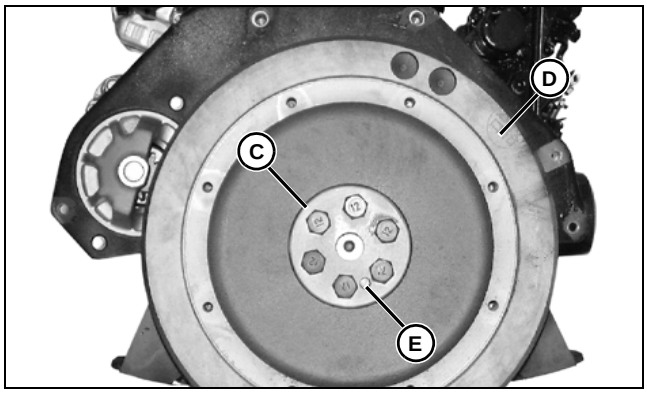
1. Flywheel can be removed without removing engine from machine. If removing flywheel in machine, remove engine driveshaft first.



MX5434

2. Remove eight cap screws (A) and flex plate (B).

IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.



MX5435

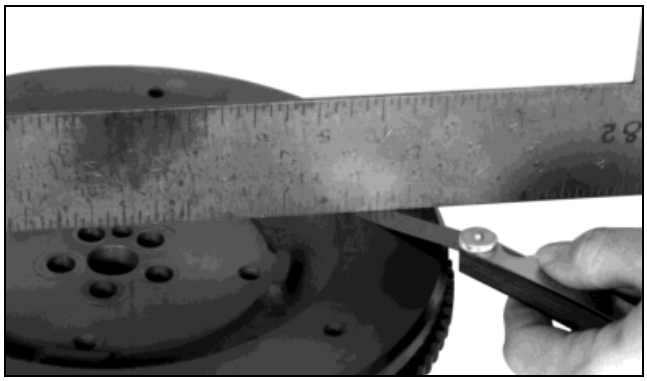
3. Remove the flywheel mounting cap screws (C) and remove the flywheel (D) from crankshaft.

4. Use pin (E) in crankshaft to correctly locate the flywheel on the crankshaft.

5. Install the flywheel. Apply lubrication oil to the mounting cap screws and tighten to specification.

6. Install flex plate with raised hub facing away from flywheel.

7. Install cap screws and tighten to specification.



M35337

8. Measure flywheel flatness. Place a straightedge across the flywheel surface opposite of ring gear. Measure the clearance between the straightedge and the flywheel surface with a feeler gauge. Replace the flywheel if the clearance exceeds specification.

Specifications

Flywheel Mounting
Cap Screw Torque . . . . . 83-88 N•m (62-65 lb-ft)
Flywheel Out-of-Flat (Maximum). . . 0.02 mm (0.001 in.)

Remove and Install Camshaft

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.

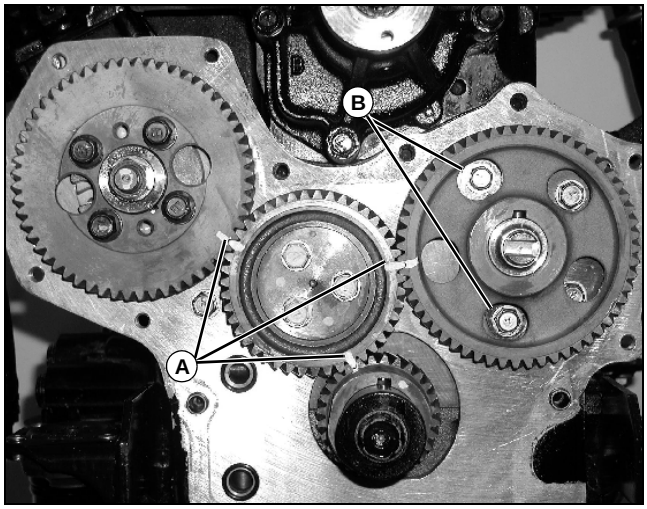
Remove

1. Remove the rocker arm assembly and push rods. (See "Remove and Install Rocker Arm Assembly" on page 77.)
2. Remove the timing gear cover. (See "Remove and Install Timing Gear Cover" on page 101.)
3. Check the camshaft end play. (See "Check Camshaft End Play" on page 59.)
4. Check the backlash of the timing gears. (See "Check Timing Gear Backlash" on page 60.)

NOTE: If a magnetic follower holder kit is not available, turn engine until oil pan is upward to hold cam followers away from camshaft.

5. Hold the cam followers away from the camshaft using D15001NU Magnetic Follower Holder Kit, or equivalent.

NOTE: Several rotations may be requried to line up all timing marks.



MX20049

6. Rotate the crankshaft and align the timing marks (A).

IMPORTANT: Avoid damage! DO NOT allow the camshaft lobes to hit any bearing surfaces while removing the camshaft. Machined surfaces can be damaged.

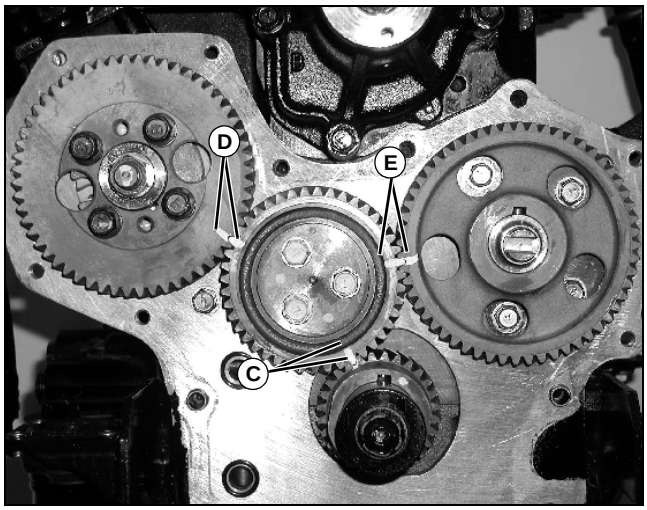
7. Remove two thrust plate mounting cap screws (B), the thrust plate, and the camshaft.
8. Inspect all parts for wear or damage.

Install

Apply clean engine oil on all parts during installation.

IMPORTANT: Avoid damage! DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces and bearings can be damaged.

NOTE: Several rotations may be requried to line up all timing marks.



MX20049

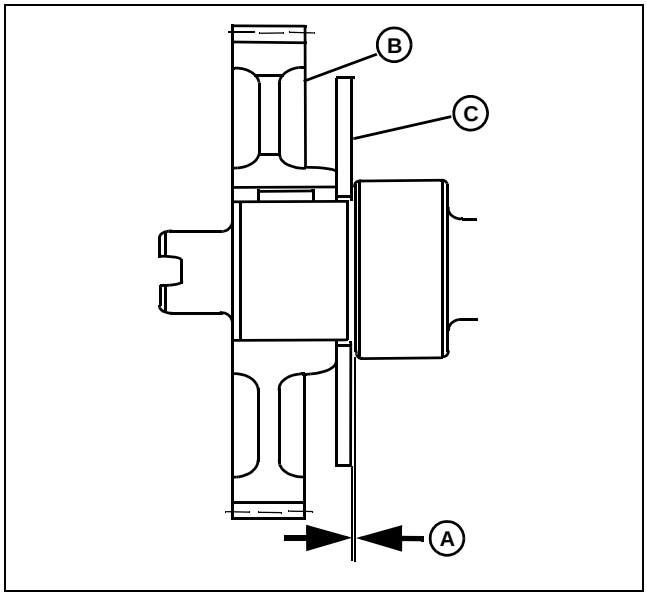
1. Rotate the crankshaft to align the timing marks (C, D and E).
2. Install the camshaft.
3. Install the thrust plate and thrust plate mounting cap screws. Tighten cap screws to specification.
4. Install the timing gear cover.
5. Install push rods and rocker arm assembly.

Specifications

Thrust Plate Mounting Cap Screws . 26 N•m (226 lb-in.)

Inspect Camshaft

Camshaft End Play

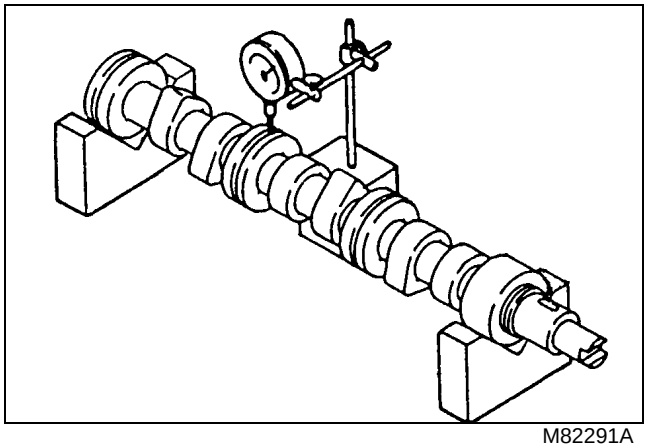


MIF

1. Check the camshaft end play (A) using a feeler gauge.

2. If the end play exceeds specification, remove the camshaft gear (B) and replace thrust plate (C). (See “Remove and Install Camshaft Gear” on page 100.)

Camshaft Bend

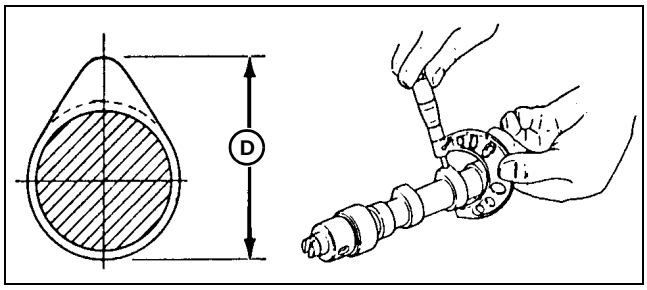


M82291A

1. Inspect the camshaft for bend using V-blocks and a dial indicator. Turn the camshaft slowly and read variation on the indicator.

   • If the variation is greater than specification, replace the camshaft.

Camshaft Lobe Height

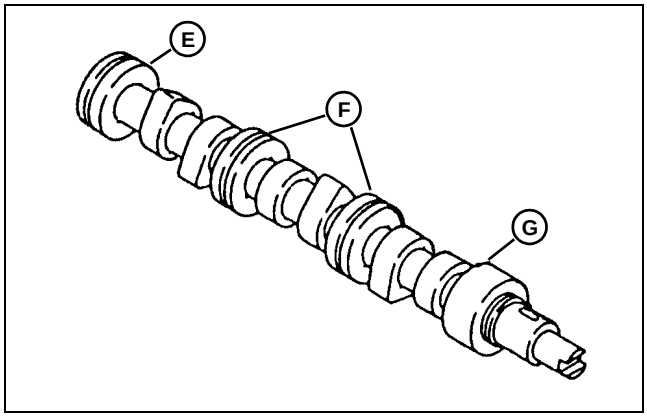


M82070A

1. Measure the camshaft lobe height (D) and compare with specifiactions.

   • If the lobe height is less than wear limit, replace the camshaft.

Camshaft Journals



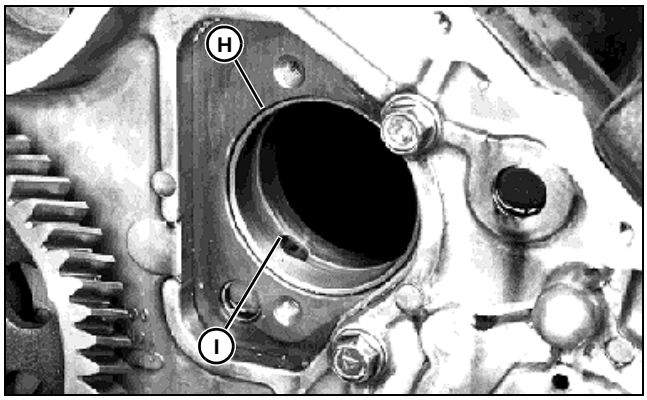
M82292A

1. Measure gear housing (G) and flywheel end (E) camshaft journal outside diameters and compare with specifications.

2. Measure intermediate (F) camshaft journal outside diameters and compare with specifications.

3. If journal diameters are less than wear limit, replace the camshaft.

Camshaft Bushings



M82072

1. Measure the camshaft bushing (H) inside diameter at the gear housing end and compare with specifications.

2. If bushing diameter exceeds wear limit, replace bushing.

3. If bushing clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft or both.

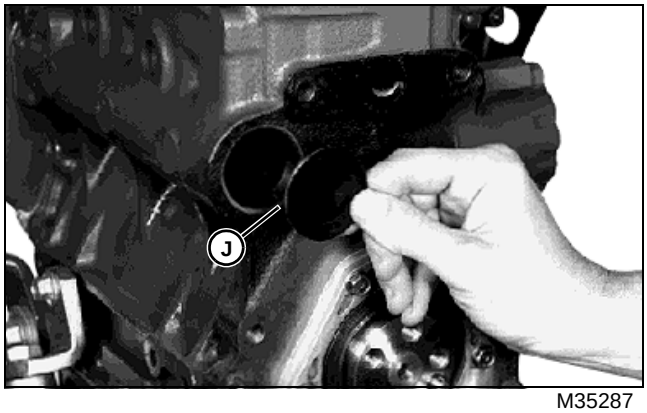
4. If replacing the camshaft bushing:

   a. Use a chisel to remove the bushing. Be careful not to push the bushing inside the engine.

   b. Align the oil holes (I) in new bushing and cylinder block. Install bushing using a driver set.

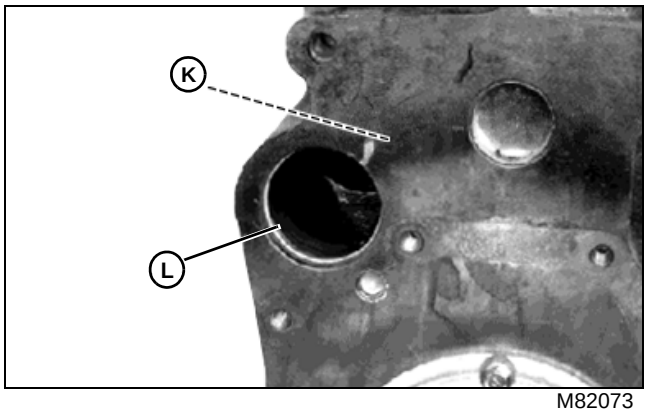
NOTE: Flywheel plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

5. Remove flywheel plate.



M35287

6. Remove plug (J) using a long wooden dowel. Insert wooden dowel through gear housing side.



M82073

7. Measure the intermediate (K) and flywheel end (L) camshaft bore diameters and compare with specifications.

8. Apply John Deere Form-In-Place Gasket, or an equivalent, on the outer edge of the plug. Install the plug until it bottoms in the bore.

Specifications

Camshaft End Play. . . . . 0.05-0.20 mm (0.002-0.010 in.)
Wear Limit. . . . . 0.30 mm (0.012 in.)
Camshaft Bend (Maximum). . . . . 0.02 mm (0.0021 in.)
Camshaft Lobe Height 38.64-38.77 mm (1.521-1.526 in.)
Wear Limit. . . . . 38.40 mm (01.512 in.)

Camshaft Journals

Gear Housing and Flywheel End Camshaft Journal OD 44.93-44.95 mm (1.769-1.770 in.)
Intermediate Camshaft Journal 44.91-44.94 mm (1.768-1.769 in.)
Wear Limit. . . . . 44.85 mm (1.766 in.)

Camshaft Bushings

Camshaft Bushing ID at Gear Housing . . 44.990-45.055 mm (1.771-1.774 in.)
Camshaft Bushing ID at Intermediate and Flywheel End 45.00-45.025 mm (1.772-1.773 in.)
Wear Limit (All). . . . . 45.10 mm (1.776 in.)
Camshaft Bushing-to-Journal Clearance (All) 0.23 mm (0.009 in.)

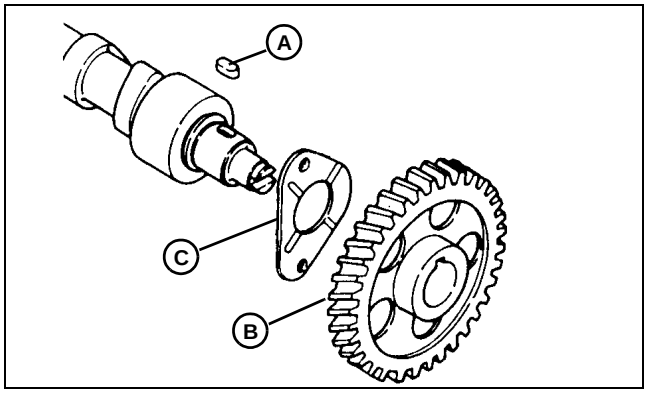
Remove and Install Camshaft Gear

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 the gear in oil to approximately 150°C (300°F).

IMPORTANT: Avoid damage! Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.

NOTE: Thrust plate must spin freely on camshaft.



M82068A

2. Install the thrust plate (C) if removed. Install the gear (B) with timing mark “C” side toward press table. Align the slot in the gear with key (A) in shaft. Press the camshaft into gear until gear is tight against camshaft shoulder.

Remove and Install Cam Followers

1. Remove camshaft. (See “Remove and Install Camshaft” on page 97.)

2. Remove the oil pan and strainer.

IMPORTANT: Avoid damage! Cam followers must be installed in the same bores from which they were removed.

3. Put a mark on each cam follower and cylinder block bore to aid in installation.

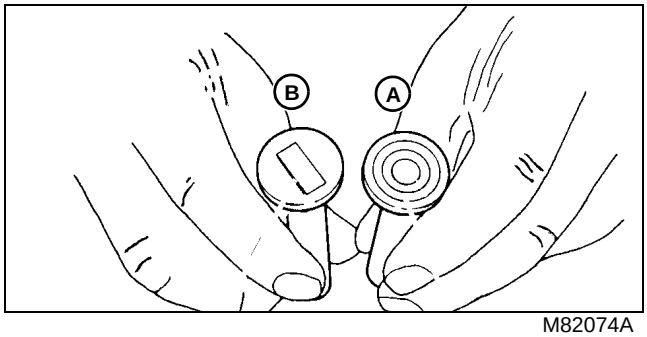
4. Remove cam followers.

5. Inspect all parts for wear or damage.

6. Apply clean engine oil to all parts during installation.

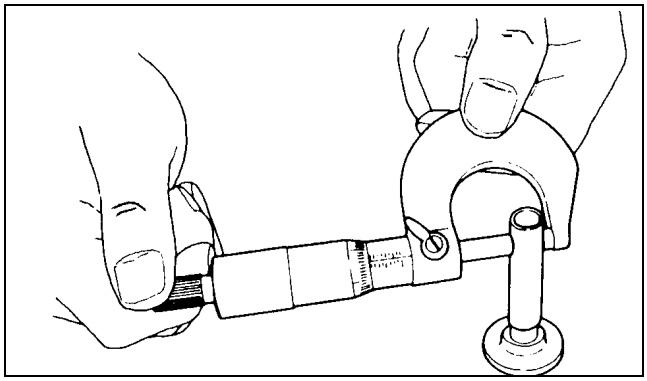
Installation is done in reverse order of removal.

Inspect Cam Followers



M82074A

1. Inspect the cam follower contact surface for normal contact (A) or abnormal wear (B). Replace if necessary.



M82075A

2. Measure the cam follower stem diameter and compare with specifications. If stem diameter is less then wear limit, replace cam follower.

3. Measure the cam follower bore diameter in the cylinder block and compare with specifications. If the cam follower bore diameter exceeds wear limit, replace the cylinder block.

4. If the bore clearance (bore ID minus follower stem OD) exceeds specification, replace the cam follower, cylinder block or both.

Specifications

Cam Follower Stem

Stem OD . . . . . 11.98-11.99 mm (0.471-0.472 in.)
Wear Limit. . . . . 11.96 mm (0.470 in.)

Cam Follower Bore

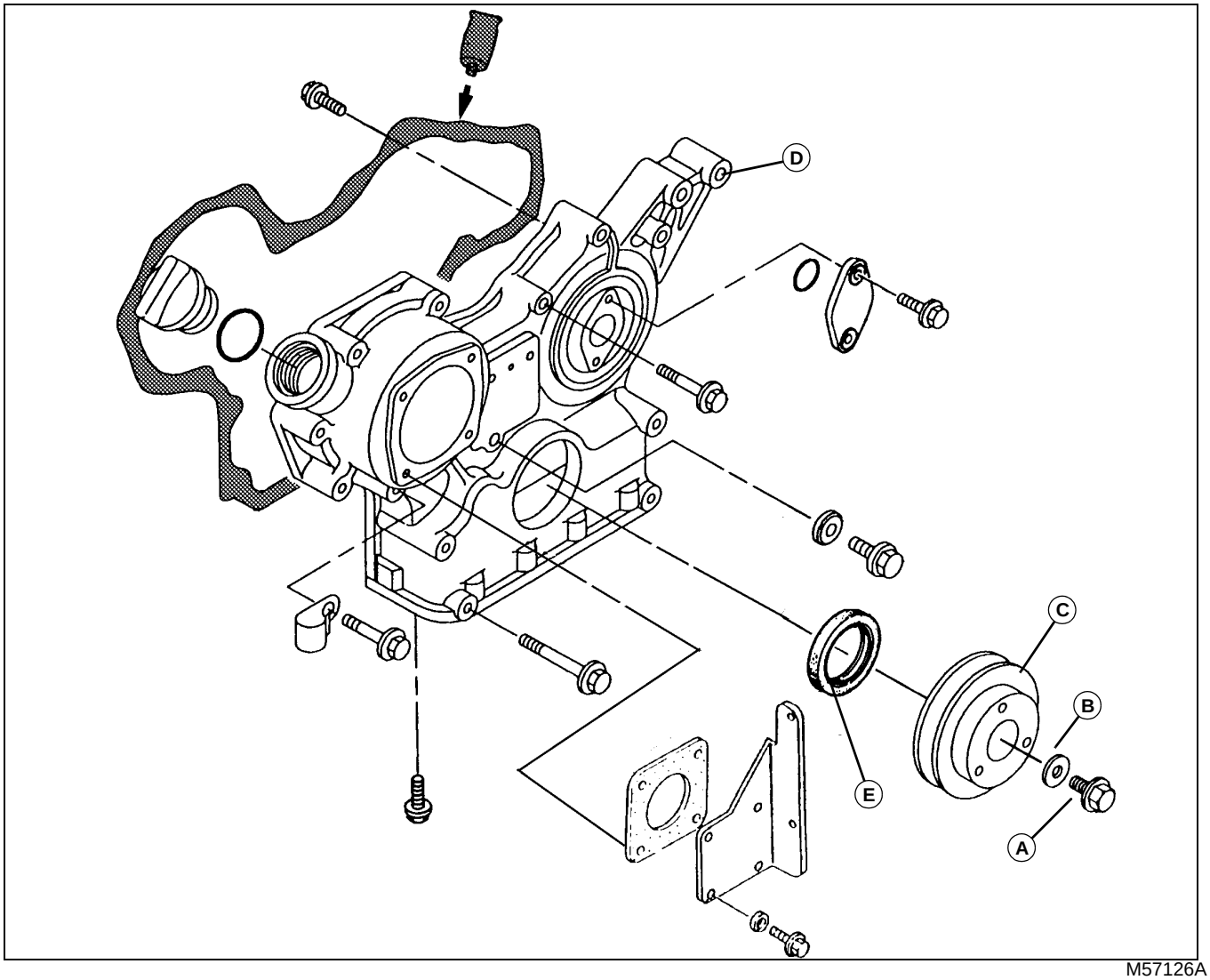
Bore ID . . . . . 12.00-12.02 mm (0.472-0.473 in.)
Wear Limit. . . . . 12.05 mm (0.474 in.)
Clearance . . . . . 0.010-0.043 mm (0.0.001-0.002 in.)

Remove and Install Timing Gear Cover

Other Material

Part No.	Part Name	Part Use
TY16135 (US) 58730 (LOCTITE ®)	ULTRA BLUE® RTV Silicone Form-in-Place Gasket	Applied to oil seal case mounting surface before installaion.

Remove



M57126A

1. Remove engine.
2. Remove oil pan and pan extension.
3. Remove alternator and belt.
4. Remove crankshaft pulley cap screw (A) and washer (B).
5. Remove crankshaft pulley (C) using a puller.

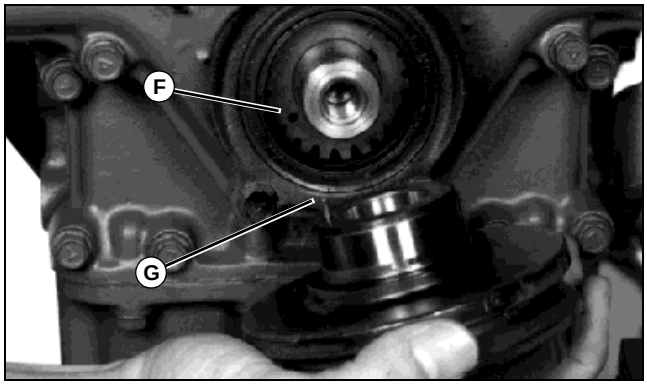
NOTE: It is not necessary to remove end cover and O-ring or fuel injection pump gear cover to remove timing gear cover.

6. Remove mounting cap screws and timing gear cover (D).
7. Inspect crankshaft oil seal (E) for wear or damage. Replace if necessary.

Install

Installation is done in the reverse order of removal.

- Replace oil seal using a driver set. Install seal with lip toward inside of gear housing cover. Install seal flush with surface of cover.
- Clean surfaces and apply a bead of RTV Form-in-Place Gasket to timing cover.
- Tighten all timing gear cover mounting cap screws to specifications.



M35295

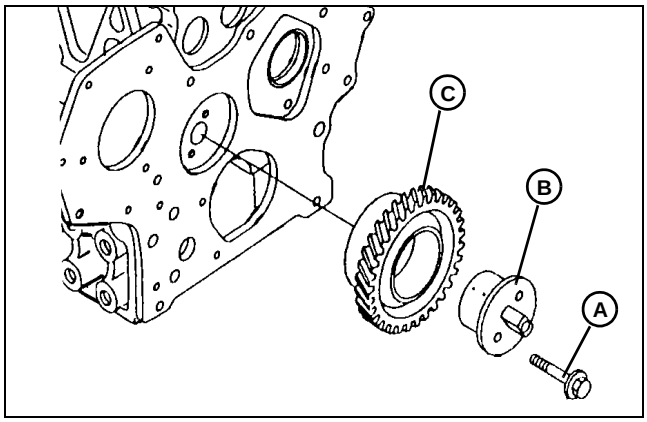
- Align pin (G) in crankshaft pulley with hole (F) in crankshaft gear. Install crankshaft pulley.
- Adjust alternator drive belt tension. (See “Adjust Fan/ Alternator Drive Belt” on page 63.)

Remove and Install Idler Gear

1. Remove the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 101.)
2. Check the backlash of timing gears. (See “Check Timing Gear Backlash” on page 60.)

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the coolant pump is at TDC on compression stroke. No. 1 cylinder is closest to the flywheel.

3. Rotate the crankshaft and align the timing marks.



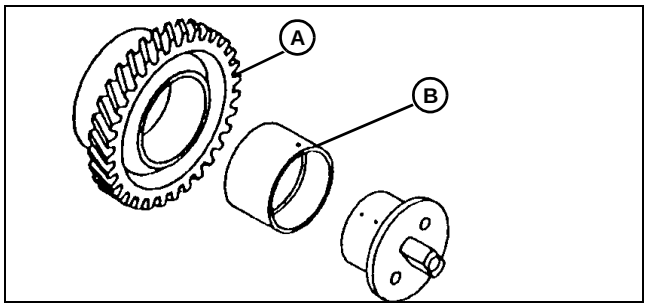
M82209A

4. Remove two cap screws (A), shaft (B) and gear (C).
5. Inspect all parts for wear or damage.

Installation is done in the reverse order of removal.

Inspect Idler Gear

1. Inspect the gear for chipped or broken teeth. Replace if necessary.
2. Measure the idler gear shaft diameter and compare with specifications.
3. Measure the idler gear bushing diameter and compare with specifications.
4. If the bore clearance (bushing ID minus shaft OD) exceeds specification, replace the bushing, shaft, or both.



M82210A

5. Remove and install bushing:
   a. Replace the bushing using a driver set.
   b. Align the oil holes in bushing (B) and idler gear (A).
   c. Install the bushing flush with surface of idler gear.

Specifications

Idler Gear Shaft OD 45.950-45.975 mm (1.809-1.810 in.)
Wear Limit . . . . . 45.93 mm (1.808 in.)
Idler Gear Bushing ID 46.00-46.025 mm (1.811-1.812 in.)
Wear Limit . . . . . 46.08 mm (1.814 in.)
Idler Gear Shaft and Bushing Clearance . . . . . 0.18 mm (0.007 in.)

Remove and Install Timing Gear Cover Mounting Plate

1. Remove the camshaft. (See “Remove and Install Camshaft” on page 97.)

2. Remove the idler gear. (See “Remove and Install Idler Gear” on page 102.)

3. Remove the fuel injection pump.

4. Remove the oil pump. (See “Remove, Inspect, and Install Oil Pump” on page 103.)

5. Remove the mounting cap screws and plate.

6. Replace the O-rings.

Install in reverse order of removal.

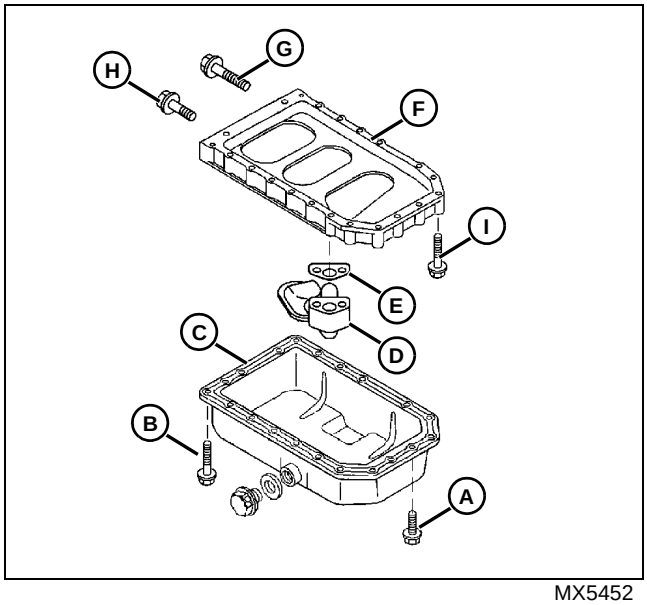
Remove and Install Oil Pan, Crankcase Extension, and Strainer

Other Material

Part No.	Part Name	Part Use
TY16135 (US) 58730 (LOCTITE®)	ULTRA BLUE® RTV Silicone Form-in-Place Gasket	Applied to oil pan crankcase mounting surface before installation.

Remove

NOTE: Engine must be removed from machine to remove the oil pan.



MX5452

1. Remove six (A) and sixteen (B) cap screws. Remove oil pan (C).

2. Remove cap screws for strainer and remove strainer (D) and gasket (E).

3. If crankcase extension (F) is being removed, remove: flywheel, three lower cap screws (G) in rear oil seal housing, four flywheel housing cap screws (H), and six cap screws (I) in front. Then remove crankcase extension.

Install

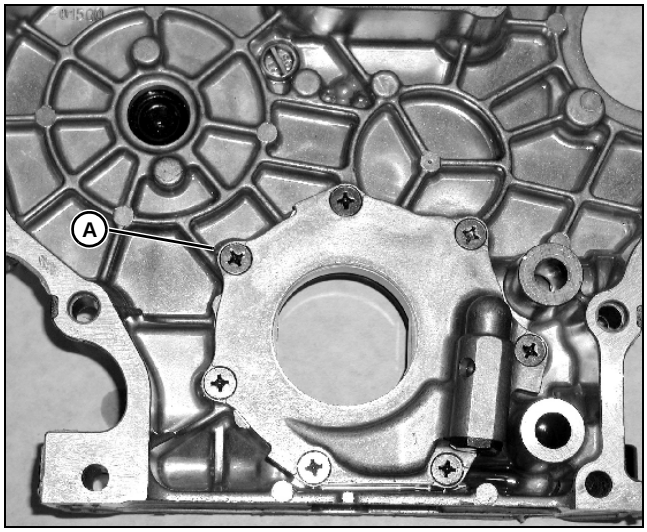
Installation is done in the reverse order of removal.

- Clean all mounting surfaces.
- Replace strainer gasket.
- Apply ULTRA BLUE® RTV Silicone Form-in-Place Gasket to oil pan and crankcase extension.

Remove, Inspect, and Install Oil Pump

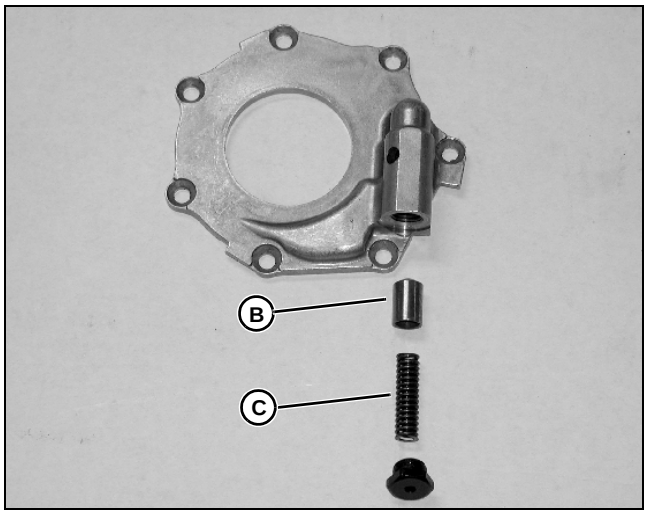
Remove

1. Remove the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 101.)



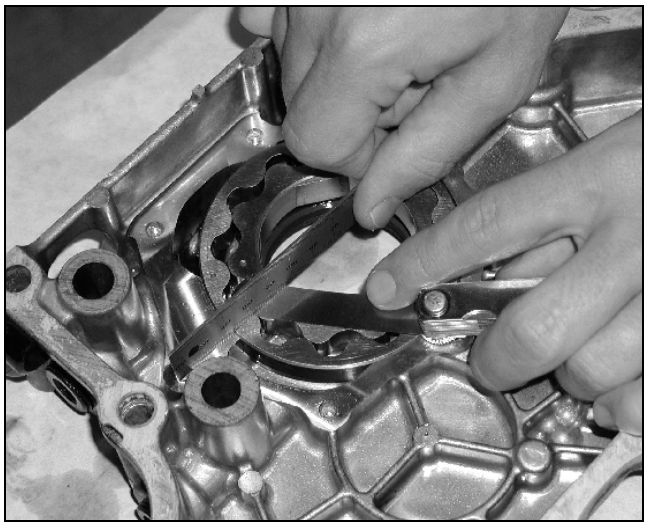
MX20023

2. Remove screws (A).



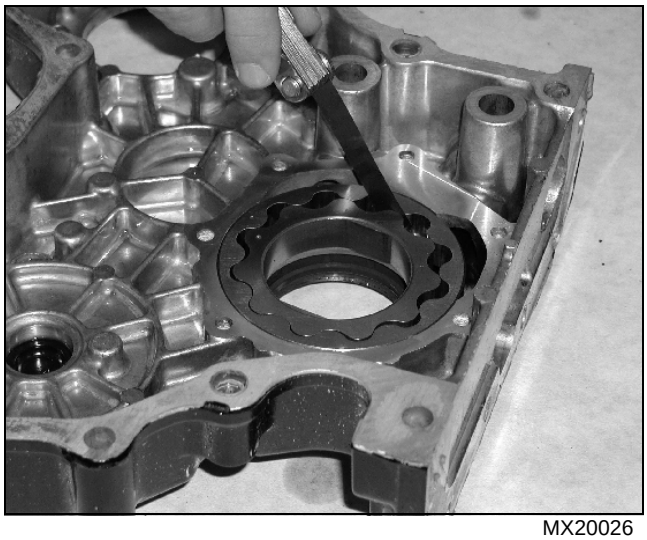
MX20024

3. Inspect pressure regulating valve poppet (B) and spring (C).



MX20025

4. Use a straightedge and feeler gauge to measure rotor recess. If rotor recess is more than wear limit, replace rotor assembly.

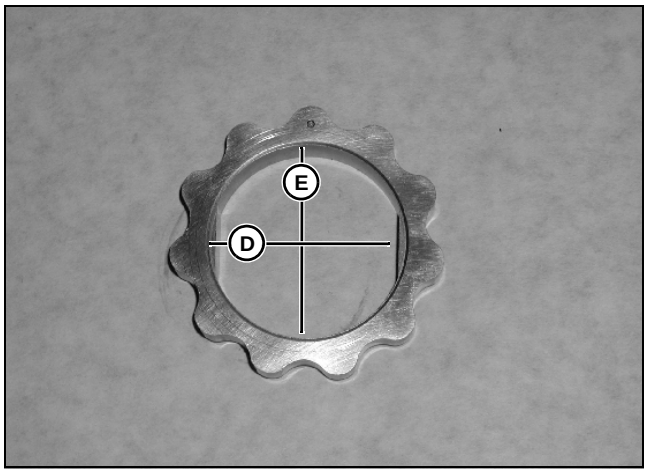


MX20026

5. Measure inner to outer rotor clearance. If clearance is more than wear limit, replace rotor assembly.

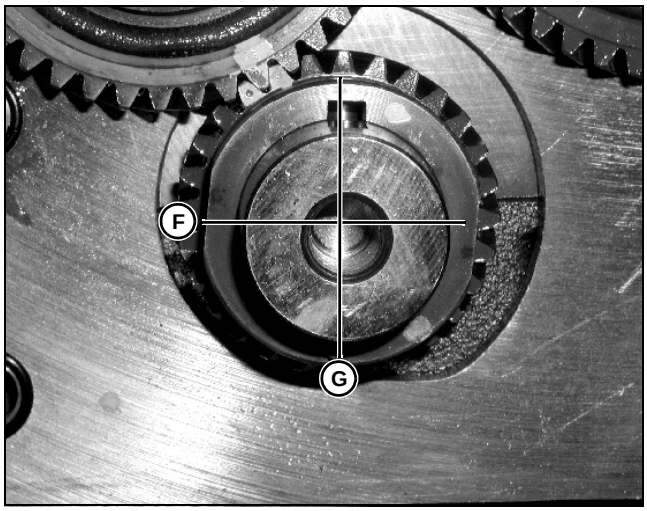
MX20027

6. Measure outer rotor clearance to pump body. If clearance is more than wear limit, replace entire assembly.



MX20028

7. Measure width across flats on inner rotor (D).
8. Measure inner rotor inner diameter (E).

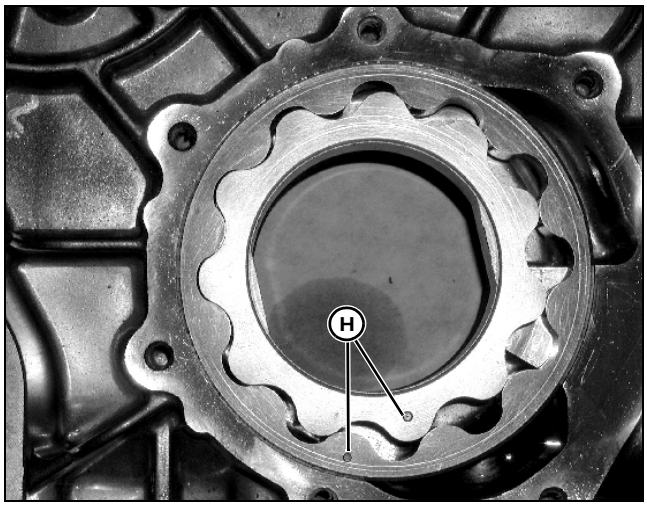


MX20029

9. Measure width across flats of crank gear (F).
10. Measure the outer diameter of crank gear (G).

Install

1. Apply clean engine oil to inner and outer rotor and pump body.



MX20030

2. Install rotors with dots (H) facing out.
3. Apply medium strength thread lock and sealer to pump cover screws. Tighten to specification.
4. Install timing cover.

Specifications

Rotor Recess

Standard . . . . . 0.02-0.07 (0.001-0.003 in.)
Wear Limit. . . . . 0.12 mm (0.005 in.)

Outer Rotor-to-Pump Body Clearance

Standard . . . . . 0.12-0.21 mm (0.005-0.008 in.)
Wear Limit. . . . . 0.30 mm (0.012 in.)

Inner-to-Outer Rotor Clearance

Wear Limit. . . . . 0.16 mm (0.006 in.)

Width Across Flats of Inner Rotor

Standard . . . . . 49.95-50.05 mm (1.967-1.974 in.)

Inner Rotor Inner Diameter

Standard . . . . . 53.05-53.15 mm (2.088-2.093 in.)

Width Across Flats of Crank Gear

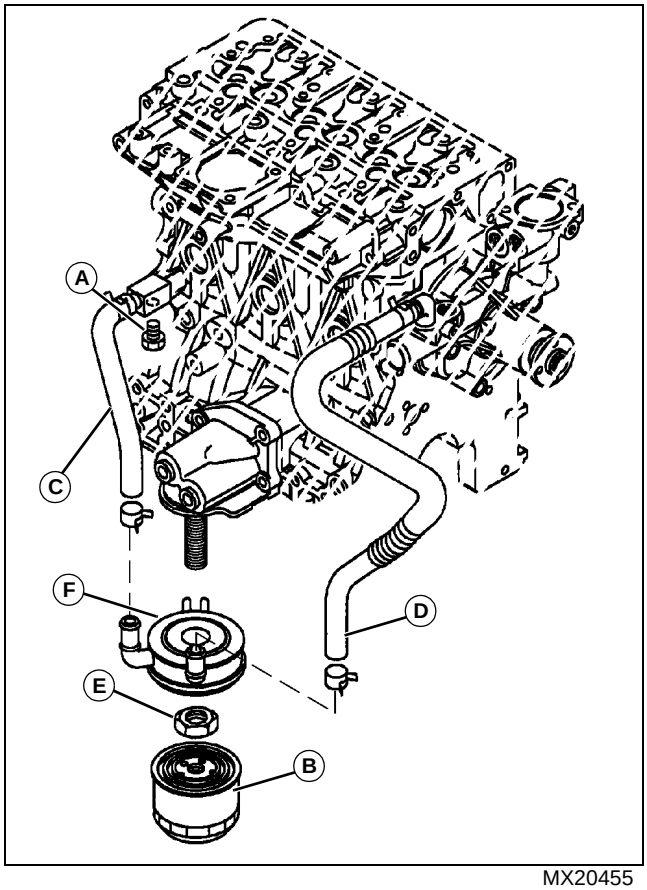
Standard . . . . . 49.45-49.75 mm (1.947-1.959 in.)

Outer Diameter of Crank Gear

Standard . . . . . 53.45-53.55 mm (2.104-2.108 in.)

Pump Cover Screws . . . . . 7 N•m (61 lb-in.)

Remove and Install Optional Oil Cooler



MX20455

1. Remove drain plug (A) to drain engine cooling system.
2. Remove oil filter (B).
3. Disconnect coolant hoses (C and D).
4. Remove nut (E) and oil cooler (F).
5. Pressure test oil cooler for leakage by applying 206-483 kPa (30-70 psi) of compressed air to oil cooler and submersing in water.

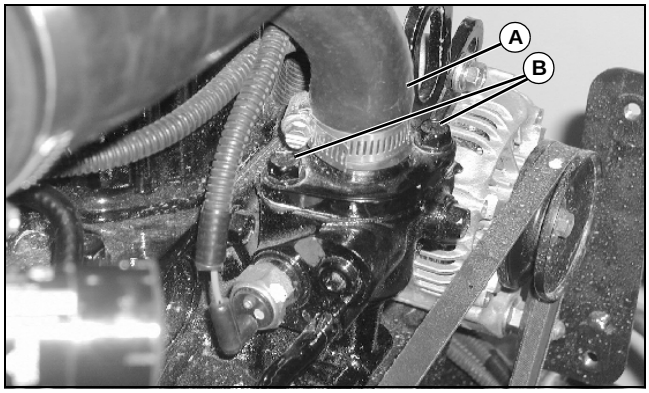
Installation is done in reverse order of removal.

- Replace O-rings.

Remove and Install Thermostat

Removal

1. Drain coolant from radiator.
2. Remove alternator belt shield.



MX18967

3. Remove upper radiator hose (A).
4. Remove cap screws (B), thermostat flange and gasket.
5. Remove thermostat from housing.
6. Inspect all parts for wear or damage. Replace as necessary.
7. Test thermostat. (See “Test Thermostat Opening” on page 62.)

Installation

Installation is done in reverse order of removal.

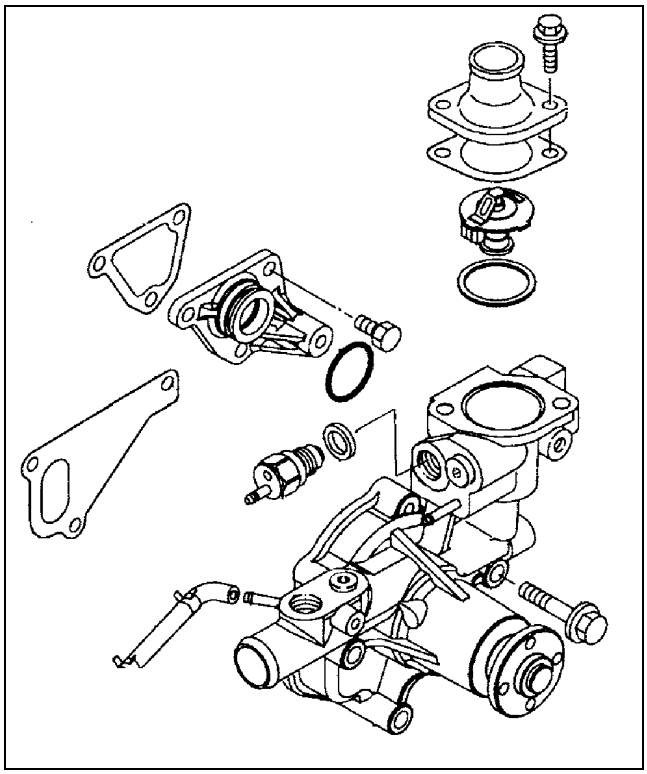
Inspect Coolant Pump

1. Inspect coolant pump for coolant leakage. (See “Test Cooling System Pressure” on page 64, if origin of leak cannot be determined.)
   - If coolant leaks at pulley flange, shaft seal is defective. Replace coolant pump.
   - If coolant leaks between plate and pump housing, gasket between plate and pump housing is defective. Remove plate and replace gasket.
   - If coolant leaks between plate and engine block, remove coolant pump and replace gasket.
2. Inspect coolant pump for worn bearing shaft by removing alternator belt and checking for excessive movement of pulley. Replace coolant pump if excessive movement is noticed.
   - If bearing shaft is making noise when operating, check alternator belt tension. (See “Adjust Fan/ Alternator Drive Belt” on page 63.) If adjustment does not relieve the noise, bearing shaft is defective. Replace coolant pump.

Remove and Install Coolant Pump

Remove

1. Drain engine coolant.
2. Remove belt guard.
3. Remove the coolant pump/alternator drive belt.
4. Remove the coolant pump pulley.



MX17961

5. Disconnect the upper and lower radiator hoses.
6. Disconnect electrical connector from coolant temperature sensor.
7. Remove coolant line and bracket securing line to pump.
8. Remove lines to coolant pump.
9. Remove the mounting cap screws, pump and gasket.
10. Inspect the pump for wear or damage.
11. Test the thermostat for proper operation. (See “Test Thermostat Opening” on page 62.)

Installation

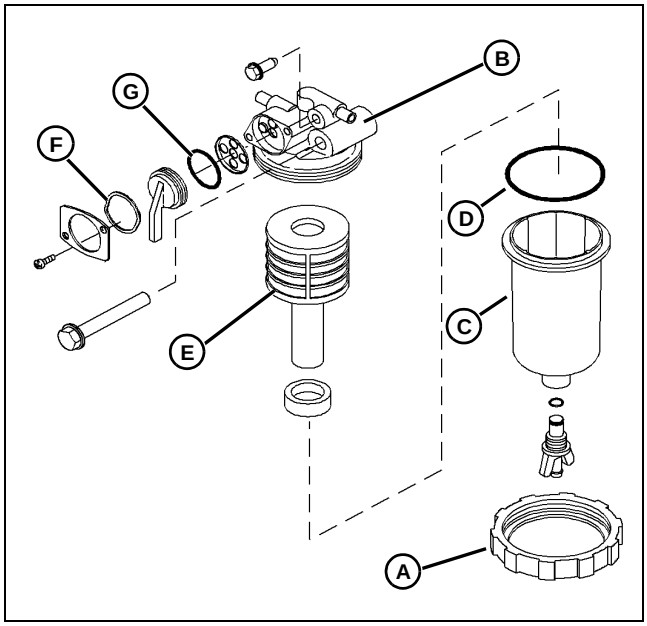
Installation is done in the reverse order of removal.

- Adjust the coolant pump/alternator drive belt tension. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

Disassemble and Assemble Water Separator

IMPORTANT: Avoid damage! Replace all copper washers on injection pump fittings. Damaged or used washers will leak.

Always use new O-ring seals when replacing separator.



MX17962

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the separator bowl (C).
2. Remove the separator bowl from the mounting base.
3. Remove and replace O-ring (D) and strainer (E).
4. Remove shutoff valve cover. Inspect and replace wave washer (F) and O-ring (G) as necessary.
5. Before installing the bowl and strainer in the mounting base, verify the O-ring is in the groove inside the mounting base.
6. Install the separator bowl and the strainer in the mounting base.

IMPORTANT: Avoid damage! Tighten only enough to keep the filter assembly from leaking. Overtightening the retaining nut may damage the filter cover or retaining ring.

7. Place the retaining ring over separator bowl and screw on the mounting base to retain bowl to mounting base.

Remove Fuel Injection Pump

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 high-pressure lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

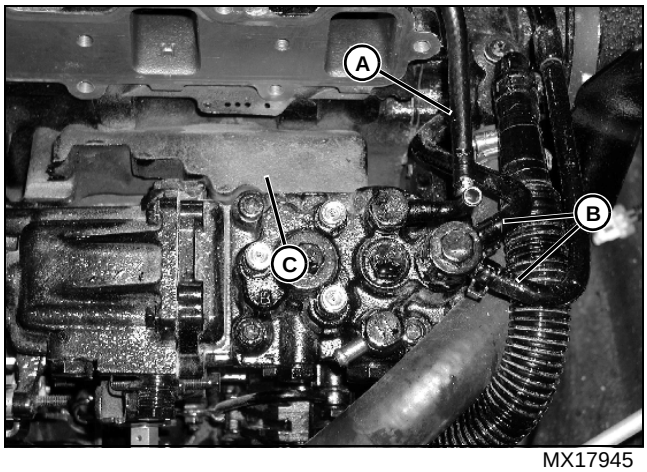
If an accident occurs, see a doctor immediately. Any fluid injected into the skin, must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

IMPORTANT: Avoid damage! DO NOT attempt to service the injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace entire unit.

DO NOT rotate engine while injection pump is removed. If engine is rotated, timing gear cover must be removed to ensure correct timing.

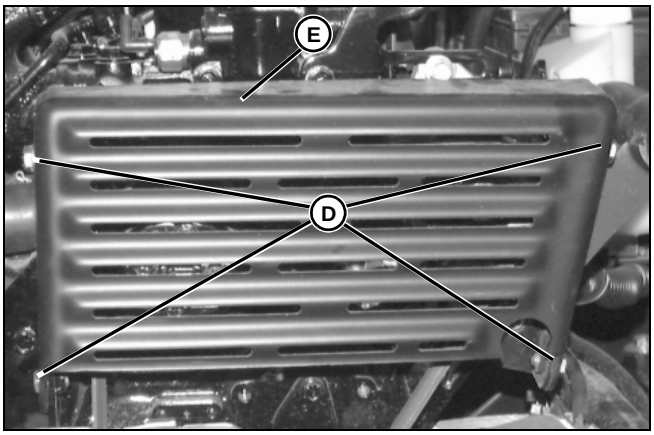
IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean injection pump lines and area around pump using a parts cleaning solvent or steam cleaner.
2. Remove intake manifold. (See “Remove and Install Intake Manifold” on page 83.)
3. Disconnect throttle cable.
4. Drain coolant from radiator.



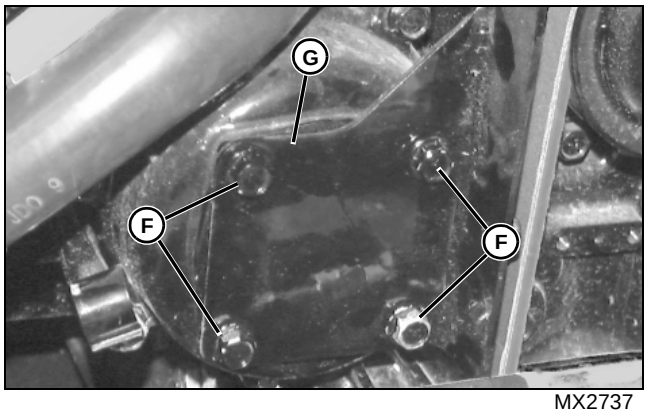
MX17945

5. Disconnect leak-off line (A).
6. Disconnect coolant lines (B).
7. Remove foam spacer (C).



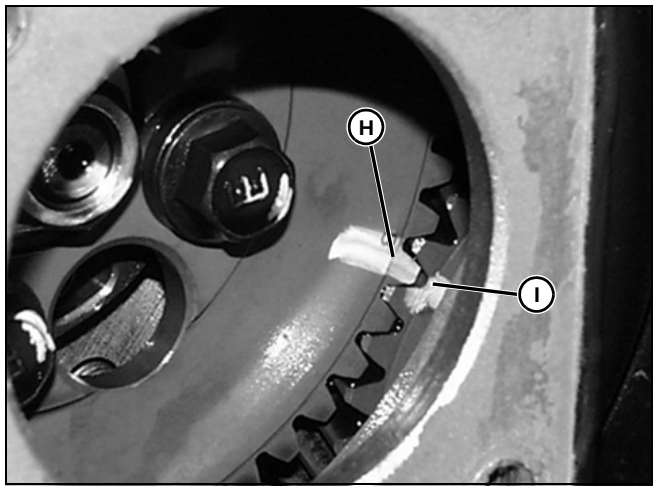
MX2738

8. Remove four cap screws (D) and fan guard (E).



MX2737

9. Remove four cap screws and washers (F), cover (G), and gasket.

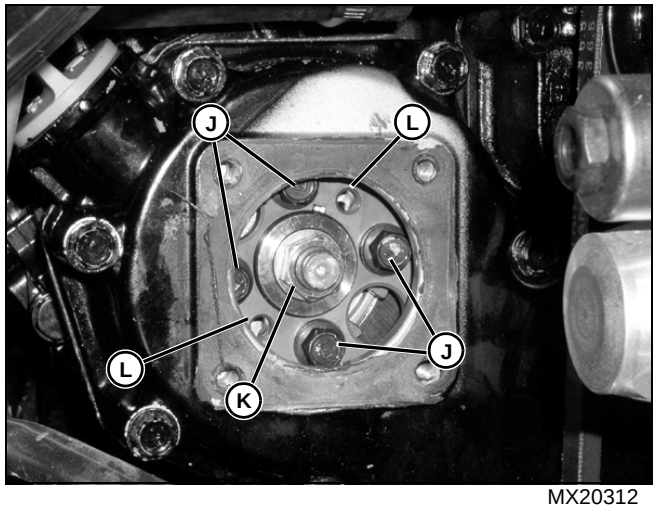


MX9675

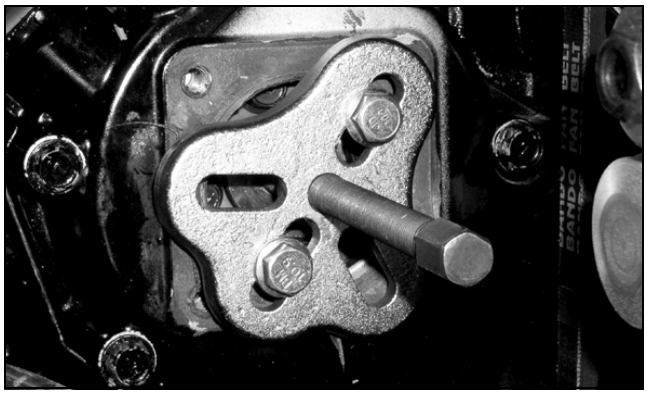
10.Rotate engine in direction of rotation until timing mark (H) on pump gear aligns with mark on idler gear (I).

IMPORTANT: Avoid damage! DO NOT loosen or disturb cap screws (J) securing gear to hub. This gear/hub assembly times the injection pump camshaft in relation to the crankshaft for precise timing of EPA engines. This procedure is done at the pump manufacturing plant and cannot be duplicated in the field!

Gear-to-hub adjustment is pre-set by the engine manufacturer to comply with strict California Air Resources Board/Environmental Protection Agency (CARB/EPA) emissions requirements and is NOT adjustable. Tampering with the gear-to-hub adjustment may result in severe fines or penalties. If hub or gear is damaged, the entire engine must be replaced.



MX20312



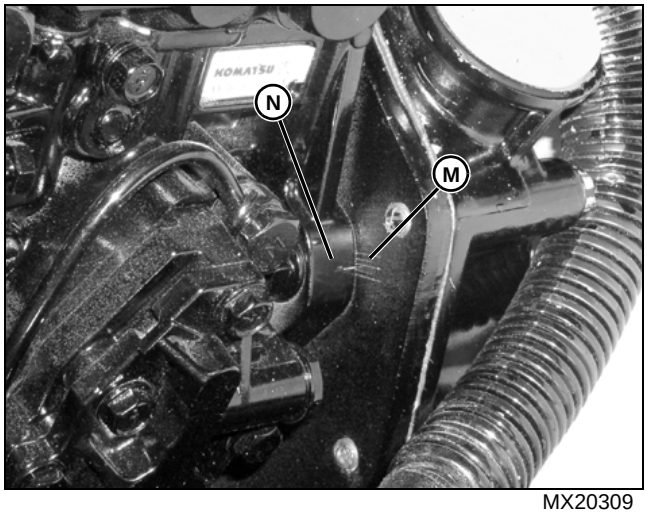
MX20313

11.Remove nut (K) and lock washer from pump shaft.

12.Install puller using tapped M8 holes (L) in gear.

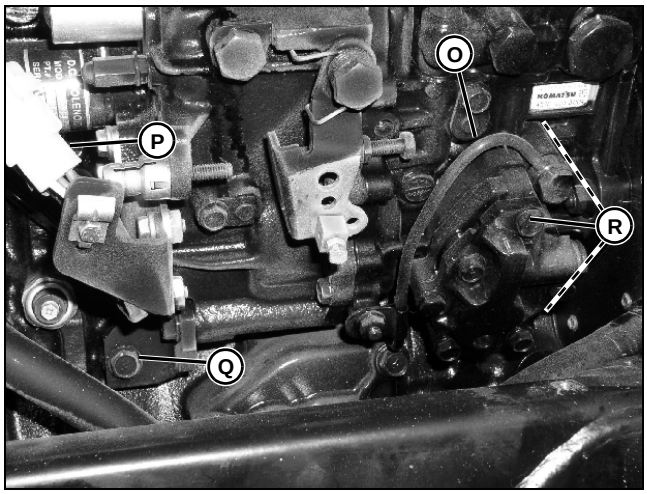
13.Remove gear from pump shaft. The gear will remain in timing cover.

IMPORTANT: Avoid damage! Pump must be installed at exact location where it was removed.



MX20309

14.Note the position of timing marks on gear cover mounting plate (M) and injection pump (N).



MX17947

15.Remove lube line (O) from pump.

16.Disconnect fuel shutoff solenoid wire connector (P).

17.Remove cap screw (Q) from bracket.

18.Remove three pump mounting nuts (R) and remove pump.

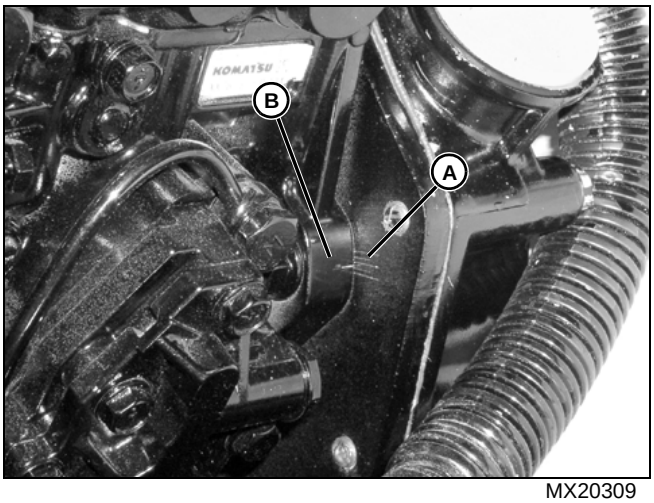
IMPORTANT: Avoid damage! Do not attempt to service the injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace the entire unit.

Install Fuel Injection Pump

1. Install new O-ring on injection pump.

2. Put injection pump onto back of gear cover mounting plate. Install three mounting nuts and one cap screw through bracket. Do not tighten. Align key on shaft with keyway in gear. Be sure to align marks on gears made during removal.

3. Install nut on timing gear. Tighten to specification.

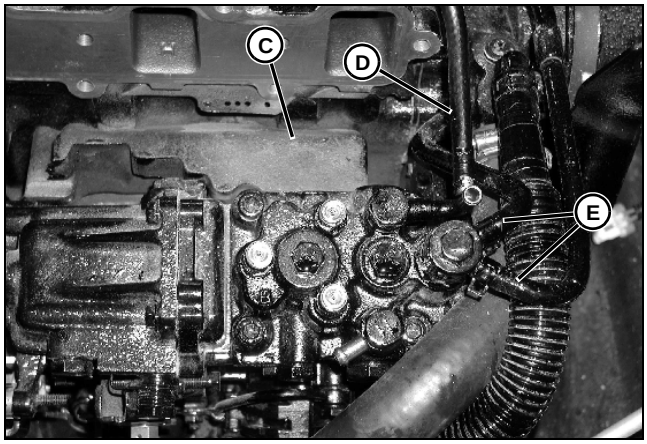


MX20309

4. Align marks on mounting plate (A) and injection pump (B) to the exact location as when removed. Tighten nuts and cap screw securely.

5. Place a thin bead of form-in-place gasket on access cover and install.

6. Connect fuel shut-off solenoid wire connector.



MX17945

7. Install foam spacer (C).

8. Connect leak off line (D).

9. Install coolant lines (E).

10.Install intake manifold. (See “Remove and Install Intake Manifold” on page 83.)

11.Install throttle cable and adjust cable. (See “Adjust Throttle Cable” on page 66.)

IMPORTANT: Avoid damage! If oil has been drained out of fuel injection pump housing, add oil as necessary. Fuel injection pump can become damaged if operated dry or without proper amount of oil.

12.Add oil through external lube line inlet until oil begins to drip out of inlet hole.

13.Install external lube line. When installing line, put one copper washer between mounting cap screw head and lube line and the other between lube line and housing.

14.Fill engine coolant to proper level.

Specifications

Fuel Injection Pump Drive Gear Nut Torque (No Lubricant) . . . . . 78-88 N•m (58-65 lb-ft.)
Fuel Injector Tube Nut Torque (No Lubricant) . . . . . 29-34 N•m (21-25 lb-ft.)

Remove and Install Fuel Injection Nozzles

Removal

IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

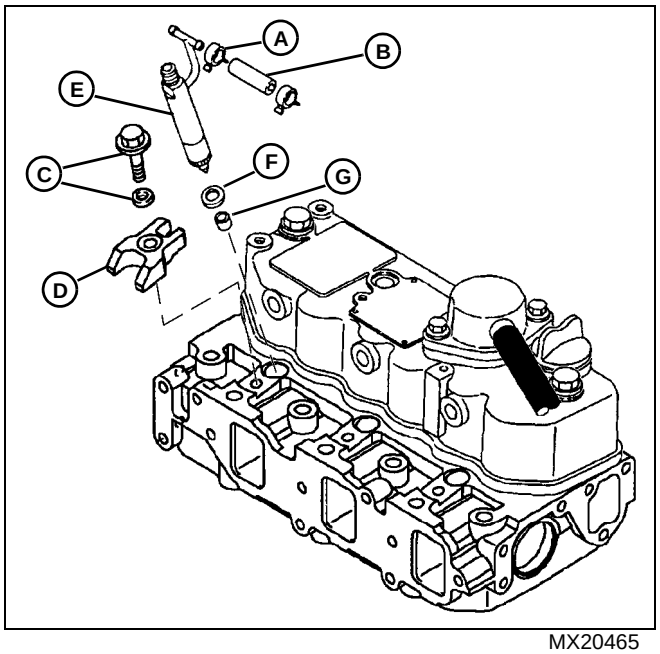
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body 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 source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.

2. Loosen fuel injection line connectors-to-nozzles slightly to relieve pressure in the fuel system.

NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag nozzles, according to the cylinder from which it was removed.

3. Loosen line clamp(s) and remove fuel injection lines.



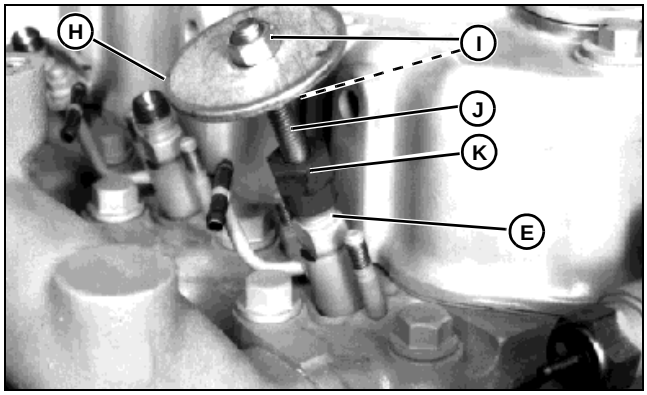
MX20465

Picture Note: 4TNE84 Shown

4. Remove clamps (A) and leak-off hoses (B).

5. Remove cap screw and washer (C) and retaining plates (D).

6. Remove injection nozzle (E), ring (F), and TEFLON® heat protector (G). If ring and protector stay in cylinder head, thread a cap screw into protector and pull from cylinder head.



M82126

7. If nozzles are stuck in cylinder head:

- Grind the head of a cap screw (J) so it fits inside a nut from an old injection line (K).
- Use two nuts (I) to attach a large flat washer (H) to the cap screw.
- Install assembly onto nozzle (E) and use a puller and slide hammer to pull nozzle from cylinder head.

8. Test injection nozzles. (See “Test Fuel Injection Nozzles” on page 60.)

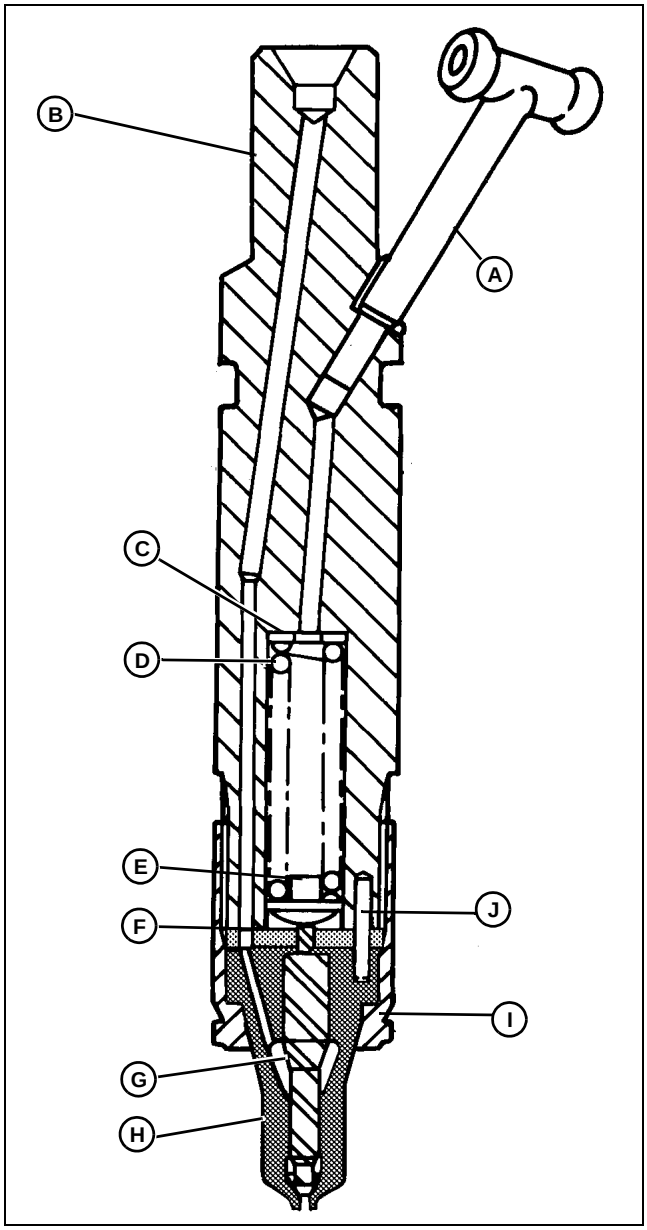
Installation

Installation is done in reverse order of removal.

- Install a new ring and heat protector when installing injection nozzles.

Disassemble and Assemble Fuel Injection Nozzles

Cross Section

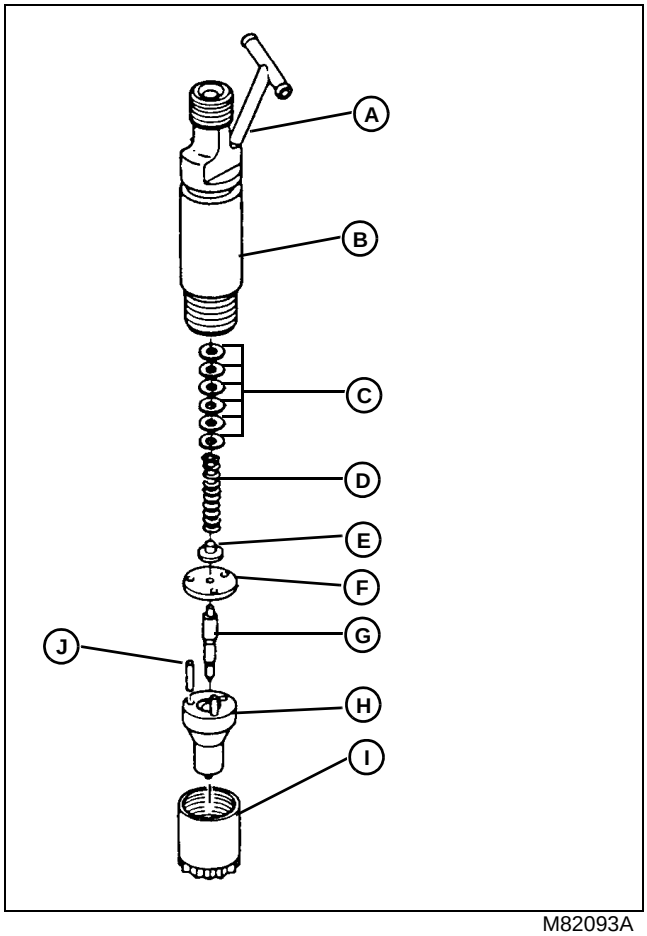


M37684

A- Return Pipe
B- Injector Body
C- Shim(s)
D- Spring
E- Spring Seat
F- Separator Plate
G- Nozzle Valve
H- Nozzle Body
I- Retaining Nut
J- Index Pin

Disassemble/Assemble

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.



M82093A

A- Return Pipe
B- Injector Body
C- Shim(s)
D- Spring
E- Spring Seat
F- Separator Plate
G- Nozzle Valve
H- Nozzle Body
I- Retaining Nut
J- Index Pin

1. Remove retaining nut (I) and disassemble internal parts of injection nozzle. Keep parts organized for ease of assembly.

2. Clean and inspect nozzle assembly. (See “Inspect and Clean Fuel Injection Nozzles” on page 113.)

3. Carefully clamp injector body (B) in a soft-jaw vice.

NOTE: Insert the same number of shims (C) that were removed from injector. Number of shims will affect the opening pressure of the fuel nozzle and will be tested after assembly.

4. Reassemble fuel nozzle in the order shown above.

5. Tighten retaining nut to specification.

6. After assembly is complete, test injection nozzle. (See “Test Fuel Injection Nozzles” on page 60.)

Specifications

Fuel Injector Retaining Nut Torque . . . 8 N•m (70 lb-in.)

Inspect and Clean Fuel Injection Nozzles

Special or Required Tools

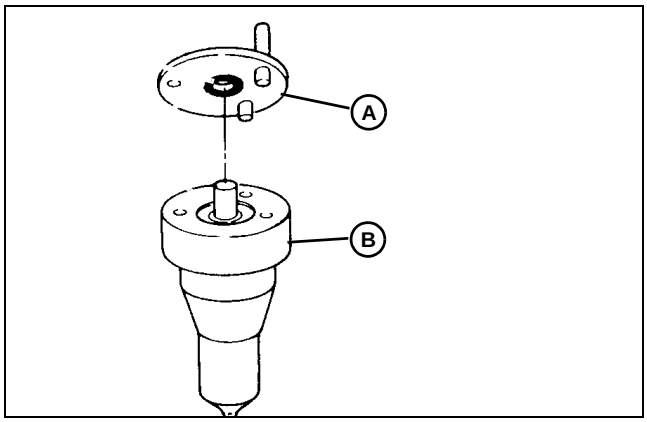
Tool Name	Tool No.	Tool Use
Fuel Injection Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.

NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

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).

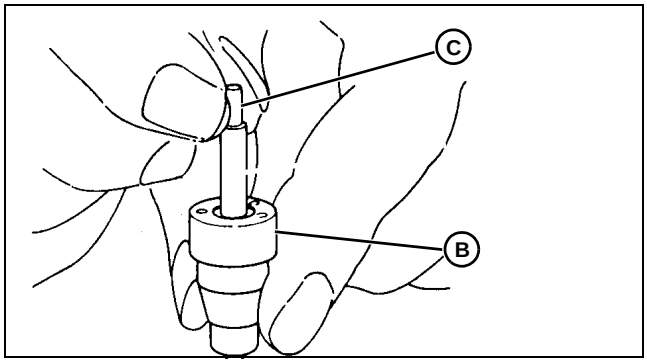


M82094A

3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate (A) and nozzle body (B) for nicks or scratches.

4. Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface on separator plate for wear. If contact surface is more than specification, replace nozzle assembly.



M82095A

6. Inspect the piston (large) part of nozzle valve (C) 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. Use the following procedure:

- Dip the nozzle valve (C) in clean diesel fuel. Insert valve in nozzle body (B).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat.

Replace nozzle assembly if the valve does not slide freely to its seat.

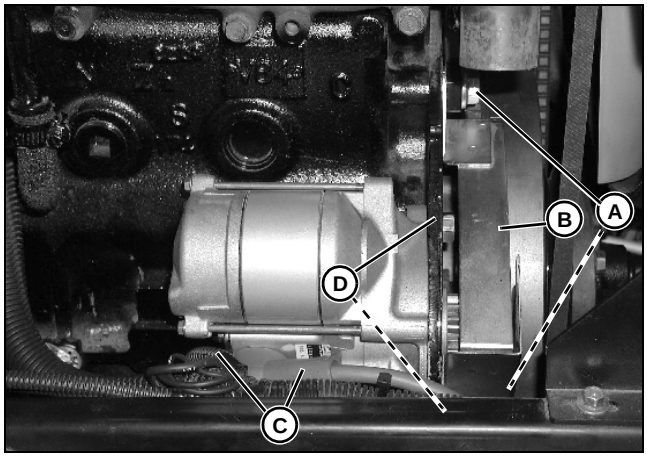
Specifications

Nozzle Contact Surface . . . . . 0.10 mm (0.004 in.)

Remove and Install Starter

Remove

1. Disconnect battery.



MX17950

2. Remove shield mounting cap screws (A) and shield (B).
3. Disconnect wires (C) to starter.
4. Remove starter mounting cap screws (D) and nuts.

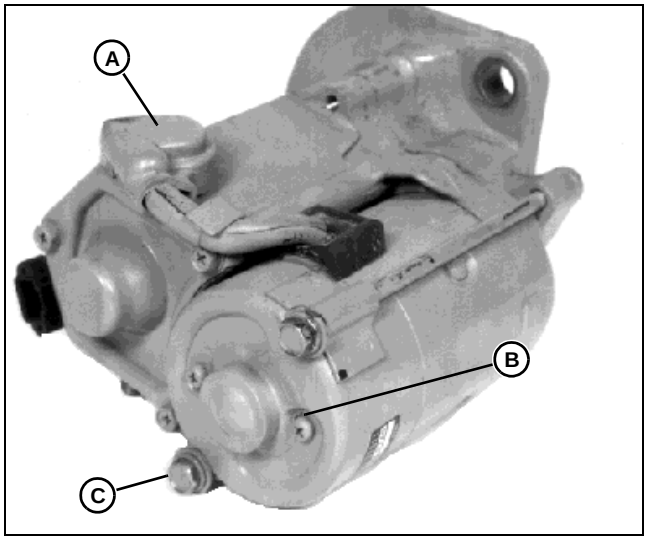
Install

NOTE: One side of two starter nuts is machined flat and should be installed toward starter flange.

Installation is done in reverse order of removal.

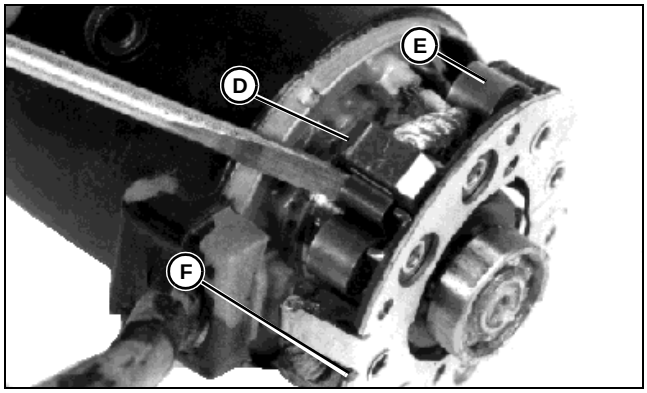
Disassemble and Assemble Starting Motor

Disassemble



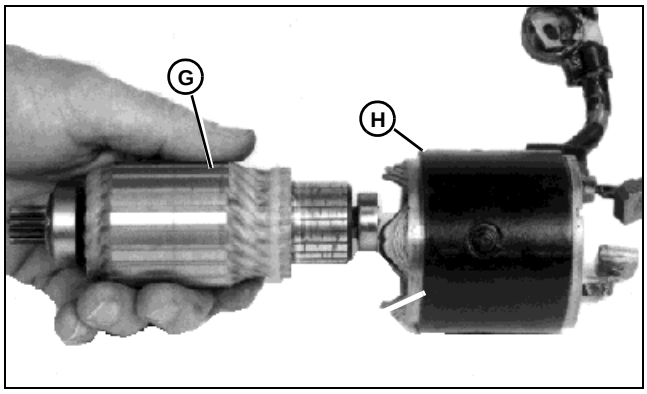
M82233

1. Disconnect field lead (A).
2. Remove two cap screws (C) that attach motor to clutch housing. Remove motor.
3. Remove two screws (B) that attach rear cover to brush holder.



M36754

4. Remove both field coil brushes (D) from brush holder (F).
5. Pry brush springs (E) away and pull negative brushes up enough to allow spring to hold brush in place.
6. Remove brush holder.

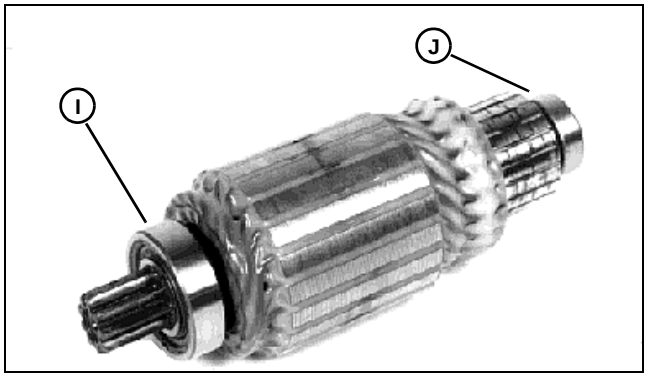


M36759

Picture Note: 1.4 kW Shown, 2.0 kW Is Similar

7. Remove armature (G) from field coil housing (H).

Replace bearings



M82237

1. Bearings are press fit. Remove bearings using a knife-edge puller set.

IMPORTANT: Avoid damage! Install both bearings with sealed side toward armature.

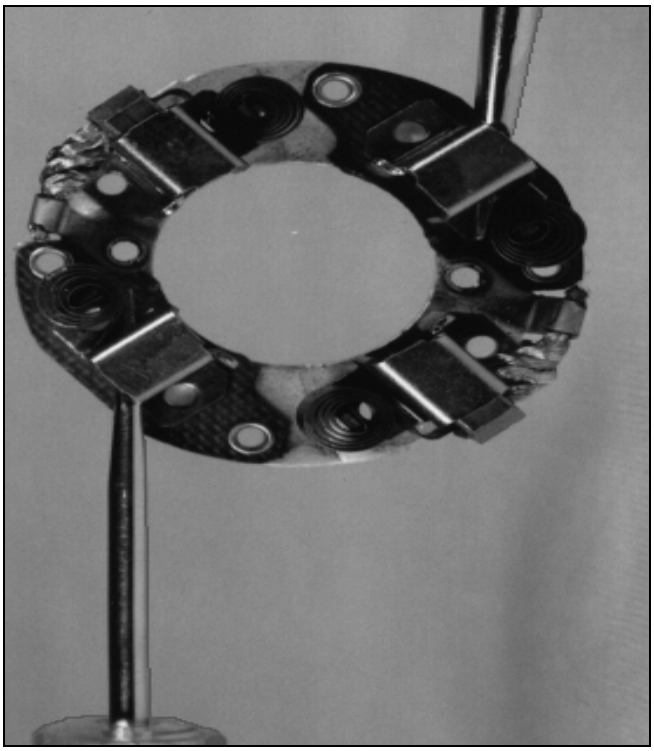
2. Install new housing bearing (I) tight against shoulder of shaft using a piece of pipe.

3. Install new rear cover bearing (J) tight against shoulder of shaft using a driver set.

4. Inspect and test brushes, holder, field coil and armature. (See “Inspect and Test Starting Motor” on page 116.)

Assembly

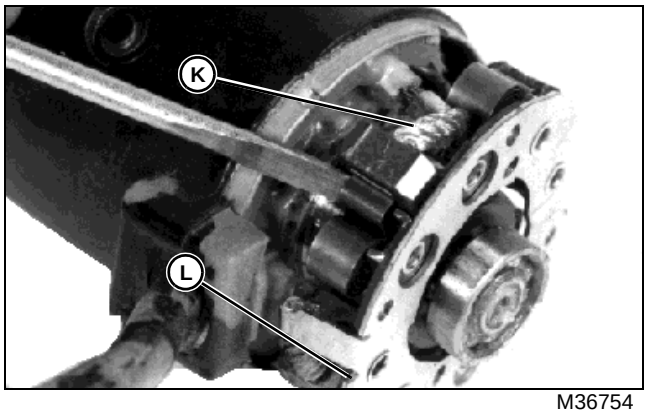
Assembly is done in the reverse order of disassembly.



M58789

NOTE: A pair of small screwdrivers inserted between the brush springs and the housing before assembly will aid in inserting the brushes.

Apply multipurpose grease to bearing cup inside rear cover.



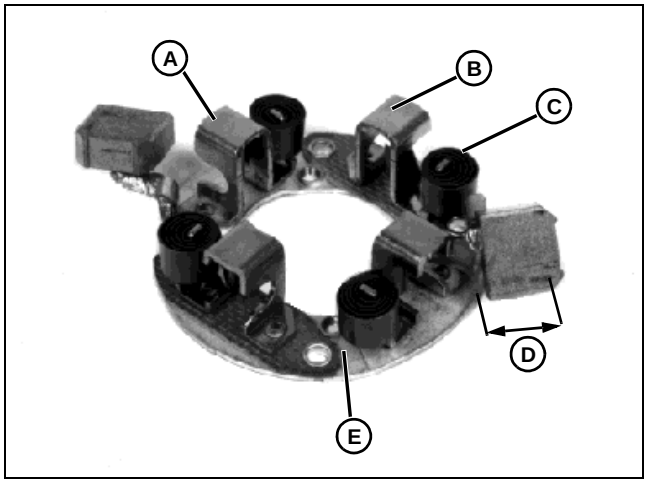
M36754

1. Turn brush holder (L) slightly to take up slack in brush wires.

IMPORTANT: Avoid damage! When installing rear cover, be sure field coil brush wires do not touch cover.

2. Press wires (K) inward to clear rear cover.

Inspect and Test Starting Motor



M82234

1. Measure brush lengths (D). Replace brush if length is below specification.

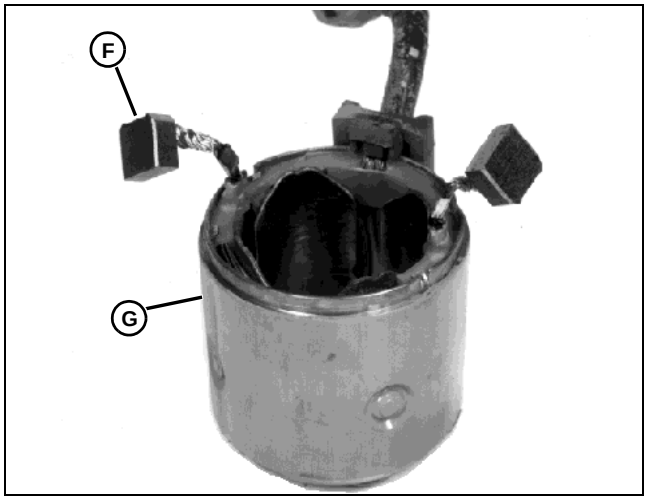
NOTE: Test brush holder using an ohmmeter or test light.

2. Test brush holder (E):

   • Touch one probe of tester to negative brush holder (A) and other probe to field brush holder (B). If there is continuity, replace the brush holder.

3. Inspect springs (C) for wear or damage. Replace if necessary.

NOTE: Test field coil using an ohmmeter or test light.



M82235

4. Test for grounded field winding:

   • Touch one probe of tester to field coil brush (F) and other probe to field coil housing (G).

   • Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.

IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a soft bristle brush.

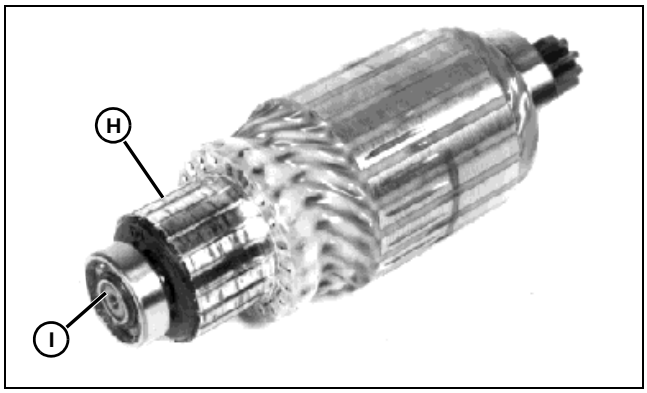
5. Test for open field coil:

   • Touch one probe of tester to each field coil brush. If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.

6. Inspect armature. Look for signs of dragging against pole shoes.

7. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400-grit sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

NOTE: Test armature windings using an ohmmeter or test light.



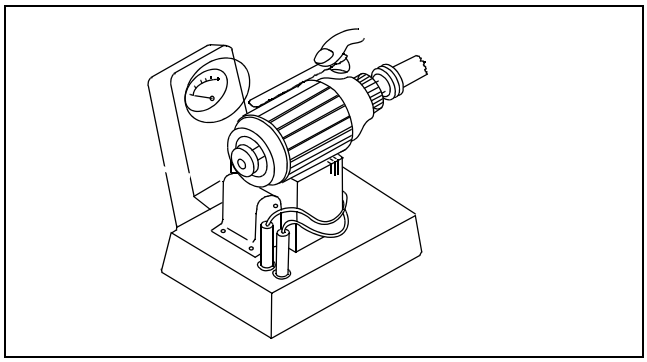
M82236

8. Test for grounded windings:

   • Touch probes on one commutator bar (H) and armature shaft (I). Armature windings are connected in series, so only one commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.

9. Test for open circuit windings:

   • Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



MIF

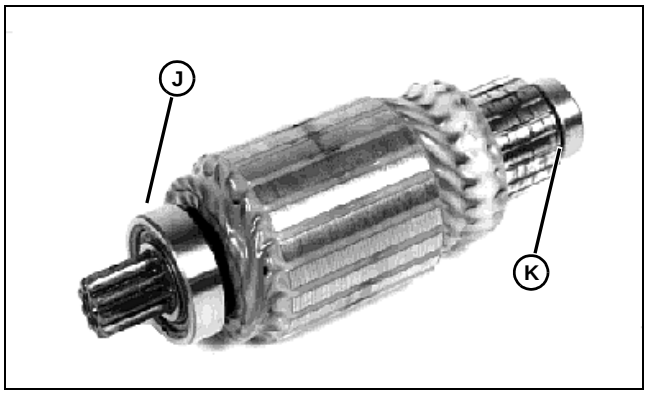
10.Test for short circuit windings using a growler.

- Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature. If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

11.If test indicates short circuit windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

12.Inspect armature cover and housing bearings for wear or damage. Replace if necessary.



M82237

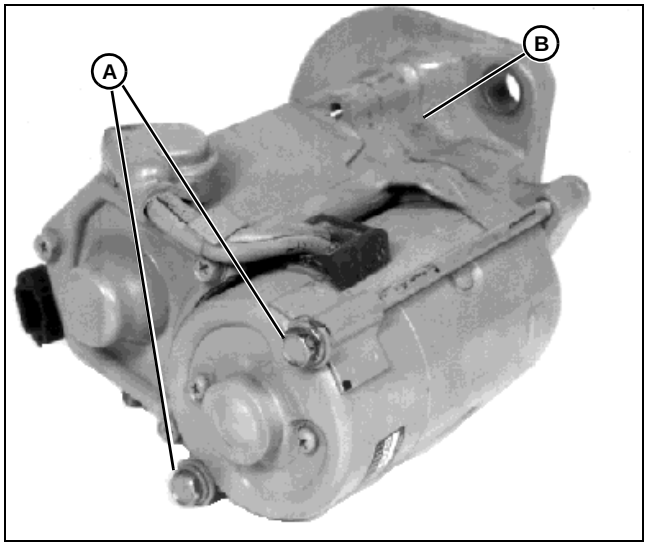
13.If replacement of bearings (J and K) is necessary, See “Disassemble and Assemble Starting Motor” on page 114.

Specifications

Brush Length (Minimum) . . . . . 9.0 mm (0.354 in.)

Disassemble and Assemble Starter Gear Train

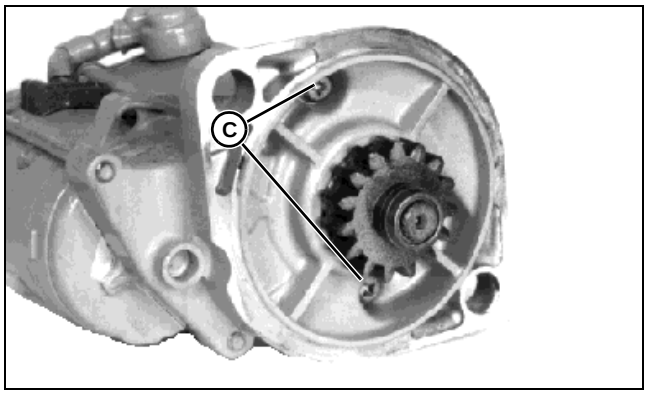
Disassemble



M82233

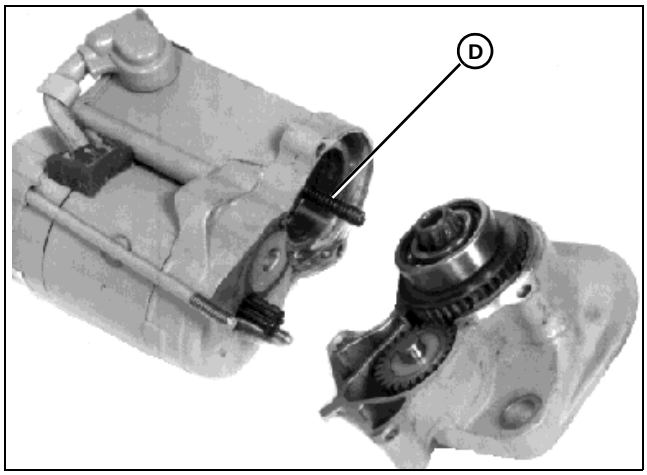
1. Remove field wire and two motor-to-clutch housing cap screws (A).

2. Remove motor from clutch housing (B).



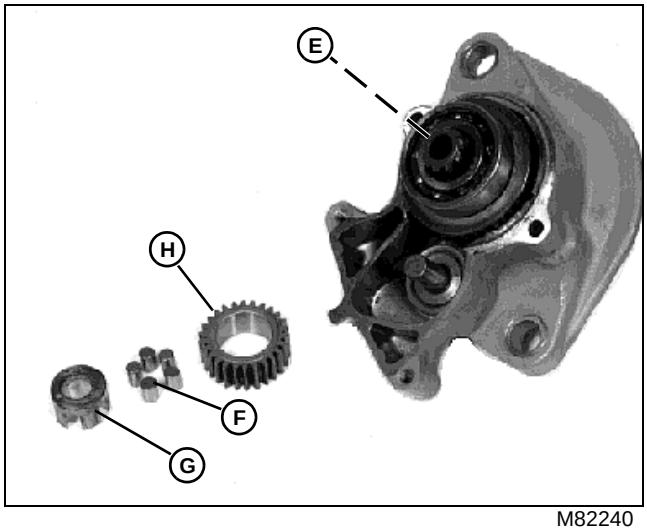
M82238

3. Remove two clutch housing-to-solenoid housing screws (C) to separate clutch housing from solenoid/motor assembly.



M82239

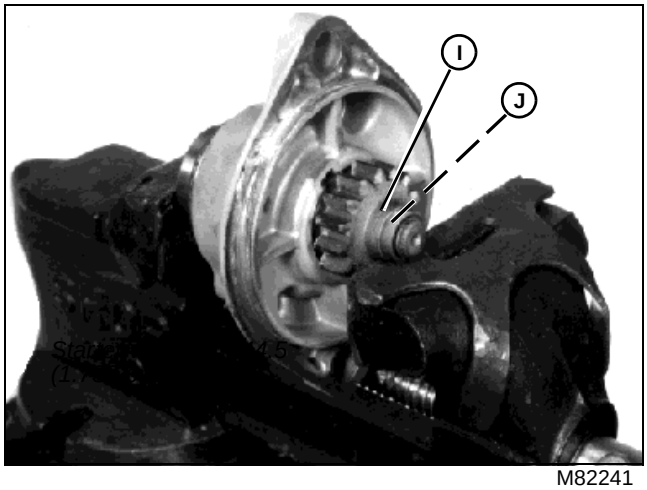
4. Remove plunger spring (D).



M82240

5. Remove retainer (G), five rollers (F) and pinion gear (H).

6. Remove steel ball (E).



M82241

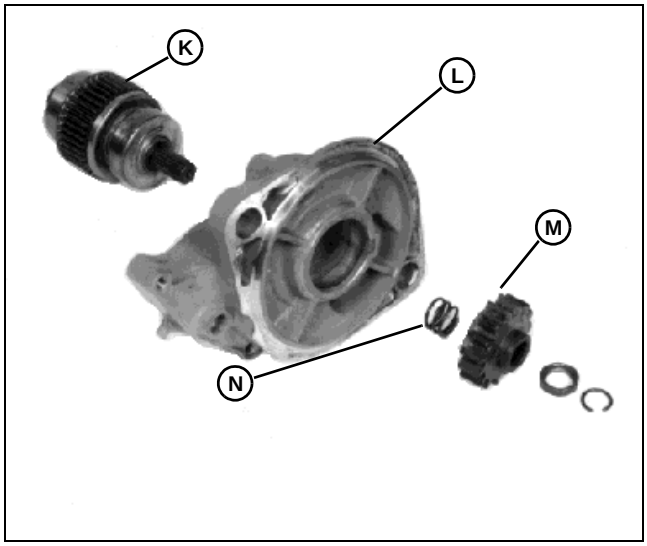
7. Place clutch (housing) assembly into a soft-jawed vise, as shown.

8. Tighten vise slowly, until drive gear compresses.

9. Remove retainer (I) and circlip (J).

CAUTION: Avoid injury! Shaft could be propelled from clutch unit with considerable force if spring is not allowed to extend fully while in vise.

10. While holding clutch assembly, slowly open vise until all spring compression is relieved.

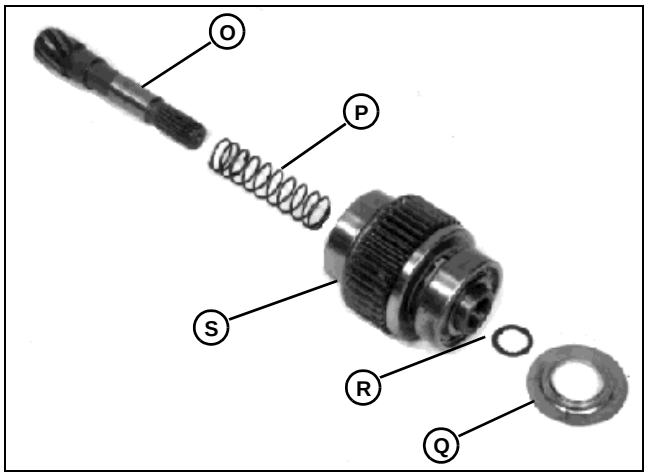


M82242

11. Remove drive gear (M), spring (N) and clutch assembly (K) from housing (L).

12. Remove large washer, toothed washer, spring and clutch shaft.

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



M82243

14. Remove large washer (not applicable to all models) (Q), toothed washer (R), spring (P) and clutch shaft (O) from clutch (S).

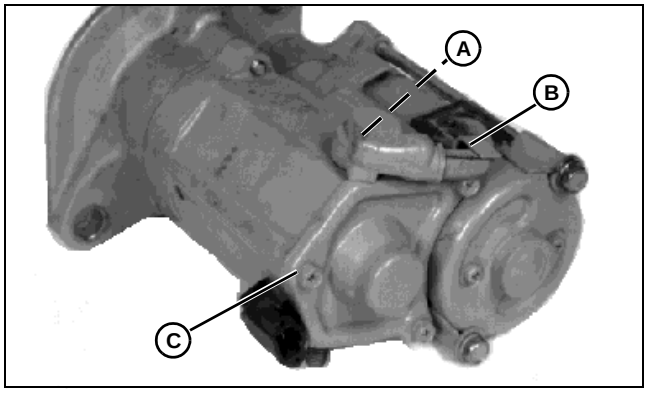
Assemble

Assembly is done in the reverse order of disassembly.

- Apply multipurpose grease to bearings, clutch shaft, springs, pinion gears, retainer, rollers and steel ball.
- Install large washer (not applicable to all models) with flat side toward clutch assembly.
- Install retainer with cupped side away from clutch assembly.

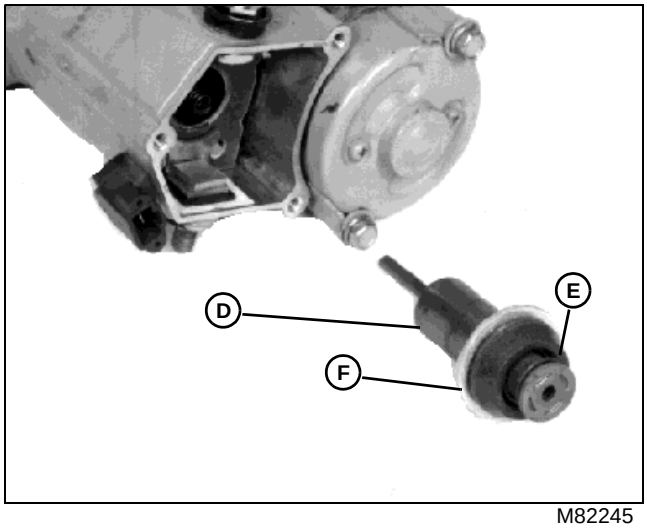
Disassemble, Inspect and Assemble Starter Solenoid

Disassemble



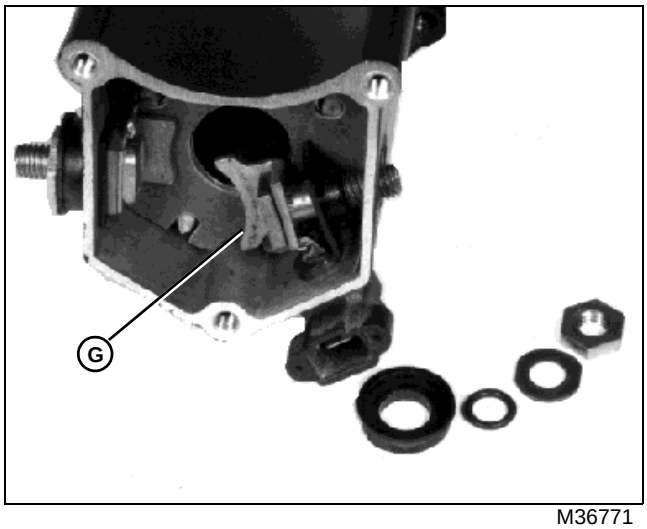
M82244

1. Disconnect field lead (A).
2. Remove three screws (C) and clip (B).
3. Remove cover and gasket.



M82245

4. Remove plunger (D).
5. Inspect the copper washer (F) and spring (E)



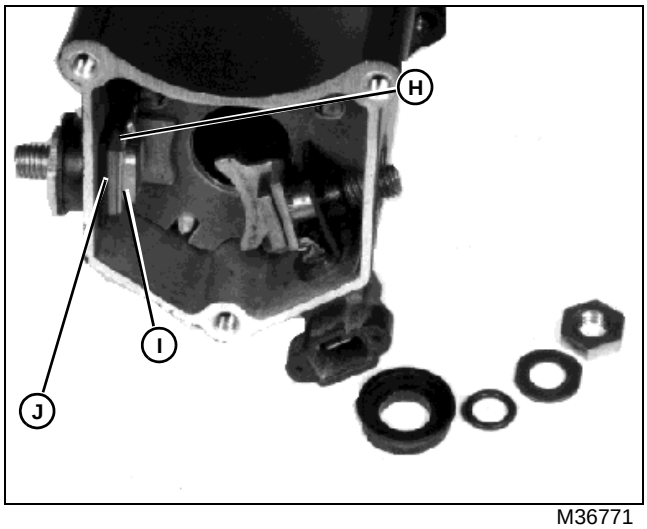
M36771

6. Inspect the contact plates (G) for excessive burning or pitting. Contacts and plunger come as a kit. If contacts or plunger are defective, replace all the parts with the kit.

Assemble

Assembly is done in the reverse order of disassembly.

NOTE: The assembly sequence of the left and right terminals is similar. Make sure smaller contact plate is on the left side.



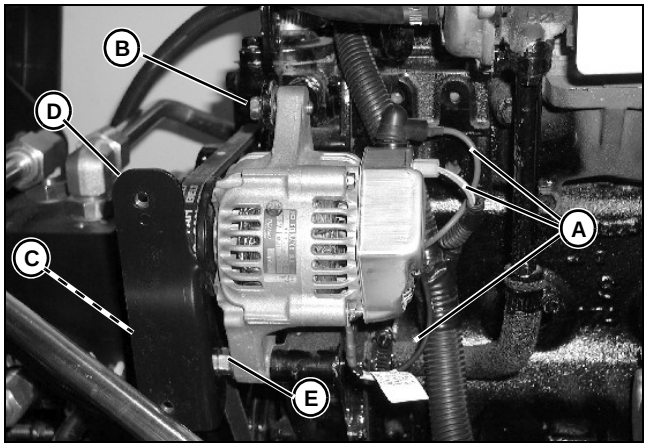
M36771

- Install solenoid terminal lead (H) between terminal bolt (I) and contact plate (J).

Remove and Install Alternator

Remove

1. Disconnect battery.
2. Remove alternator shield.



MX17949

3. Remove wires (A).
4. Remove cap screw (B).
5. Remove nut (C) and shield bracket (D).
6. Remove nut from stud (E).
7. Remove belt from alternator pulley and slide alternator from stud.

Install

Installation done in reverse order of removal.

- Adjust alternator belt. (See “Adjust Fan/Alternator Drive Belt” on page 63.)

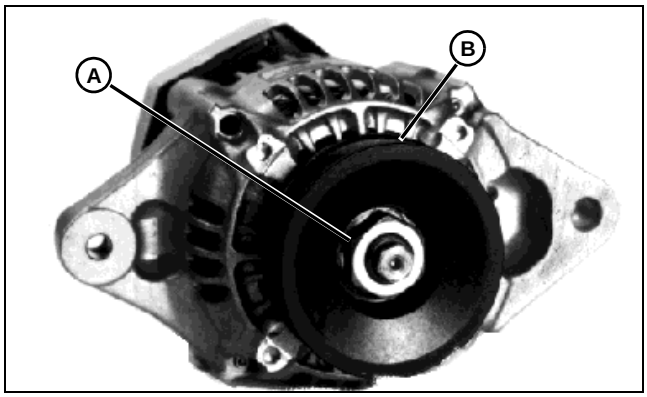
Disassemble, Inspect and Assemble Alternator

Special or Required Tools

Tool Name	Tool No.	Tool Use
Volt-Ohm-Amp Meter	NA	Used to test alternator components.

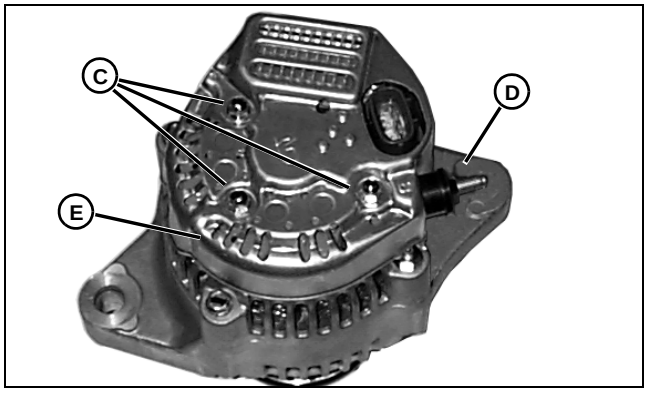
Disassemble

NOTE: Clamp the pulley in a soft-jawed vise and use an air impact wrench to remove the pulley nut.



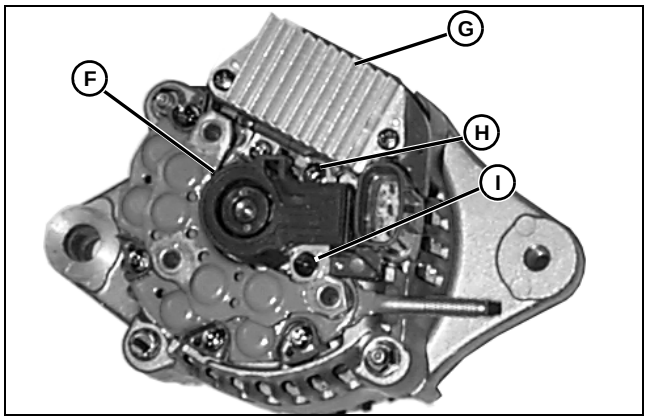
M52469

1. Remove the pulley nut (A) and pulley (B).



M52470

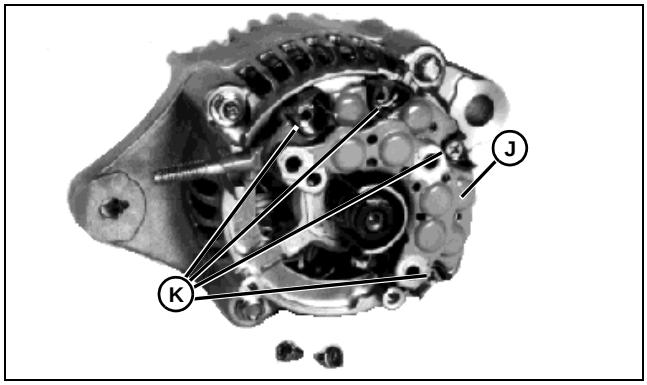
2. Remove the nut, washer and insulator from the battery terminal post (D).
3. Remove three screws (C) securing the cover (E) to the body. Remove the cover.



M52472

4. Note the location of the short screw (H) on the regulator tab, and the long screw (I) on the brush holder. Remove two screws securing the brush holder and cover (F) to the body. Remove the brush holder and cover.

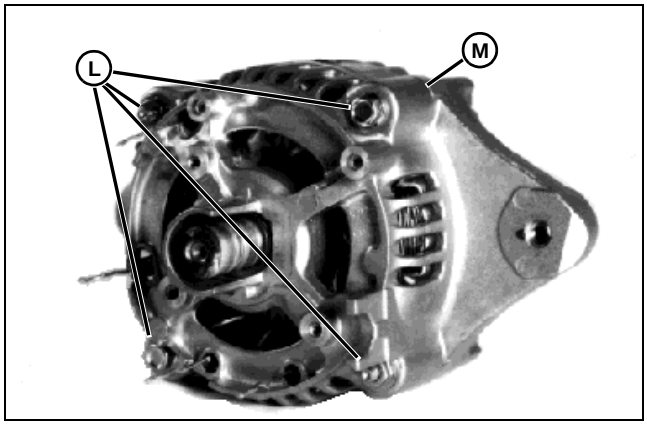
5. Remove the three screws securing the voltage regulator (G) to body. Remove the voltage regulator.



M52471

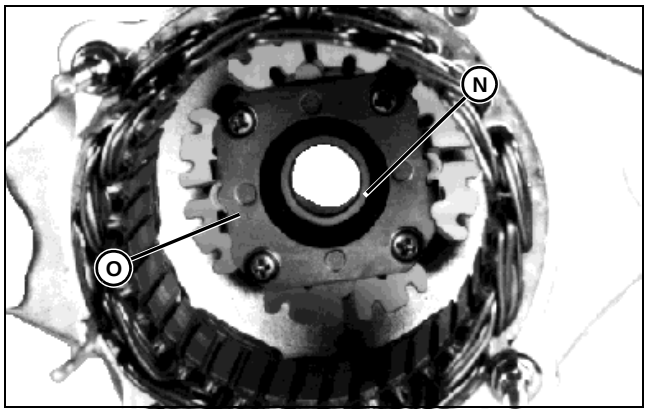
6. Remove four screws (K) and straighten the wire leads.

7. Remove the rectifier (J).



M52473

8. Remove cap screws and nuts (L) and slide off the rear case assembly (M).



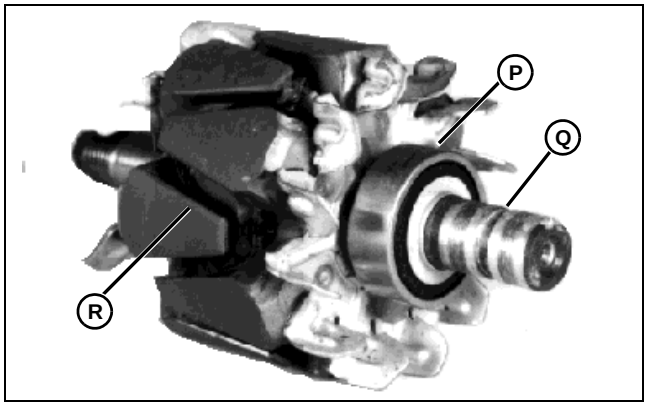
M52475

9. Slide the rotor out of the front frame.

10. Remove the bearing retainer plate (O).

11. Press bearing (N) from the case.

Inspect



M52474

1. Inspect bearing (P) for smooth rotation. Replace if necessary.

2. Inspect slip rings (Q) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicon carbide paper to polish the rings.

3. Measure the outer diameter of the slip rings. Replace the rotor if less than specification.

4. Check for continuity between slip rings using an ohmmeter or continuity tester. Replace the rotor assembly if there is no continuity.

5. Check for continuity between the slip rings and the rotor core (R). Replace the rotor assembly if there is continuity.

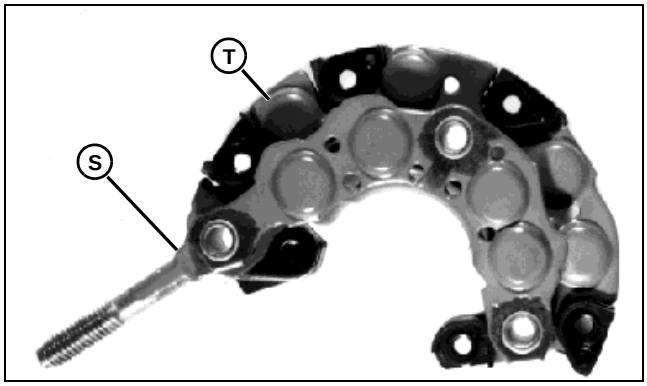
NOTE: Use an ohmmeter that is sensitive to 0-1 ohm.

6. Inspect the stator for defective insulation, discoloration, or burned odor.

NOTE: The stator is not serviced separately. If the stator is bad it must be replaced as part of the frame assembly.

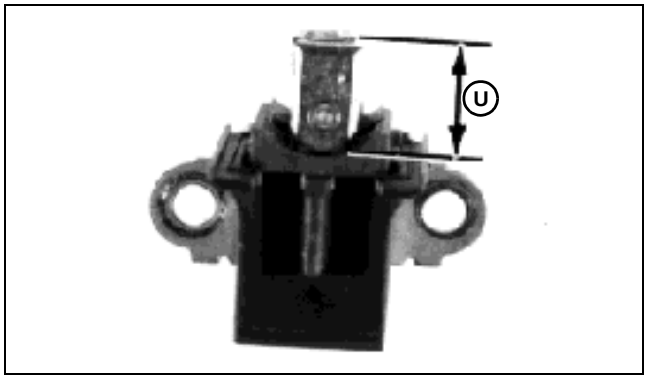
7. Check for continuity between each of the four stator leads and the body. Replace the frame assembly if there is continuity.

NOTE: Set the ohmmeter to the K-ohm range.



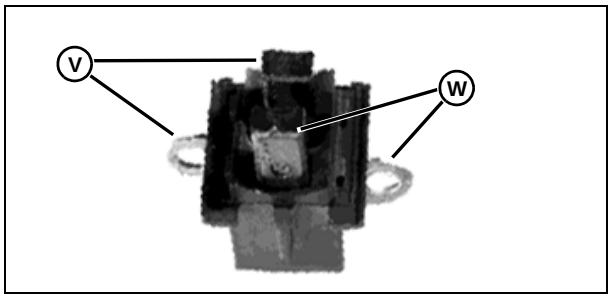
M52477

8. Check for continuity between the main lead (S) and each diode lead (T). Reverse the ohmmeter leads and recheck. If there is continuity in one direction, but not the other, the diode is working correctly. Replace any diode or rectifier plate that is not working correctly.



M52478

9. Measure the length of the brush protruding from the holder (U). Compare dimension with minimum specification. Replace the brushes if worn below the minimum. Check maximum exposed new brush length and compare with specification.



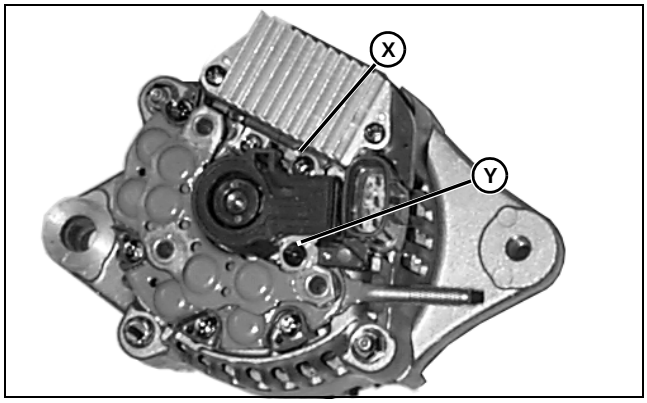
M52479

10. Check for continuity between the brush and terminal (V). Check for continuity between the brush and terminal (W). There should be continuity only at these points.

Assemble

Assembly procedure is the reverse of disassembly.

NOTE: Check that the rotor fan does not contact the case, and that the rotor assembly turns smoothly in the bearing.



M91674

IMPORTANT: Avoid damage! If the longer screw is installed in the wrong position it will contact the frame and will cause damage to the charging system.

1. Install the short screw in slot (X) and install the longer screw in slot (Y).

2. Clamp the pulley in a soft-jawed vise. Install the pulley nut. Tighten the nut to specification.

Specification

Slip Ring Diameter (Minimum) . . . . . 14 mm (0.55 in.)
Exposed Brush Length (Minimum). . . 4.5 mm (0.17 in.)
Exposed Brush Length (Maximum) . 10.5 mm (0.41 in.)
Pulley Nut Torque. . . . . 69 N•m (51 lb-ft)

Remove and Install Turbocharger

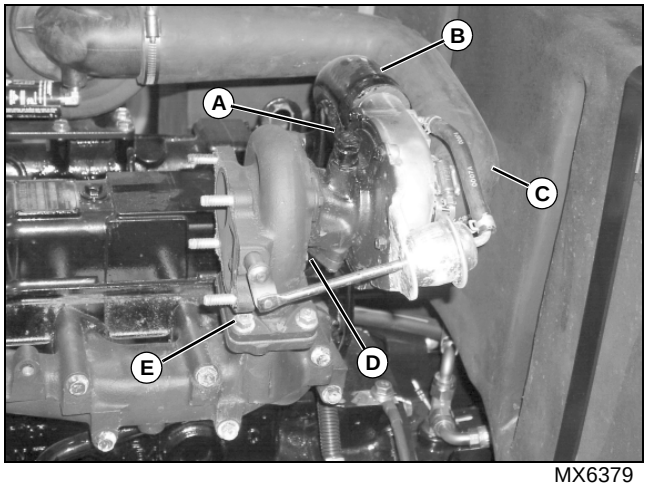
Removal

CAUTION: Avoid injury! Muffler may be hot. Allow muffler to cool before removing. A hot muffler can cause serious burns.

IMPORTANT: Avoid damage! When cleaning turbocharger, DO NOT spray directly into compressor turbine housing. If inspection is required of turbocharger, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode

If inspection is not required, thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

1. Remove muffler.



MX6379

2. Remove turbocharge-to-intake manifold hose (B).
3. Remove air cleaner-to-turbocharger hose (C).
4. Remove oil supply line (A) with copper washers on top and bottom surface of oil supply line.
5. Remove oil drain line (D).
6. Remove four nuts (E).
7. Remove turbocharger and gasket.
8. Close all openings using caps and plugs to prevent contamination.

Installation

Installation is done in the reverse order of removal.

- Prelube turbocharger: Fill oil inlet or drain port with clean oil and turn rotating assembly (by hand) to properly lubricate bearings.
- Install new gasket between exhaust manifold and turbocharger.
- Install new O-ring on oil drain line.
- Install new copper washers on oil supply line.

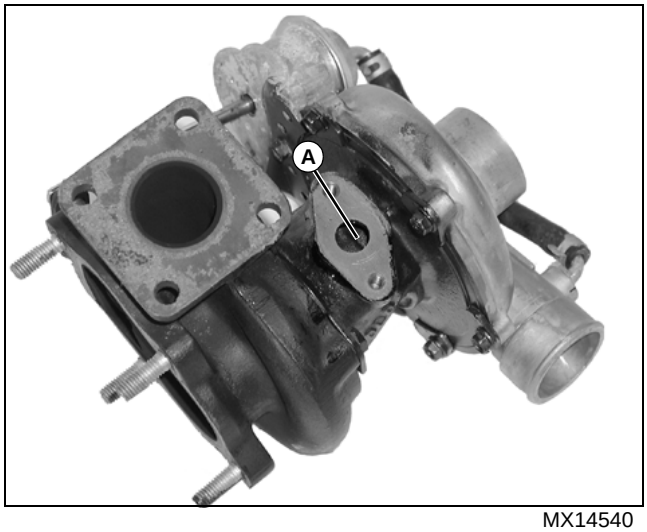
IMPORTANT: Avoid damage! A new or repaired turbocharger does not have an adequate oil supply for immediate start-up of engine. Perform the following steps to prevent damage to turbocharger bearings.

1. Disconnect fuel shutoff connector.
2. Crank engine over with starter until oil pressure light goes out. DO NOT crank engine longer than 30 seconds at a time to avoid damaging the starter.

Repair Turbocharger

Turbochargers used on the engines covered in this manual are available through service parts as a complete remanufactured assembly only. Individual components for repair are not available.

Prelube Turbocharger



MX14540

IMPORTANT: Avoid damage! DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil inlet or drain port (A) with clean engine oil and spin rotating assembly (by hand) to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.

ELECTRICAL TABLE OF CONTENTS

Table of Contents

Specifications

General Specifications

Battery

Voltage	12
BCI Group	45
CCA Rating at -18°C (0°F)	480
Reserve Capacity (Minutes)	80
Specific Gravity	1.225 or above
Load Test for 5 Seconds (Minimum)	480 amps

Starter

Type	Solenoid shift
Loaded (On Vehicle) Draw (1.2 kW) at 300 rpm (Max)	300 amps
No-Load (Free Spinning) Draw (1.2 kW) at 3000 rpm (Max)	120 amps

Alternator

Type	Nippondenso
Regulator	Internal
Rating	40 amps
Regulated Amperage (Min)	35 amps
Unregulated Amperage (Min)	35 amps
Regulated Voltage	12.2-14.8 volts
Resistor at 25°C (77°F)	47-53 ohms
Tachometer Output (“P” Terminal) (Min)	6.3 volts

Engine Coolant Temperature Switch

Closing Temperature	107-113°C (225-235°F)
Opening Temperature	97-103°C (207-217°F)

Fuel Shutoff Solenoid

Pull-In Coil Resistance	0.4 ohm
Hold-In Coil Resistance	23.6 ohms

Four-Wheel Drive Solenoid

Coil Resistance	10 ± 2 ohms

Mow Solenoid

Coil Resistance	10 ± 2 ohms

Raise Solenoid

Coil Resistance	10 ± 2 ohms

Lower Solenoid

Coil Resistance	10 ± 2 ohms

Hydraulic Oil Temperature Sensor Resistance

At 128°C (262°F)	78.96-85.30 ohms

Hydraulic Oil Filter Restriction Switch

Closing Pressure	**276 ± 28 kPa (40 ± 4 psi)**
Opening Pressure	**207 kPa (30 psi)**

Air Preheater

Resistance	**0.40-0.50 ohm**

Lighting

Headlights (halogen)	**37.5 watts**
Taillights (Optional)	**21 watts**

Cruise Control Magnet

Coil Resistance	**20 ± 4 ohms**

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to test battery.
Battery Tester	JT05685	Used to test battery. Used to test alternator amperage and voltage. Used to test starter loaded amperage draw.
Battery Charger (Variable Rate) (use according to manufacturer's instructions)	NA	Used to charge battery.
Digital Multimeter	JT05791	Used to test alternator amperage and voltage. Used to test diodes. Used to test various switches. Used to test relays. Used to test solenoids. Used to test fuse continuity.
Ammeter Shunt Assembly	JT05792	Used to test alternator amperage and voltage.
Two (2) Jumper Wires	NA	Used to test starter solenoid. Used to test relays. Used to test fuel pump.
Two (2) Jumper Cables	NA	Used to test starter solenoid.
12-V Battery	NA	Used to test starter solenoid. Used to test relays.

General Information

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 shows only the 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 provides:

- Test conditions
- Test location
- A question regarding the normal reading
- A yes or no answer 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.

Common Circuit Tests

Shorted Circuit

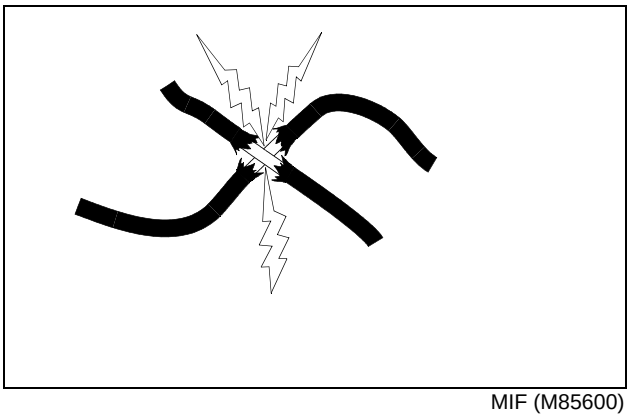
A shorted circuit may result in the wrong component operating (i.e., improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

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.



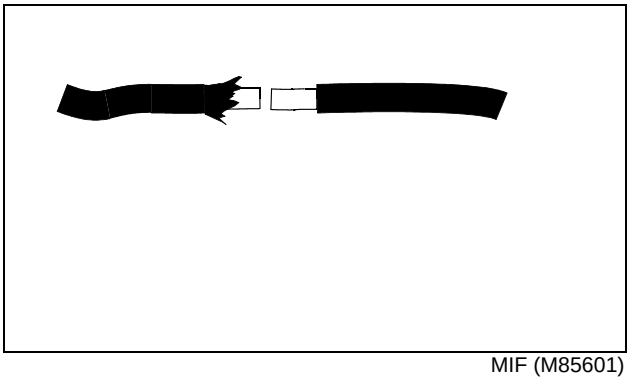
MIF (M85600)

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.

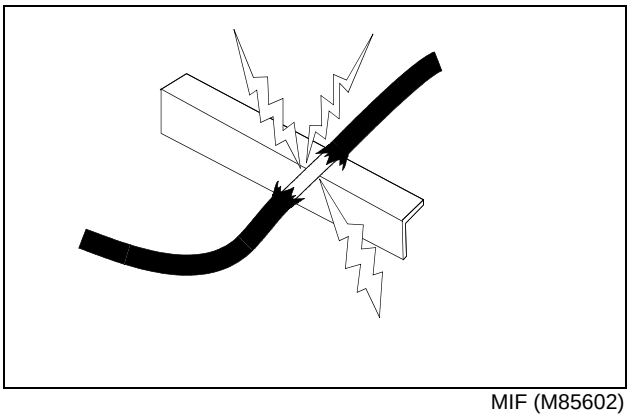
2. If terminals are not corroded or loose, the problem is in the component or wiring.



MIF (M85601)

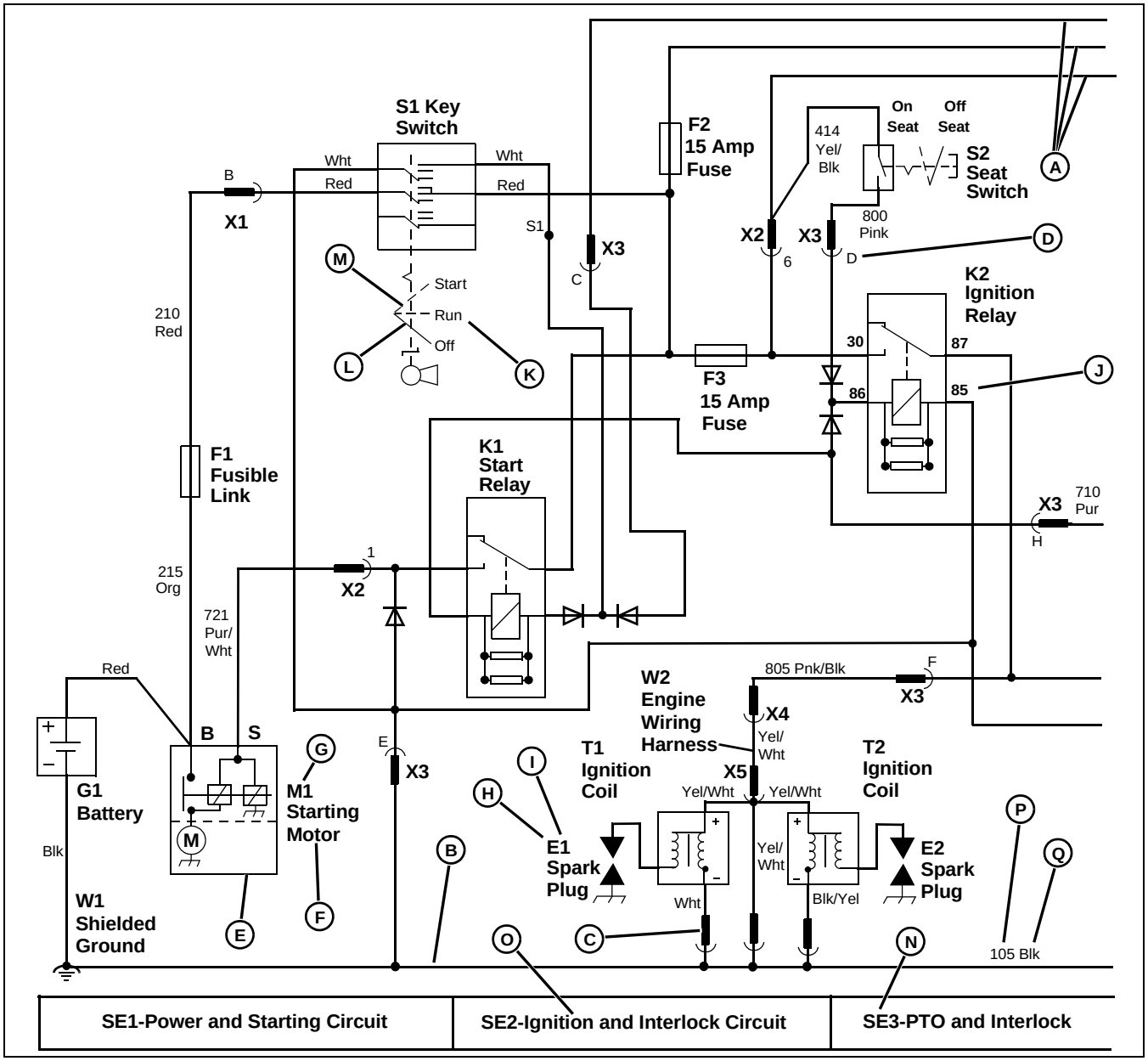
Grounded Circuit

Grounded circuits usually result in no component operation or a blown fuse.



MIF (M85602)

Reading Electrical Schematics



MIF

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) of the wires are shown directly next to the wire path.

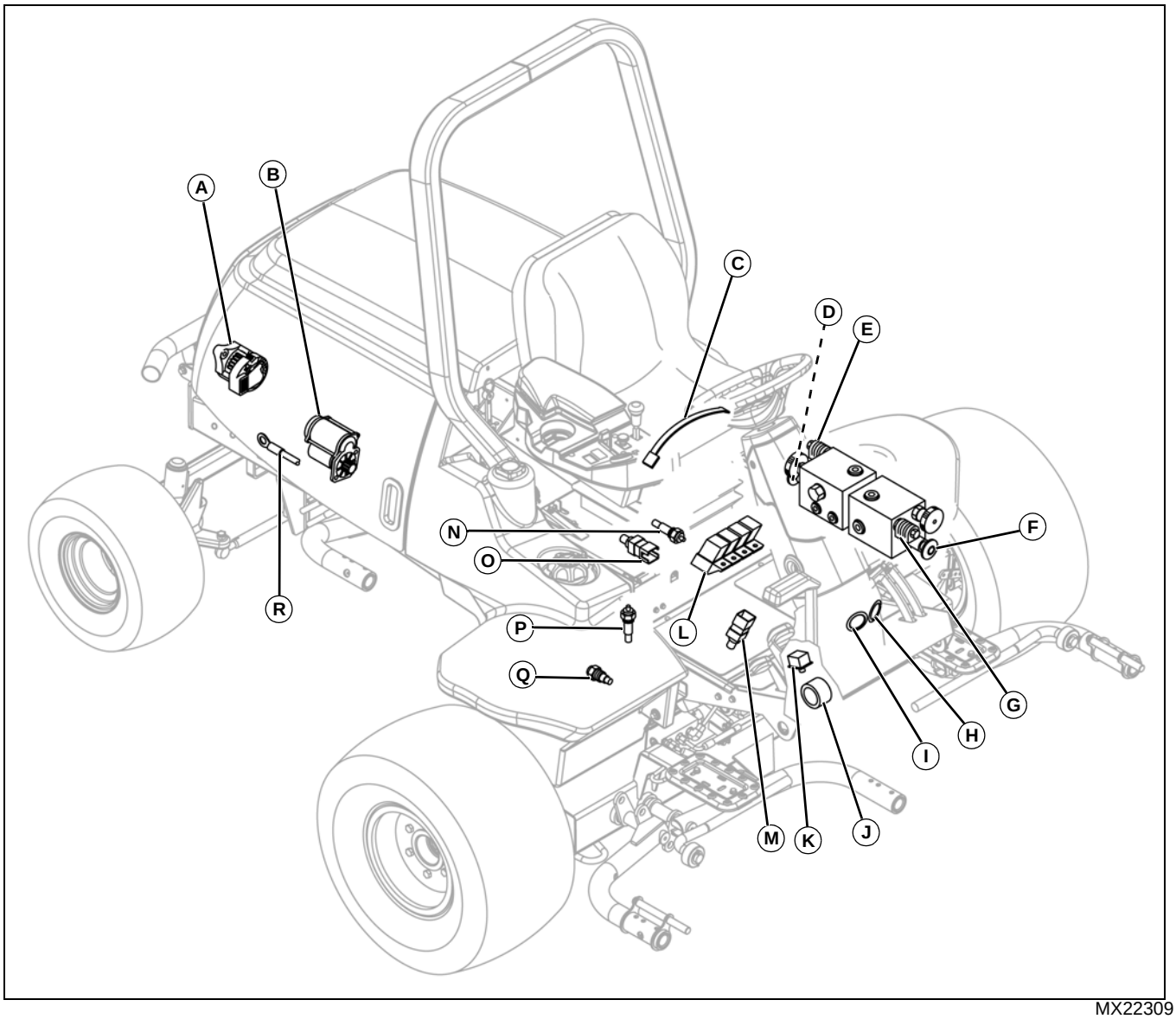
The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Wire Color Abbreviation Chart

Blk	Black
Blu	Blue
Brn	Brown
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Tan	Tan
Wht	White
Yel	Yellow

Component Location

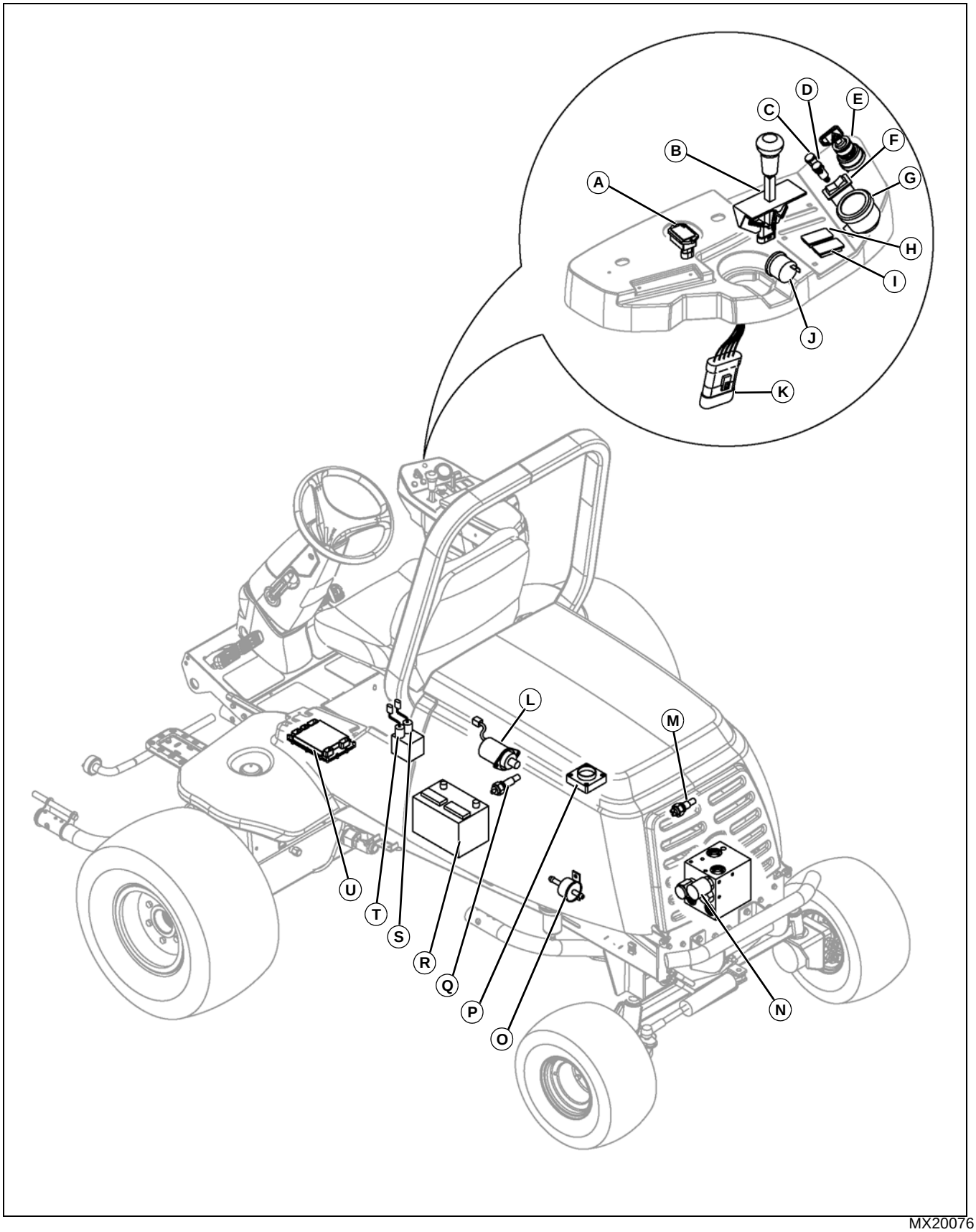
Electrical Components



MX22309

A - Alternator (G2)
B - Starting Motor (M1)
C - Seat Switch (S5)
D - Rear Backlap Switch (S9)
E - Rear Mow Solenoid (Y4)
F - Front Backlap Switch (S8)
G - Front Mow Solenoid (Y3)
H - Left Headlight (E2)
I - Right Headlight (E1)
J - Cruise Control Magnet
K - Brake Switch (S3)
L - Relays (K1-K5)
M - Mow/Trans Switch (S2)
N - Neutral Switch (S6)
O - Reverse Switch (S4)
P - Hydraulic Oil Filter Restriction Switch (B1)
Q - Hydraulic Oil Temperature Sensor (B4)
R - Engine-to-Frame Ground Strap

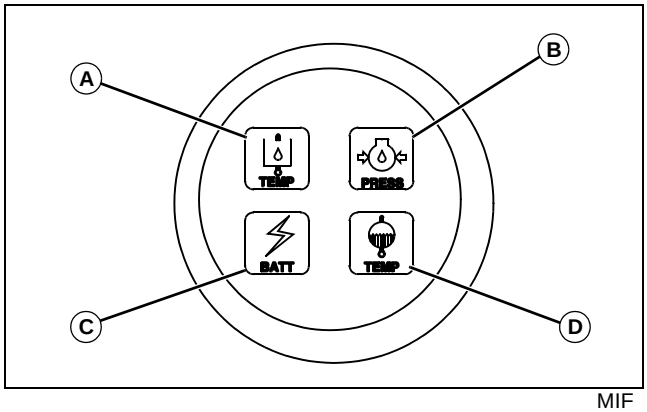
ELECTRICAL COMPONENT LOCATION



MX20076

A - Hour Meter (P1)
B - Raise/Lower Switch (S10)
C - Air Preheater Light (H2)
D - Hydraulic Air Filter Restriction Light (H3)
E - Key Switch (S1)
F - Light Switch (S12)
G - Indicator Cluster (A2)
H - Cruise Control Switch (S11)
I - Four Wheel Drive Switch (S7)
J - Buzzer (H1)
K - Diode Pack (V4)
L - Fuel Shutoff Solenoid (Y1)
M - Engine Coolant Temperature Switch (B3)
N - Four Wheel Drive Solenoid (Y5)
O - Fuel Pump (M2)
P - Air Preheater (R1)
Q - Engine Oil Pressure Switch (B2)
R - Battery (G1)
S - Raise Solenoid (Y7)
T - Lower Solenoid (Y6)
U - Electronic Control Module (A1)

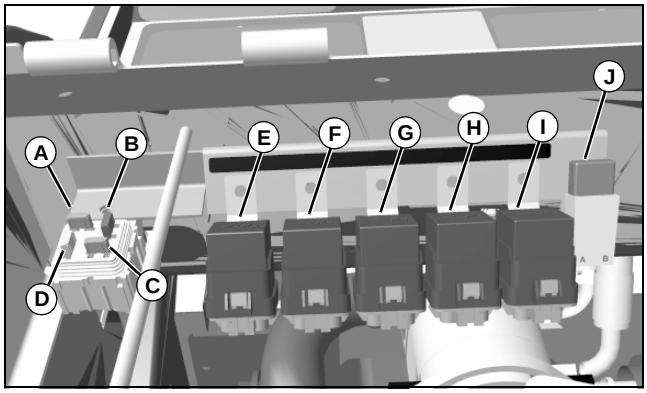
Indicator Cluster



MIF

A - Hydraulic Oil Temperature Light
B - Engine Oil Pressure Light
C - Discharge Light
D - Engine Coolant Temperature Light

Fuse/Diode Block, Relays and Circuit Breaker



MX18612

A - Headlight Fuse (F5) (15A)
B - Start Relay Diode (V1)
C - Key Switch Fuse (F3) (15A)
D - Tail/Work Light Fuse (F6) (20A)
E - Start Relay (K1)
F - Not Used S.N. (-020000)
G - Air Preheater Relay (K4)
H - Light Relay (K5)
I - Fuel Pull-In Relay (K2)
J - Not Used S.N. (-020000)

Schematics and Harnesses

Schematic and Wiring Harness Legend

Component

A1 - Electronic Control Module (SE7)

A2 - Indicator Cluster (SE12, W1)

B1 - Hydraulic Oil Filter Restriction Switch (SE12, W2)

B2 - Engine Oil Pressure Switch (SE12, W2)

B3 - Engine Coolant Temperature Switch (SE12, W2)

B4 - Hydraulic Oil Temperature Sensor (SE12, W9)

E1 - Right Headlight (SE14, W2)

E2 - Left Headlight (SE 14, W2)

F1 - Fusible Link (SE2, W2)

F3 - Key Switch Fuse (SE2, W2)

F5 - Headlight Fuse (SE14, W2)

F6 - Tail/Work Light Fuse (SE14, W2)

G1 - Battery (SE1)

G2 - Alternator (SE1, W2)

H1 - Buzzer (SE12, W1)

H2 - Air Preheater Light (SE12, W1)

H3 - Hydraulic Oil Filter Restriction Light (SE12, W1)

H4 - Engine Oil Pressure Light (SE12, W1)

H5 - Engine Coolant Temperature Light (SE12, W1)

H6 - Discharge Light (SE12, W1)

H7 - Hydraulic Oil Temperature Light (SE12, W1)

K1 - Start Relay (SE2, W2)

K2 - Fuel Pull-In Relay (SE3, W2)

K4 - Air Preheater Relay (SE11, W2)

K5 - Light Relay (SE14, W2)

K6 - Down Pressure Relay (SE15, W14) (Optional)

M1 - Starting Motor (SE2, W2)

M2 - Fuel Pump (SE11, W2)

P1 - Hour Meter (SE12, W1)

R1 - Air Preheater (SE11, W2)

S1 - Key Switch (SE2, W1)

S2 - Mow/Trans Switch (SE5, W11)
S.N. (-020000)

S2 - Mow/Trans Switch (SE5, W2)
S.N. (020001-)

S3 - Brake Switch (SE4, W10)

S4 - Reverse Switch (SE5, W6)

S5 - Seat Switch (SE4, W2)

S6 - Neutral Switch (SE4, W12)

S7 - Four-Wheel Drive Switch (SE6, W1)

S8 - Front Backlap Switch (SE9, W2)

S9 - Rear Backlap Switch (SE9, W2)

S10 - Raise/Lower Switch (SE10, W1)

S11 - Cruise Control Switch (SE13, W1)

S12 - Light Switch (SE14, W1)

V1 - Start Relay Diode (SE2, W2)

V2 - Fuel Shutoff Solenoid Diode (SE3, W2)

V4 - Diode Pack (SE12, W1)

W1 - Control Arm Wiring Harness

W2 - Main Wiring Harness

W3 - Battery Ground (SE1)

W4 - Harness Ground (SE1, W2)

W5 - Harness Ground (SE1, W2)

W6 - Reverse Switch Wiring Harness

W7 - Delay Wiring Harness (SE4)

W8 - Headlight Wiring Harness

W9 - Hydraulic Oil Temperature Sensor Wiring Harness

W10 - Brake Switch Wiring Harness

W11 - Mow/Trans Switch Wiring Harness

W12 - Neutral Switch Wiring Harness

W13 - Down Pressure Y-Wiring Harness (Optional)

W14 - Down Pressure Relay Wiring Harness (Optional)

Y1 - Fuel Shutoff Solenoid (SE3, W2)

Y3 - Front Mow Solenoid (SE5, W2)

Y4 - Rear Mow Solenoid (SE5, W2)

Y5 - Four-Wheel Drive Solenoid (SE6, W2)

Y6 - Lower Solenoid (SE10, W2)

Y7 - Raise Solenoid (SE10, W2)

Y8 - Cruise Control Magnet (SE13, W2)

Y9 - Down Pressure Solenoid (SE15, W14) (Optional)

Connectors

X1 - Air Preheater Light Terminal (W1)

X2 - Air Preheater Light Terminal (W1)

X3 - Light Switch Connector (W1)

X4 - Hydraulic Oil Filter Restriction Light Terminal (W1)

X5 - Hydraulic Oil Filter Restriction Light Terminal (W1)

X6 - Key Switch Connector (W1)

X7 - Indicator Cluster Connector (W1)

X8 - Mow/Trans Harness Connector (W1, W11)
S.N. (-020000)

X8 - Mow/Trans Switch Connector (W2)
S.N. (020001-)

X9 - Cruise Control Switch Connector (W1)

X10 - Raise/Lower Switch Connector (W1)

X11 - Four-Wheel Drive Switch Connector (W1)

X12 - Diode Pack Connector (W1)

X13 - Hour Meter Connector (W1)

X14 - Buzzer Connector (W1)

X15 - Control Arm Harness Connector (W1, W2)

X16 - Control Arm Harness Connector (W1, W2)

X17 - Left Work Light Connector (W2)

X18 - Right Work Light Connector (W2)

X19 - Headlight Connector (W2, W8)

X20 - Brake Switch Harness Connector (W2, W10)

X21 - Cruise Control Magnet Connector (W2)

X22 - Rear Mow Solenoid Connector (W2)

X23 - Rear Backlap Switch Connector (W2)

X24 - Hydraulic Oil Temperature Sensor Harness Connector (W2, W9)

X25 - Hydraulic Oil Filter Restriction Switch Connector (W2)

X26 - Fuse/Diode Block Connector (W2)

X27 - Start Relay Connector (W2)

X28 - Connector (Not Used) (W2)
S.N. (-020000)

X29 - Air Preheater Relay Connector (W2)

X30 - Light Relay Connector (W2)

X31 - Fuel Pull-In Relay Connector (W2)

X32 - Connector (Not Used) (W2)
S.N. (-020000)

X33 - Front Mow Solenoid Connector (W2)

X34 - Front Backlap Switch Connector (W2)

X35 - Reverse Switch Harness Connector (W2, W7)

X36 - Seat Switch Connector (W2)

X37 - Neutral Switch Harness Connector (W2, W12)

X38 - Raise Solenoid Connector (W2)

X39 - Lower Solenoid Connector (W2)

X40 - Electronic Control Module (J5) Connector (W2)

X41 - Electronic Control Module (J2) Connector (W2)

X42 - Connector (Not Used) (W2)
S.N. (-020000)

X43 - Connector (Not Used) (W2)
S.N. (-020000)

X44 - Electronic Control Module (J1) Connector (W2)

X45 - Electronic Control Module (J3) Connector (W2)

X46 - Electronic Control Module (J4) Connector (W2)

X47 - Fuel Shutoff Solenoid Connector (W2)

X48 - Fuel Shutoff Solenoid Diode Connector (W2)

X49 - Fuel Pump Connector (W2)

X50 - Taillight Connector (W2)

X51 - W4 Harness Ground Terminal (W2)

X52 - Engine Oil Pressure Switch Connector (W2)

X53 - Engine Coolant Temperature Switch Connector (W2)

X54 - Air Preheater Connector (W2)

X55 - Alternator Battery Terminal (W2)

X56 - Alternator Ground Terminal (W2)

X57 - Starter Solenoid Connector (W2)

X58 - Alternator Connector (W2)

X59 - Hood Switch Connector (W2)

X60 - Four-Wheel Drive Solenoid Connector (W2)

X61 - Starting Motor Battery Terminal (W2)

X62 - W5 Harness Ground Terminal (W2)

X63 - Reverse Switch Connector (W8)

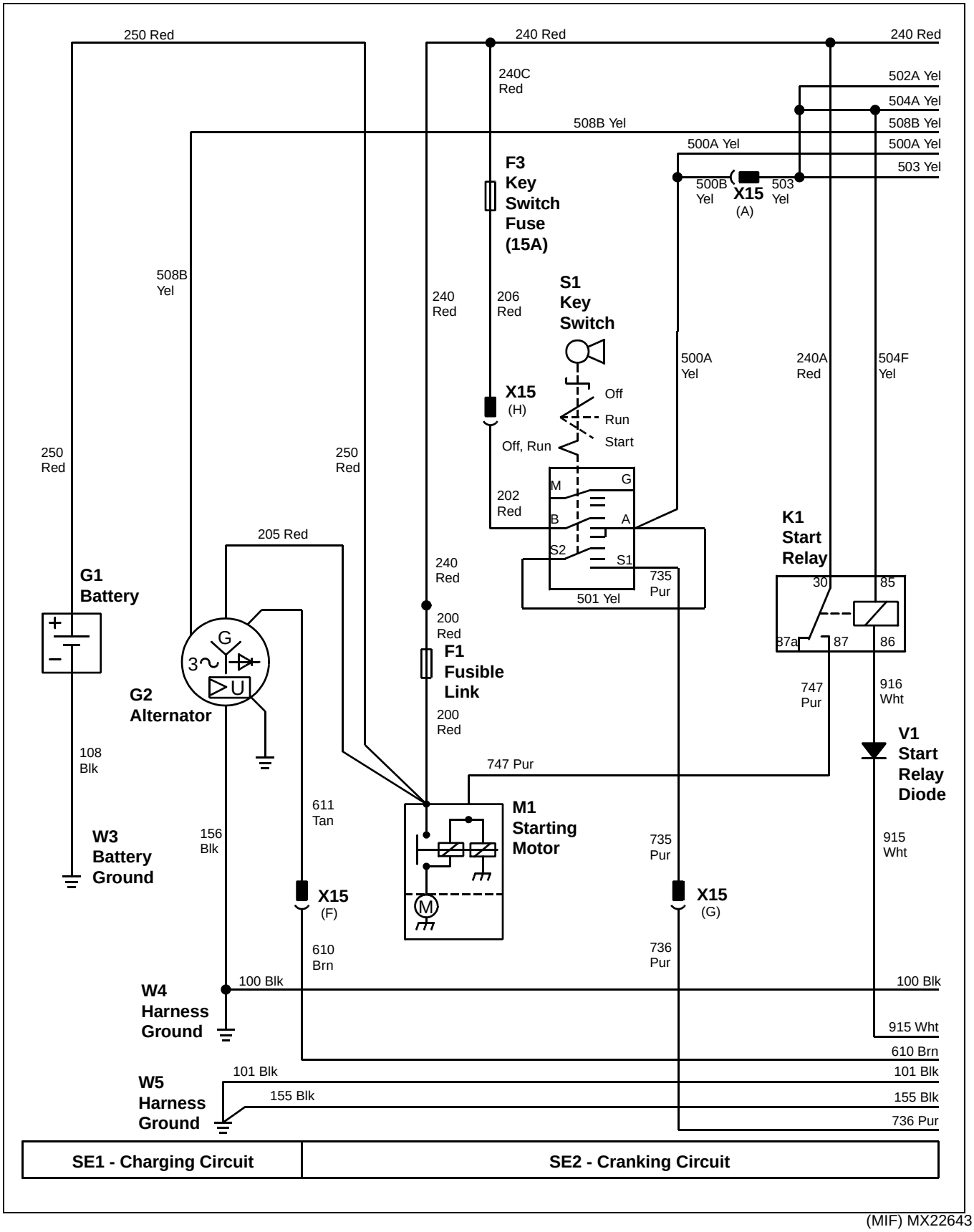
X64 - Down Pressure Relay Wiring Harness-to-Electronic Control Module Connector (J3) (SE15, W14) (Optional)

X65 - Down Pressure Relay Wiring Harness-to-Main Wiring Harness Electronic Control Module Connector (X45) (SE15, W14) (Optional)

X66 - Down Pressure Relay Wiring Harness-to-Down Pressure Y-Wiring Harness Connector (SE15, W13, W14) (Optional)

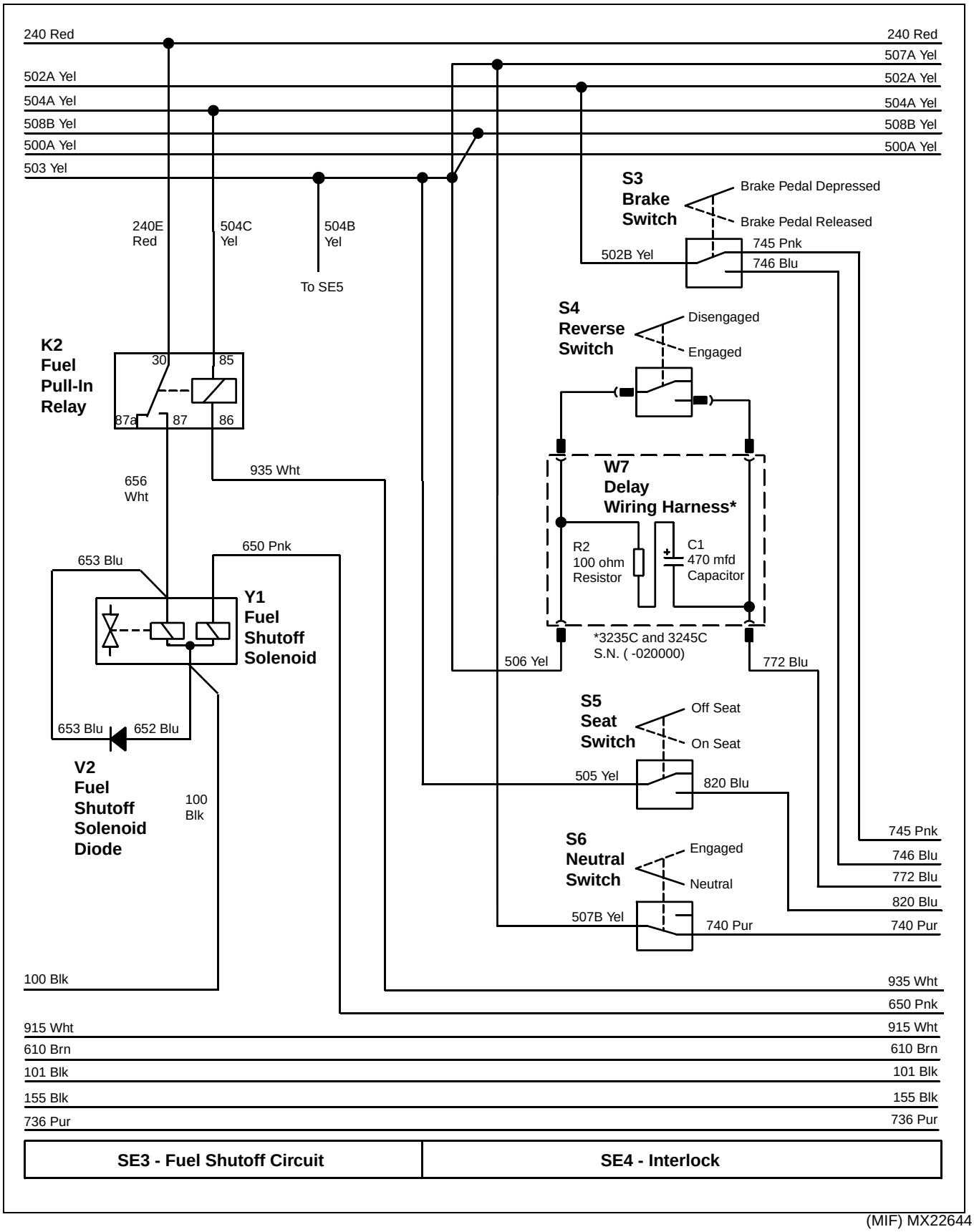
X67 - Down Pressure Y-Wiring Harness-to-Main Wiring Harness Rear Mow Solenoid Connector (SE15, W13) (Optional)

Main Electrical Schematic (Sheet 1 of 9)



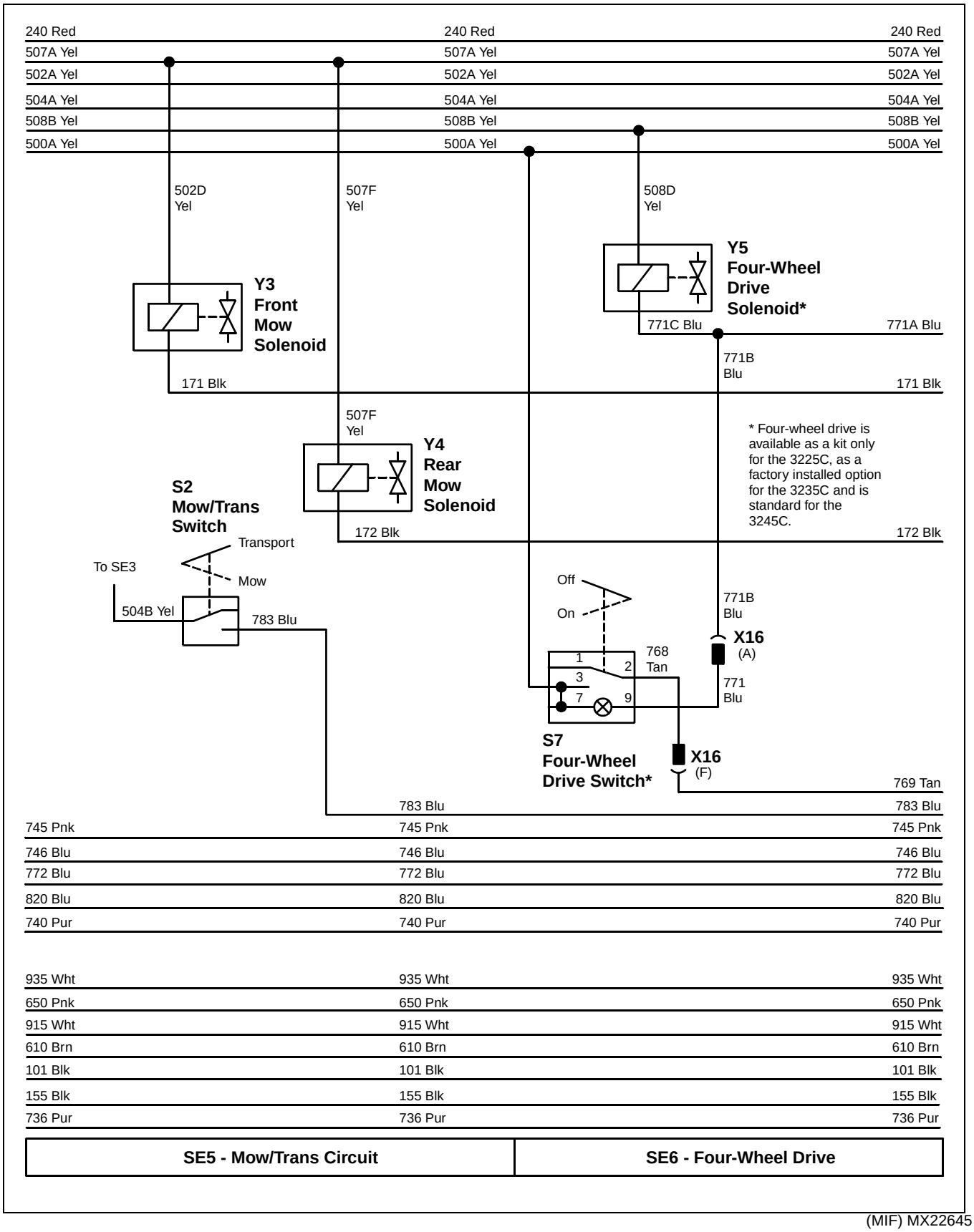
(MIF) MX22643

Main Electrical Schematic (Sheet 2 of 9)



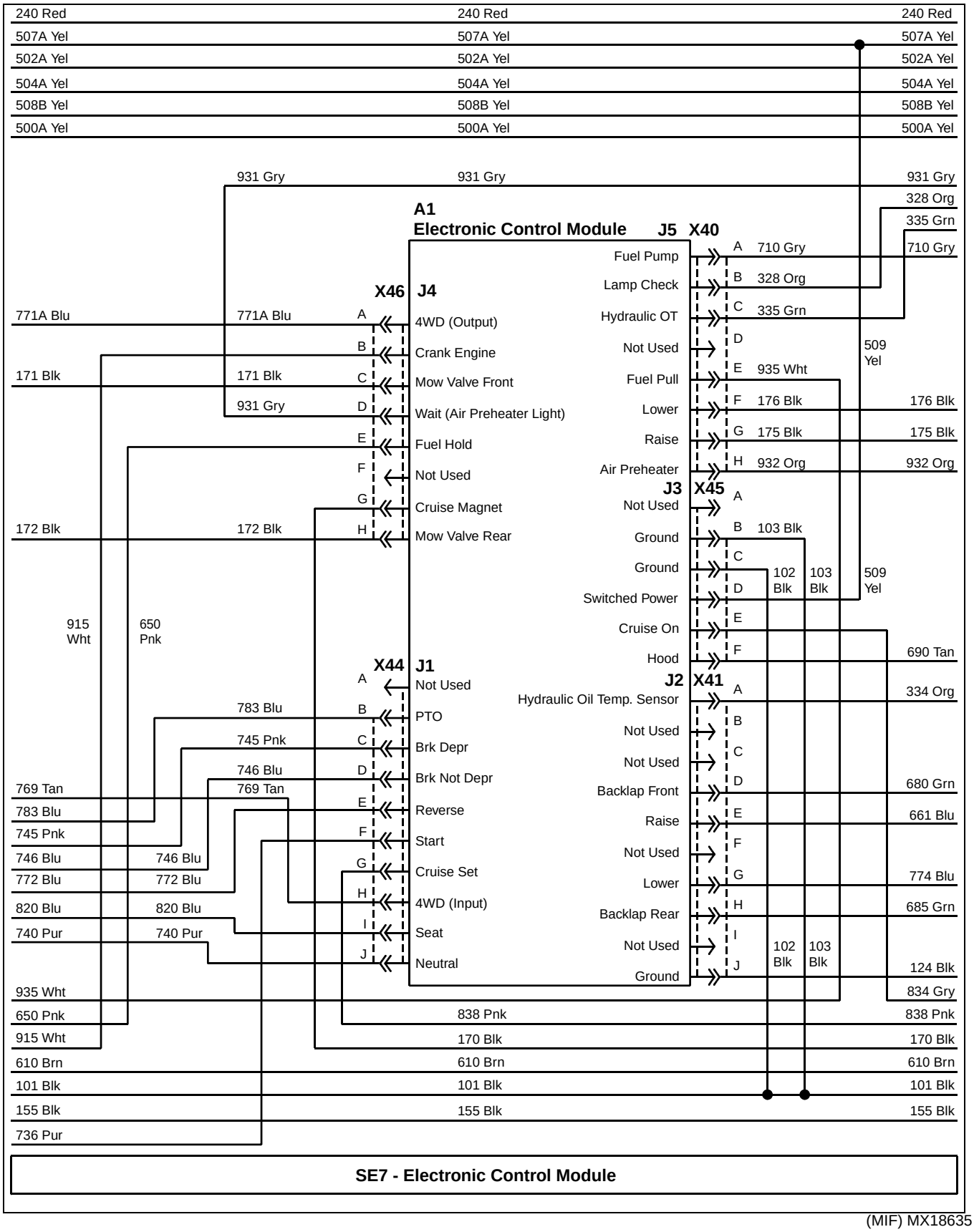
(MIF) MX22644

Main Electrical Schematic (Sheet 3 of 9)



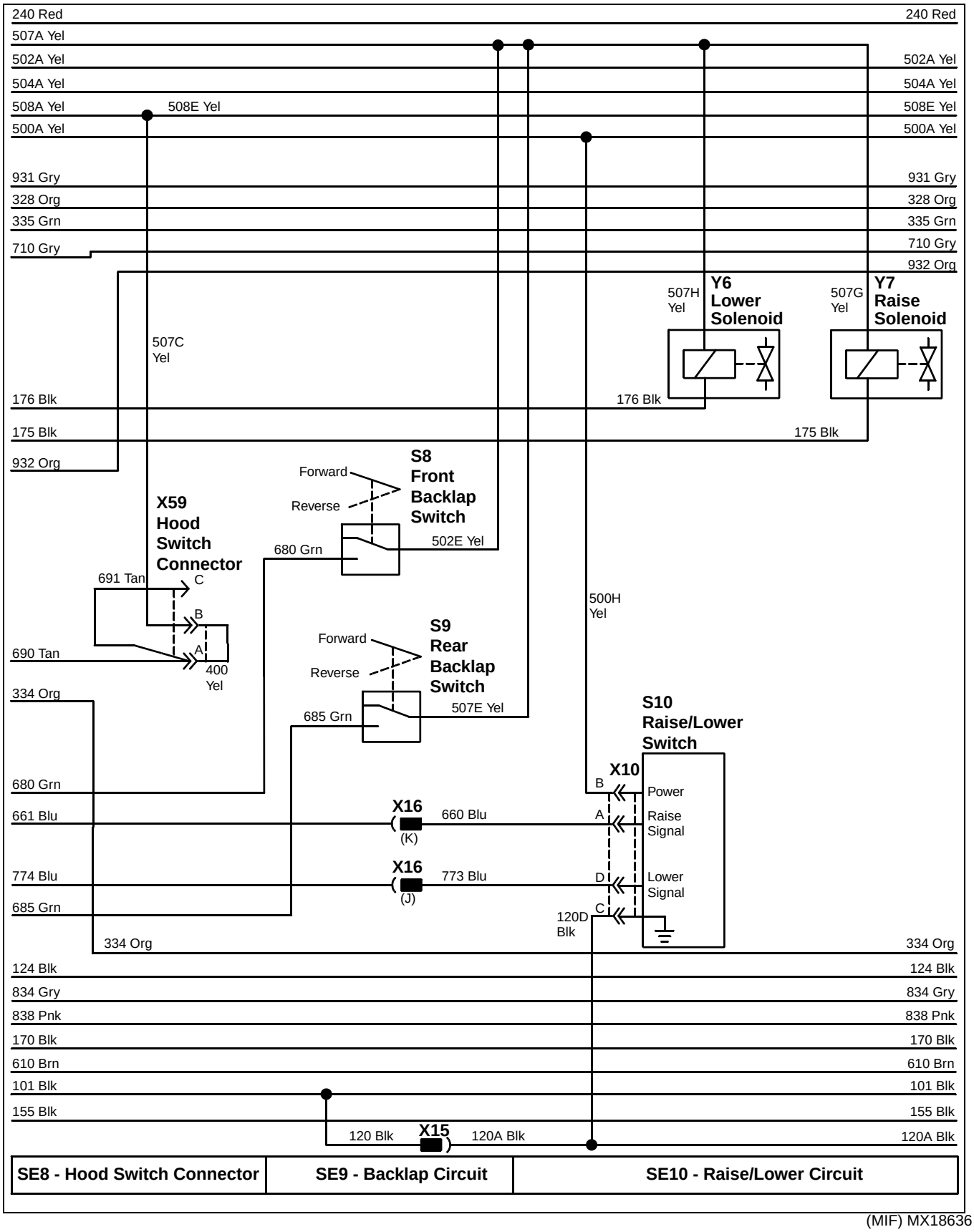
(MIF) MX22645

Main Electrical Schematic (Sheet 4 of 9)



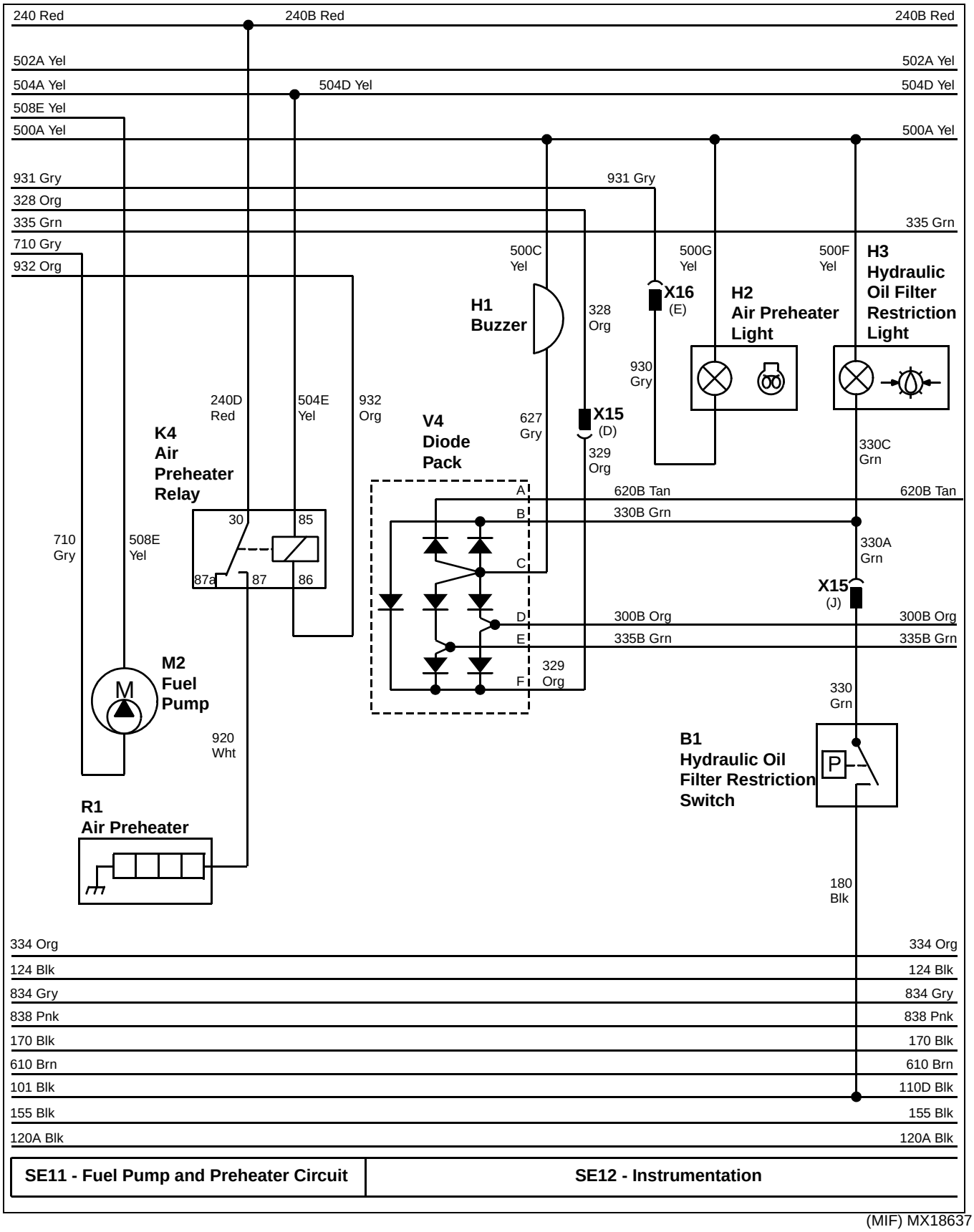
(MIF) MX18635

Main Electrical Schematic (Sheet 5 of 9)



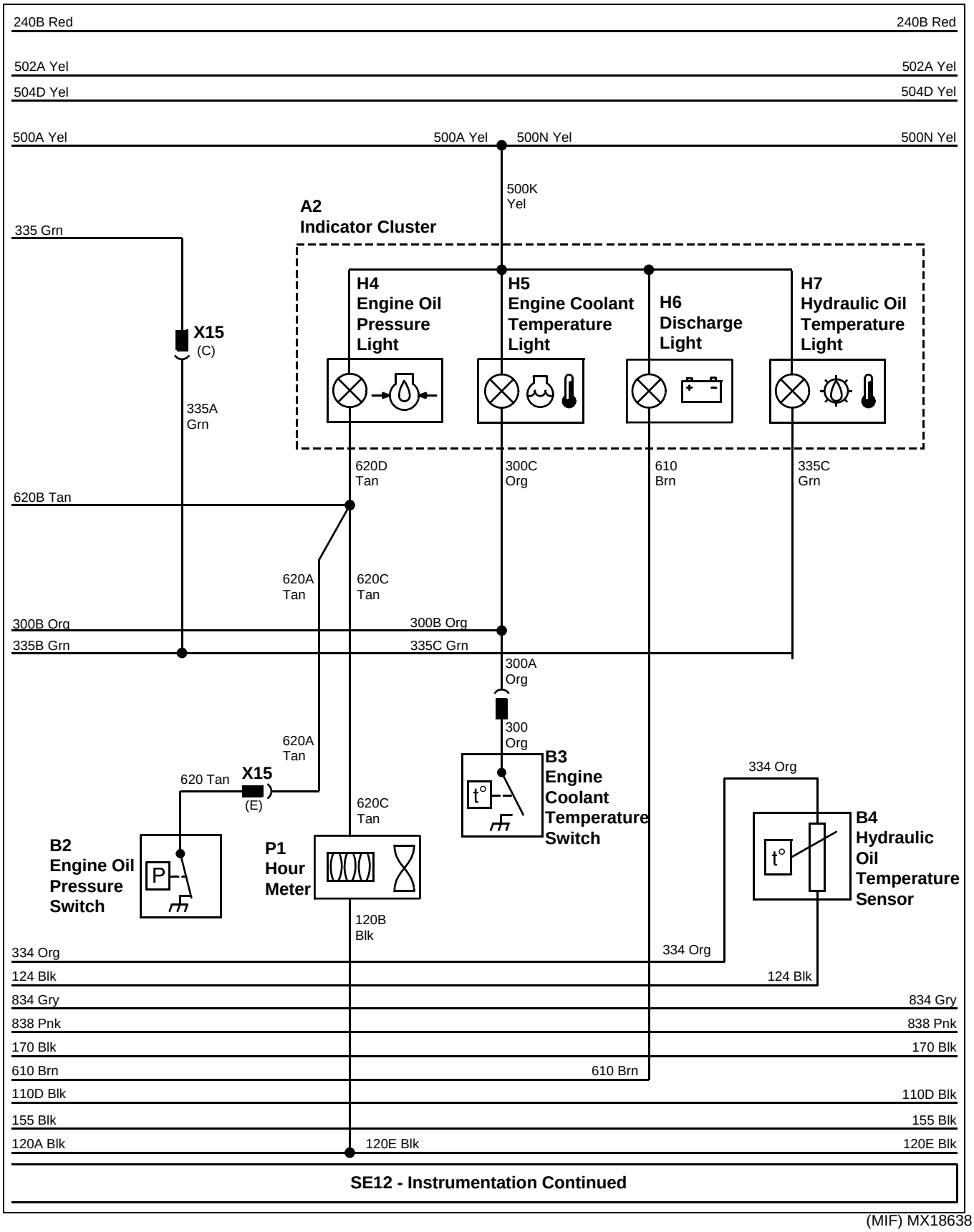
(MIF) MX18636

Main Electrical Schematic (Sheet 6 of 9)



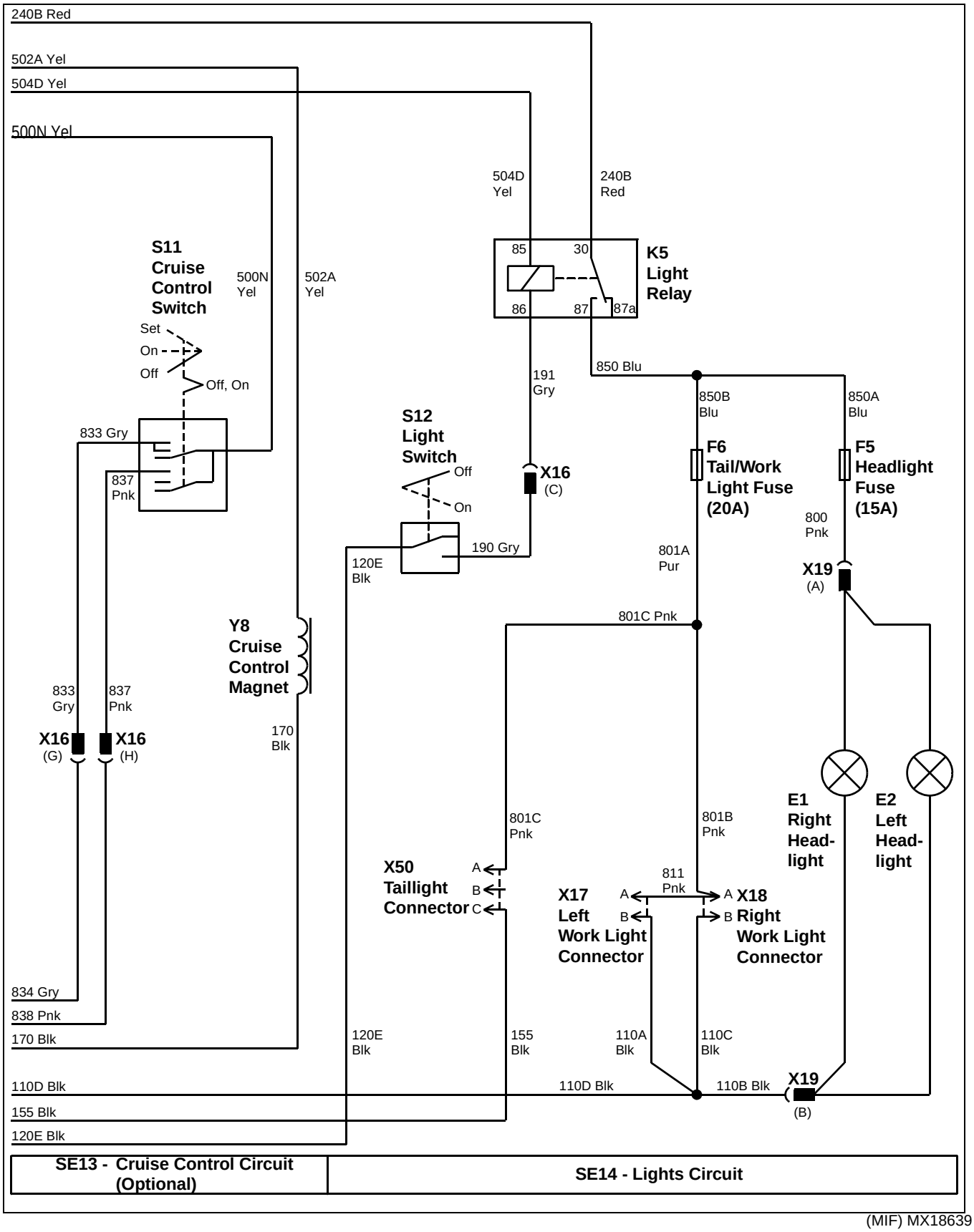
(MIF) MX18637

Main Electrical Schematic (Sheet 7 of 9)



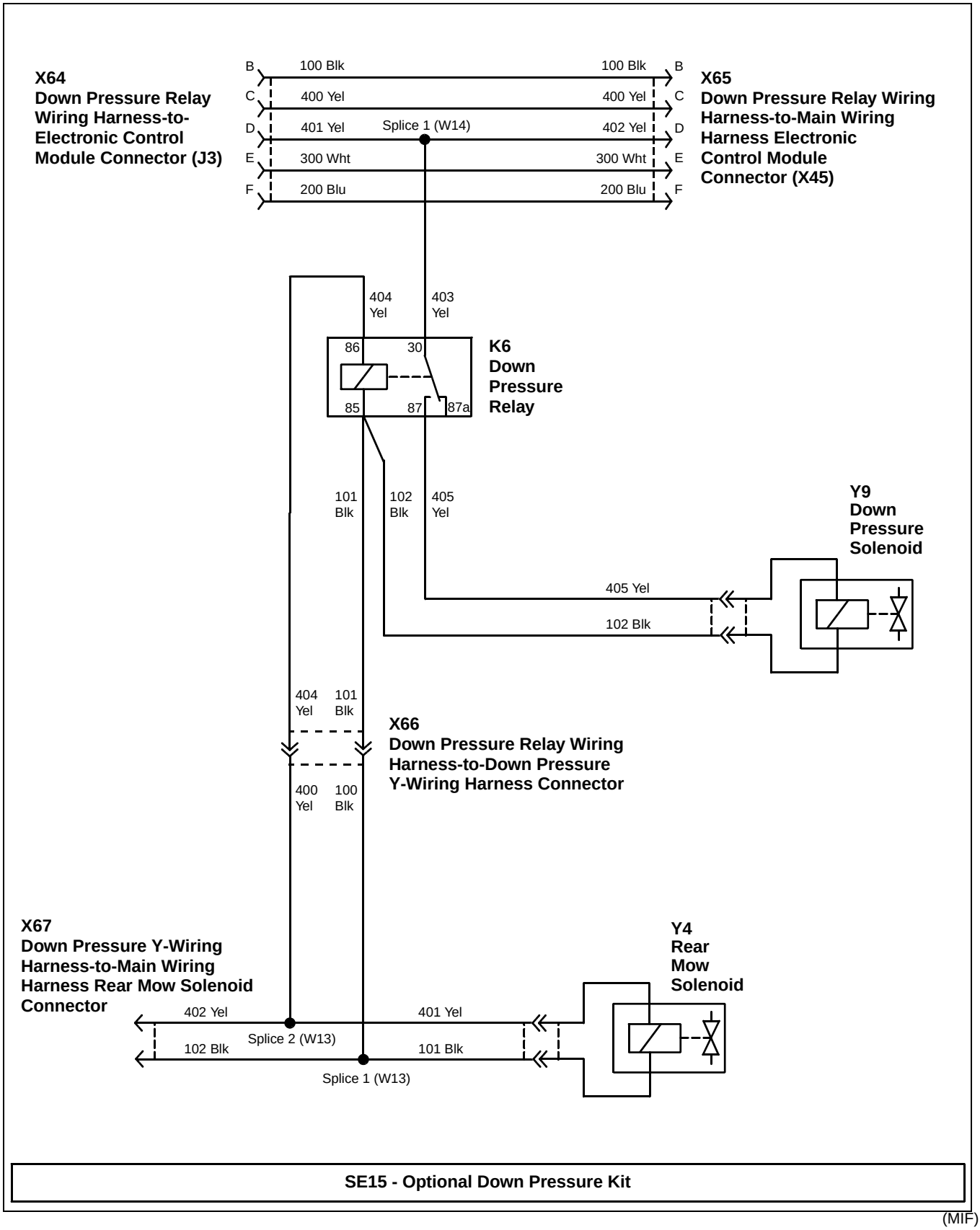
(MIF) MX18638

Main Electrical Schematic (Sheet 8 of 9)



(MIF) MX18639

Main Electrical Schematic (Sheet 9 of 9)
Optional Down Pressure Kit



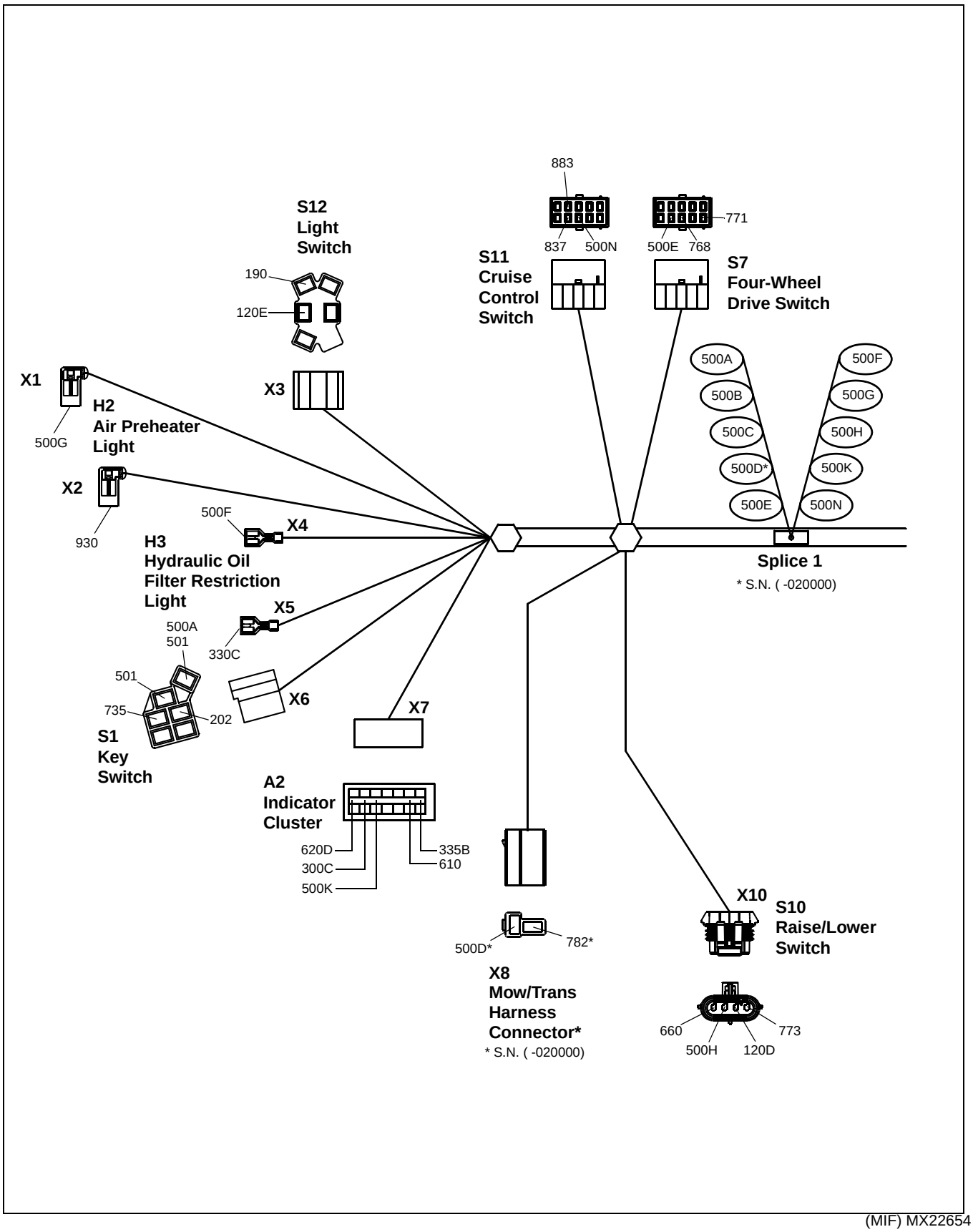
SE15 - Optional Down Pressure Kit

(MIF)

Control Arm Wiring Harness (W1) Wire Code Table

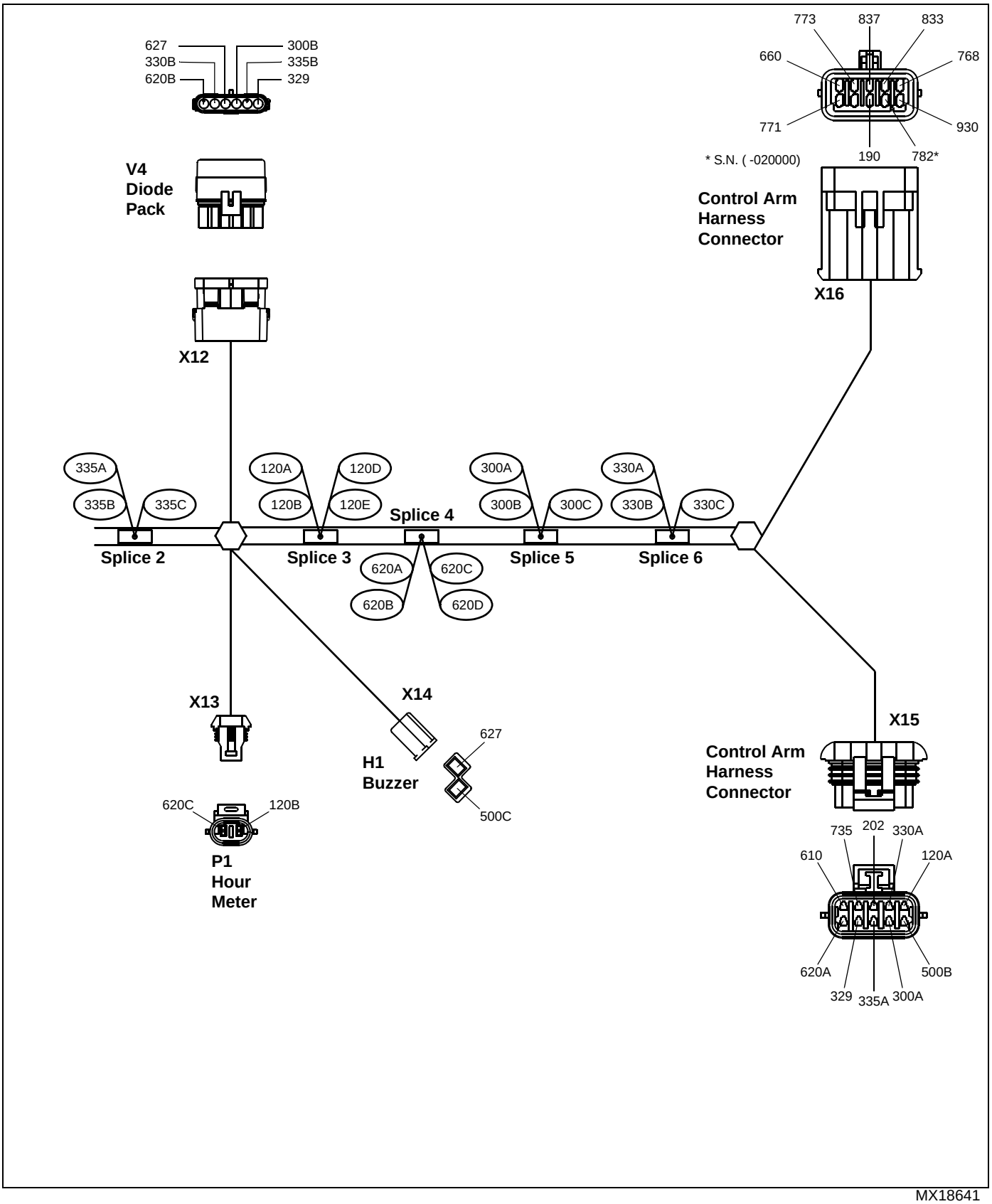
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
120A	0.8	Blk	X15 (K), Splice 3
120B	0.8	Blk	X13 (B), Splice 3
120D	0.8	Blk	X10 (C), Splice 3
120E	0.8	Blk	X3 (1), Splice 3
190	0.8	Gry	X16 (C), X3 (2)
202	1.0	Red	X15 (H), X6
329	0.8	Org	X15 (D), X12 (F)
300A	0.8	Org	X15 (J), Splice 4
300B	0.8	Org	X12 (D), Splice 4
300C	0.8	Org	X7 (2), Splice 4
330A	0.8	Grn	X15 (J), Splice 6
330B	0.8	Grn	X12 (B), Splice 6
330C	0.8	Grn	X5, Splice 6
335A	0.8	Grn	X15 (C), Splice 2
335B	0.8	Grn	X12 (E), Splice 2
335C	0.8	Grn	X7 (6), Splice 2
500A	1.0	Yel	X6 (A), Splice 1
500B	1.0	Yel	X15 (A), Splice 1
500C	0.8	Yel	X14 (A), Splice 1
500D	0.8	Yel	X8, Splice 1 S.N. (-020000)
500E	0.8	Yel	X11 (3), Splice 1
500F	0.8	Yel	X4, Splice 1
500G	0.8	Yel	X1, Splice 1
500H	0.8	Yel	X10 (B), Splice 1
500K	0.8	Yel	X7 (3), Splice 1
500N	0.8	Yel	X9 (2), Splice 1
501	0.8	Yel	X6 (A), X6 (S2)
610	0.8	Brn	X15 (F), X7 (5)
620A	0.8	Tan	X15 (E), Splice 4
620B	0.8	Tan	X12 (A), Splice 4
620C	0.8	Tan	X13 (A), Splice 4
620D	0.8	Tan	X7 (1), Splice 4
627	0.8	Gry	X12 (C), X14 (B)
660	0.8	Blu	X16 (K), X10 (A)
735	0.8	Pur	X15 (G), X6 (S1)
768	0.8	Tan	X16 (F), X11 (2)
771	0.8	Blu	X16 (A), X11 (9)
773	0.8	Blu	X16 (J), X10 (D)
782	0.8	Blu	X16 (D), X8 (4) S.N. (-020000)
833	0.8	Gry	X16 (G), X9 (6)
837	0.8	Pnk	X16 (H), X9 (3)
930	0.8	Gry	X16 (E), X2

Control Arm Wiring Harness (W1) (Sheet 1 of 2)



(MIF) MX22654

Control Arm Wiring Harness (W1) (Sheet 2 of 2)



MX18641

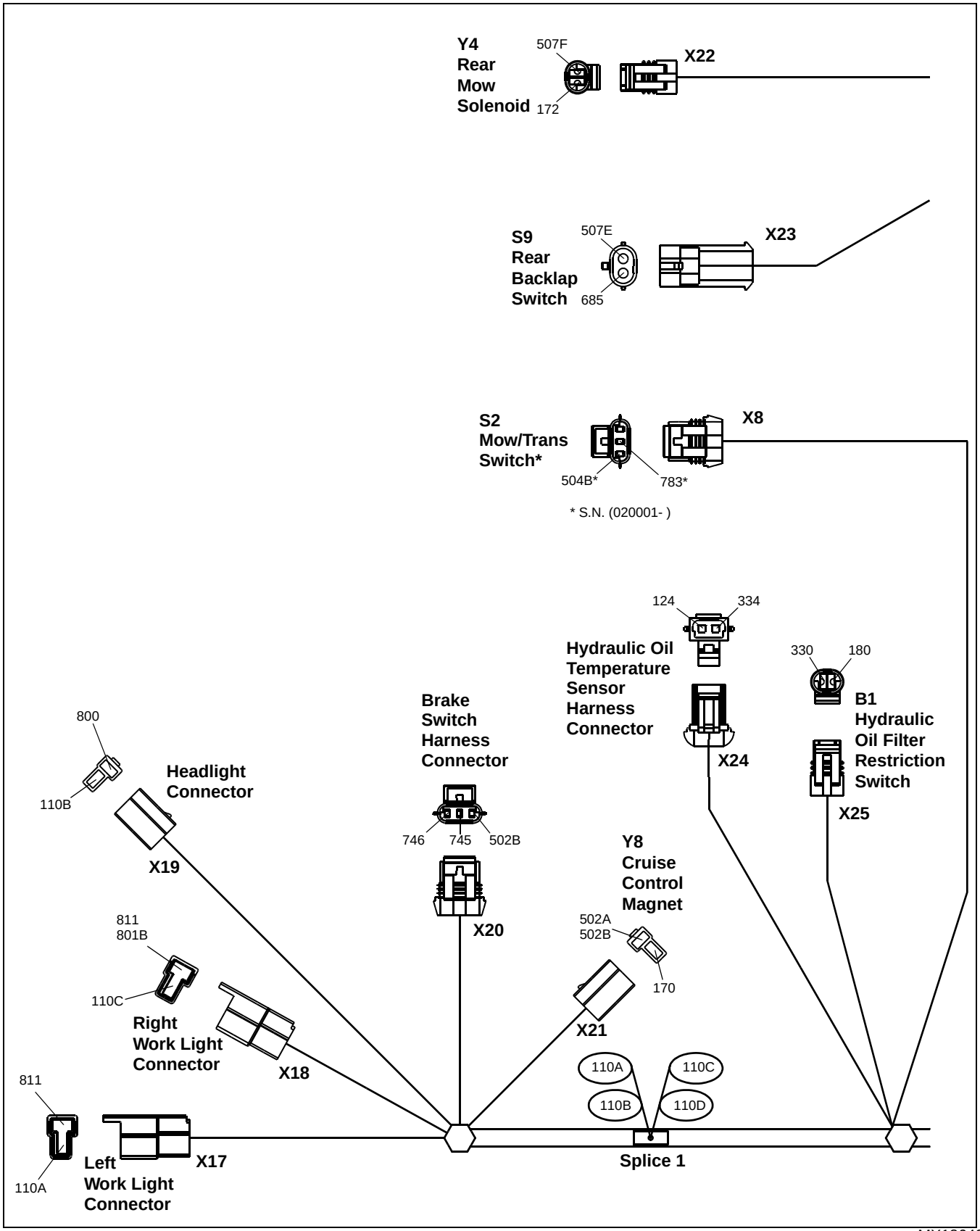
Main Wiring Harness (W2) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	3.0	Blk	X51 (W4), X47 (A)
101	5.0	Blk	X62 (W5), Splice 8
102	1.0	Blk	X45 (J3-C), Splice 8
103	1.0	Blk	X45 (J3-B), Splice 8
104	3.0	Blk	X28 (30), Splice 8 S.N. (-020000)
105	3.0	Brn	X28 (87), X32 (2) S.N. (-020000)
105A	3.0	Brn	X32 (1), Splice 3 S.N. (-020000)
106	3.0	Brn	X43 (B), Splice 3 S.N. (-020000)
107	2.0	Brn	X42 (B), Splice 3 S.N. (-020000)
110A	0.8	Blk	X17 (B), Splice 1
110B	1.0	Blk	X19 (B), Splice 1
110C	0.8	Blk	X18 (B), Splice 1
110D	1.0	Blk	Splice 1, Splice 8
120	0.8	Blk	X15 (K), Splice 8
124	0.8	Blk	X24 (B), X41(J2-K)
155	1.0	Blk	X50 (C), X62
156	3.0	Blk	X51, X56
170	0.8	Blk	X21 (B), X46 (J4-G)
171	0.8	Blk	X33 (B), X46 (J4-C)
172	0.8	Blk	X22 (B), X46 (J4-H)
175	0.8	Blk	X38 (B), X40 (J5-G)
176	0.8	Blk	X39 (B), X40 (J5-F)
180	0.8	Blk	X25 (A), Splice 8
191	0.8	Gry	X30 (86), X16 (C)
200	2.0	Red	X61, Fusible Link (F1)
201	1.0	Red	X61, Fusible Link S.N. (-020000)
205	3.0	Red	X62 (W5), X55
206	1.0	Red	X15 (H), X26
207	3.0	Red	Fusible Link, Splice 11 S.N. (-020000)
208	3.0	Red	X43 (C), Splice 11 S.N. (-020000)
209	2.0	Red	X42 (A), Splice 11 S.N. (-020000)
240	8.0	Red	Fusible Link (F1), Splice 5
240A	3.0	Red	X27 (30), Splice 5
240B	3.0	Red	X30 (30), Splice 5
240C	1.0	Red	X26, Splice 5
240D	3.0	Red	X29 (30), Splice 5
240E	3.0	Red	X31 (30), Splice 5
300	0.8	Org	X53, X15 (B)
328	0.8	Org	X15 (D), X40 (J5-B)
330	0.8	Grn	X15 (J), X25 (B)
334	0.8	Org	X24 (A), X41(J2-A)
335	0.8	Grn	X15 (C), X40 (J5-C)
502A	0.8	Yel	X21 (A), Splice 9
502B	0.8	Yel	X21 (A), X20 (A)
502D	0.8	Yel	X33 (A), Splice 7
502E	0.8	Yel	X34 (A), Splice 7
503	1.0	Yel	X15 (A), Splice 9
504A	0.8	Yel	Splice 9, Splice 4
504B	0.8	Yel	X28 (85), Splice 4 S.N. (-020000)
504B	0.8	Yel	S2, Splice 9 S.N. (020001-)
504C	0.8	Yel	X31 (85), Splice 4
504D	0.8	Yel	X30 (85), Splice 4
504E	0.8	Yel	X29 (85), Splice 4
504F	0.8	Yel	X27 (85), Splice 4

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
505	0.8	Yel	X36 (A), Splice 9
506	0.8	Yel	X35 (B), Splice 9
507A	1.0	Yel	Splice 9, Splice 7
507B	0.8	Yel	X37 (A), Splice 7
507C	0.8	Yel	X59 (B), Splice 12
507E	0.8	Yel	X23 (A), Splice 7
507F	0.8	Yel	X22 (A), Splice 7
507G	0.8	Yel	X38 (A), Splice 7
507H	0.8	Yel	X39 (A), Splice 7
508A	0.8	Yel	Splice 12, Splice 9
508B	0.8	Yel	X58 (A), Splice 12
508D	0.8	Yel	X60 (A), Splice 12
508E	0.8	Yel	X49 (A), Splice 12
509	1.0	Yel	X45 (J3-D), Splice 7
611	0.8	Tan	X15 (F), X58 (B)
620	0.8	Tan	X15 (E), X52
650	1.0	Pnk	X47 (C), X46 (J4-E)
652	2.0	Blu	X47 (A), X48 (B)
653	2.0	Blu	X47 (B), X48 (A)
656	3.0	Wht	X47 (B), X31 (87)
661	0.8	Blu	X16 (K), X41 (J2-E)
680	0.8	Grn	X34 (B), X41 (J2-D)
685	0.8	Grn	X23 (B), X41 (J2-H)
690	0.8	Tan	X59 (A), X45 (J3-F)
691	0.8	Tan	X59 (A), X59 (C)
710	0.8	Gry	X49 (B), X40 (J5-A)
736	0.8	Pur	X15 (G), X44 (J1-F)
740	0.8	Pur	X37 (B), X44 (J1-K)
745	0.8	Pnk	X20 (B), X44 (J1-C)
746	0.8	Blu	X20 (C), X44 (J1-D)
747	2.0	Pur	X57, X27 (87)

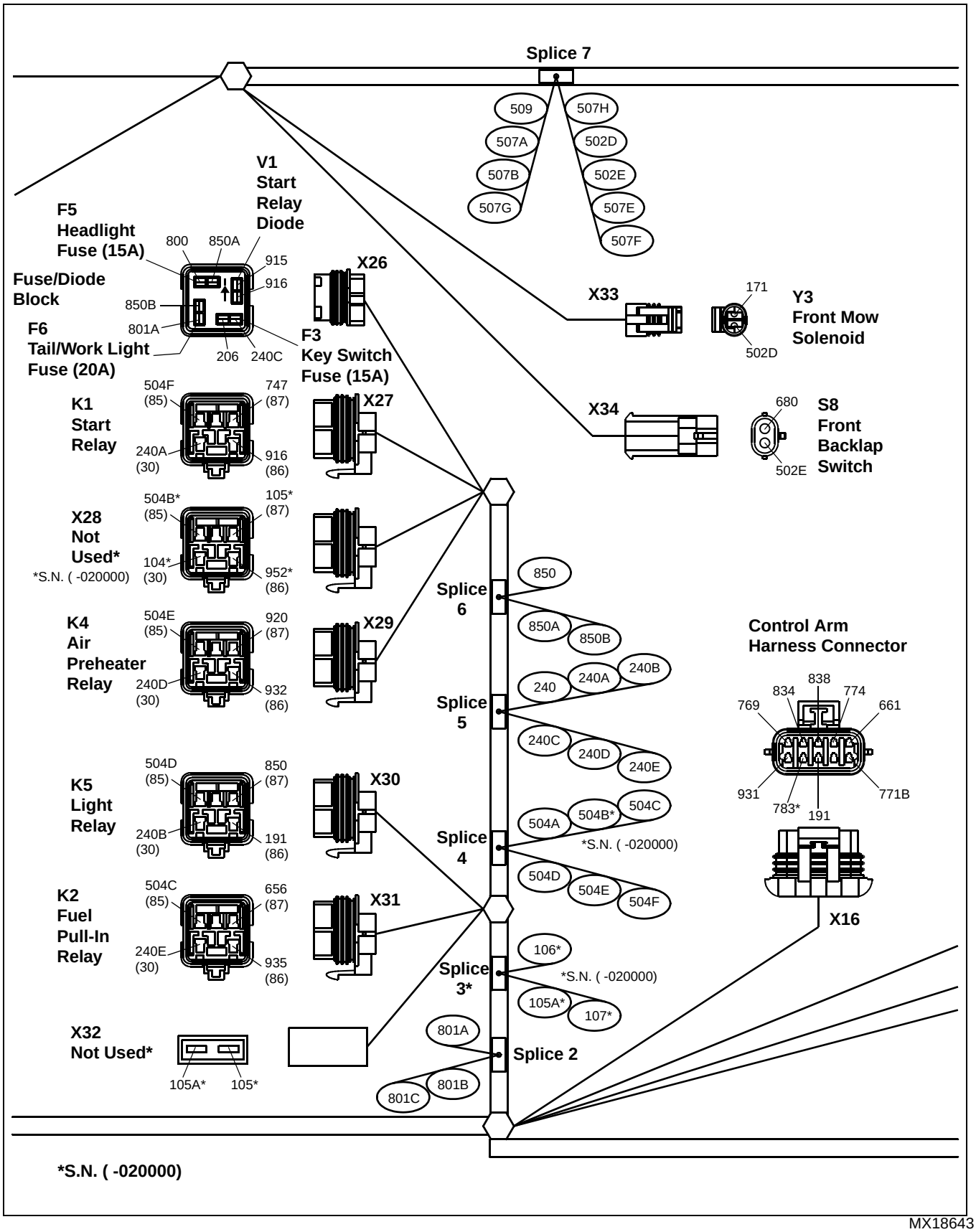
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
769	0.8	Tan	X16 (F), X44 (J1-H)
771A	0.8	Blu	X46 (J4-A), Splice 10
771B	0.8	Blu	X16 (A), Splice 10
771C	0.8	Blu	X60 (B), Splice 10
772	0.8	Blu	X35 (C), X44 (J1-E)
774	0.8	Blu	X16 (J), X41 (J2-G)
783	0.8	Blu	X16 (D), X44 (J1-B) S.N. (-020000)
783	0.8	Blu	S2, X44 (J1-B) S.N. (020001-)
784	1.0	Pur	X43 (A), X46 (J4-F) S.N. (-020000)
800	1.0	Pnk	X19 (A), X26
801A	2.0	Pur	X26, Splice 2
801B	1.0	Pnk	X18 (A), Splice 2
801C	1.0	Pnk	X50 (A), Splice 2
811	0.8	Pnk	X17 (A), X18 (A)
820	0.8	Blu	X36 (B), X44 (J1-J)
834	0.8	Gry	X16 (G), X45 (J3-E)
838	0.8	Pnk	X16 (H), X44 (J1-G)
850	3.0	Blu	X30 (87), Splice 6
850A	1.0	Blu	X26, Splice 6
850B	2.0	Blu	X26, Splice 6
915	0.8	Wht	X26, X46 (J4-B)
916	0.8	Wht	X26, X27 (86)
920	3.0	Wht	X54, X29 (87)
931	0.8	Gry	X16 (E), X46 (J4-D)
932	0.8	Org	X29 (86), X40 (J5-H)
935	0.8	Wht	X31 (86), X40 (J5-E)
952	0.8	Wht	X28 (86), X40 (J5-D) S.N. (-020000)

Main Wiring Harness (W2) (Sheet 1 of 5)



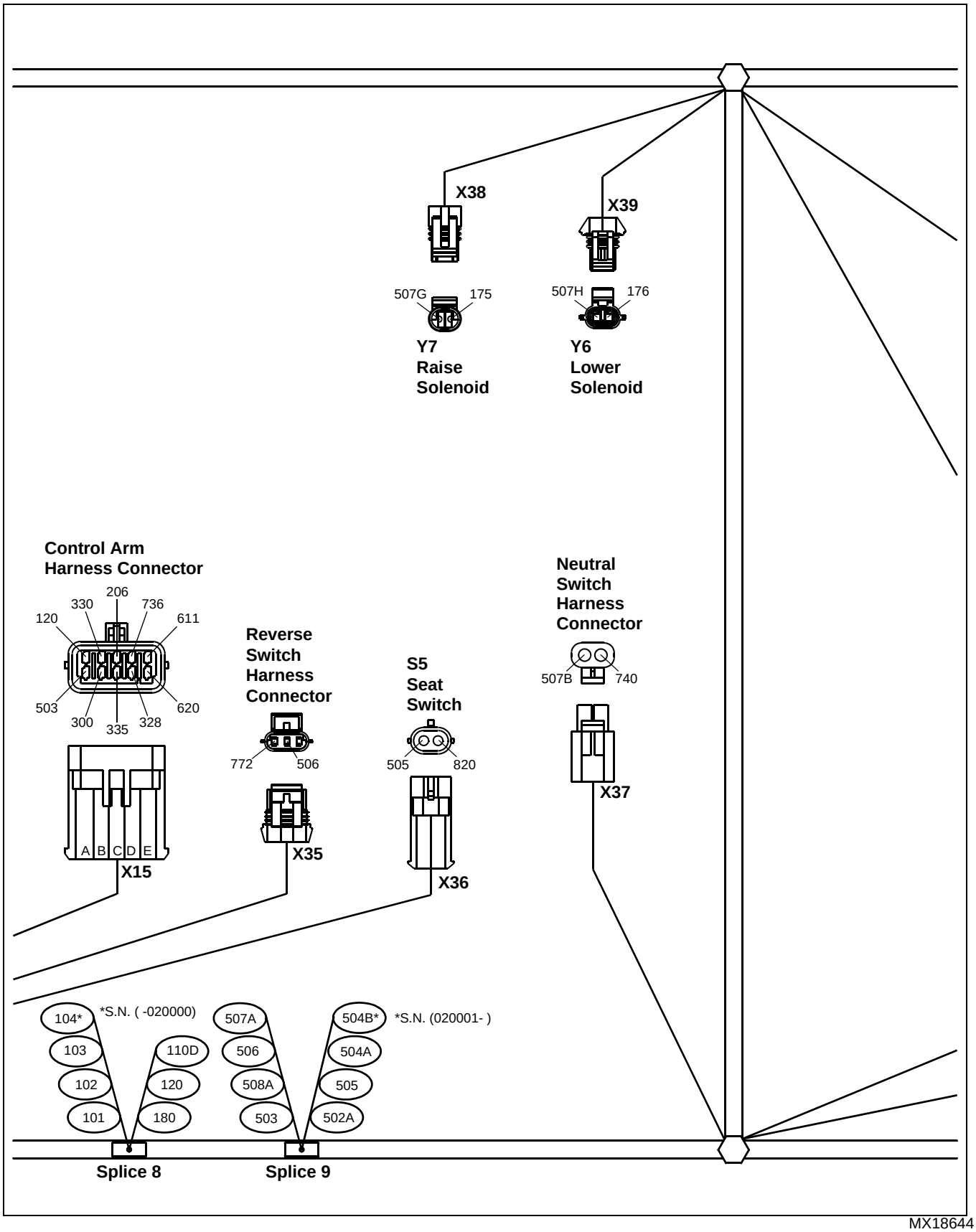
MX18642

Main Wiring Harness (W2) (Sheet 2 of 5)



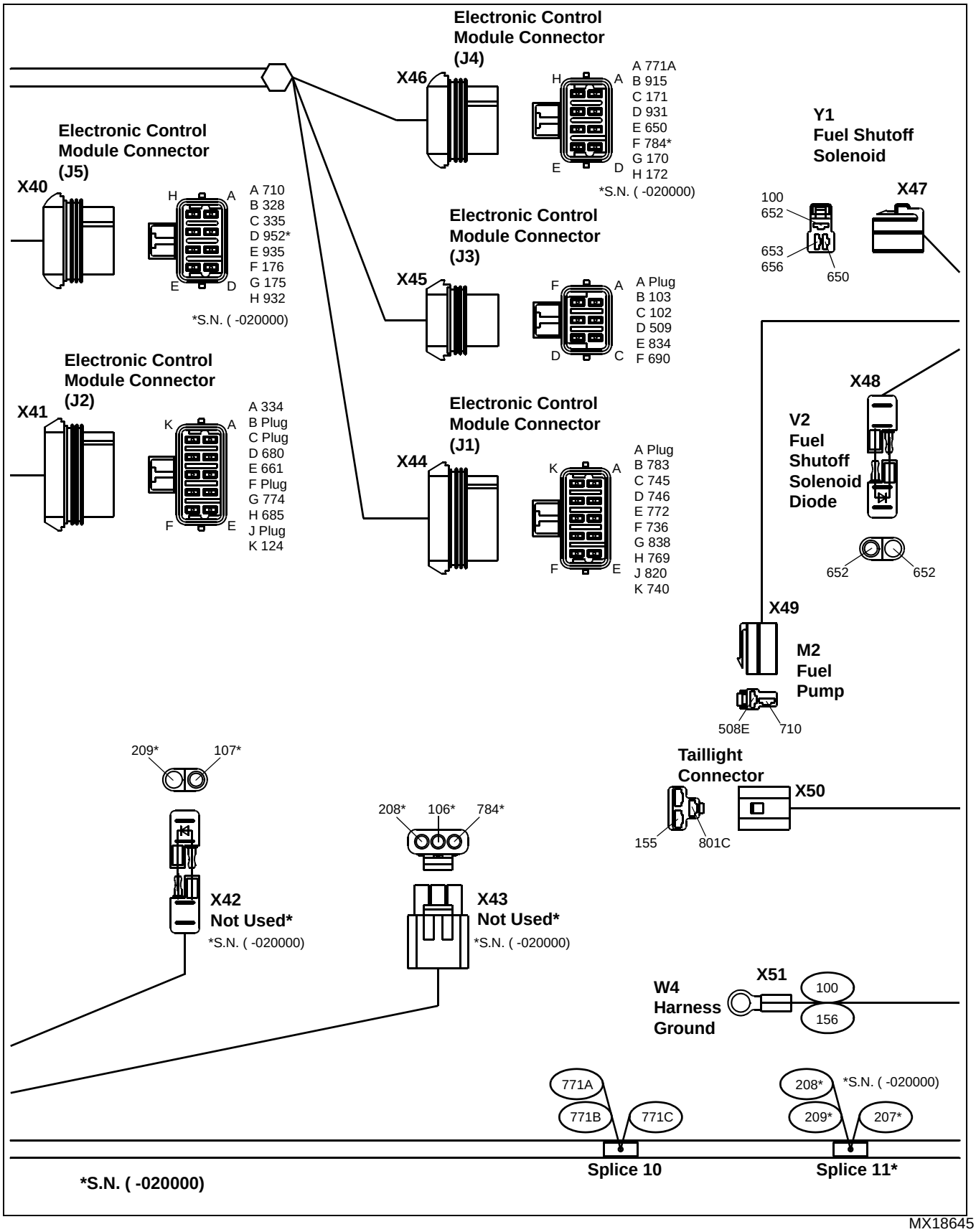
MX18643

Main Wiring Harness (W2) (Sheet 3 of 5)



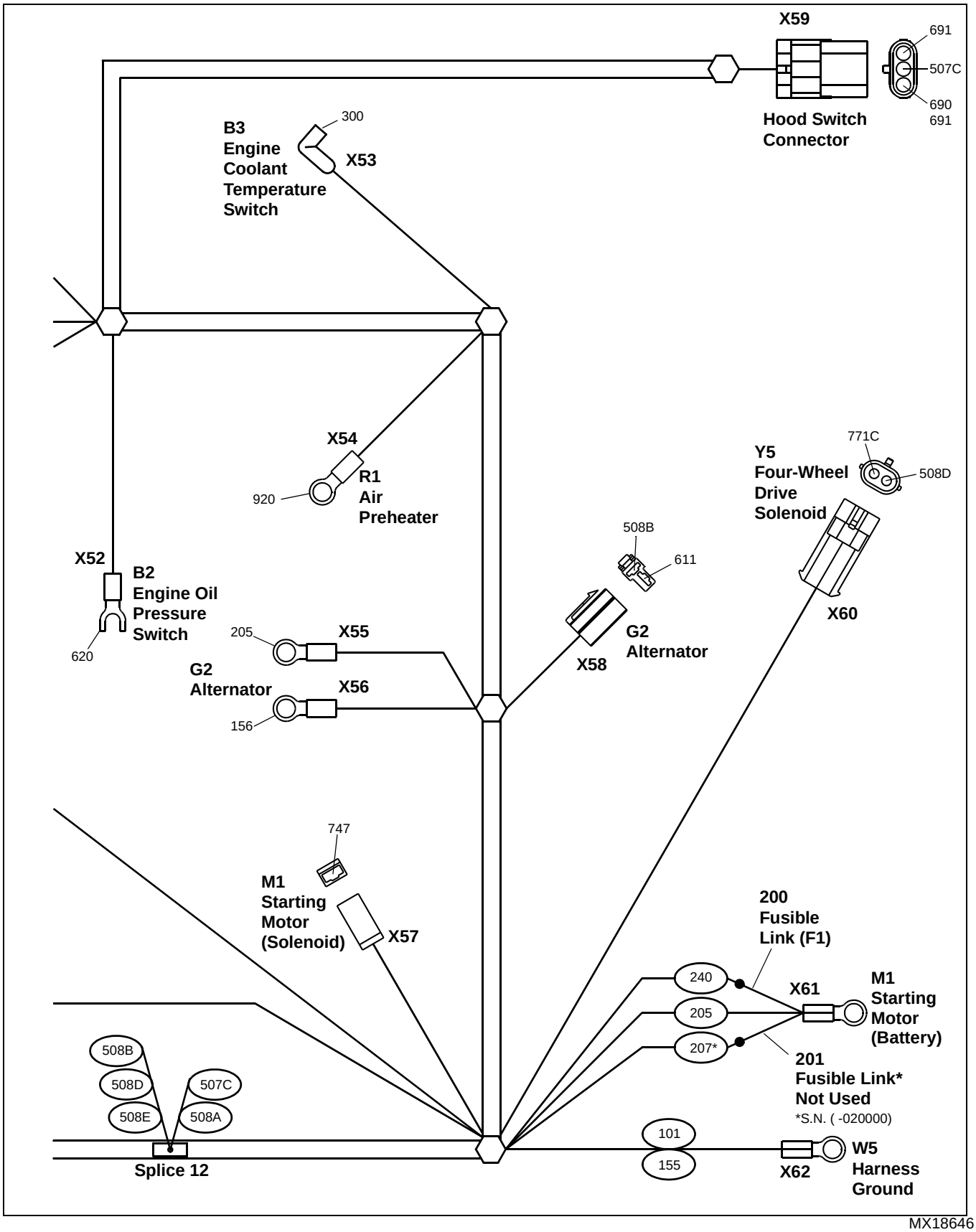
MX18644

Main Wiring Harness (W2) (Sheet 4 of 5)



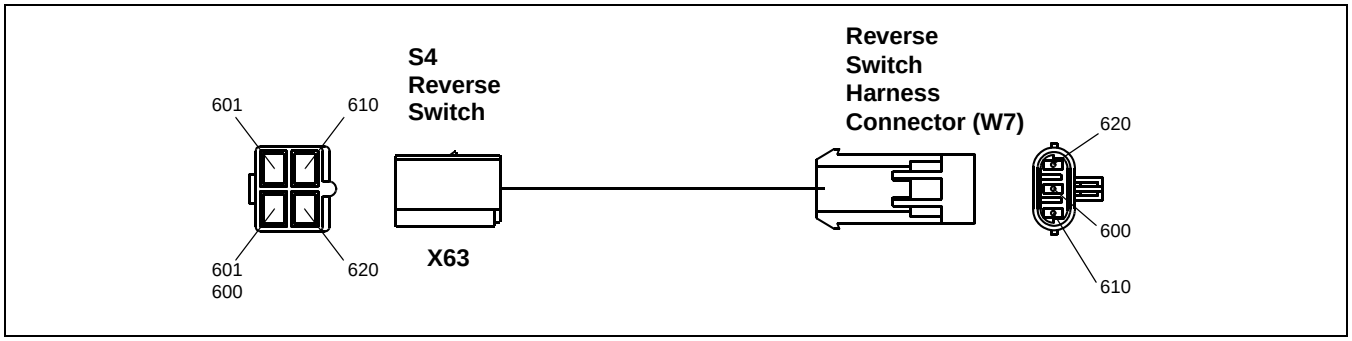
MX18645

Main Wiring Harness (W2) (Sheet 5 of 5)



MX18646

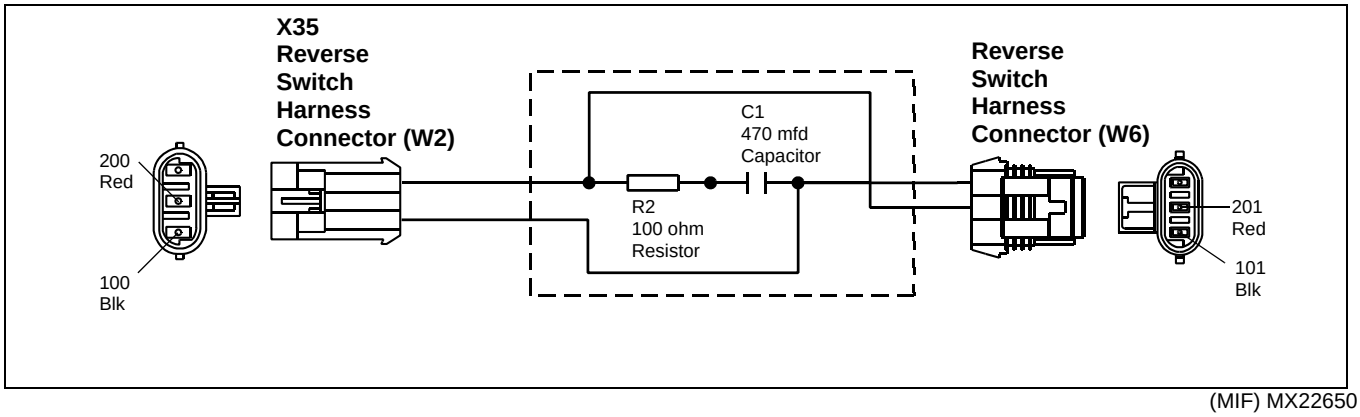
Reverse Switch Wiring Harness (W6)



MX18647

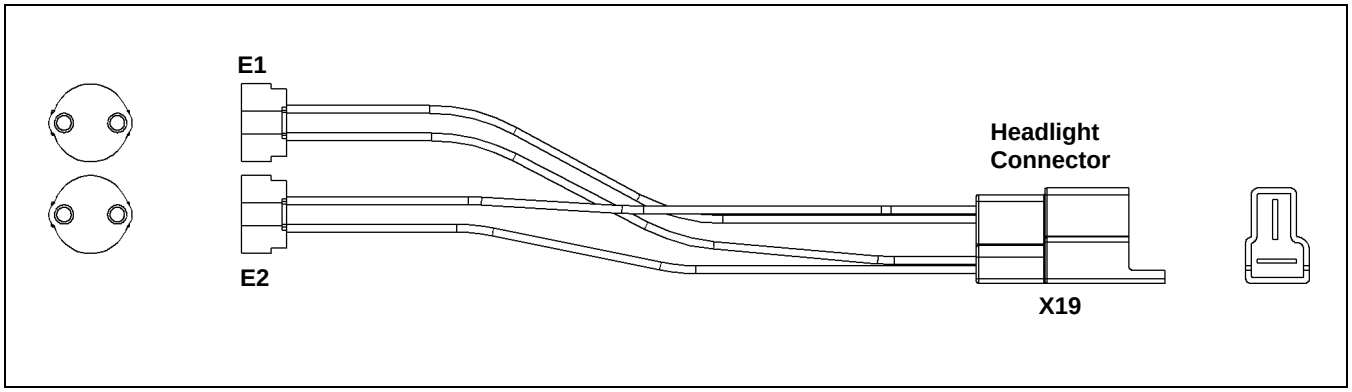
Delay Wiring Harness (W7)

Models 3235C and 3245C S.N. (-020000)



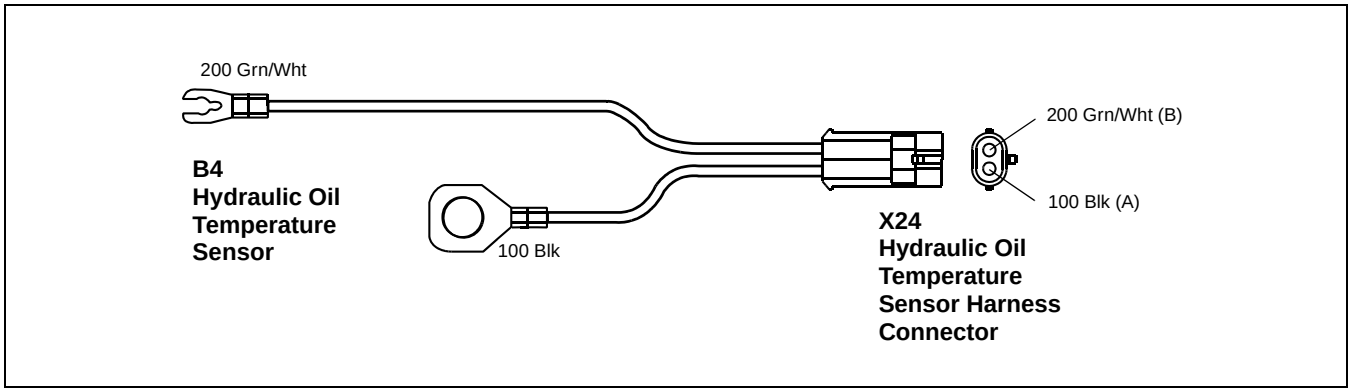
(MIF) MX22650

Headlight Wiring Harness (W8)



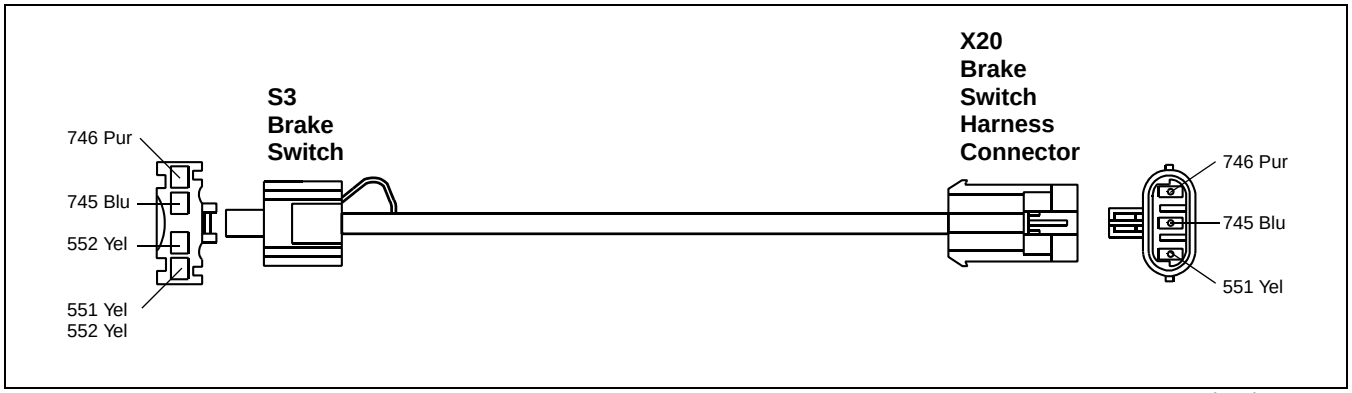
MX20158

Hydraulic Oil Temperature Sensor Wiring Harness (W9)



(MIF) MX22652

Brake Switch Wiring Harness (W10)

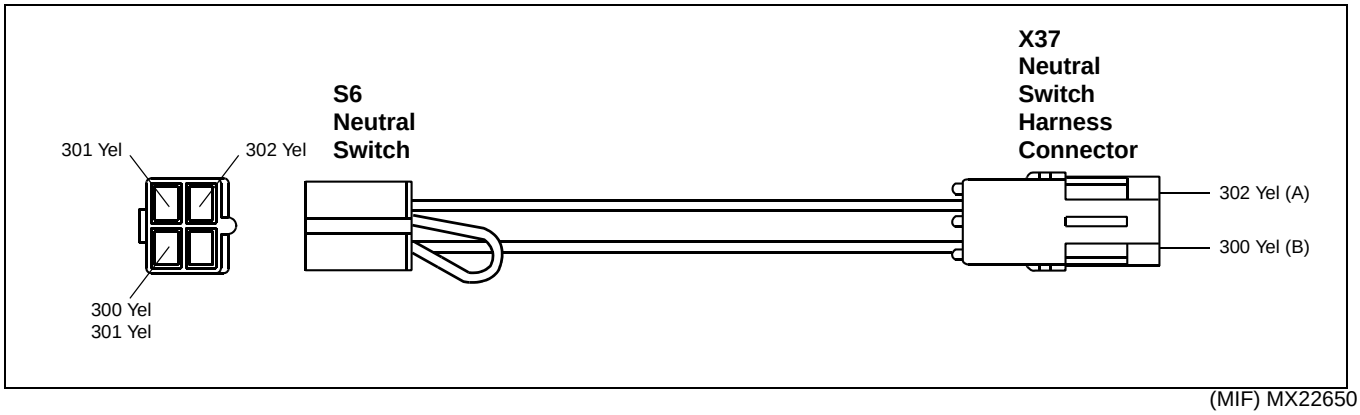


(MIF) MX22651

Mow/Trans Switch Wiring Harness (W11) S.N. (-020000)

(MIF) MX22648

Neutral Switch Wiring Harness (W12)



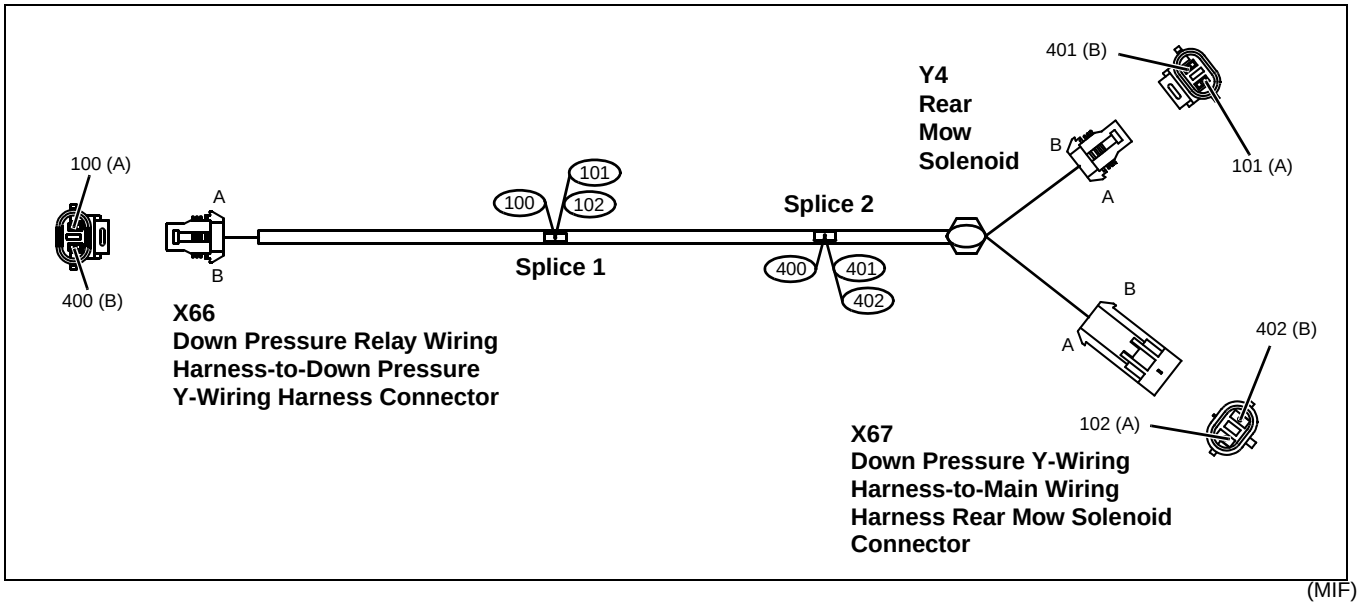
(MIF) MX22650

Down Pressure Y-Wiring Harness (W13) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	X66, Splice 1
101	0.8	Blk	Splice 1, Y4
102	0.8	Blk	Splice 1, X67

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
400	0.8	Yel	X66, Splice 2
401	0.8	Yel	Splice 2, Y4
402	0.8	Yel	Splice 2, X67

Down Pressure Y-Wiring Harness (W13)



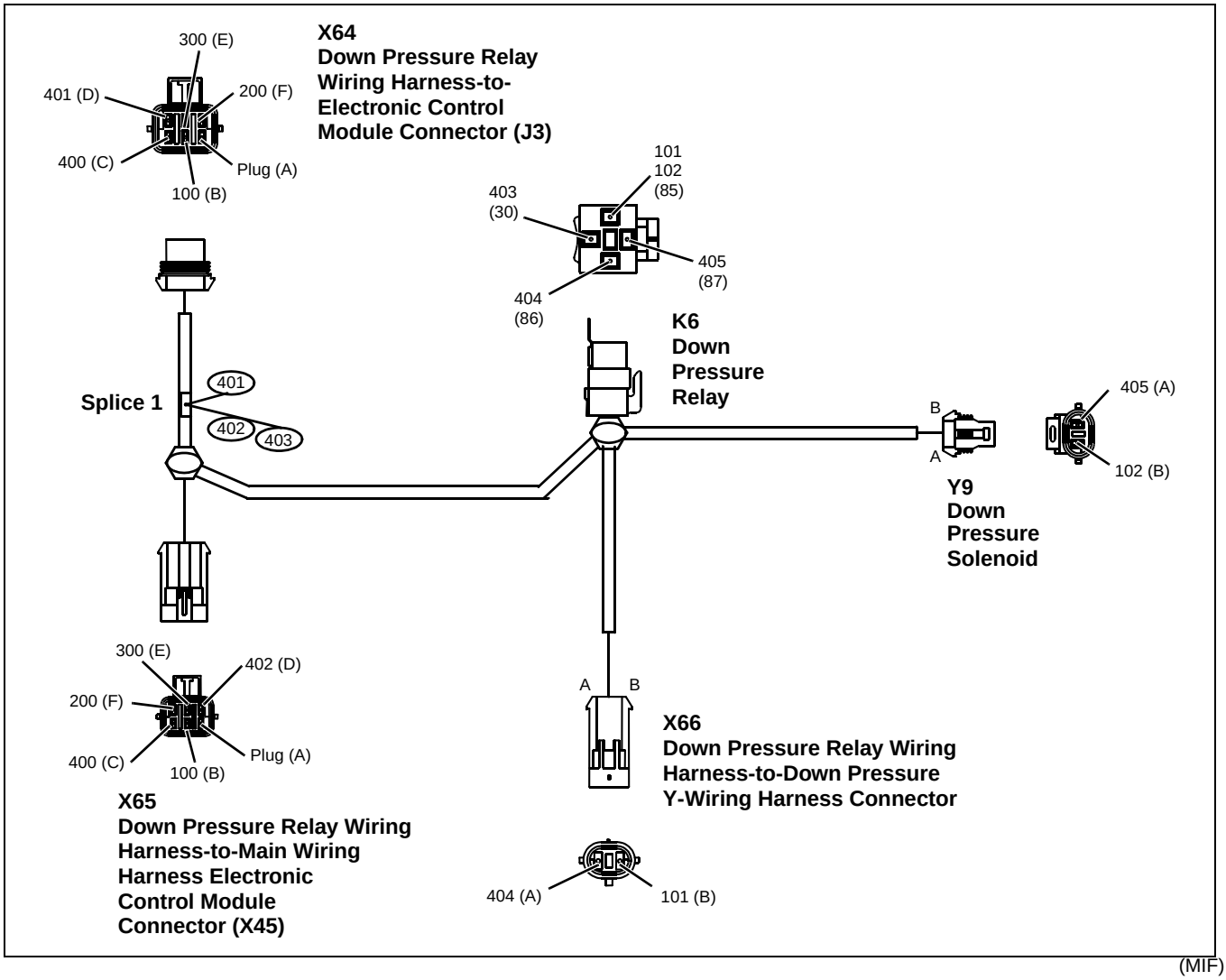
(MIF)

Down Pressure Relay Wiring Harness (W14) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	X64 (B), X65 (B)
101	0.8	Blk	K6 (85), X66
102	0.8	Blk	K6 (85), Y9
200	0.8	Blu	X64 (F), X65 (F)
300	0.8	Wht	X64 (E), X65 (E)
400	0.8	Yel	X64 (C), X65 (C)

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
401	0.8	Yel	X64 (D), Splice 1
402	0.8	Yel	Splice 1, X65 (D)
403	0.8	Yel	Splice 1, K6 (30)
404	0.8	Yel	K6 (86), X66
405	0.8	Yel	K6 (87), Y9

Down Pressure Relay Wiring Harness (W14)



(MIF)

Operation and Diagnostics

Electronic Control Module Operation

This machine is equipped with an electronic control module (A1). The module controls and monitors all safety interlock functions and the engine air preheater function.

When key switch (S1) is in the RUN position, current flows through the following circuits, causing the electronic control module to power up:

- Key Switch (S1) - terminals B and A.
- Wires 500A and 500B yel.
- Control Arm Harness Connector (X15) - terminal A
- Wires 503, 507A, and 509 yel.
- Electronic Control Module Connector (X45) - terminal D.

Ground is provided to the control module through:

- W5 Harness Ground.
- Wire 101 blk.
- Wires 102 and 103 blk.
- Electronic Control Module Connector (X45) - terminals B and C.

The electronic control module features input LEDs, output LEDs, and a status LED (known as the “heartbeat” LED) to aid in electrical circuit diagnosis.

The input LEDs will light whenever a function switch has been activated. This will indicate that the input circuit is functioning properly.

The output LEDs, when lit, indicate that the control module circuitry for that particular function is operating properly, and that a controlled ground is available for that circuit at the control module output terminal.

If all circuits are OK, the status LED will flash at a steady rate called the heartbeat. The heartbeat pattern is 130 milliseconds ON and 830 milliseconds OFF.

If the control module detects a malfunction, the LED will flash a specific pattern to indicate one of the diagnostic codes. The flash pattern is 280 milliseconds ON and 280 milliseconds OFF for a given digit. There is a one second OFF delay between digits and two second OFF delay before the code is repeated.

- For diagnostic codes caused by the operator, see “Safety Interlock Diagnostic Codes” on page 162.
- For diagnostic codes most likely caused by a system malfunction on an input circuit, see “Electronic Control Module Input Circuits Diagnostic Codes” on page 162.
- For diagnostic codes most likely caused by a system malfunction on an output circuit, see “Electronic Control Module Output Circuits Diagnostic Codes” on page 163.

Safety Interlock Diagnostic Codes

The Sit On Seat (SOS) diagnostic feature alerts the operator when an attempt is made to start the machine when one or more safety interlock switches are not in the correct position for starting.

The following diagnostic codes are displayed by the flashing of the status LED on the electronic control module and the air preheater lamp on the control arm.

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.

- **Code 1-2** (One pulse followed by a short pause followed by two pulses.) Indicates that the brake switch is not activated and/or forward/reverse pedals are not in he NEUTRAL position during an attempted start.
- **Code 1-3** (One pulse followed by a short pause followed by three pulses.) Indicates that the mow/trans lever is in the MOW position during an attempted start.
- **Code 2-2** (Two pulses followed by a short pause followed by two pulses.) Indicates hydraulic oil is in an over-temperature condition.
- **Code 2-3** (Two pulses followed by a short pause followed by three pulses.) Indicates that the hood switch is not activated (European machines) or jumper wire is missing from hood switch connector (North American machines).

Electronic Control Module Input Circuits Diagnostic Codes

NOTE: The code will cycle continuously with a two-second pause between display cycles.

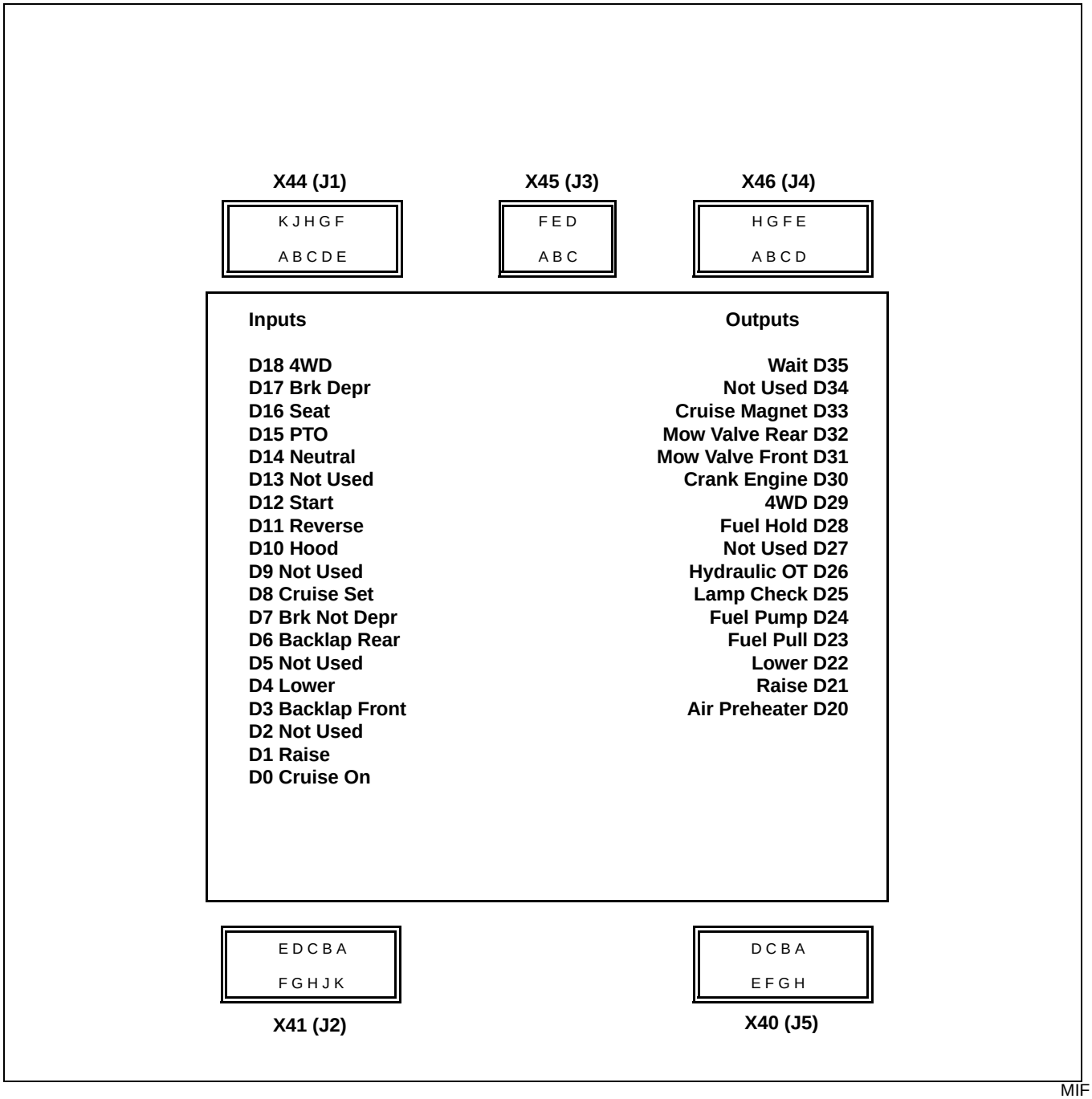
Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

- **Code 3-1** (Three pulses followed by a short pause followed by one pulse.) Indicates an over-voltage condition (voltage input to control box over 18 volts). This could also be caused by attempting to jump start the machine with a 24-volt power source.
- **Code 3-5** (Three pulses followed by a short pause followed by five pulses.) Indicates control module is missing ground connection.
- **Code 3-6** (Three pulses followed by a short pause followed by six pulses.) Indicates control module is missing supply voltage.
- **Code 3-7** (Three pulses followed by a short pause followed by seven pulses.) Indicates control module has an internal over-temperature condition.

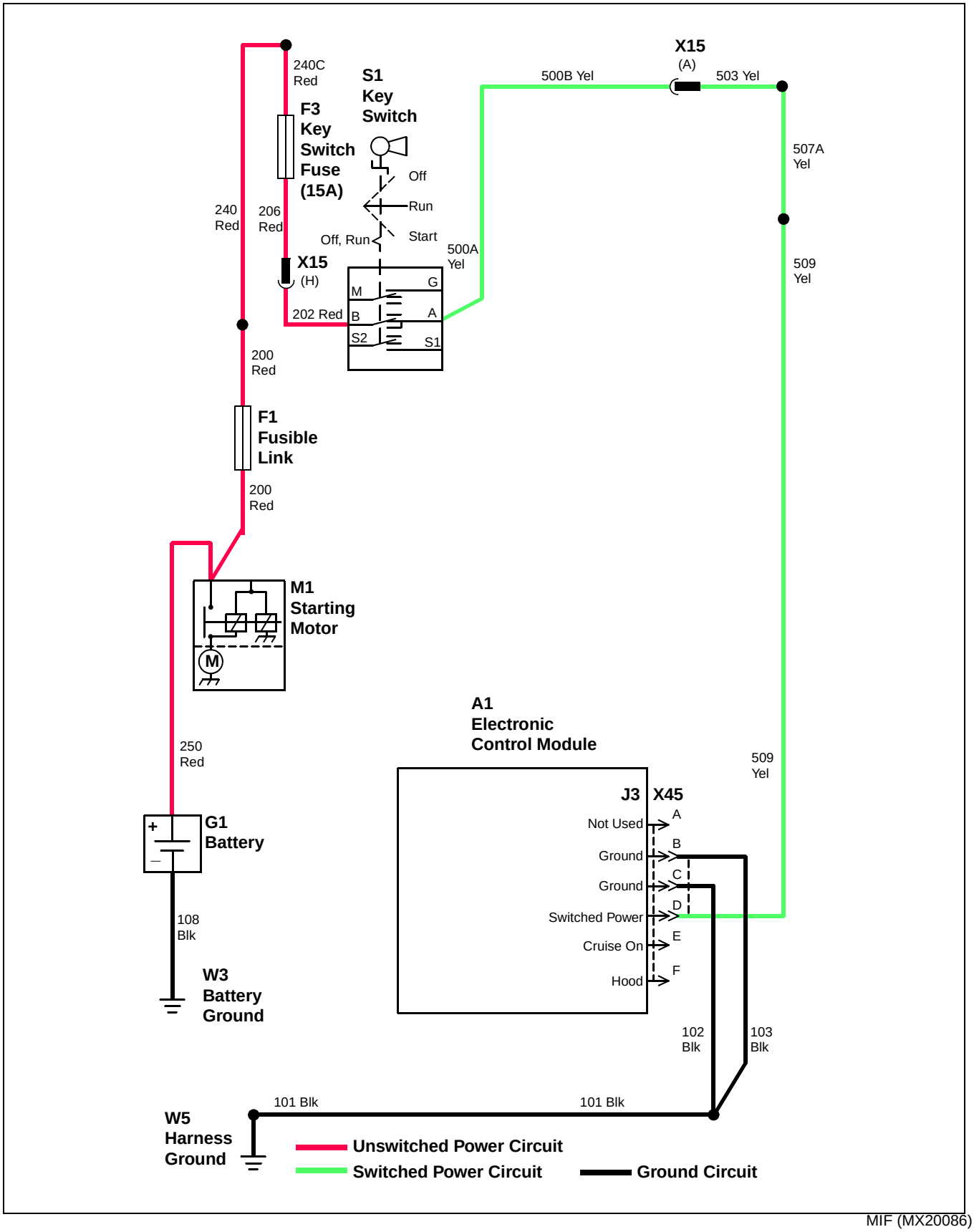
Electronic Control Module Output Circuits Diagnostic Codes

- **Code 4-2** (Four pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning start relay circuit.
- **Code 4-3** (Four pulses followed by a short pause followed by three pulses.) Indicates a malfunctioning front mow solenoid circuit.
- **Code 4-4** (Four pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning air preheater light circuit.
- **Code 4-5** (Four pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel hold-in coil circuit.
- **Code 4-7** (Four pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning cruise control magnet circuit.
- **Code 4-8** (Four pulses followed by a short pause followed by eight pulses.) Indicates a malfunctioning rear mow solenoid circuit.
- **Code 5-1** (Five pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning fuel pump circuit.
- **Code 5-2** (Five pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning lamp check circuit.
- **Code 5-3** (Five pulses followed by a short pause followed by three pulses.) Indicates a malfunctioning hydraulic temperature light circuit.
- **Code 5-4** (Five pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning mow/ trans solenoid circuit.
- **Code 5-5** (Five pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel hold-in coil circuit.
- **Code 5-6** (Five pulses followed by a short pause followed by six pulses.) Indicates a malfunctioning lower solenoid circuit.
- **Code 5-7** (Five pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning raise solenoid circuit.
- **Code 5-8** (Five pulses followed by a short pause followed by eight pulses.) Indicates a malfunctioning air preheater circuit.

Electronic Control Module Input and Output Identification



MIF


240C
Red
S1
Key
Switch
F3
Key
Switch
Fuse
(15A)
Off
Run
Start
Off, Run
240
Red
206
Red
X15
(H)
202 Red
500A
Yel
500B Yel
X15
(A)
503 Yel
507A
Yel
509
Yel
M
G
B
A
S2
S1
200
Red
F1
Fusible
Link
200
Red
M1
Starting
Motor
M
250
Red
A1
Electronic
Control Module
509
Yel
J3
X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
A
B
C
D
E
F
G1
Battery
108
Blk
W3
Battery
Ground
102
Blk
103
Blk
101 Blk
101 Blk
W5
Harness
Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit

MIF (MX20086)

Electronic Control Module Circuit Diagnosis

Before replacing the electronic control module the following must be checked:

- Electrical components connected to the control module must be checked for an internal short circuit. Failure to do so may damage the replacement control module.
- Verify control module has power, a good ground, and valid inputs for proper operation.

Electronic Control Module Circuit Test

Test Conditions:

- Key switch in RUN position.
- Operator ON seat.
- Brake pedal DEPRESSED and in locked position.
- Mow/trans lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Electronic Control Module Circuit

(1) Measure voltage at electronic control module connector (X45) - terminal D. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 509, 507A, 503, 500B and 500A yel and connections.

(2) Measure ground circuit resistance at electronic control module connector (X45) - terminal B. Is there less than 0.1 ohm of resistance?

Yes - Go to step (3).

No - Test wires 103 and 101 blk and connections.

(3) Measure ground circuit resistance at electronic control module connector (X45) - terminal C. Is there less than 0.1 ohm of resistance?

Yes - Replace electronic control module.

No - Test wires 102 and 101 blk and connections.

Electronic Control Module Checks

Operating Conditions

- Operator ON seat.
- Brake pedal DEPRESSED and in locked position.
- Mow/trans lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Key switch in OFF position.

Procedure

1. Turn key switch to the RUN position.
2. Check the status LED, input LEDs, and output LEDs.

NORMAL

- Status (heartbeat) LED flashing in a regular, even rate (about once per second).

NOT NORMAL

- If the status LED and input/output LEDs are not lit, check key switch fuse (F3). If fuse is good, check power to the control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

3. Turn key switch to the START position.

NORMAL

- The engine must crank and start.

NOT NORMAL

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.

- Engine does not crank and the air preheater light begins to flash one of the following codes:

CODE 1-2

Indicates that the brake switch or neutral switch is not activated during an attempted start.

For brake switch, engage and lock brake pedal, then repeat procedure. If the code continues to flash after the brake has been engaged and locked, perform Brake Switch Input check. (See “Brake Switch Input” on page 167.)

For neutral switch, make sure that forward and reverse pedals are in NEUTRAL position, then repeat procedure.

If the code continues to flash after the forward and reverse pedals are in NEUTRAL position, perform Neutral Switch Input check. (See “Neutral Switch Input” on page 167.)

For seat switch, activate seat switch by sitting on seat, then repeat procedure. If the code continues to flash after the seat switch has been activated, perform Seat Switch Input check. (See “Seat Switch Input” on page 167.)

CODE 1-3

Indicates that the mow/trans switch is in the MOW position during an attempted start.

If the code continues to flash after the mow/trans lever has been moved to the TRANSPORT position, perform Mow/Trans Switch Input check. (See “Mow/Trans Switch Input” on page 167.)

Input Circuit Light Check

Key Switch Input

1. Disable the starting motor, by disconnecting the starting motor solenoid connector (wire 747 pur).

2. Move key switch to START position and back to RUN position.

3. Observe the START input light. The light must be ON when the key switch is in the START position and OFF when the key switch is in the RUN position.

If the light does not come ON when the key switch is in the START position: Test key switch circuit. (See “Key Switch Circuit Test” on page 179.)

Seat Switch Input

1. Move key switch to RUN position.

2. Press down on the lower cushion of the seat to close the seat switch contacts.

3. Observe the SEAT input light. The light must be ON when the seat switch contacts are closed (operator ON seat).

4. Release seat cushion.

5. Observe the SEAT input light. The light must be OFF when the seat switch contacts are open (operator OFF seat).

If the light does not come ON: Test seat switch circuit. (See “Seat Switch Circuit Test” on page 179.)

Brake Switch Input

1. Move key switch to RUN position.

2. Depress the brake pedal.

3. Observe the BRK DEPR input light and BRK NOT DEPR input light. The BRK DEPR light must be ON and BRK NOT DEPR light must be OFF.

4. Release the brake pedal.

5. Observe the BRK DEPR input light and BRK NOT DEPR input light. The BRK DEPR light must be OFF and BRK NOT DEPR light must be ON.

If the lights do not function as described: Test brake switch circuit. (See “Brake Switch Circuit Test” on page 179.)

Mow/Trans Switch Input

1. Move key switch to RUN position.

2. Move mow/trans lever to MOW position.

3. Observe the PTO input light. The light must be ON when the mow/trans lever is in the MOW position and OFF when the mow/trans lever is in the TRANSPORT position.

If the light does not function as described: Test the PTO input circuit. (See “Interlock Circuit Diagnosis” on page 179.)

Reverse Switch Input

NOTE: Reverse switch used only on machines with four-wheel drive. Some early model 3225C four-wheel drive kits were not equipped with reverse switch.

1. Move key switch to RUN position.

2. Alternately, depress the reverse pedal.

3. Observe the REVERSE input light. The light must be ON when the pedal is depressed.

If the light does not function as described: Test the reverse switch input circuit. (See “Interlock Circuit Diagnosis” on page 179.)

Neutral Switch Input

1. Move key switch to RUN position.

2. Alternately, depress and release the forward and reverse pedals.

3. Observe the NEUTRAL input light. The light must be OFF when either pedal is depressed and ON when both pedals are released.

If the light does not function as described: Test the neutral switch input circuit. (See “Interlock Circuit Diagnosis” on page 179.)

Power Circuit Operation - Unswitched

Function

Provides power to the primary circuit whenever the battery is connected.

Operating Conditions

- Key switch in OFF position.

Theory of Operation

Voltage must be present at the following components with the key switch in the OFF position:

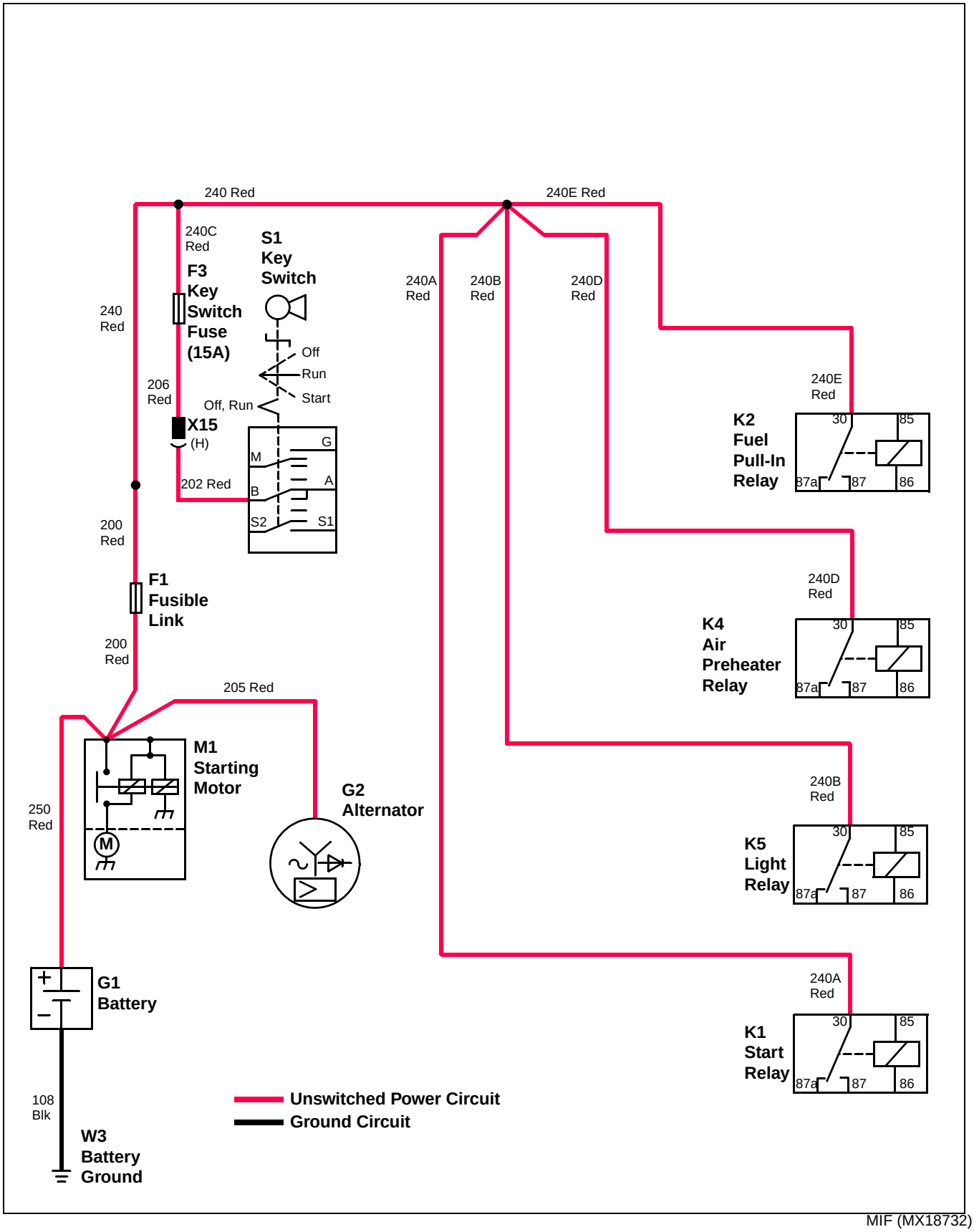
- Battery (G1) positive (+) terminal
- Battery terminal of starting motor (M1) solenoid
- Battery terminal of alternator (G2)
- Battery terminal of key switch (S1)
- Terminal 30 of start relay (K1)
- Terminal 30 of fuel pull-in relay (K2)
- Terminal 30 of air preheater relay (K4)
- Terminal 30 of light relay (K5)

The positive (+) battery cable connects the battery to the starting motor solenoid. The starting motor solenoid connection is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor solenoid connections must be in good condition for the electrical system to function properly.

The ground cable connections are equally as important as the positive (+) cable. Starting motor operation depends on these cables and connections to carry the high current necessary for its operation.

The power circuit is protected by fusible link (F1). The link is a short length of wire which is designed to fail if load current becomes excessive or if a short circuit occurs.


240 Red
240E Red
240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
240 Red
240A Red
240B Red
240D Red
Off
Run
Start
206 Red
Off, Run
X15
(H)
G
M
A
B
S2
S1
202 Red
240E Red
K2 Fuel Pull-In Relay
30
85
87a
87
86
200 Red
F1 Fusible Link
240D Red
K4 Air Preheater Relay
200 Red
205 Red
M1 Starting Motor
G2 Alternator
250 Red
240B Red
K5 Light Relay
240A Red
K1 Start Relay
G1 Battery
108 Blk
W3 Battery Ground
Unswitched Power Circuit
Ground Circuit

MIF (MX18732)

Power Circuit Diagnosis - Unswitched

Test Conditions:

- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Unswitched Power Circuit

(1) Measure voltage at battery positive (+) post. Is voltage in the range of 11.8-13.2 V?

Yes - Go to step (2).

No - Check battery condition. See “Test Battery” on page 238.

(2) Measure voltage at starting motor solenoid. Is battery voltage present?

Yes - Go to step (3).

No - Check battery positive (+) cable and clamps. Clean and tighten connections.

(3) Measure voltage at alternator battery terminal. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 205 red and connections.

(4) Measure voltage at key switch (S1) - terminal B. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 202 and 206 red and key switch fuse (F3). Test wires 240C and 240 red and 200 fusible link (F1) and connections.

(5) Measure voltage at start relay (K1) - terminal 30. Is battery voltage present?

Yes - Go to step (6).

No - Test wire 240A red and connections.

(6) Measure voltage at fuel pull-in relay (K2) - terminal 30. Is battery voltage present?

Yes - Go to step (7).

No - Test wire 240E red and connections.

(7) Measure voltage at air preheater relay (K4) - terminal 30. Is battery voltage present?

Yes - Go to step (8).

No - Test wire 240D red and connections.

System: Unswitched Power Circuit

(8) Measure voltage at light relay (K5) - terminal 30. Is battery voltage present?

No - Test wire 240B red and connections.

Power Circuit Operation - Switched

NOTE: Four-wheel drive is available as a kit only for the 3225C, as a factory installed option for the 3235C and is standard for the 3245C. If four-wheel drive is not installed, machine will not be equipped with reverse switch (S4), four-wheel drive switch (S7) or four-wheel drive solenoid (Y5)

Function

Provides power to components by means of a key switch.

Operating Conditions:

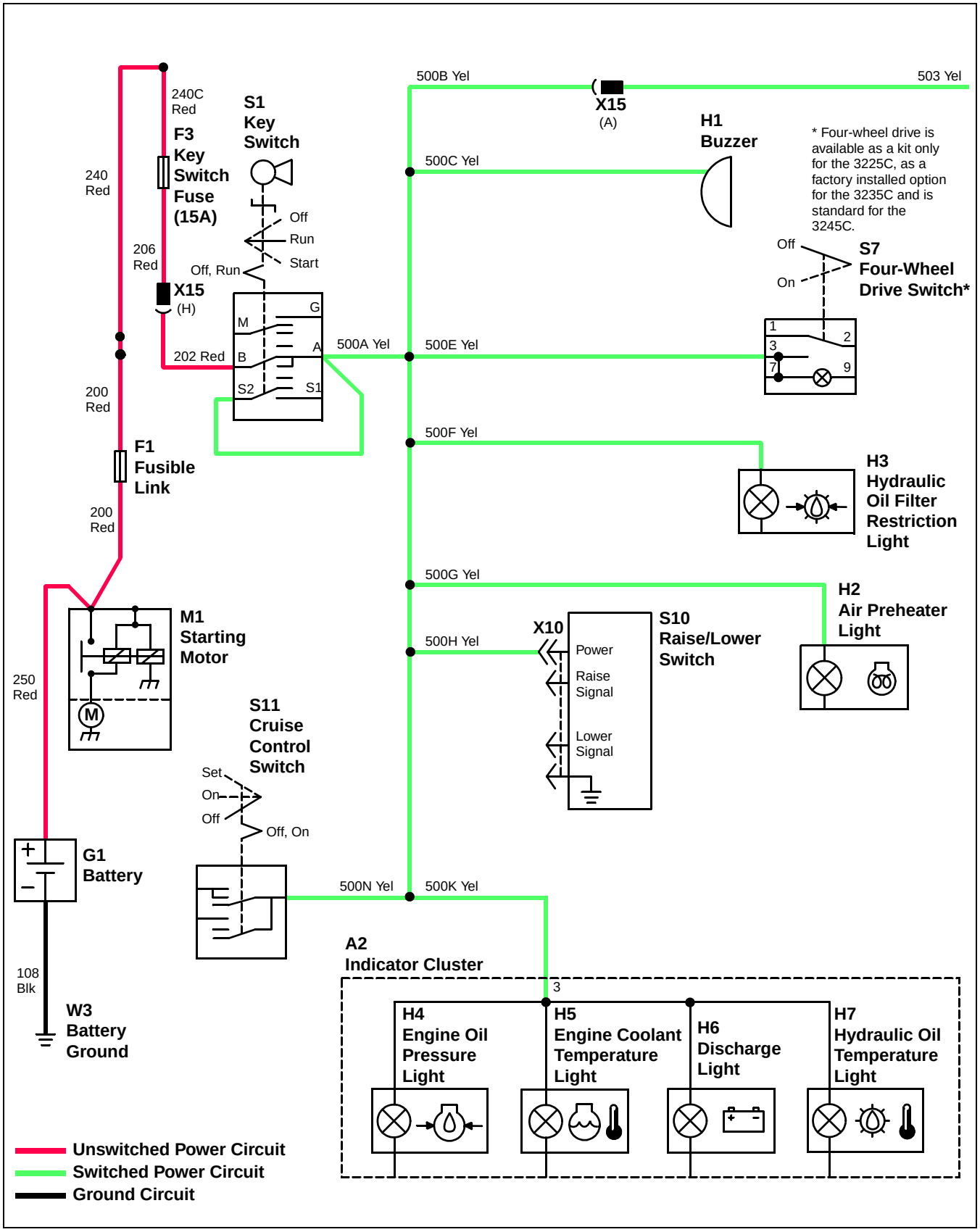
- Key switch in RUN position.

Theory of Operation

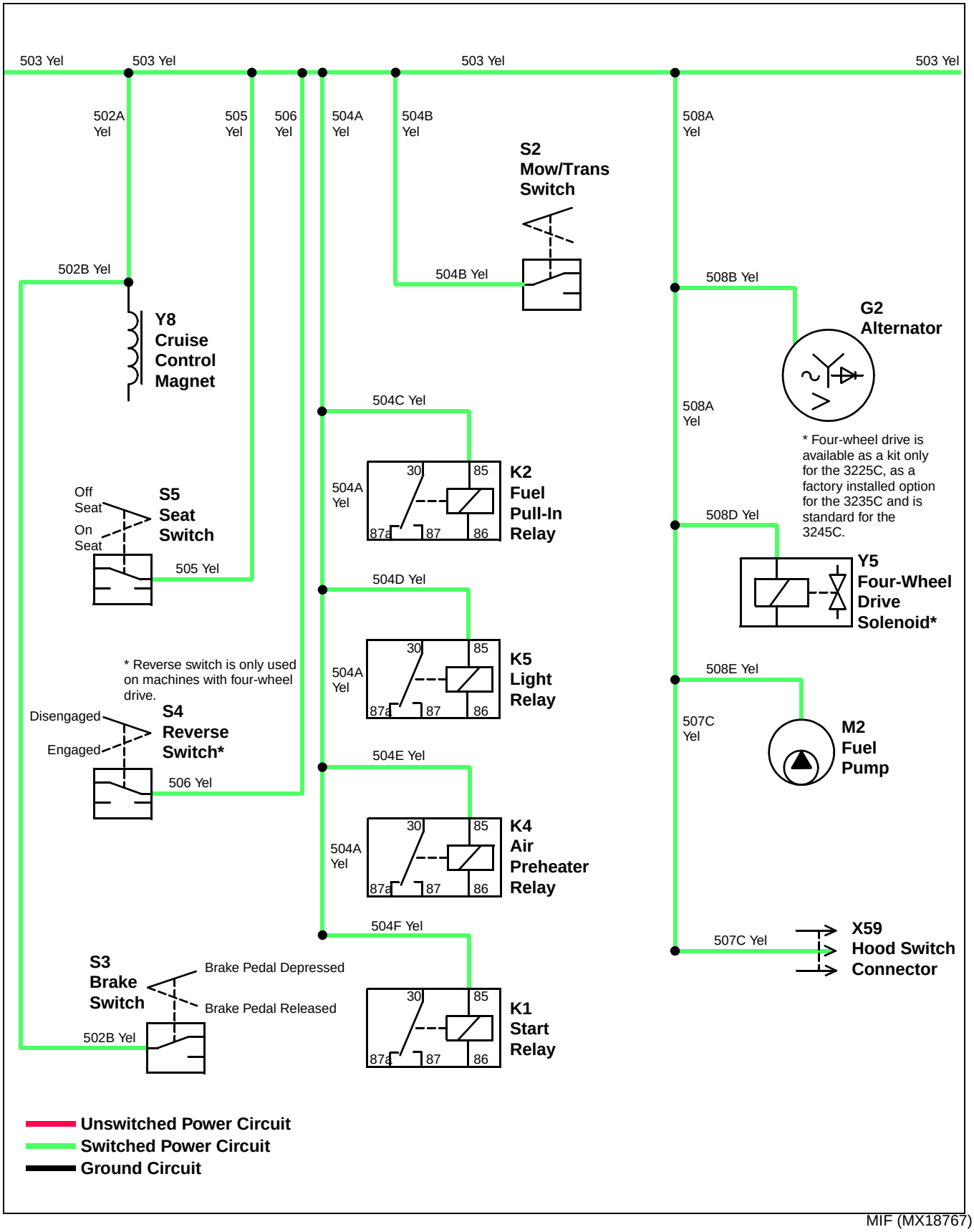
Voltage must be present at the following components with the key switch in the RUN position:

- Key switch (S1) - terminals A and S2.
- Alternator (G2) - wire 508B yel.
- Start relay (K1) - terminal 85.
- Fuel pull-in relay (K2) - terminal 85.
- Air preheater relay (K4) - terminal 85.
- Light relay (K5) - terminal 85.
- Mow/Trans switch (S2) - wire 504B yel.
- Brake switch (S3) - wire 502B yel.
- Reverse switch (S4) - wire 506 yel.
- Seat switch (S5) - wire 505 yel.
- Neutral switch (S6) - wire 507B yel.
- Front mow solenoid (Y3) - wire 502D yel.
- Electronic control module (A1) - wire 509 yel.
- Four-wheel drive switch (S7) - wire 500E yel.
- Rear mow solenoid (Y4) - wire 507F yel.
- Four-wheel drive solenoid (Y5) - wire 508D yel.
- Raise/lower switch (S10) - wire 500H yel.
- Hood switch connector (X59) - wire 507C yel.
- Front backlap switch (S8) - wire 502E yel.
- Rear backlap switch (S9) - wire 507E yel.
- Lower solenoid (Y6) - wire 507H yel.
- Raise solenoid (Y7) - wire 507G yel.
- Indicator cluster (A2) - wire 500K yel.
- Fuel pump (M2) - wire 508E yel.
- Buzzer (H1) - wire 500C yel.
- Air preheater light (H2) - wire 500G yel.
- Hydraulic oil filter restriction light (H3) - wire 500F yel.
- Cruise control switch (S11) - wire 500N yel.
- Cruise control magnet (Y8) - wire 502A yel.

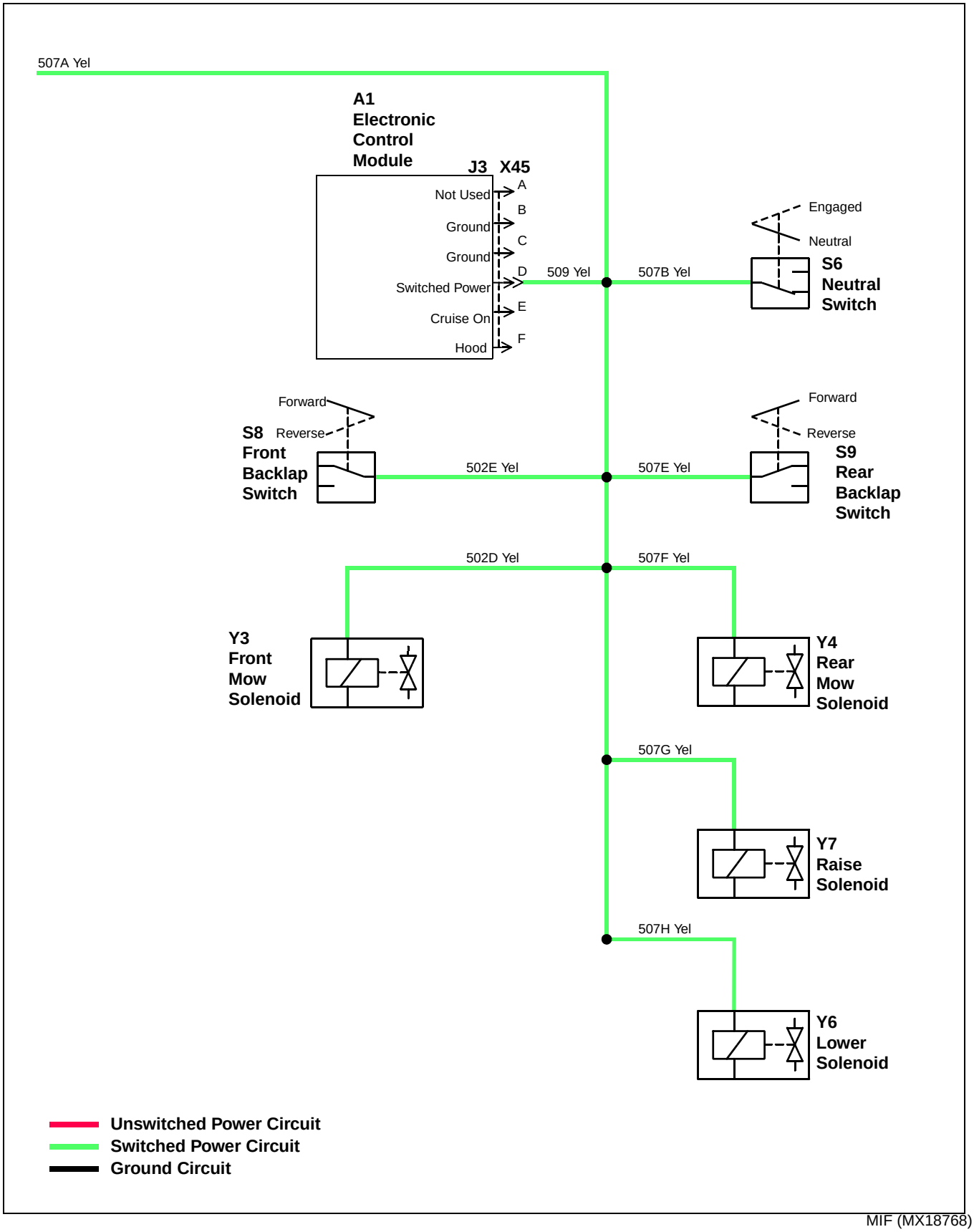
The switched power circuit is protected by 15-amp key switch fuse (F3).


240C Red
F3 Key Switch Fuse (15A)
240 Red
206 Red
X15 (H)
202 Red
200 Red
F1 Fusible Link
200 Red
250 Red
M1 Starting Motor
M
S1 Key Switch
Off
Run
Start
Off, Run
G
M
A
B
S2
S1
500A Yel
500B Yel
X15 (A)
503 Yel
H1 Buzzer
500C Yel
* Four-wheel drive is available as a kit only for the 3225C, as a factory installed option for the 3235C and is standard for the 3245C.
Off
On
S7 Four-Wheel Drive Switch*
1
2
3
7
9
500E Yel
500F Yel
H3 Hydraulic Oil Filter Restriction Light
500G Yel
H2 Air Preheater Light
500H Yel
X10
Power
Raise Signal
Lower Signal
S10 Raise/Lower Switch
S11 Cruise Control Switch
Set
On
Off
Off, On
G1 Battery
108 Blk
W3 Battery Ground
500N Yel
500K Yel
A2 Indicator Cluster
3
H4 Engine Oil Pressure Light
H5 Engine Coolant Temperature Light
H6 Discharge Light
H7 Hydraulic Oil Temperature Light
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit

MIF (MX18733)


503 Yel
503 Yel
503 Yel
503 Yel
502A Yel
505 Yel
506 Yel
504A Yel
504B Yel
508A Yel
S2 Mow/Trans Switch
504B Yel
502B Yel
Y8 Cruise Control Magnet
508B Yel
G2 Alternator
504C Yel
508A Yel
* Four-wheel drive is available as a kit only for the 3225C, as a factory installed option for the 3235C and is standard for the 3245C.
Off Seat
On Seat
S5 Seat Switch
505 Yel
504A Yel
30
85
87a
87
86
K2 Fuel Pull-In Relay
508D Yel
Y5 Four-Wheel Drive Solenoid*
504D Yel
* Reverse switch is only used on machines with four-wheel drive.
504A Yel
K5 Light Relay
508E Yel
Disengaged
Engaged
S4 Reverse Switch*
506 Yel
507C Yel
M2 Fuel Pump
504E Yel
504A Yel
K4 Air Preheater Relay
504F Yel
507C Yel
X59 Hood Switch Connector
S3 Brake Switch
Brake Pedal Depressed
Brake Pedal Released
502B Yel
K1 Start Relay
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit

MIF (MX18767)


507A Yel
A1
Electronic
Control
Module
J3 X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
A
B
C
D
E
F
509 Yel
507B Yel
Engaged
Neutral
S6
Neutral
Switch
Forward
Reverse
S8
Front
Backlap
Switch
502E Yel
507E Yel
Forward
Reverse
S9
Rear
Backlap
Switch
502D Yel
507F Yel
Y3
Front
Mow
Solenoid
Y4
Rear
Mow
Solenoid
507G Yel
Y7
Raise
Solenoid
507H Yel
Y6
Lower
Solenoid
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit

MIF (MX18768)

Power Circuit Diagnosis - Switched

NOTE: Four-wheel drive is available as a kit only for the 3225C, as a factory installed option for the 3235C and is standard for the 3245C. If four-wheel drive is not installed, machine will not be equipped with reverse switch (S4), four-wheel drive switch (S7) or four-wheel drive solenoid (Y5)

Test Conditions:

- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Switched Power Circuit

(1) Measure voltage at key switch (S1) - terminal A. Is battery voltage present?

Yes - Go to step (2).

No - Test key switch. (See “Bench Test Electrical Switches” on page 244.)

(2) Measure voltage at start relay (K1) - terminal 85. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 504F, 504A, 503, 500B and 500A yel and connections.

(3) Measure voltage at fuel pull-in relay (K2) - terminal 85. Is battery voltage present?

Yes - Go to step (4).

No - Test wires 504C, 504A, 503, 500B and 500A yel and connections.

(4) Measure voltage at air preheater relay (K4) - terminal 85. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 504E, 504A, 503, 500B and 500A yel and connections.

System: Switched Power Circuit

(5) Measure voltage at light relay (K5) - terminal 85. Is battery voltage present?

Yes - Go to step (6).

No - Test wire 504D, 504A, 503, 500B and 500A yel and connections.

(6) Measure voltage at mow/trans switch (S2) - wire 504B yel. Is battery voltage present?

Yes - Go to step (7).

No - Test wires 504B and 503 yel and connections.

(7) Measure voltage at brake switch (S3) - wire 502B yel. Is battery voltage present?

Yes - Go to step (8).

No - Test wires 502B, 502A, 503, 500B, and 500A yel and connections.

(8) Measure voltage at reverse switch (S4) - wire 506 yel. Is battery voltage present?

Yes - Go to step (9).

No - Test wires 506, 503, 500B, and 500A yel and connections.

(9) Measure voltage at seat switch (S5) - wire 505 yel. Is battery voltage present?

Yes - Go to step (10).

No - Test wires 505, 503, 500B, and 500A yel and connections.

(10) Measure voltage at neutral switch (S6) - wire 507B yel. Is battery voltage present?

Yes - Go to step (11).

No - Test wires 507B, 507A, 503, 500B and 500A yel and connections.

(11) Measure voltage at front mow solenoid (Y3) - wire 502D yel. Is battery voltage present?

Yes - Go to step (12).

No - Test wires 502D, 507A, 503, 500B and 500A yel and connections.

(12) Measure voltage at electronic control module (A1) - connector X45, terminal D. Is battery voltage present?

Yes - Go to step (13).

No - Test wires 509, 507A, 503, 500B and 500A yel and connections.

System: Switched Power Circuit

(13) Measure voltage at four-wheel drive switch (S7) - wire 500E yel. Is battery voltage present?

Yes - Go to step (14).

No - Test wires 500E and 500A yel and connections.

(14) Measure voltage at rear mow solenoid (Y4) - wire 507F yel. Is battery voltage present?

Yes - Go to step (15).

No - Test wires 507F, 507A, 503, 500B and 500A yel and connections.

(15) Measure voltage at four-wheel drive solenoid (Y5) - wire 508D yel. Is battery voltage present?

Yes - Go to step (16).

No - Test wires 508D, 508A, 503, 500B and 500A yel and connections.

(16) Measure voltage at raise/lower switch (S10) - connector X10, terminal B. Is battery voltage present?

Yes - Go to step (17).

No - Test wires 500H and 500A yel and connections.

(17) Measure voltage at hood switch connector (X59) - wire 507C yel. Is battery voltage present?

Yes - Go to step (18).

No - Test wires 507C, 508A, 503, 500B and 500A yel and connections.

(18) Measure voltage at front backlap switch (S8) - wire 502E yel. Is battery voltage present?

Yes - Go to step (19).

No - Test wires 502E, 507A, 503, 500B and 500A yel and connections.

(19) Measure voltage at rear backlap switch (S9) - wire 507E yel. Is battery voltage present?

Yes - Go to step (20).

No - Test wires 507E, 507A, 503, 500B and 500A yel and connections.

(20) Measure voltage at lower solenoid (Y6) - wire 507H yel. Is battery voltage present?

Yes - Go to step (21).

No - Test wires 507H, 507A, 503, 500B and 500A yel and connections.

System: Switched Power Circuit

(21) Measure voltage at raise solenoid (Y7) - wire 507G yel. Is battery voltage present?

Yes - Go to step (22).

No - Test wires 507G, 507A, 503, 500B and 500A yel and connections.

(22) Measure voltage at indicator cluster (A2) - wire 500K yel. Is battery voltage present?

Yes - Go to step (23).

No - Test wires 500K and 500A yel and connections.

(23) Measure voltage at fuel pump (M2) - wire 508E yel. Is battery voltage present?

Yes - Go to step (24).

No - Test wires 508E, 508A, 503, 500B and 500A yel and connections.

(24) Measure voltage at buzzer (H1) - wire 500C yel. Is battery voltage present?

Yes - Go to step (25).

No - Test wires 500C and 500A yel and connections.

(25) Measure voltage at air preheater light (H2) - wire 500G yel. Is battery voltage present?

Yes - Go to step (26).

No - Test wires 500G and 500A yel and connections.

(26) Measure voltage at hydraulic oil filter restriction light (H3) - wire 500F yel. Is battery voltage present?

Yes - Go to step (27).

No - Test wires 500F and 500A yel and connections.

(27) Measure voltage at cruise control switch (S11) - wire 500N yel. Is battery voltage present?

Yes - Go to step (28).

No - Test wires 500N and 500A yel and connections.

(28) Measure voltage at cruise control magnet (Y8) - wire 502A yel. Is battery voltage present?

Yes - Go to step (29).

No - Test wires 502A, 503, 500B and 500A yel and connections.

(29) Measure voltage at alternator (G2) - wire 508B yel. Is battery voltage present.

No - Test wires 508B, 508A, 503, 500B and 500A yel and connections.

Interlock Circuit Operation

Function

To enable/disable the start relay (K1) and/or the fuel shutoff solenoid (Y1), based on inputs from various switches and controls.

Operating Conditions

- Operator ON seat
- Key switch in RUN position
- Mow/trans lever in TRANSPORT position
- Brake pedal depressed and park brake locked
- Forward and reverse pedals in NEUTRAL position

Theory of Operation

With the key switch (S1) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

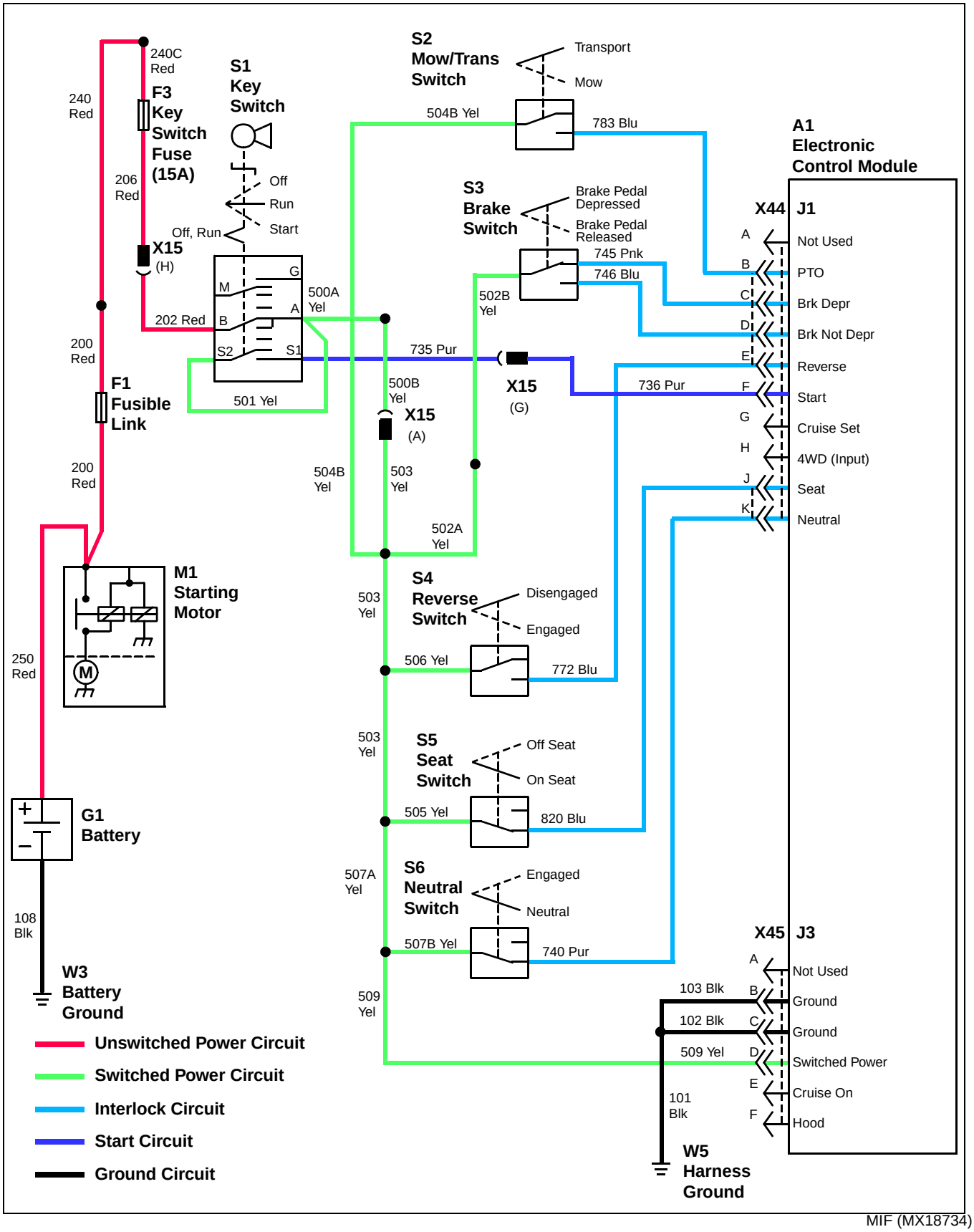
- Trans/mow switch (S2) (wires 500B, 503, and 504B yel)
- Brake switch (S3) (wires 500B, 503, 502A and 502B yel)

NOTE: Reverse switch is installed only on machines with four-wheel drive.

- Reverse switch (S4) (wires 500B, 503 and 506 yel)
- Seat switch (S5) (wires 500B, 503 and 505 yel)
- Neutral switch (S6) (wires 500B, 503, 507A and 507B yel)

From each switch, current flows to the electronic control module (A1) as follows:

- Mow/trans switch - When in the ON position, current flows to control module connector (X44), terminal B (wire 783 blu), indicating that the switch is in the ON position.
- Brake switch - When in the BRAKE PEDAL RELEASED position, current flows to control module connector (X44), terminal D (wire 746 blu), indicating that the brake switch is in the BRAKE PEDAL RELEASED position. When in the BRAKE PEDAL DEPRESSED position, current flows to control module connector (X44), terminal C (wire 745 pnk), indicating that the brake switch is in the BRAKE PEDAL DEPRESSED position.
- Reverse switch - When in the ENGAGED position, current flows to control module connector (X44), terminal E (wire 772 blu), indicating that the reverse switch is in the ENGAGED position.
- Seat switch - When in the ON SEAT position, current flows to control module connector (X44), terminal J (wire 820 blu), indicating that the seat switch is in the ON SEAT position.
- Neutral switch - When in the NEUTRAL position, current flows to control module connector (X44), terminal K (wire 740 pur), indicating that the neutral switch is in the NEUTRAL position.


240C Red
240 Red
F3 Key Switch Fuse (15A)
206 Red
S1 Key Switch
Off
Run
Start
Off, Run
X15 (H)
202 Red
200 Red
F1 Fusible Link
200 Red
M1 Starting Motor
250 Red
M
G1 Battery
108 Blk
W3 Battery Ground
500A Yel
501 Yel
S2 Mow/Trans Switch
Transport
Mow
504B Yel
783 Blu
S3 Brake Switch
Brake Pedal Depressed
Brake Pedal Released
745 Pnk
746 Blu
502B Yel
735 Pur
X15 (G)
736 Pur
500B Yel
X15 (A)
504B Yel
503 Yel
502A Yel
S4 Reverse Switch
Disengaged
Engaged
506 Yel
772 Blu
503 Yel
S5 Seat Switch
Off Seat
On Seat
505 Yel
820 Blu
507A Yel
S6 Neutral Switch
Engaged
Neutral
507B Yel
740 Pur
509 Yel
A1 Electronic Control Module
X44 J1
A Not Used
B PTO
C Brk Depr
D Brk Not Depr
E Reverse
F Start
G Cruise Set
H 4WD (Input)
J Seat
K Neutral
X45 J3
A Not Used
B Ground
C Ground
D Switched Power
E Cruise On
F Hood
103 Blk
102 Blk
509 Yel
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Start Circuit
Ground Circuit

MIF (MX18734)

Interlock Circuit Diagnosis

Key Switch Circuit Test

Test Conditions:

- Key switch in START position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Key Switch Circuit

(1) Measure voltage at key switch (S1) - terminal B. Is battery voltage present?

Yes - Go to step (2).

No - Test key switch fuse (F3). If fuse tests good, test wires 202, 206, 240C and 240 red and 200 fusible link and connections.

(2) Measure voltage at key switch (S1) - terminal A. Is battery voltage present?

Yes - Go to step (3).

No - Test key switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Measure voltage at key switch (S1) - terminal S2. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 501 yel and connections.

(4) Measure voltage at key switch (S1) - terminal S1. Is battery voltage present?

Yes - Go to step (5).

No - Test key switch. (See “Bench Test Electrical Switches” on page 244.)

(5) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal F. Is battery voltage present?

Yes - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

No - Test wires 736 and 735 pur and connections.

Seat Switch Circuit Test

Test Conditions:

- Key switch in RUN position.
- Seat switch depressed.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

System: Seat Switch Circuit

(1) Measure voltage at seat switch (S5) - wire 505 yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 505, 503, 500B and 500A yel and connections.

(2) Measure voltage at seat switch (S5) - wire 820 blu. Is battery voltage present?

Yes - Go to step (3).

No - Test seat switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal J. Is battery voltage present?

Yes - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

No - Test wire 820 blu and connections.

Brake Switch Circuit Test

Test Conditions:

- Key switch in RUN position.
- Brake pedal in RELEASED position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Brake Switch Circuit

(1) Measure voltage at brake switch (S3) - wire 502B yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 502B, 502A, 503, 500B, and 500A yel and connections

System: Brake Switch Circuit

(2) Measure voltage at brake switch (S3) - wire 746 blu. Is battery voltage present?

Yes - Go to step (3).

No - Test brake switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal D. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 746 blu and connections.

(4) Depress brake pedal. Measure voltage at brake switch (S3) - wire 745 pnk. Is battery voltage present?

Yes - Go to step (5).

No - Test brake switch. (See “Bench Test Electrical Switches” on page 244.)

(5) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal C (wire 745 pnk). Is battery voltage present?

Yes - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

No - Test wire 745 pnk and connections.

Mow/Trans Switch Circuit Test

Test Conditions:

- Key switch in RUN position.
- Mow/trans lever in MOW position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Mow/Trans Switch Circuit

(1) Measure voltage at mow/trans switch (S2) - wire 504B yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 504B and 503 yel and connections.

System: Mow/Trans Switch Circuit

(2) Measure voltage at mow/trans switch (S2) - wire 783 blu. Is battery voltage present?

Yes - Go to step (3).

No - Test mow/trans switch. (See “Bench Test Electrical Switches” on page 244.

(3) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal B. Is battery voltage present?

Yes - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

No - Test wires 783 and 782 blu and connections.

Reverse Switch Circuit Test

NOTE: Reverse switch is installed only on machines with four-wheel drive.

Test Conditions:

- Key switch in RUN position.
- Reverse pedal depressed.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Reverse Switch Circuit

(1) Measure voltage at reverse switch (S4) - wire 506 yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 506, 503, 500B and 500A yel and connections

(2) Measure voltage at reverse switch (S4) - wire 772 blu. Is battery voltage present?

Yes - Go to step (3).

No - Test reverse switch. (See “Bench Test Electrical Switches” on page 244.)

System: Reverse Switch Circuit

(3) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal E. Is battery voltage present?

Yes - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

No - Test wire 772 blu and connections.

Neutral Switch Circuit Test

Test Conditions:

- Key switch in RUN position.
- Forward and reverse pedals released.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Neutral Switch Circuit

(1) Measure voltage at neutral switch (S6) - wire 507B yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 507B, 503, 500B and 500A yel and connections.

(2) Measure voltage at neutral switch (S6) - wire 740 pur. Is battery voltage present?

Yes - Go to step (3).

No - Test neutral switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal K. Is battery voltage present?

Yes - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

No - Test wire 740 pur and connections.

Cranking Circuit Operation

Function

Provides power to the starting motor (M1) to crank the engine.

Operating Conditions

To crank the engine, the following conditions must be met:

- Operator ON seat.
- Brake pedal DEPRESSED and in locked position.
- Mow/trans lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Key switch in START position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

The power circuit provides current to the key switch (S1) and protects the cranking circuit with a fusible link (F1) and 15-amp key switch fuse (F3).

Unswitched power from the battery (G1) positive (+) terminal is available at the following components:

- Starting motor (M1), battery terminal (wire 250 red).
- Key switch (S1), terminal B (wires 202 and 206 red).
- Start relay (K1), terminal 30 (wires 200, 240, and 240A red)

Moving key switch (S1) to the START position allows power to be present at all the components as when in the RUN position. (See “Power Circuit Operation - Switched” on page 171.)

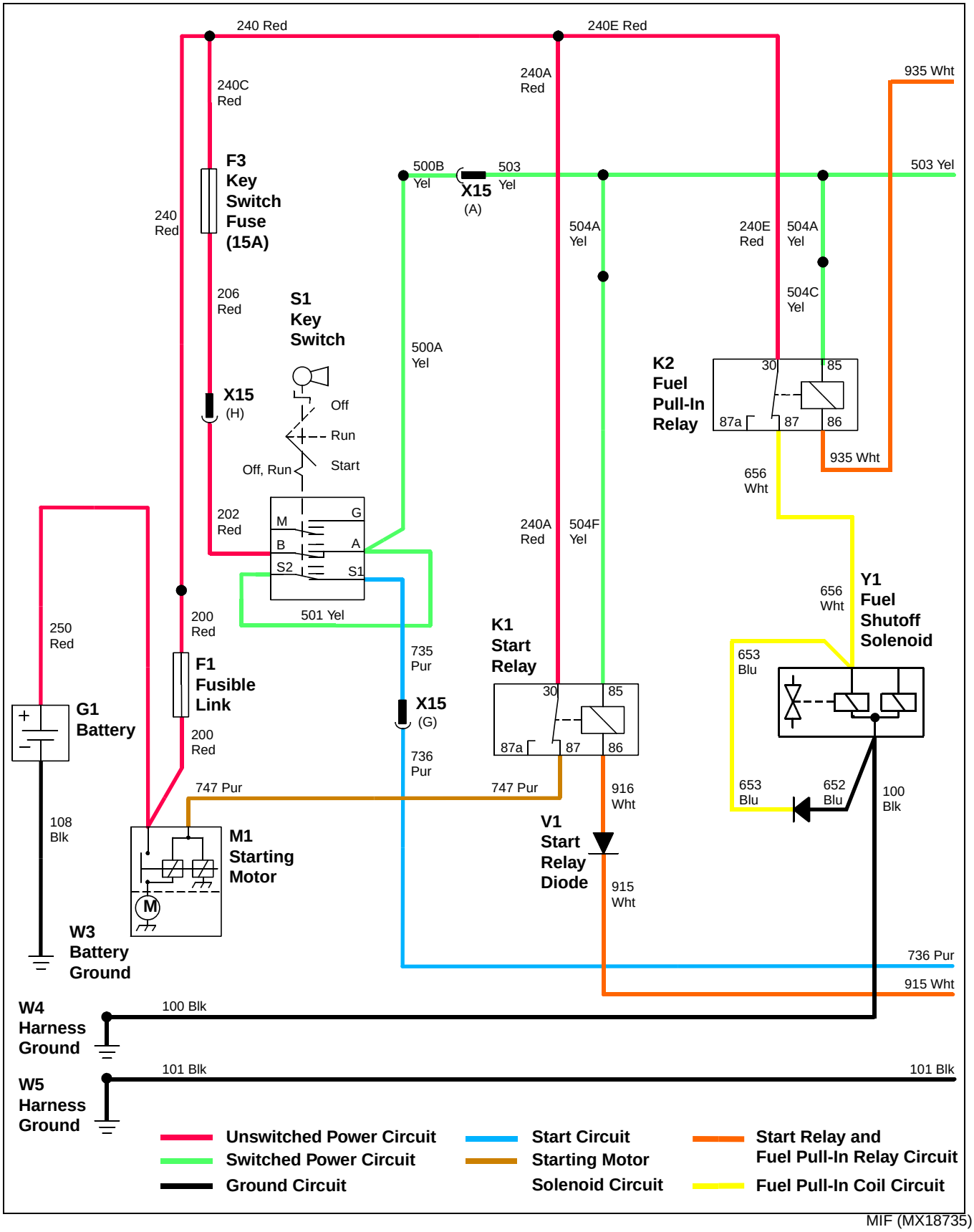
When the key switch (S1) is in the START position, current flows from key switch terminal S1 to control module connector (X44), terminal F (wires 735 and 736 pur).

With the key switch in the START position, the control module will energize start relay (K1) and at the same time momentarily energize fuel pull-in relay (K2). This can only occur when the following conditions are met from the interlock circuit:

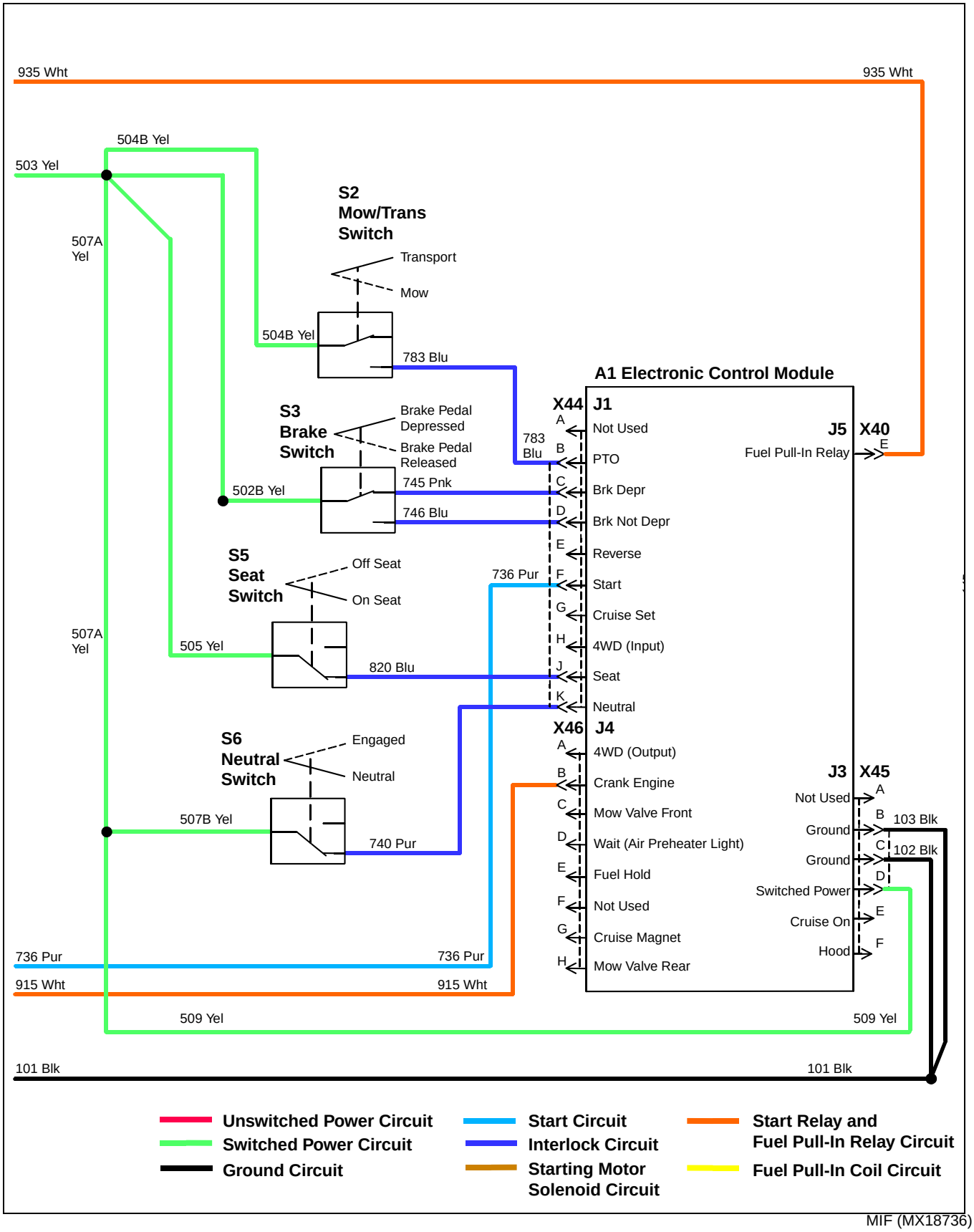
- Operator ON seat.
- Brake pedal DEPRESSED.
- Forward and reverse pedals in NEUTRAL position.
- Mow/trans lever in TRANSPORT position.

With the key switch in the START position and operating conditions met, electronic control module (A1) provides a controlled ground to start relay (K1), terminal 86 through wire 915 wht, start relay diode (V1) and wire 915 wht, energizing the relay. With start relay energized, current flows between start relay terminals (30 and 87) to the solenoid of starting motor (M1) (wire 747 pur), engaging the starting motor.

At the same time, electronic control module (A1) momentarily provides a controlled ground to fuel pull-in relay (K2), terminal 86 (wire 935 wht), momentarily energizing the relay. With fuel pull-in relay momentarily energized, current flows between fuel pull-in relay terminals (30 and 87) to fuel shutoff pull-in coil (wire 656 wht), momentarily energizing the fuel shutoff pull-in coil.


240 Red
240E Red
240C Red
240A Red
935 Wht
F3 Key Switch Fuse (15A)
240 Red
500B Yel
X15 (A)
503 Yel
503 Yel
504A Yel
240E Red
504A Yel
206 Red
S1 Key Switch
504C Yel
500A Yel
X15 (H)
Off
Run
Off, Run
Start
K2 Fuel Pull-In Relay
30
85
87a
87
86
935 Wht
656 Wht
202 Red
M
G
B
A
S2
S1
240A Red
504F Yel
656 Wht
Y1 Fuel Shutoff Solenoid
501 Yel
250 Red
200 Red
735 Pur
K1 Start Relay
653 Blu
F1 Fusible Link
X15 (G)
G1 Battery
200 Red
736 Pur
747 Pur
747 Pur
916 Wht
653 Blu
652 Blu
100 Blk
108 Blk
M1 Starting Motor
V1 Start Relay Diode
915 Wht
W3 Battery Ground
736 Pur
915 Wht
W4 Harness Ground
100 Blk
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Start Circuit
Starting Motor Solenoid Circuit
Start Relay and Fuel Pull-In Relay Circuit
Fuel Pull-In Coil Circuit

MIF (MX18735)


935 Wht
935 Wht
504B Yel
503 Yel
507A Yel
S2 Mow/Trans Switch
Transport
Mow
504B Yel
783 Blu
A1 Electronic Control Module
X44 J1
S3 Brake Switch
Brake Pedal Depressed
Brake Pedal Released
783 Blu
A Not Used
B PTO
C Brk Depr
D Brk Not Depr
E Reverse
F Start
G Cruise Set
H 4WD (Input)
J Seat
K Neutral
J5 X40
Fuel Pull-In Relay
E
502B Yel
745 Pnk
746 Blu
S5 Seat Switch
Off Seat
On Seat
736 Pur
507A Yel
505 Yel
820 Blu
S6 Neutral Switch
Engaged
Neutral
X46 J4
A 4WD (Output)
B Crank Engine
C Mow Valve Front
D Wait (Air Preheater Light)
E Fuel Hold
F Not Used
G Cruise Magnet
H Mow Valve Rear
J3 X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
103 Blk
102 Blk
507B Yel
740 Pur
736 Pur
736 Pur
915 Wht
915 Wht
509 Yel
509 Yel
101 Blk
101 Blk
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Start Circuit
Interlock Circuit
Starting Motor Solenoid Circuit
Start Relay and Fuel Pull-In Relay Circuit
Fuel Pull-In Coil Circuit

MIF (MX18736)

Cranking Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

The multi-step process is as follows:

IMPORTANT: Avoid damage! When diagnosing the cranking circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)

2. Cranking Circuit Tests. (See “Cranking Circuit Tests” on page 185.)

Cranking Circuit Tests

Test Conditions:

- Key switch in RUN position.
- Operator ON seat.
- Brake pedal depressed and locked.
- Mow/trans lever in TRANSPORT position.
- Forward/reverse pedals in NEUTRAL position.
- Starter solenoid connector (X57) (wire 747 pur) disconnected.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.

System: Start Relay Circuit

(1) Electronic control module (A1) output LED check. Cycle key switch between RUN and START positions. Is crank engine output LED ON when key switch is in START position and output LED OFF in RUN position?

Yes - Go to step (2).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

System: Start Relay Circuit

(2) Measure voltage at start relay (K1) - terminal 85. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 504F, 503, 500B and 500A yel and connections.

(3) Key switch in START position. Measure voltage at start relay (K1) - terminal 86. Is voltage approximately 0.90 volt?

Yes - Go to step (4).

No - Test start relay diode (V1). (See “Test Diode” on page 248.) If diode tests good, test wire 915 wht, fuse/diode block terminals and electronic control module connector (X46) - terminal B.

(4) Measure voltage at start relay (K1) - terminal 30. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 240A and 240 red and 200 fusible link.

(5) Measure voltage at start relay (K1) - terminal 87. Is battery voltage present?

Yes - Go to step (6).

No - Test relay. (See “Test Electrical Relays” on page 246.)

(6) Measure voltage at starter motor solenoid - wire 747 pur. Is battery voltage present?

Yes - Test starter solenoid. (See “Test Starter Solenoid” on page 243.)

No - Test wire 747 pur and connections.

System: Fuel Shutoff Hold-In Coil Circuit

(1) Electronic control module (A1) output LED check. Cycle key switch between RUN and START positions. Is fuel pull output LED ON when key switch is in START position and output LED OFF in RUN position?

Yes - Go to step (2).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Measure voltage at fuel pull-in relay (K2) - terminal 30. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 240E and 240 red and 200 fusible link.

System: Fuel Shutoff Hold-In Coil Circuit

(3) Measure voltage at fuel pull-in relay (K2) - terminal 85. Is battery voltage present?

Yes - Go to step (4).

No - Test wires 504C, 504A, 503, 500B and 500A yel and connections.

(4) Measure continuity between fuel pull-in relay (K2) - terminal 86 and electronic control module connector (X40) - terminal E. Is there continuity?

Yes - Go to step (5).

No - Test wires 935 wht and connections.

(5) Key switch in START position. Measure voltage at start relay (K1) - terminal 87. Is battery voltage present?

Yes - Go to step (6).

No - Test relay. (See “Test Electrical Relays” on page 246.)

(6) Measure voltage at fuel shutoff solenoid (Y1) - wire 656 wht. Is battery voltage present?

Yes - Test fuel shutoff solenoid. (See “Test Fuel Shutoff Solenoid” on page 247.)

No - Test wire 656 wht and connections.

Run Circuit Operation - Operator ON Seat

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

When the key switch (S2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wires 500A, 500B, and 503 yel to the following:

- Electronic control module (A1), wires 507A and 509 yel
- Fuel pump (M2), wires 508A and 508E yel

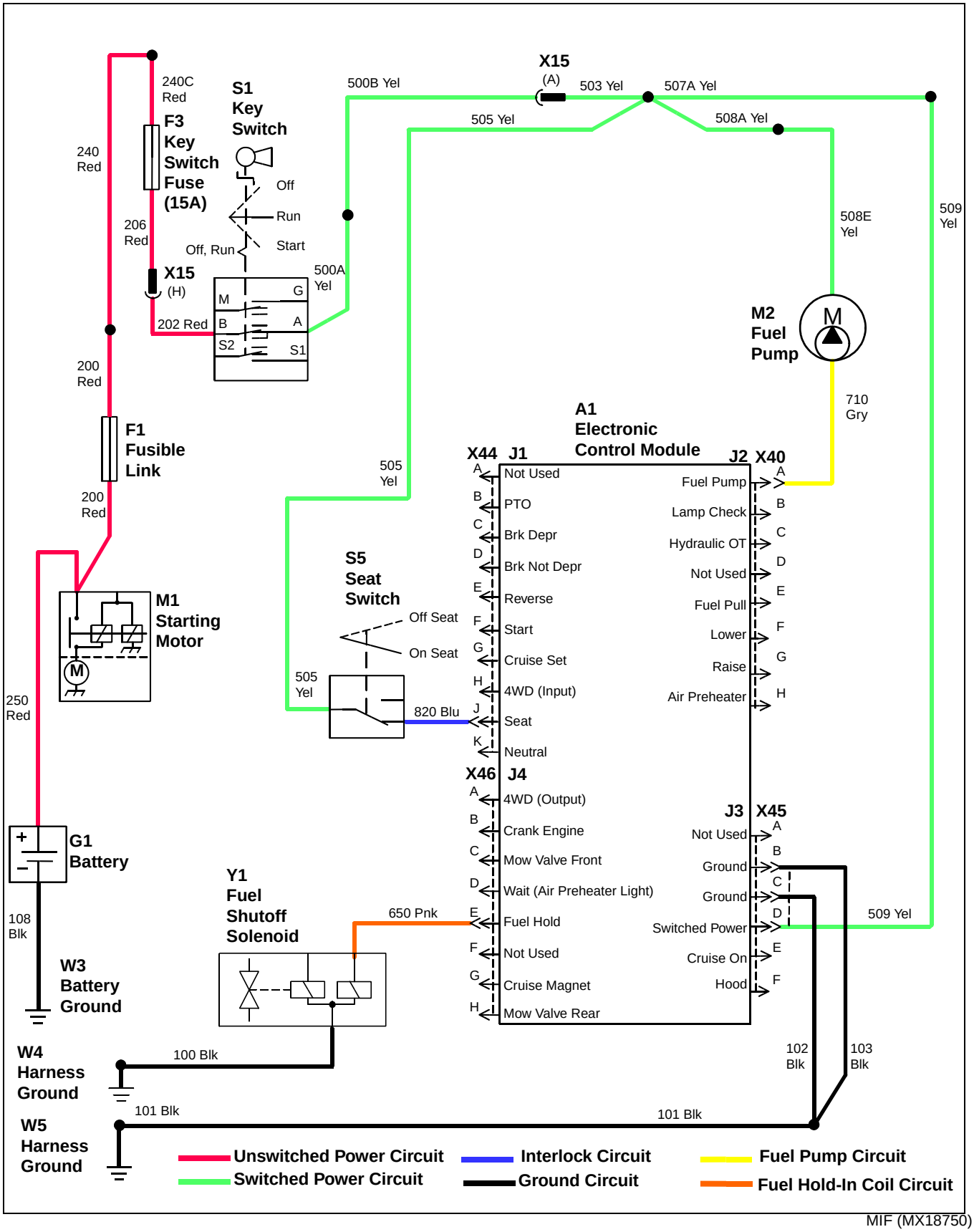
The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 177.) as follows:

- Seat switch (S5)

With the operator ON seat and the key switch in the RUN position, the electronic control module (A1) provides a controlled ground circuit for the fuel pump (M2) (wire 710 gry) and energizes the fuel pump. Also, the electronic control module provides current to the hold coil of the fuel shutoff solenoid (Y1) (wire 650 pnk). The hold coil is provided ground (wire 100 blk) and the fuel shutoff solenoid is held in the energized position and the engine continues to run.

The electronic control module will shut down the engine by opening outputs to the fuel shutoff solenoid hold coil and fuel pump circuits when the following conditions exist:

- Operator OFF seat.
- Brake pedal released.
- Hood OPEN (European machines).
- Hood switch connector with jumper wire disconnected (North American machines).


240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
240 Red
206 Red
Off
Run
Start
Off, Run
X15 (H)
202 Red
500A Yel
M G
B A
S2 S1
200 Red
F1 Fusible Link
200 Red
M1 Starting Motor
250 Red
G1 Battery
108 Blk
W3 Battery Ground
W4 Harness Ground
100 Blk
W5 Harness Ground
101 Blk
Y1 Fuel Shutoff Solenoid
650 Pnk
S5 Seat Switch
Off Seat
On Seat
505 Yel
820 Blu
500B Yel
X15 (A)
503 Yel
507A Yel
505 Yel
508A Yel
508E Yel
509 Yel
M2 Fuel Pump
710 Gry
A1 Electronic Control Module
X44 J1
A Not Used
B PTO
C Brk Depr
D Brk Not Depr
E Reverse
F Start
G Cruise Set
H 4WD (Input)
J Seat
K Neutral
J2 X40
A Fuel Pump
B Lamp Check
C Hydraulic OT
D Not Used
E Fuel Pull
F Lower
G Raise
H Air Preheater
X46 J4
A 4WD (Output)
B Crank Engine
C Mow Valve Front
D Wait (Air Preheater Light)
E Fuel Hold
F Not Used
G Cruise Magnet
H Mow Valve Rear
J3 X45
A Not Used
B Ground
C Ground
D Switched Power
E Cruise On
F Hood
509 Yel
102 Blk
103 Blk
101 Blk
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Fuel Pump Circuit
Fuel Hold-In Coil Circuit

MIF (MX18750)

Run Circuit Diagnosis - Operator ON Seat

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the fuel pump circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See "Electronic Control Module Checks" on page 166.)
2. Run Circuit Test. (See "Run Circuit Test" on page 189.)

Run Circuit Test

Test Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Fuel Pump Circuit

(1) Electronic control module (A1) output LED check. Is fuel pump LED ON?

Yes - Go to step (2).

No - Test electronic control module circuit. (See "Electronic Control Module Circuit Diagnosis" on page 166.)

(2) Measure voltage at fuel pump (M2) - wire 508E yel. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 508E, 508A, 503, 500B and 500A and connections.

(3) Measure voltage at electronic control module connector (X40) - terminal A. Is voltage less than 0.10 volt?

Yes - Go to step (4).

No - Test connector terminal A.

System: Fuel Pump Circuit

(4) Measure voltage at fuel pump (M2) - wire 710 gry. Is voltage less than 0.10 volt?

Yes - Replace fuel pump. (See "Test Fuel Pump" on page 248.)

No - Test wire 710 gry and connections.

Fuel Shutoff Solenoid Circuit Test

Test Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Fuel Shutoff Solenoid Hold Coil Circuit

(1) Electronic control module (A1) output LED check. Is fuel hold LED ON?

Yes - Go to step (2).

No - Test electronic control module circuit. (See "Electronic Control Module Circuit Diagnosis" on page 166.)

(2) Measure voltage at electronic control module connector (X46) - terminal E. Is battery voltage present?

Yes - Go to step (3).

No - Test connector terminal E.

(3) Measure voltage at fuel shutoff solenoid connector (X47) - wire 650 pnk. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 650 pnk and connections.

(4) Measure voltage at fuel shutoff solenoid connector (X47) - wire 100 blk. Is voltage less than 0.10 volt?

Yes - Test fuel shutoff solenoid. (See "Test Fuel Shutoff Solenoid" on page 247.)

No - Test wire 100 blk and connections.

Run Circuit Operation - Operator OFF Seat

Function

To allow the engine to run with the operator off the seat.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow/trans lever in TRANSPORT position.
- Brake switch in PEDAL DEPRESSED position.
- Neutral switch in NEUTRAL position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wires 500A, 500B, and 503 yel to the following:

- Electronic control module (A1), wires 507A and 509 yel
- Fuel pump (M2), wires 508A and 508E yel

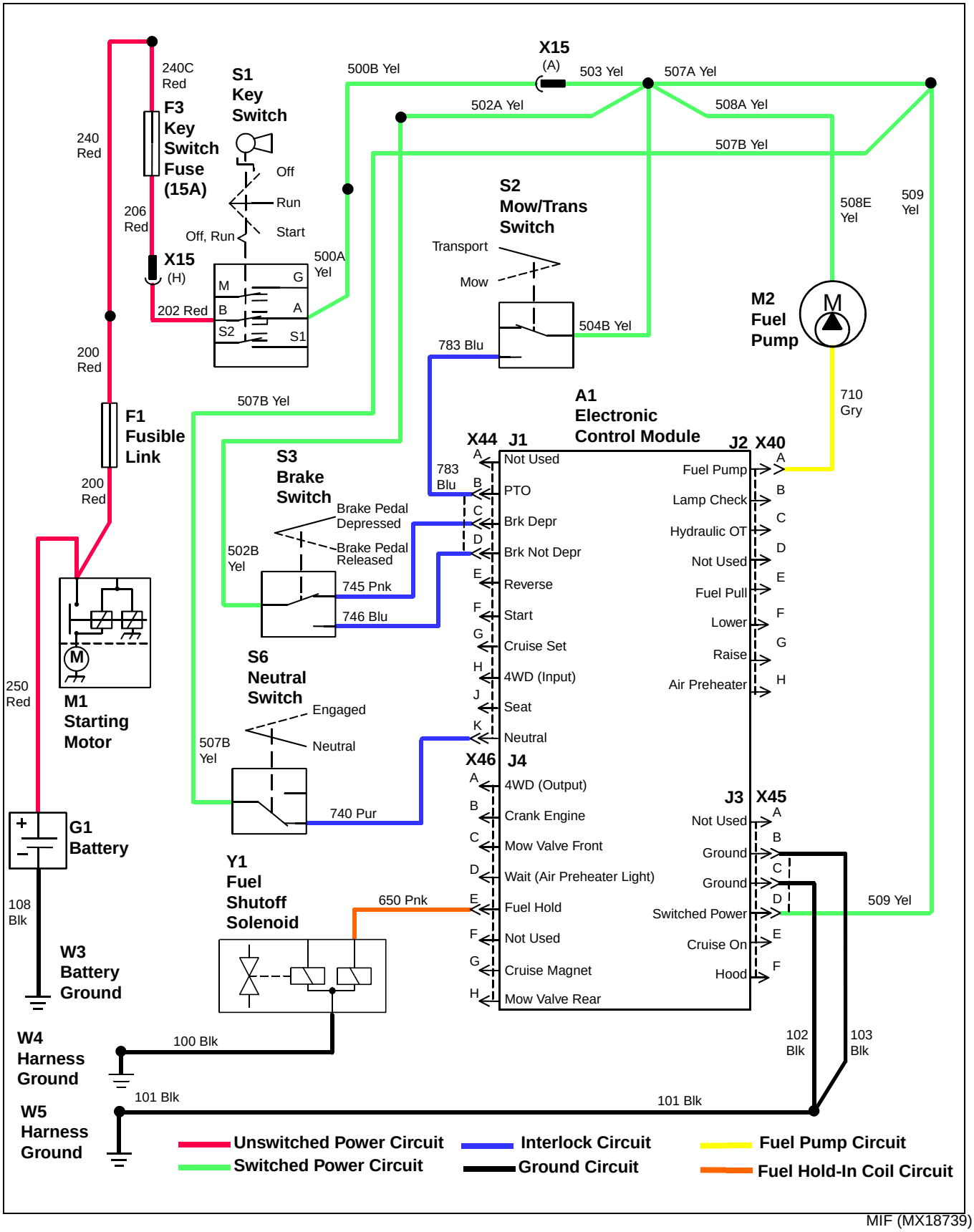
When the operator is OFF the seat, electronic control module will allow the engine to operate, when the following conditions are met.

- Mow/trans switch (S2) is in the OFF position.
- Brake switch (S3) is in the PEDAL DEPRESSED position.
- Neutral switch (S6) is in the NEUTRAL position.

The electronic control module provides a ground circuit for the fuel pump (M2), (wire 710 gry) and energizes the fuel pump. Also, the electronic control module provides current to the hold coil of the fuel shutoff solenoid (Y1) (wire 650 pnk). The hold coil is provided ground (wire 100 blk) and the fuel shutoff solenoid is held in the energized position, and the engine continues to operate.

With the operator OFF the seat, the electronic control module will shut down the engine by opening outputs to the fuel shutoff solenoid hold coil and fuel pump circuits when any of the following conditions exist:

- Brake pedal in the RELEASED position.
- Forward or reverse pedals NOT in the NEUTRAL position.
- Mow/trans lever in the MOW position.
- Hood OPEN (European machines).
- Hood switch connector with jumper wire disconnected (North American machines).


240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
240 Red
206 Red
Off
Run
Start
Off, Run
X15 (H)
202 Red
500A Yel
500B Yel
X15 (A)
503 Yel
507A Yel
502A Yel
508A Yel
507B Yel
508E Yel
509 Yel
S2 Mow/Trans Switch
Transport
Mow
504B Yel
783 Blu
M2 Fuel Pump
710 Gry
200 Red
F1 Fusible Link
507B Yel
A1 Electronic Control Module
X44 J1
J2 X40
S3 Brake Switch
Brake Pedal Depressed
Brake Pedal Released
502B Yel
745 Pnk
746 Blu
783 Blu
Not Used
PTO
Brk Depr
Brk Not Depr
Reverse
Start
Cruise Set
4WD (Input)
Seat
Neutral
Fuel Pump
Lamp Check
Hydraulic OT
Not Used
Fuel Pull
Lower
Raise
Air Preheater
250 Red
M1 Starting Motor
S6 Neutral Switch
Engaged
Neutral
507B Yel
740 Pur
X46 J4
4WD (Output)
Crank Engine
Mow Valve Front
Wait (Air Preheater Light)
Fuel Hold
Not Used
Cruise Magnet
Mow Valve Rear
J3 X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
509 Yel
G1 Battery
108 Blk
W3 Battery Ground
Y1 Fuel Shutoff Solenoid
650 Pnk
W4 Harness Ground
100 Blk
102 Blk
103 Blk
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Fuel Pump Circuit
Fuel Hold-In Coil Circuit

MIF (MX18739)

Run Circuit Diagnosis - Operator OFF Seat

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the fuel pump circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)
2. Run Circuit Tests. (See “Run Circuit Test” on page 192.)

Run Circuit Test

Test Conditions:

- Operator OFF seat.
- Brake switch in PEDAL DEPRESSED position.
- Mow/trans lever in TRANSPORT position.
- Neutral switch in NEUTRAL position.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Fuel Pump Circuit

(1) Electronic control module (A1) output LED check. Is fuel pump LED ON?

Yes - Go to step (2).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Measure voltage at fuel pump (M2) - wire 508E yel. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 508E, 508A, 503, 500B and 500A and connections.

(3) Measure voltage at electronic control module connector (X40) - terminal A. Is voltage less than 0.10 volt?

System: Fuel Pump Circuit

Yes - Go to step (4).

No - Test connector terminal A.

(4) Measure voltage at fuel pump (M2) - wire 710 gry. Is voltage less than 0.10 volt?

Yes - Test fuel pump. (See “Test Fuel Pump” on page 248.)

No - Test wire 710 gry and connections.

Fuel Shutoff Solenoid Circuit Test

Test Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Fuel Shutoff Solenoid Hold Coil Circuit

(1) Electronic control module (A1) output LED check. Is fuel hold LED ON?

Yes - Go to step (2).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Measure voltage at electronic control module connector (X46) - terminal E. Is battery voltage present?

Yes - Go to step (3).

No - Test connector terminal E.

(3) Measure voltage at fuel shutoff solenoid connector (X47) - wire 650 pnk. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 650 pnk and connections.

(4) Measure voltage at fuel shutoff solenoid connector (X47) - wire 100 blk. Is voltage less than 0.10 volt?

Yes - Test fuel shutoff solenoid. (See “Test Fuel Shutoff Solenoid” on page 247.)

No - Test wire 100 blk and connections.

Charging Circuit Operation

Function

To maintain battery voltage between 11.8 and 13.2 VDC.

Operating Conditions

- Key switch in the RUN position.
- Engine running.

Theory of Operation

With the key switch (S1) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

- Discharge light (H6) (wires 500A yel and 500K yel)
- Alternator (G2) (wires 500B 503, 508A and 508B yel)

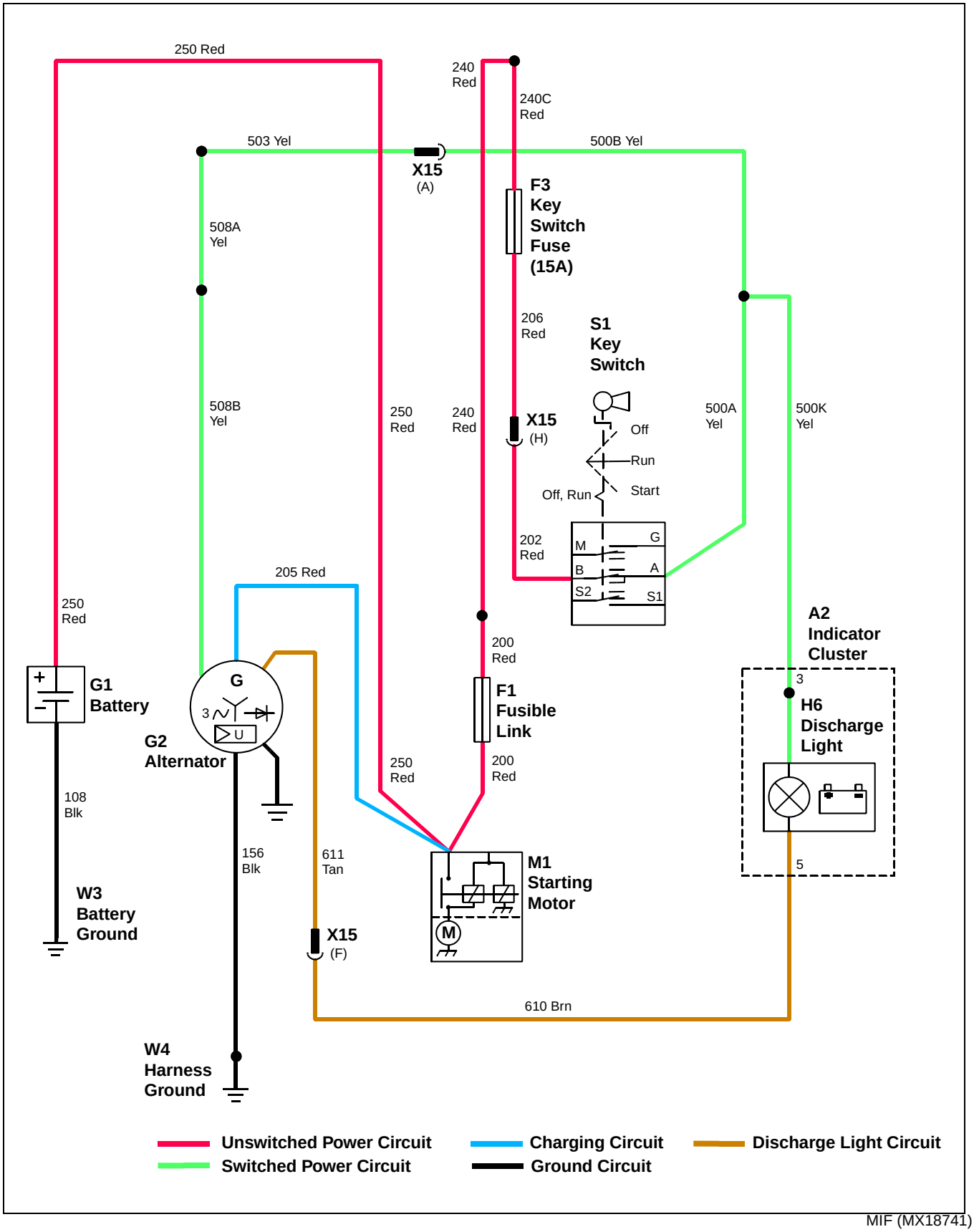
The alternator has an internal voltage regulator that monitors battery voltage and increases alternator output to maintain proper running voltage and battery charge. Alternator output is determined by the intensity of magnetism at the field coil. As the battery voltage fluctuates, the regulator adjusts the voltage to the field coil, which intensifies the magnetic field at the field coil and increases alternator output.

The alternator produces alternating current (AC) which is then rectified to direct current (DC) by an internal rectifier in the alternator.

Charging current flows from the alternator to the battery terminal on starting motor (M1) (red wire 205) and then to the battery positive (+) terminal through the positive (+) battery cable (red wire 205).

When the alternator has no output or low output, discharge light (H6) is turned on by providing ground (wire 611 tan and 610 brn). The alternator provides the ground internally.

Ground for alternator (G2) is provided by wire 156 blk.


250 Red
240 Red
240C Red
503 Yel
500B Yel
X15 (A)
F3 Key Switch Fuse (15A)
508A Yel
206 Red
S1 Key Switch
508B Yel
250 Red
240 Red
X15 (H)
Off
Run
Start
Off, Run
500A Yel
500K Yel
202 Red
M
G
B
A
S2
S1
205 Red
250 Red
200 Red
A2 Indicator Cluster
G1 Battery
G
3
U
G2 Alternator
F1 Fusible Link
250 Red
200 Red
3
H6 Discharge Light
108 Blk
156 Blk
611 Tan
M1 Starting Motor
M
5
W3 Battery Ground
X15 (F)
610 Brn
W4 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Charging Circuit
Ground Circuit
Discharge Light Circuit

MIF (MX18741)

Charging Circuit Diagnosis

Test Conditions:

- Key switch in RUN position, engine OFF.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Charging Circuit

(1) Measure ground circuit for resistance at alternator (G2) - wire 156 blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (2).

No - Test wire 156 blk and connections.

(2) Measure voltage at alternator (G2) - wire 205 red. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 205 and 250 red and connections.

(3) With alternator connector (X58) disconnected, measure voltage at alternator (G2) - wire 508B yel. Is battery voltage present?

Yes - Go to step (4).

No - Test wires 508B, 508A, 503, 500B and 500A yel and connections.

(4) With alternator connector (X58) connected, measure voltage at indicator cluster (A2) - terminal 3. Is battery voltage present?

Yes - Go to step (5).

No - Test wire 500K yel and connections.

(5) Measure voltage at indicator cluster (A2) - terminal 2. Is battery voltage present?

Yes - Go to step (6).

No - Check discharge light bulb in indicator cluster (A2). If bulb is good, replace indicator cluster (A2).

(6) With alternator connector (X58) disconnected, measure voltage at harness side of connector - wire 611 tan. Is battery voltage present?

Yes - Test alternator regulated amperage and voltage. (See “Test Regulated Amperage and Voltage” on page 241.)

No - Test wires 611and 610 tan and connections.

Cruise Control Circuit Operation

NOTE: Cruise control is offered as an option.

Function

To provide a means of keeping the speed of the machine constant without the need of having the operator's foot on the forward hydrostatic control pedal.

The circuit controls an electromagnet that, when energized, holds the forward hydrostatic control pedal at the desired position.

Operating Conditions

- Key switch in the RUN position.
- Operator ON seat.
- Brake switch in PEDAL RELEASED position.
- Cruise control switch in the SET or ON position.

Theory of Operation

NOTE: To engage the cruise control, the cruise control switch must first be moved to the SET position to latch the circuit.

When the key switch (S1) is in the RUN position, switched power (See "Power Circuit Operation - Switched" on page 171) flows from key switch terminal A through wire 500A yel to the following:

- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)
- Cruise control switch (S11) (wire 500N yel)
- Cruise control magnet (Y8) (wires 500B, 503 and 502A yel)

The control module requires inputs from the interlock circuit (See "Interlock Circuit Operation" on page 177.) as follows:

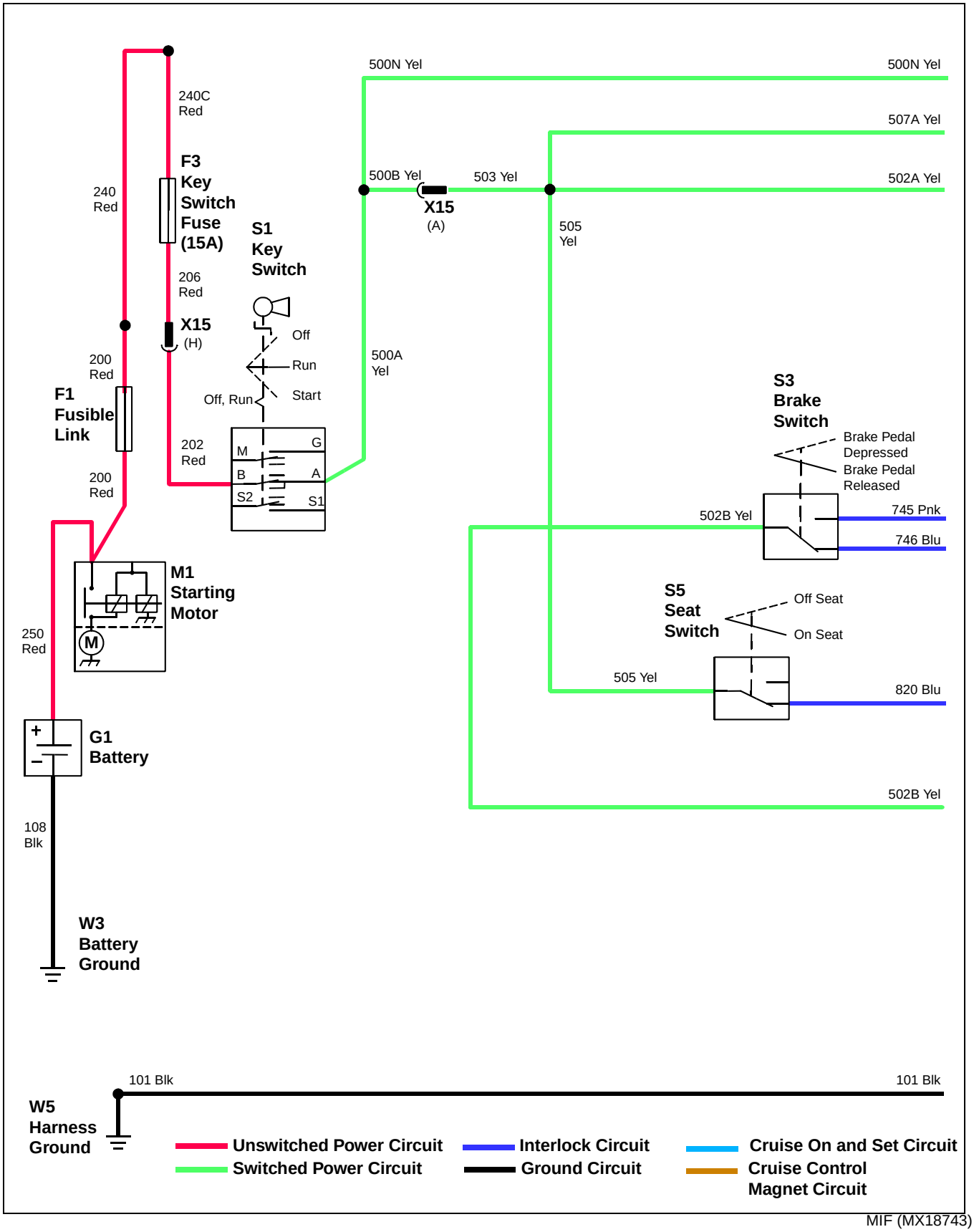
- Brake switch (S3) disengaged (pedal released)
- Seat switch (S5) (operator ON seat)

With the cruise control switch at the momentary SET position, current flows from the cruise control switch to terminal G of the electronic control module connector (X44) (wires 833 and 834 gry). Current also flows to terminal E of the electronic control module connector (X45) (wires 837 and 838 pnk). The control module then supplies a ground path to the cruise control magnet (Y8) (wire 170 blk), energizing the magnet.

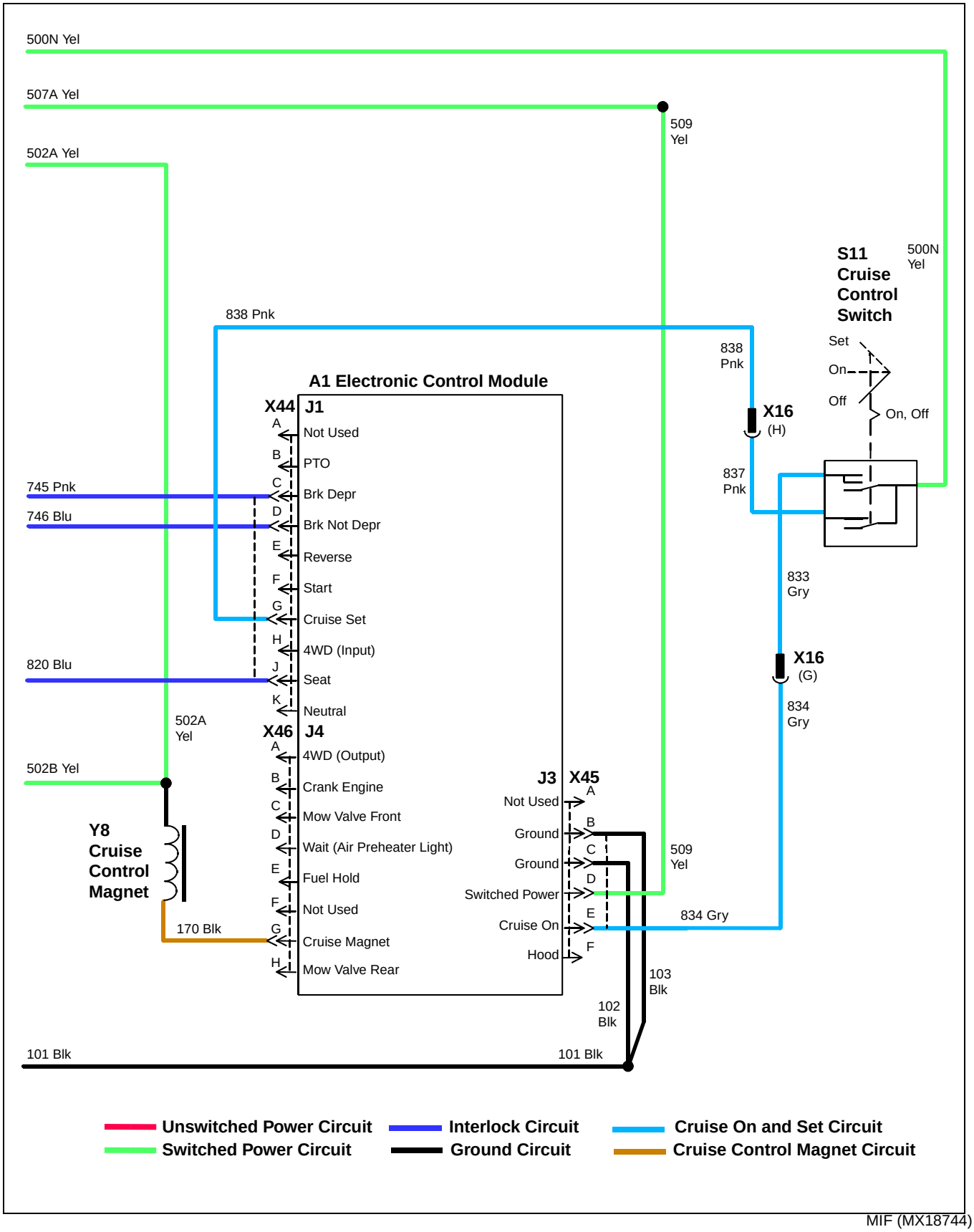
When energized, the magnet pushes against the arm of the forward hydrostatic control pedal, holding the pedal at the desired position.

The cruise control will stay activated unless any of the following occurs:

- Cruise control switch moved to the OFF position
- Brake is depressed
- Operator OFF seat
- Key switch turned to the OFF position


240C Red
F3 Key Switch Fuse (15A)
240 Red
206 Red
X15 (H)
200 Red
F1 Fusible Link
200 Red
250 Red
M1 Starting Motor
M
G1 Battery
108 Blk
W3 Battery Ground
S1 Key Switch
Off
Run
Off, Run
Start
202 Red
M
G
B
A
S2
S1
500A Yel
500N Yel
500N Yel
507A Yel
500B Yel
503 Yel
502A Yel
X15 (A)
505 Yel
S3 Brake Switch
Brake Pedal Depressed
Brake Pedal Released
502B Yel
745 Pnk
746 Blu
S5 Seat Switch
Off Seat
On Seat
505 Yel
820 Blu
502B Yel
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Cruise On and Set Circuit
Cruise Control Magnet Circuit

MIF (MX18743)


500N Yel
507A Yel
502A Yel
509 Yel
S11 Cruise Control Switch
500N Yel
838 Pnk
838 Pnk
Set
On
Off
On, Off
X16 (H)
837 Pnk
A1 Electronic Control Module
X44 J1
A Not Used
B PTO
C Brk Depr
D Brk Not Depr
E Reverse
F Start
G Cruise Set
H 4WD (Input)
J Seat
K Neutral
745 Pnk
746 Blu
820 Blu
833 Gry
X16 (G)
834 Gry
502A Yel
X46 J4
A 4WD (Output)
B Crank Engine
C Mow Valve Front
D Wait (Air Preheater Light)
E Fuel Hold
F Not Used
G Cruise Magnet
H Mow Valve Rear
502B Yel
J3 X45
Not Used A
Ground B
Ground C
Switched Power D
Cruise On E
Hood F
Y8 Cruise Control Magnet
170 Blk
509 Yel
834 Gry
103 Blk
102 Blk
101 Blk
101 Blk
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Cruise On and Set Circuit
Cruise Control Magnet Circuit

MIF (MX18744)

Cruise Control Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the cruise control circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)

2. Cruise Control Circuit Tests. (See “Cruise Control Circuit Tests” on page 199.)

Cruise Control Circuit Tests

Test Conditions:

- Operator ON seat.
- Brake pedal released.
- Key switch in RUN position, engine OFF.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Cruise Control Switch Circuit

(1) Measure voltage at cruise control switch (S11) - wire 500N yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wire 500N yel and connections.

(2) Hold the cruise control switch (S11) in the SET position. Measure voltage at cruise control switch (S11) - wire 833 gry. Is battery voltage present?

Yes - Go to step (3).

No - Test cruise control switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Cruise control switch (S11) in the ON position. Measure voltage at cruise control switch (S11) - wire 833 gry. Is battery voltage present?

Yes - Go to step (4).

No - Test cruise control switch. (See “Bench Test Electrical Switches” on page 244.)

System: Cruise Control Switch Circuit

(4) Disconnect electronic control module connector (X45). Measure voltage at X45 - terminal E. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 833 and 834 gry and connections.

(5) Connect electronic control module connector (X45). Cruise control switch (S11) in the ON position. Electronic control module (A1) input LED check. Is cruise control ON LED ON?

Yes - Go to step (6).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(6) Hold the cruise control switch (S11) in the SET position. Measure voltage at cruise control switch (S11) - wire 837 pnk. Is battery voltage present?

Yes - Go to step (7).

No - Test cruise control switch. (See “Bench Test Electrical Switches” on page 244.)

(7) Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44) - terminal G. Is battery voltage present?

Yes - Go to step (8).

No - Test wires 838 and 837 pnk and connections.

(8) Connect electronic control module connector (X44). Cruise control switch (S11) in the SET position. Electronic control module (A1) input LED check. Is cruise control SET LED ON?

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

Test Conditions:

- Operator ON seat.
- Brake pedal released.
- Key switch in RUN position, engine OFF.
- Cruise control switch (S11) in ON position. (Push switch to momentary SET position, then release.)
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Cruise Control Magnet Circuit

(1) Measure voltage at cruise control magnet (Y8) - wire 502A yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 502A, 503, 500B and 500A and connections.

(2) Electronic control module (A1) output LED check. Is the cruise magnet LED ON?

Yes - Go to step (3).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X46) - terminal G. Is voltage less than 0.1 volt?

Yes - Go to step (4).

No - Test connector terminal G.

(4) Measure voltage at cruise control magnet (Y8) - wire 170 blk. Is voltage less than 0.1 volt?

Yes - Test cruise control magnet (Y8). (See “Test Cruise Control Magnet” on page 252.)

No - Test wire 170 blk and connections.

Mow Circuit Operation

Function

To energize and de-energize the mow solenoids that, in turn, engage and disengage the mower decks.

Operating Conditions:

- Operator ON seat
- Key switch in RUN position
- Mower decks in the lowered position
- Mow/trans lever in TRANSPORT position

Theory of Operation

When the key switch is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171.) flows from key switch terminal A through wire 500A yel and to the following:

- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)
- Front mow solenoid (Y3) (wires 500B, 503, 507A and 502D yel)
- Rear mow solenoid (Y4) (wires 500B, 503, 507A and 507F yel)
- Raise/lower switch (S10) (wire 500H yel)

The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 177.) as follows:

- Mow/trans switch (S2)
- Seat switch (S5)

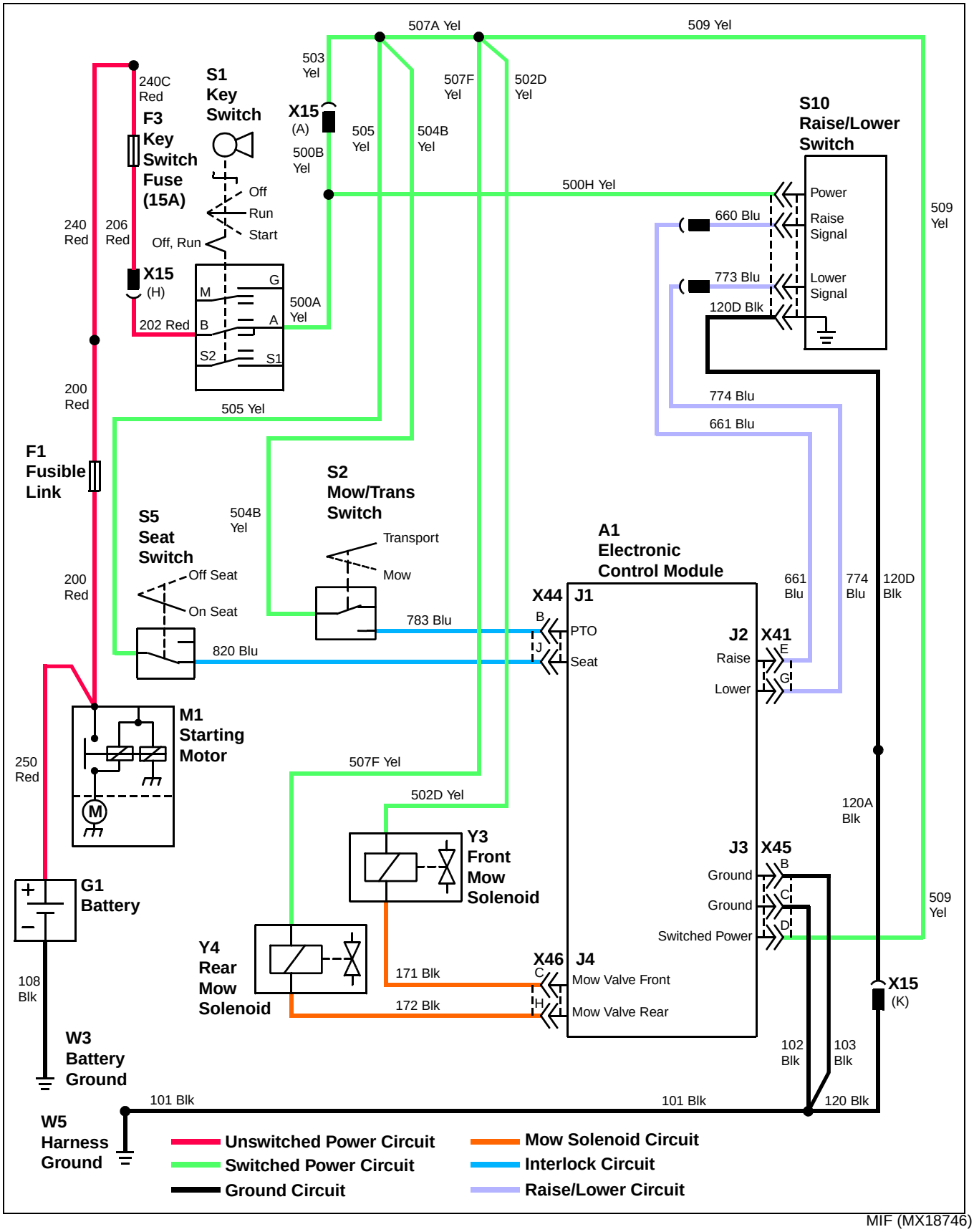
The raise/lower switch is provided ground (wires 120D, 120A, 120 and 101 blk) and has two outputs. One output goes to the electronic control module connector (X41), terminal E (wires 660 and 661 blu), indicating that the raise/lower switch is in the RAISE position. The other output goes to the electronic control module connector (X41), terminal G (wires 773 and 774 blu), indicating that the raise/lower switch is in the LOWER position.

With the key switch in the RUN position, the electronic control module will energize the front mow solenoid (Y3) and the rear mow solenoid (Y4) when the following conditions are met:

- Mow/trans lever in the MOW position.
- Raise/lower switch in the LOWER position.

If the raise/lower switch is moved to the RAISE position, the electronic control module will disengage the front and rear mow solenoids, and the raise/lower switch must be moved back to the LOWER position before the solenoids will be engaged again.

To engage the front and rear mow solenoids (Y3 and Y4), the electronic control module provides a ground path for each solenoid (wire 171 blk for the front mow solenoid [Y3] and wire 172 blk for the rear mow solenoid [Y4]).


507A Yel
509 Yel
503 Yel
507F Yel
502D Yel
240C Red
S1 Key Switch
X15 (A)
505 Yel
504B Yel
S10 Raise/Lower Switch
F3 Key Switch Fuse (15A)
500B Yel
500H Yel
Off
Run
Start
240 Red
206 Red
Off, Run
509 Yel
660 Blu
Power
Raise Signal
X15 (H)
M
G
B
A
S2
S1
500A Yel
202 Red
773 Blu
Lower Signal
120D Blk
200 Red
505 Yel
774 Blu
661 Blu
F1 Fusible Link
S2 Mow/Trans Switch
S5 Seat Switch
504B Yel
Transport
Mow
A1 Electronic Control Module
661 Blu
774 Blu
120D Blk
Off Seat
On Seat
X44
J1
B
PTO
J
Seat
783 Blu
J2
X41
E
Raise
G
Lower
820 Blu
M1 Starting Motor
250 Red
507F Yel
502D Yel
120A Blk
J3
X45
B
Ground
C
Ground
D
Switched Power
509 Yel
Y3 Front Mow Solenoid
G1 Battery
Y4 Rear Mow Solenoid
171 Blk
X46
C
J4
Mow Valve Front
108 Blk
172 Blk
H
Mow Valve Rear
X15 (K)
W3 Battery Ground
102 Blk
103 Blk
101 Blk
101 Blk
120 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Mow Solenoid Circuit
Interlock Circuit
Raise/Lower Circuit

MIF (MX18746)

Mow Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the mow circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)

2. Raise/Lower Circuit Diagnosis. (See “Raise and Lower Circuit Diagnosis” on page 214.)

3. Mow Circuit Tests. (See “Mow Circuit Tests” on page 203.)

Mow Circuit Tests

Test Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Mow/trans lever in TRANSPORT position.
- Move raise/lower switch to LOWER position and release.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Front Mow Circuit

(1) Measure voltage at front mow solenoid (Y3) - wire 502D yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 502D, 507A, 503, 500B and 500A yel and connections.

(2) Electronic control module (A1) output LED check. Is mow valve front LED ON?

Yes - Go to step (3).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X46) - terminal C. Is voltage less than 0.1 volt?

Yes - Go to step (4).

System: Front Mow Circuit

No - Test connector terminal C.

(4) Measure voltage at front mow solenoid (Y3) - wire 171 blk. Is voltage less than 0.1 volt?

Yes - Test front mow solenoid. (See “Test Mow Solenoid” on page 249.)

No - Test wire 171 blk and connections.

Test Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Mow/trans lever in MOW position.
- Move raise/lower switch to LOWER position and release.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Rear Mow Circuit

(1) Measure voltage at rear mow solenoid (Y4) - wire 507F yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 507F, 507A, 503, 500B and 500A yel and connections.

(2) Electronic control module (A1) output LED check. Is mow valve rear LED ON?

Yes - Go to step (3).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X46) - terminal H. Is voltage less than 0.1 volt?

Yes - Go to step (4).

No - Test connector terminal H.

(4) Measure voltage at rear mow solenoid (Y4) - wire 172 blk. Is voltage less than 0.1 volt?

Yes - Test rear mow solenoid. (See “Test Mow Solenoid” on page 249.)

No - Test wire 172 blk and connections.

Four-Wheel Drive Circuit Operation

NOTE: Four-wheel drive is available as a kit only for the 3225C, as a factory installed option for the 3235C and is standard for the 3245C.

Function

To automatically engage four-wheel drive when the mow/trans lever is in MOW position).

Operating Conditions:

- Operator ON seat
- Key switch in RUN position
- Mow/trans switch in MOW position

Theory of Operation

When the key switch (S1) is in the RUN position, current flows from key switch terminal A through wires 500A, 500B, 503, 507A and 509 yel, causing the electronic control module (A1) to power up.

With the key switch in the RUN position, voltage is available to the following:

- Four-wheel drive solenoid (Y5) (wire 500B, 503, 508A and 508D yel).
- Four-wheel drive switch (S7) (wire 500E yel).

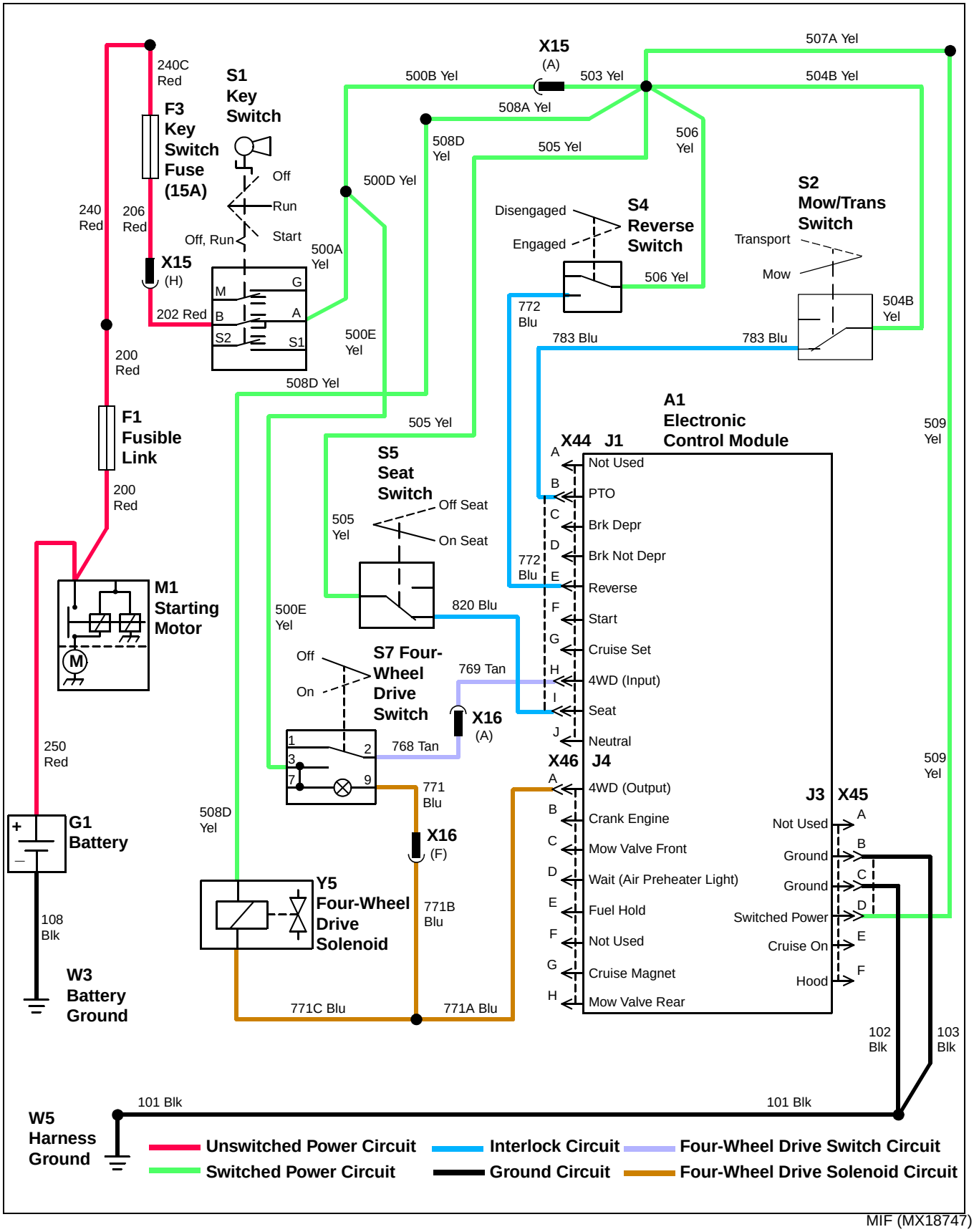
The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 177.) as follows:

- Mow/trans switch (S2)
- Seat switch (S5)

When the mow/trans switch (S2) in the MOW position, electronic control module (A1) provides a controlled ground to electronic control module connector (X46) - terminal A, current flows through the four-wheel drive solenoid (wires 771C and 771A blu), energizing the solenoid. While at the same time current flows through the four-wheel drive indicator light (wires 771, 771B and 771A blu), causing the indicator light to come ON.

When the reverse switch (S4) is in the ENGAGED position (See “Interlock Circuit Operation” on page 177), it signals the electronic control module (A1) that the machine is operating in reverse. When this happens, the electronic control module disengages the four-wheel drive circuit. The electronic control module automatically enables the four-wheel drive circuit when the machine returns to forward operation.

When the four-wheel drive switch (S7) is in the ON position, current flows to electronic control module connector (X44), terminal H (wires 768 and 769 tan), causing the 4WD input LED to come ON. When this happens, electronic control module (A1) enables the four-wheel drive circuit. This allows the operator to enable four-wheel drive operation when the mow/trans switch is in the OFF position.


240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
Off
Run
Start
Off, Run
240 Red
206 Red
X15 (H)
202 Red
M
G
B
A
S2
S1
500A Yel
500B Yel
X15 (A)
503 Yel
507A Yel
504B Yel
508A Yel
508D Yel
505 Yel
506 Yel
500D Yel
500E Yel
Disengaged
Engaged
S4 Reverse Switch
506 Yel
772 Blu
S2 Mow/Trans Switch
Transport
Mow
504B Yel
783 Blu
783 Blu
200 Red
F1 Fusible Link
200 Red
508D Yel
505 Yel
S5 Seat Switch
Off Seat
On Seat
505 Yel
500E Yel
820 Blu
772 Blu
A1 Electronic Control Module
X44 J1
A Not Used
B PTO
C Brk Depr
D Brk Not Depr
E Reverse
F Start
G Cruise Set
H 4WD (Input)
I Seat
J Neutral
509 Yel
M1 Starting Motor
M
Off
On
S7 Four-Wheel Drive Switch
769 Tan
X16 (A)
768 Tan
1
2
3
7
9
771 Blu
250 Red
508D Yel
X16 (F)
771B Blu
X46 J4
A 4WD (Output)
B Crank Engine
C Mow Valve Front
D Wait (Air Preheater Light)
E Fuel Hold
F Not Used
G Cruise Magnet
H Mow Valve Rear
J3 X45
Not Used A
Ground B
Ground C
Switched Power D
Cruise On E
Hood F
509 Yel
G1 Battery
+
–
108 Blk
Y5 Four-Wheel Drive Solenoid
771C Blu
771A Blu
W3 Battery Ground
102 Blk
103 Blk
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Four-Wheel Drive Switch Circuit
Four-Wheel Drive Solenoid Circuit

MIF (MX18747)

Four-Wheel Drive Circuit Diagnosis

NOTE: Four-wheel drive is available as a kit only for the 3225C, as a factory installed option for the 3235C and is standard for the 3245C.

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the four-wheel drive circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)

2. Four-Wheel Drive Circuit Tests. (See “Four-Wheel Drive Circuit Tests” on page 206.)

Four-Wheel Drive Circuit Tests

Test Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Mow/trans lever in MOW position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Four-Wheel Drive Solenoid Circuit

(1) Measure voltage at four-wheel drive solenoid (Y5) - wire 508D yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 508D, 508A, 503, 500B and 500A yel and connections.

(2) Electronic control module (A1) output LED check. Is 4WD LED ON?

Yes - Go to step (3).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X46) - terminal A. Is voltage less than 0.1 volt?

Yes - Go to step (4).

No - Test connector terminal A.

System: Four-Wheel Drive Solenoid Circuit

(4) Measure voltage at four-wheel drive solenoid (Y5) - wire 771C blu. Is voltage less than 0.1 volt?

Yes - Test four-wheel drive solenoid. (See “Test Four-Wheel Drive Solenoid” on page 247.)

No - Test wires 771C and 771 blu and connections.

System: Four-Wheel Drive Indicator Light Circuit

(1) Measure voltage at four-wheel drive switch (S7) - wire 500E yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 500E and 500A yel and connections.

(2) Measure voltage at four-wheel drive switch (S7) - wire 771 blu. Is voltage less than 0.1 volt?

Yes - Test four-wheel drive switch. (See “Bench Test Electrical Switches” on page 244.)

No - Test wires 771 and 771B blu and connections.

Test Conditions:

- Key switch in RUN position.
- Four-wheel drive switch in ON position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Four-Wheel Drive Indicator Light Circuit

(1) Measure voltage at four-wheel drive switch (S7) - wire 500E yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wire 500E yel and connections. (See “Power Circuit Diagnosis - Switched” on page 175.)

(2) Measure voltage at four-wheel drive switch (S7) - wire 768 tan. Is battery voltage present?

Yes - Go to step (3).

No - Test four-wheel drive switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Measure voltage at electronic control module connector (X44) - wire 769 tan. Is battery voltage present?

Yes - Go to step (4).

No - Test wires 768 and 769 tan and connections.

System: Four-Wheel Drive Indicator Light Circuit

(4) Measure voltage at four-wheel drive switch (S7) - wire 771 blu. Is battery voltage present?

Yes - Go to step (5).

No - Test four-wheel drive switch. (See “Bench Test Electrical Switches” on page 244.)

(5) Measure voltage at electronic control module connector (X46) - wire 771A blu. Is battery voltage present?

No - Test wires 771, 771B and 771A blu and connections.

Backlap Circuit Operation

Function

To allow the engine to run and engage the reel motors when the operator is OFF the seat and a backlap switch is in the BACKLAP position.

Operating Conditions

- Forward/reverse knobs in REVERSE position (pulled out into locked position)
- Key switch in RUN position
- Engine running
- Mow/trans level in MOW position
- Operator OFF seat

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171.) flows from key switch terminal A through wire 500A yel to the following:

- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)
- Front backlap switch (S8) (wires 500B, 503, 507A and 502E)
- Rear backlap switch (S9) (wires 500B, 503, 507A and 507E)
- Front mow solenoid (Y3) (wires 500B, 503, 507A and 502D)
- Rear mow solenoid (Y4) (wires 500B, 503, 507A and 507F)

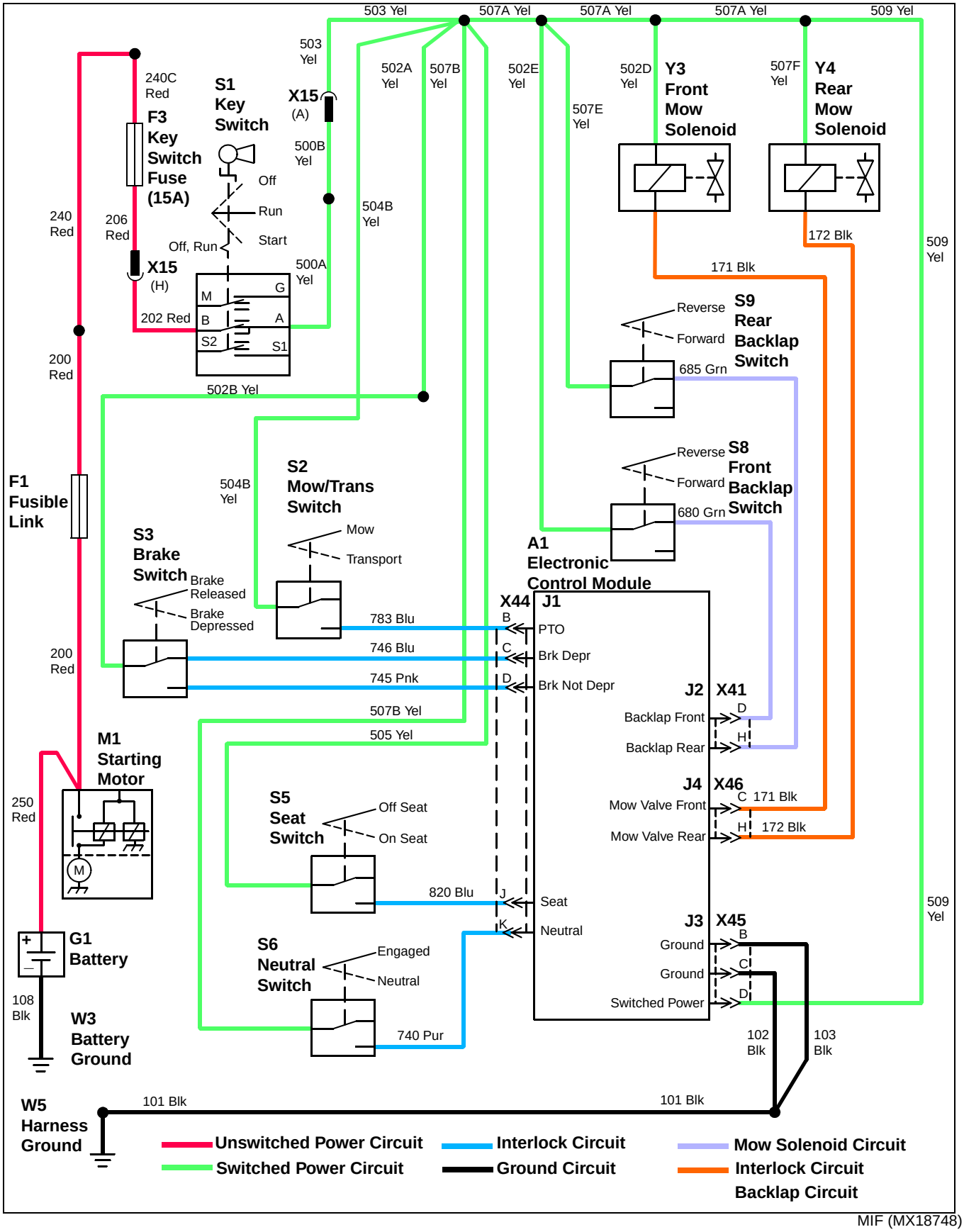
The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 177.) as follows:

- Mow/trans switch (S2)
- Seat switch (S5)

When the control module receives input from the front backlap switch (S8) (wire 680 grn) indicating that the front forward/reverse knob is pulled out and locked in the REVERSE position, the control module provides ground to the front mow solenoid (Y3) (wire 171 blk) and energize the solenoid. With the front mow solenoid energized and the front forward/reverse knob pulled out in the REVERSE position, the front cutting units will turn in the reverse direction for backlapping.

When the control module receives input from the rear backlap switch (S9) (wire 685 grn) indicating that the rear forward/reverse knob is pulled out and locked in the REVERSE position, the control module provides ground to the rear mow solenoid (Y4) (wire 172 blk) and energize the solenoid. With the rear mow solenoid energized and the rear forward/reverse knob pulled out in the locked REVERSE position, the rear cutting units will turn in the reverse direction for backlapping.

Normally, when the mow/trans switch is in the MOW position and the operator is OFF the seat, the engine will stop. However, if either the front backlap switch (S8) or rear backlap switch (S9) is in the ON position and the operator leaves the seat (operator OFF seat), the engine will continue to run.


503 Yel
507A Yel
507A Yel
507A Yel
509 Yel
503 Yel
502A Yel
507B Yel
502E Yel
502D Yel
507F Yel
507E Yel
240C Red
F3 Key Switch Fuse (15A)
S1 Key Switch
X15 (A)
500B Yel
Off
Run
Start
Off, Run
504B Yel
240 Red
206 Red
X15 (H)
500A Yel
M
G
B
A
S2
S1
202 Red
200 Red
502B Yel
Y3 Front Mow Solenoid
Y4 Rear Mow Solenoid
172 Blk
509 Yel
171 Blk
Reverse
Forward
S9 Rear Backlap Switch
685 Grn
Reverse
Forward
S8 Front Backlap Switch
680 Grn
F1 Fusible Link
504B Yel
S2 Mow/Trans Switch
Mow
Transport
S3 Brake Switch
Brake Released
Brake Depressed
A1 Electronic Control Module
X44
J1
783 Blu
746 Blu
745 Pnk
B
C
D
PTO
Brk Depr
Brk Not Depr
200 Red
J2
X41
Backlap Front
Backlap Rear
D
H
507B Yel
505 Yel
M1 Starting Motor
250 Red
J4
X46
Mow Valve Front
Mow Valve Rear
C
H
171 Blk
172 Blk
S5 Seat Switch
Off Seat
On Seat
820 Blu
J
K
Seat
Neutral
J3
X45
Ground
Ground
Switched Power
B
C
D
509 Yel
G1 Battery
S6 Neutral Switch
Engaged
Neutral
740 Pur
108 Blk
W3 Battery Ground
102 Blk
103 Blk
W5 Harness Ground
101 Blk
101 Blk
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Mow Solenoid Circuit
Interlock Circuit
Backlap Circuit

MIF (MX18748)

Backlap Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the backlap circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)

2. Backlap Circuit Tests. (See “Backlap Circuit Tests” on page 210.)

Backlap Circuit Tests

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in MOW position.
- Brake pedal depressed and park brake locked.
- Forward and reverse pedals in NEUTRAL position.
- Front forward/reverse knob in REVERSE position (pulled out in locked position).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Front Backlap Switch (S8) Circuit

(1) Measure voltage at front backlap switch (S8) - wire 502E yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 502E, 507A, 503, 500B and 500A yel and connections.

(2) Measure voltage at front backlap switch - wire 680 grn. Is battery voltage present?

Yes - Go to step (3).

No - Test front backlap switch. (See “Bench Test Electrical Switches” on page 244.)

System: Front Backlap Switch (S8) Circuit

(3) Measure voltage at electronic control module connector (X41) - terminal D. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 680 grn and connections.

(4) Electronic control module (A1) input LED check. Is backlap front LED ON?

No - Test electronic control module connector terminal D. If connector terminal tests good, test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in MOW position.
- Brake pedal depressed and park brake locked.
- Forward and reverse pedals in NEUTRAL position.
- Rear forward/reverse knob in REVERSE position (pulled out in locked position).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Rear Backlap Switch (S9) Circuit

(1) Measure voltage at rear backlap switch (S9) - wire 507E yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 507E, 507A, 503, 500B and 500A yel and connections.

(2) Measure voltage at rear backlap switch - wire 685 grn. Is battery voltage present?

Yes - Go to step (3).

No - Test rear backlap switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Measure voltage at electronic control module connector (X41) - terminal H. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 685 grn and connections.

System: Rear Backlap Switch (S9) Circuit

(4) Electronic control module (A1) input LED check. Is backlap rear LED ON?

No - Test electronic control module connector terminal H. If connector terminal tests good, test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in MOW position.
- Brake pedal depressed and park brake locked.
- Forward and reverse pedals in NEUTRAL position.
- Front forward/reverse knob in REVERSE position (pulled out in locked position).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Front Mow Circuit

(1) Measure voltage at front mow solenoid (Y3) - wire 502D yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 502D, 507A, 503, 500B and 500A yel and connections.

(2) Electronic control module (A1) output LED check. Is mow valve front LED ON?

Yes - Go to step (3).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X46) - terminal C. Is voltage less than 0.1 volt?

Yes - Go to step (4).

No - Test connector terminal C.

(4) Measure voltage at front mow solenoid (Y3) - wire 171 blk. Is voltage less than 0.1 volt?

Yes - Test front mow solenoid. (See “Test Mow Solenoid” on page 249.)

No - Test wire 171 blk and connections.

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in MOW position.
- Brake pedal depressed and park brake locked.
- Forward and reverse pedals in NEUTRAL position.
- Rear forward/reverse knob in REVERSE position (pulled out in locked position).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Rear Mow Circuit

(1) Measure voltage at rear mow solenoid (Y4) - wire 507F yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 507F, 507A, 503, 500B and 500A yel and connections.

(2) Electronic control module (A1) output LED check. Is mow valve rear LED ON?

Yes - Go to step (3).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X46) - terminal H. Is voltage less than 0.1 volt?

Yes - Go to step (4).

No - Test connector terminal H.

(4) Measure voltage at rear mow solenoid (Y4) - wire 172 blk. Is voltage less than 0.1 volt?

Yes - Test rear mow solenoid. (See “Test Mow Solenoid” on page 249.)

No - Test wire 172 blk and connections.

Raise and Lower Circuit Operation

Function

To energize the raise and lower solenoids (Y7 and Y6) as necessary to raise and lower the cutting units.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)
- Lower solenoid (Y6) (wires 500B, 503, 507A and 507H yel)
- Raise solenoid (Y7) (wires 500B, 503, 507A and 507G yel)
- Raise/lower switch (S10) (wire 500H yel)

The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 177) as follows:

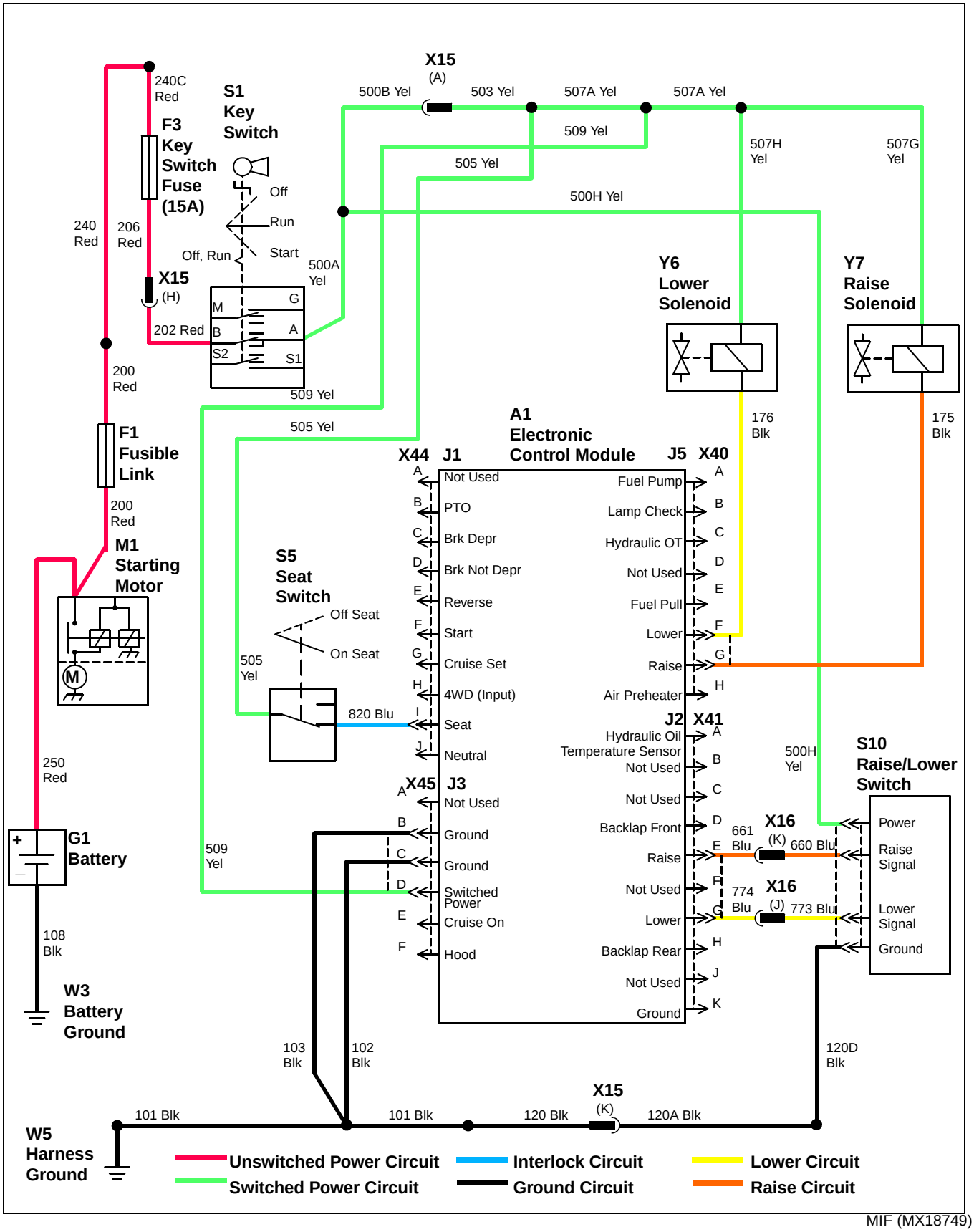
- Mow/trans switch (S2)
- Seat switch (S5)

The raise/lower switch is provided ground (wires 120D, 120A, 120 and 101 blk) and has two outputs. One output goes to the electronic control module connector (X41), terminal E (wires 660 and 661 blu), indicating that the raise/lower switch is in the RAISE position. The other output goes to terminal G (wires 773 and 774 blu), indicating that the raise/lower switch is in the LOWER position.

When the electronic control module senses that the mow/trans switch is in the MOW position and the raise/lower switch is in the RAISE position, the module provides ground at electronic control module connector (X40), terminal G. When this ground is provided, current flows from the raise solenoid (Y7) to ground (wire 175 blk), energizing the solenoid to raise the cutting units. The electronic control module provides this ground for only about three seconds, even if the raise/lower switch is returned to the MIDDLE position. Ground is not provided again until the raise/lower switch is returned to the MIDDLE position and then back to the RAISE position.

When the mow/trans switch is in the TRANSPORT position the operator must hold the raise/lower switch in the RAISE position to move the cutting units to the up position.

When the electronic control module senses that the raise/lower switch is cycled between the MIDDLE and LOWER positions, the module provides ground at electronic control module connector (X40), terminal F. Current flows from the lower solenoid (Y6) to ground (wire 176 blk), energizing the solenoid to lower the cutting units. The electronic control module continuously provides this ground after the raise/lower switch is released to the MIDDLE position.


X15
(A)
500B Yel
503 Yel
507A Yel
507A Yel
509 Yel
505 Yel
500H Yel
507H Yel
507G Yel
240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
Off
Run
Start
Off, Run
240 Red
206 Red
X15
(H)
202 Red
500A Yel
M
G
B
A
S2
S1
509 Yel
200 Red
Y6 Lower Solenoid
Y7 Raise Solenoid
176 Blk
175 Blk
F1 Fusible Link
200 Red
A1 Electronic Control Module
X44 J1
J5 X40
Not Used
PTO
Brk Depr
Brk Not Depr
Reverse
Start
Cruise Set
4WD (Input)
Seat
Neutral
Fuel Pump
Lamp Check
Hydraulic OT
Not Used
Fuel Pull
Lower
Raise
Air Preheater
M1 Starting Motor
S5 Seat Switch
Off Seat
On Seat
505 Yel
820 Blu
J2 X41
Hydraulic Oil Temperature Sensor
Not Used
Not Used
Backlap Front
Raise
Not Used
Lower
Backlap Rear
Not Used
Ground
500H Yel
S10 Raise/Lower Switch
Power
Raise Signal
Lower Signal
Ground
X16
(K)
661 Blu
660 Blu
X16
(J)
774 Blu
773 Blu
X45 J3
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
509 Yel
250 Red
G1 Battery
108 Blk
W3 Battery Ground
103 Blk
102 Blk
120D Blk
X15
(K)
101 Blk
101 Blk
120 Blk
120A Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Interlock Circuit
Ground Circuit
Lower Circuit
Raise Circuit

MIF (MX18749)

Raise and Lower Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and/or continuity checks.

IMPORTANT: Avoid damage! When diagnosing the raise/lower circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 166.)

2. Raise/Lower Circuit Tests. (See “Raise/Lower Circuit Tests” on page 214.)

Raise/Lower Circuit Tests

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Raise/Lower Switch Circuit

(1) Disconnect raise/lower switch connector (X10). Measure voltage at raise/lower switch connector - wire 500H yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 500H and 500A yel and connections.

(2) Measure ground circuit resistance at raise/lower connector (X10) - wire 120D blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (3).

No - Test wires 120D, 120A, 120 and 101 blk and connections.

(3) Connect raise/lower switch connector (X10). Move raise/lower switch (S10) to the RAISE position and hold. Measure voltage at raise/lower switch connector - wire 660 blu. Is battery voltage present?

Yes - Go to step (4).

No - Test raise/lower switch. (See “Test Raise and Lower Switch” on page 246.)

System: Raise/Lower Switch Circuit

(4) With the raise/lower switch (S10) in the RAISE position, measure voltage at electronic control module connector (X41) - terminal E. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 661 and 660 blu and connections.

(5) Raise/lower switch (S10) in the RAISE position. Electronic control module (A1) input LED check. Is raise LED ON?

Yes - Go to step (6).

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(6) Move raise/lower switch (S10) to LOWER position. Measure voltage at raise/lower switch connector - wire 773 blu. Is battery voltage present?

Yes - Go to step (7).

No - Test raise/lower switch. (See “Test Raise and Lower Switch” on page 246)

(7) With the raise/lower switch (S10) in the LOWER position, measure voltage at electronic control module connector (X41) - terminal G. Is battery voltage present?

Yes - Go to step (8).

No - Test wires 773 and 774 blu and connections.

(8) Raise/lower switch (S10) in the LOWER position. Electronic control module (A1) input LED check. Is lower LED ON?

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Raise Solenoid Circuit

(1) Hold raise/lower switch (S10) in the RAISE position. Electronic control module (A1) output LED check. Is raise output LED ON?

Yes - Go to step (2).

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Mow/trans switch (S2) in MOW position. Move raise/lower switch (S10) to RAISE position and release to MIDDLE position. Electronic control module (A1) output LED check. Is raise output LED ON for approximately 3 seconds?

Yes - Go to step (3).

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Mow/trans switch (S2) in TRANSPORT position. Hold raise/lower switch (S10) in RAISE position. Measure voltage at raise solenoid (Y7) - wire 507G yel. Is battery voltage present?

Yes - Go to step (4).

No - Test wires 507G, 507A, 503, 500B and 500A yel and connections.

(4) Measure voltage at electronic control module connector (X40) - terminal G. Is voltage less than 0.1 volt?

Yes - Go to step (5).

No - Test connector terminal G.

(5) Measure voltage at raise solenoid (Y7) - wire 175 blk. Is voltage less than 0.1 volt?

Yes - Test raise solenoid. (See “Test Raise or Lower Solenoid” on page 249.)

No - Test wire 175 blk and connections.

Test Conditions:

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow/trans lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Lower Solenoid Circuit

(1) Measure voltage at lower solenoid (Y6) - wire 507H yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 507H, 507A, 503, 500B and 500A yel and connections.

(2) Move raise/lower switch (S10) to LOWER position and release to MIDDLE position. Electronic control module (A1) output LED check. Is lower LED ON?

Yes - Go to step (3).

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(3) Measure voltage at electronic control module connector (X40) - terminal F. Is voltage less than 0.1 volt?

Yes - Go to step (4).

No - Test connector terminal F.

(4) Measure voltage at lower solenoid (Y6) - wire 176 blk. Is voltage less than 0.1 volt?

Yes - Test lower solenoid. (See “Test Raise or Lower Solenoid” on page 249.)

No - Test wire 176 blk and connections.

Air Preheater Circuit Operation

Function

To provide power to the air preheater (R1) and to automatically turn it on and off as needed.

Operating Conditions

- Key switch in RUN position

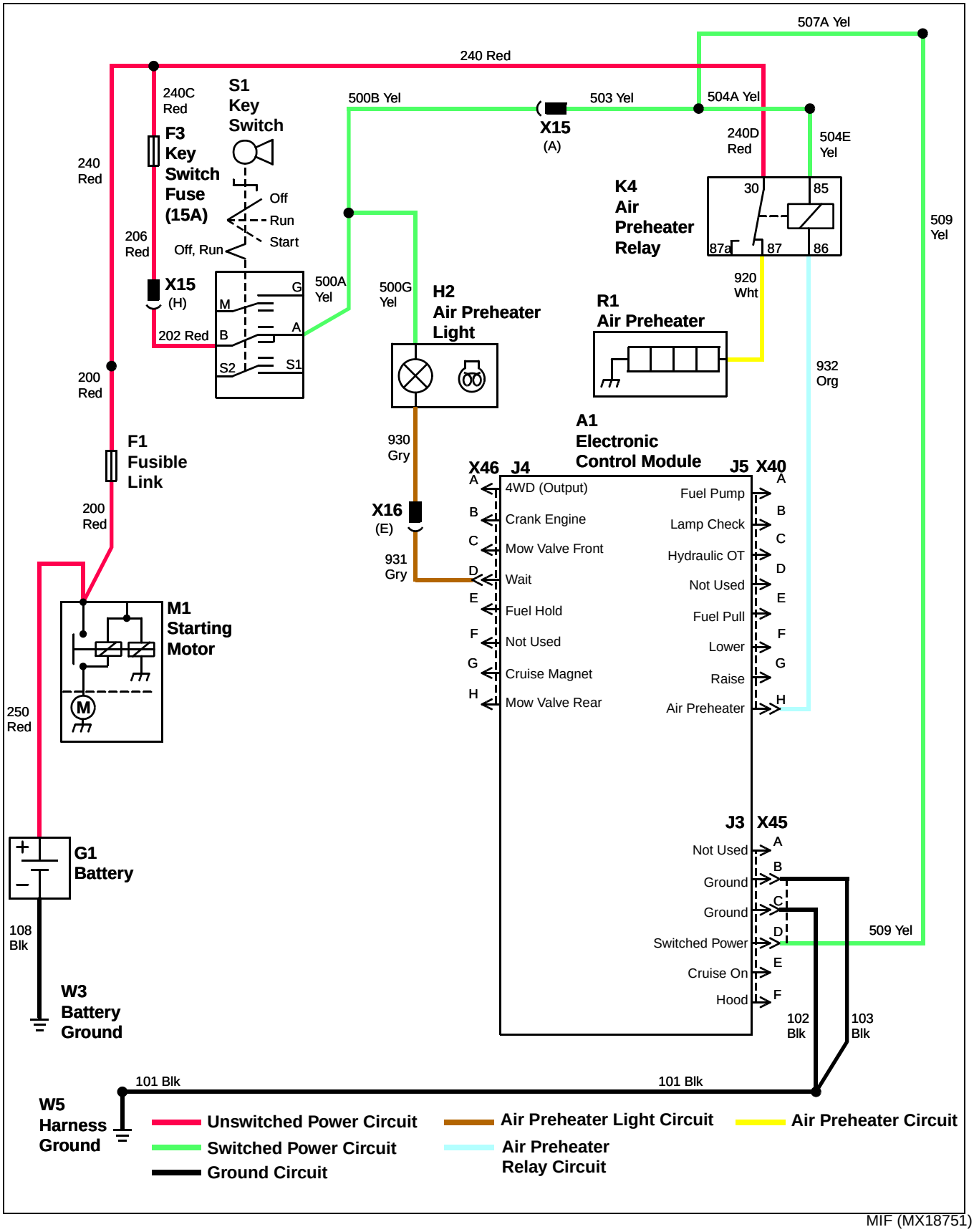
Theory of Operation

Unswitched power (See “Power Circuit Diagnosis - Unswitched” on page 170) is provided to the air preheater relay (K4) contact - terminal 30 (wires 250, 200, 240 and 240D red).

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wires 500A, 500B, 503, 504A and 504E yel to the air preheater relay (K4) - terminal 85.

With the key switch in the RUN position, the electronic control module (A1) provides a ground circuit for the air preheater relay (K4) - terminal 86 (wire 932 org) and energizes the relay.

With the air preheater relay energized, current flows from the relay to the air preheater (R1) (920 wht). The air preheater has an internal ground to the engine that allows current to flow through the air preheater, causing it to heat the air as it enters the engine. After approximately five seconds, electronic control module (A) automatically turns OFF the air preheater circuit.


507A Yel
240 Red
240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
240 Red
500B Yel
503 Yel
X15 (A)
504A Yel
240D Red
504E Yel
K4 Air Preheater Relay
30
85
87a
87
86
509 Yel
206 Red
Off
Run
Start
Off, Run
X15 (H)
G
M
A
B
S2
S1
202 Red
500A Yel
500G Yel
H2 Air Preheater Light
920 Wht
R1 Air Preheater
932 Org
200 Red
F1 Fusible Link
200 Red
930 Gry
A1 Electronic Control Module
X46 J4
J5 X40
X16 (E)
931 Gry
4WD (Output)
Crank Engine
Mow Valve Front
Wait
Fuel Hold
Not Used
Cruise Magnet
Mow Valve Rear
Fuel Pump
Lamp Check
Hydraulic OT
Not Used
Fuel Pull
Lower
Raise
Air Preheater
M1 Starting Motor
250 Red
J3 X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
509 Yel
G1 Battery
108 Blk
W3 Battery Ground
102 Blk
103 Blk
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Air Preheater Light Circuit
Air Preheater Relay Circuit
Air Preheater Circuit

MIF (MX18751)

Air Preheater Circuit Diagnosis

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.

System: Air Preheater Circuit

(1) Cycle key switch (S1) between OFF and RUN positions. Electronic control module (A1) output LED check. Is air preheater LED ON for approximately 5 seconds?

Yes - Go to step (2).

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Key switch in RUN position. Measure voltage at air preheater relay (K4) - terminal 30. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 240D, 240, and 200 red and connections.

(3) Measure voltage at air preheater relay (K4) - terminal 85. Is battery voltage present?

Yes - Go to step (4).

No - Test wires 504E, 504A, 503, 500B and 500A yel and connections.

(4) Cycle key switch (S1) between OFF and RUN positions. Measure voltage at electronic control module connector (X40) - terminal H. Is voltage less than 0.1 volt for approximately 5 seconds?

Yes - Go to step (5).

No - Test connector terminal H.

(5) Cycle key switch (S1) between OFF and RUN positions. Measure voltage at air preheater relay (K4) - terminal 86. Is voltage less than 0.1 volt for approximately 5 seconds?

Yes - Go to step (6).

No - Test wire 932 org and connections.

System: Air Preheater Circuit

(6) Cycle key switch (S1) between OFF and RUN positions. Measure voltage at air preheater relay (K4) - terminal 87. Is battery voltage present for approximately 5 seconds?

Yes - Go to step (7).

No - Test relay. (See “Test Electrical Relays” on page 246.)

(7) Cycle key switch (S1) between OFF and RUN positions. Measure voltage at air preheater (R1) - wire 920 wht. Is battery voltage present for approximately 5 seconds?

Yes - Test air preheater. (See “Test Air Preheater” on page 252.)

No - Test wire 920 wht and connections.

System: Air Preheater Light Circuit

(1) Cycle key switch (S1) between OFF and RUN positions. Electronic control module (A1) output LED check. Is wait LED ON for approximately 5 seconds?

Yes - Go to step (2).

No - Test electronic control module. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Key switch in RUN position. Measure voltage at air preheater light (H2) - wire 500G yel. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 500G and 500A yel and connections.

(3) Measure voltage at air preheater light (H2) - wire 930 gry. Is battery voltage present?

Yes - Go to step (4).

No - Check air preheater light and connections.

(4) Measure voltage at electronic control module connector (X46) - terminal D.

No - Test wire 931 gry and connections.

Engine Oil Pressure and Hour Meter Circuit Operation

Function

Engine oil pressure - To warn the operator if the engine oil pressure drops below the safe operation level.

Hour meter - To energize the hour meter when the oil pressure is at operating pressure, indicating total machine operating time.

Operating Conditions

- Key switch in the RUN position

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

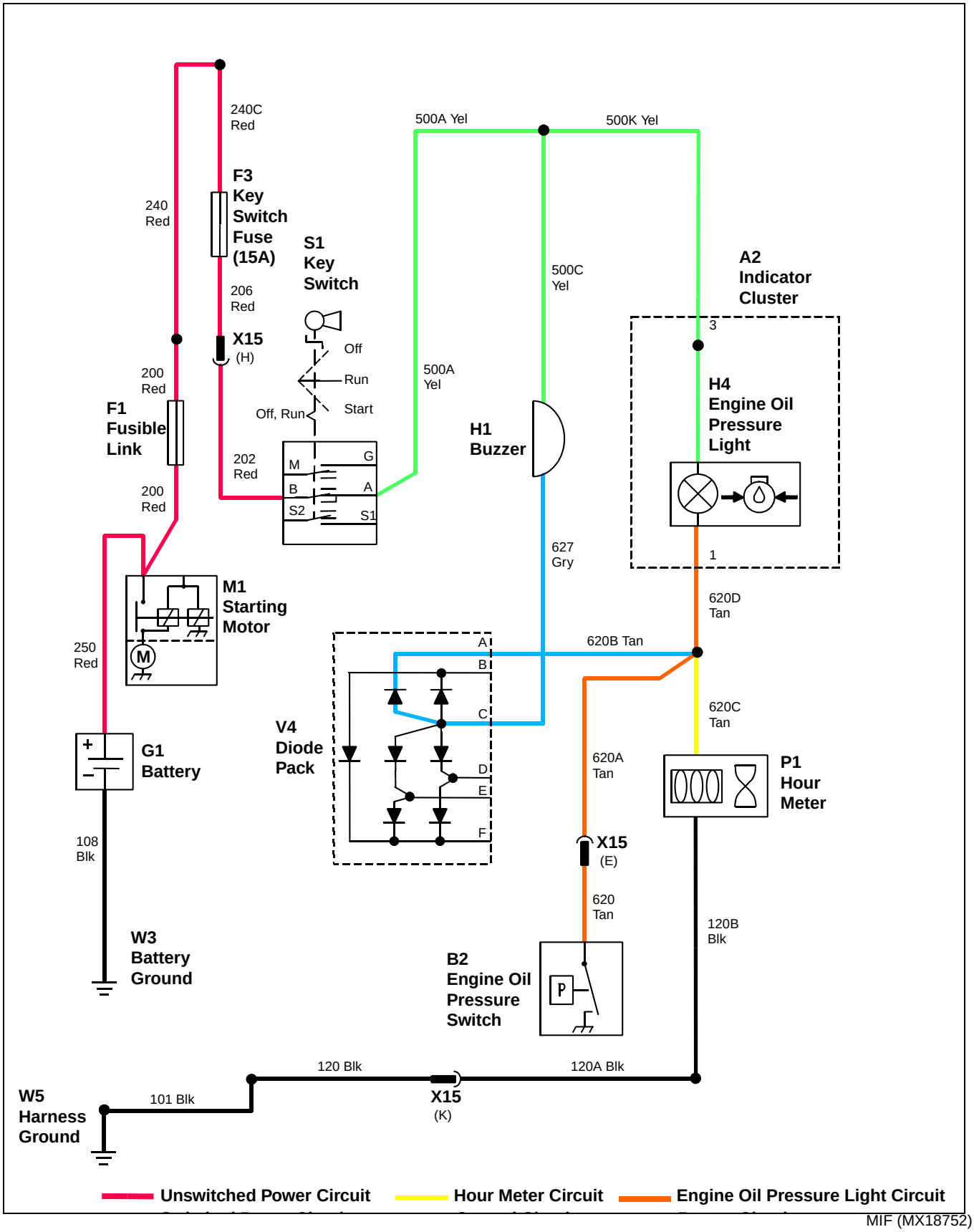
- Buzzer (H1) (wire 500C yel)
- Engine oil pressure light (H4) (wire 500K yel)

When the engine oil pressure is below operating pressure, the engine oil pressure switch (B2) closes. With the engine oil pressure switch closed:

- Current flows from the engine oil pressure light (H4) to the engine oil pressure switch (B2) (wires 620D, 620A and 620 tan). The engine oil pressure switch allows the current to flow to ground, causing the engine oil pressure light to come on.
- Current flows from the buzzer (H1) to diode pack (V4) (wire 627 gry). From the diode pack, current flows to the engine oil pressure switch (B2) (wires 620B, 620A and 620 tan). The engine oil pressure switch allows the current to flow to ground, causing the buzzer to come on.

When the engine oil pressure is at operating pressure (engine running), the engine oil pressure switch (B2) opens. With the engine oil pressure switch open:

- Current flows from the engine oil pressure light (H4) to the hour meter (P1) (wires 620D and 620C tan). The hour meter is supplied a ground (wires 120B, 120A, 120 and 101 blk) that causes the hour meter to operate.
- The buzzer and the engine oil pressure light do not come on because the hour meter is an LCD type that uses very little current, and the current flowing through it is too small.


240C
Red
240
Red
F3
Key
Switch
Fuse
(15A)
206
Red
X15
(H)
200
Red
F1
Fusible
Link
200
Red
S1
Key
Switch
Off
Run
Start
Off, Run
202
Red
M
G
B
A
S2
S1
500A Yel
500K Yel
500C
Yel
500A
Yel
H1
Buzzer
A2
Indicator
Cluster
3
H4
Engine Oil
Pressure
Light
1
627
Gry
620D
Tan
M1
Starting
Motor
250
Red
M
A
B
C
D
E
F
620B Tan
V4
Diode
Pack
620C
Tan
620A
Tan
P1
Hour
Meter
G1
Battery
108
Blk
X15
(E)
620
Tan
120B
Blk
W3
Battery
Ground
B2
Engine Oil
Pressure
Switch
P
120 Blk
120A Blk
W5
Harness
Ground
101 Blk
X15
(K)
Unswitched Power Circuit
Hour Meter Circuit
Engine Oil Pressure Light Circuit

MIF (MX18752)

Engine Oil Pressure and Hour Meter Circuit Diagnosis

Test Conditions:

- Key switch in OFF position.
- Wire 620 tan disconnected from engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Engine Oil Pressure Switch Circuit

(1) Measure ground circuit for continuity at engine oil pressure switch (B2) terminal. Is there continuity?

Yes - Go to step (2).

No - Test oil pressure switch. (See “Test Engine Oil Pressure Switch” on page 250.)

(2) Key switch in RUN position, engine OPERATING. Measure ground circuit for continuity at engine oil pressure switch (B2) terminal. Is there continuity?

Yes - Test oil pressure switch. (See “Test Engine Oil Pressure Switch” on page 114.)

Test Conditions:

- Key switch in OFF position.
- Wire 620 tan connected to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Engine Oil Pressure Buzzer Circuit

(1) Measure ground circuit for continuity at diode pack (V4) - wire 620B tan. Is there continuity?

Yes - Go to step (2).

No - Test wires 620B, 620A and 620 tan and connections.

System: Engine Oil Pressure Buzzer Circuit

(2) Set meter to diode test. Measure forward voltage drop at diode pack (V4) - wire 627 gry. Is voltage in the range of 0.7-0.5 volt?

Yes - Go to step (3).

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

(3) Measure forward voltage at buzzer (H1) - wire 627 gry. Is voltage in the range of 0.7-0.5 volt?

Yes - Go to step (4).

No - Test wire 627 gry and connections.

(4) Key switch in RUN position. Set meter to measure voltage. Measure voltage at buzzer (H1) - wire 500C yel. Is battery voltage present?

Yes - Replace buzzer.

No - Test wires 500C and 500A and connections.

Test Conditions:

- Key switch in OFF position.
- Wire 620 tan connected to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Engine Oil Pressure Light Circuit

(1) Measure ground circuit for resistance at indicator cluster (A2) - wire 620D tan. Is there less than 0.1 ohm of resistance?

Yes - Go to step (2).

No - Test wires 620D, 620A, and 620 tan and connections.

(2) Key switch in RUN position. Measure voltage at indicator cluster (A2) - wire 500K yel. Is battery voltage present?

Yes - Test engine oil pressure light (H4) light bulb. If bulb tests good, replace indicator cluster.

No - Test wires 500K and 500A yel and connections.

Test Conditions:

- Key switch in OFF position.
- Wire 620 tan connected to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Hour Meter Circuit

(1) Measure ground circuit for resistance at hour meter (P1) - wire 120B blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (2).

No - Test wires 120B, 120A, 120 and 101 blk and connections.

(2) Diode pack disconnected. Key switch in RUN position with engine OPERATING. Measure voltage at hour meter (P1) - wire 620C tan. Is battery voltage present?

Yes - Go to step (3).

No - Test wire 620C tan and connections.

(3) Diode pack connected. Key switch in RUN position with engine OPERATING. Hour meter LCD display check. Does hour meter increment after 10 minutes?

No - Replace hour meter.

Engine Coolant Temperature Light Circuit Operation

Function

To warn the operator if the engine coolant temperature exceeds the safe operating level.

Operating Conditions

- Key switch in the RUN position, engine OFF

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

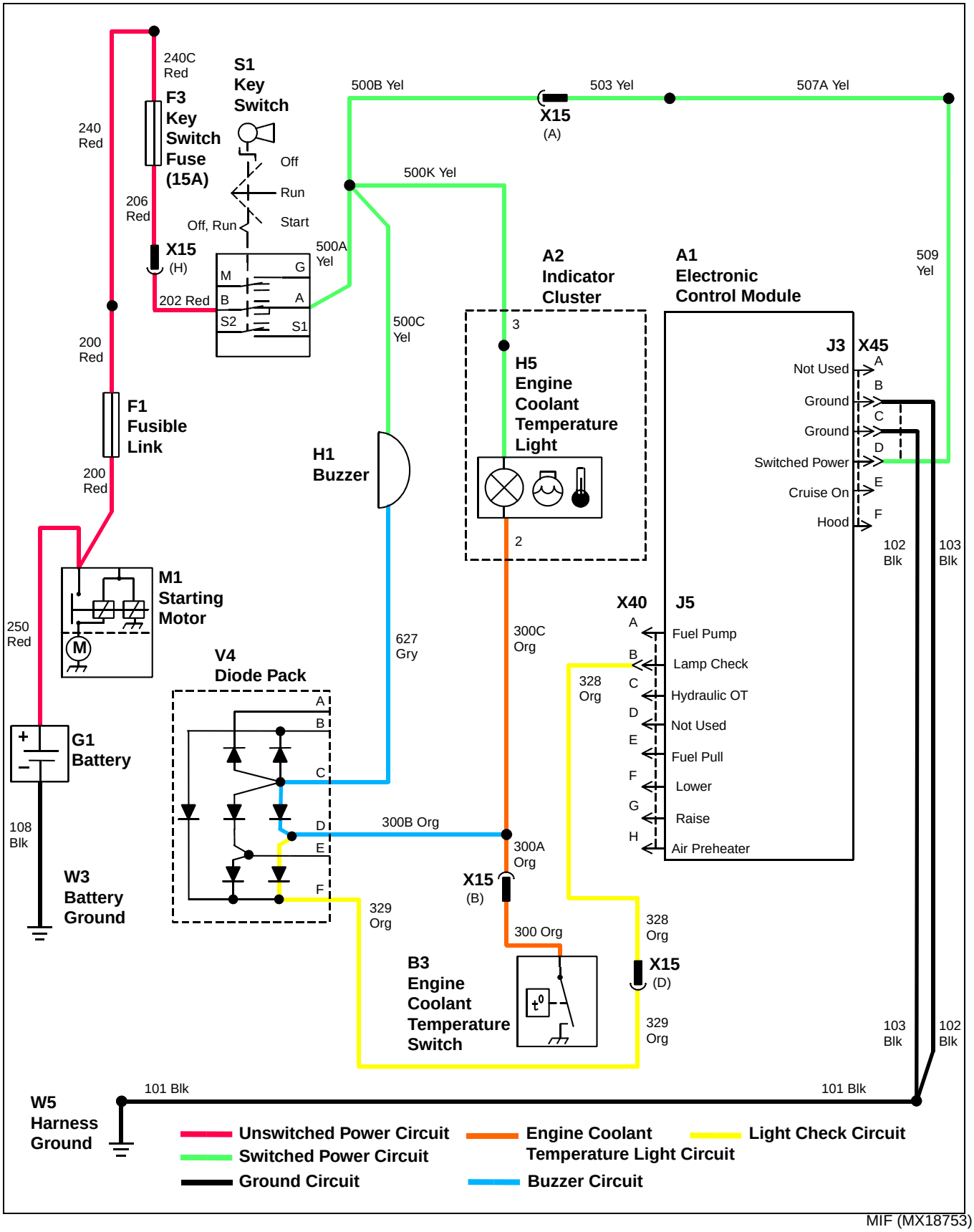
- Buzzer (H1) (wire 500C yel)
- Engine coolant temperature light (H5) (wire 500K yel)
- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)

When the coolant temperature exceeds the safe operating level, the engine coolant temperature switch (B3) closes and completes the circuit to ground (wires 300 and 300C org), causing the coolant temperature light to come on. The coolant temperature switch also completes the buzzer (H1) ground circuit (wires 300A and 300B org and 627 gry), causing the buzzer to come on. Diode pack (V4) is used to isolate the coolant temperature light from other circuits that turn on the buzzer.

When the key switch is moved from the OFF to the RUN position, the electronic control module provides a controlled ground to electronic control module connector (X40) - terminal B for approximately five seconds. When this happens, current flows for approximately five seconds through:

- Buzzer (H1) - wire 627 gry.
- Diode pack (V4) - terminal C.
- Engine coolant temperature light (H5) - wires 300C and 300B org.
- Diode pack (V4) - terminal D.
- Diode pack (V4) - terminal F.
- Wires 329 and 328 org.

This completes the circuit for the buzzer and coolant temperature light to turn them on. This serves as a way to check the operation of the buzzer and coolant temperature light.


240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
240 Red
206 Red
X15 (H)
202 Red
Off
Run
Off, Run
Start
M
G
B
A
S2
S1
500A Yel
500B Yel
503 Yel
507A Yel
X15 (A)
500K Yel
509 Yel
A2 Indicator Cluster
A1 Electronic Control Module
J3
X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
102 Blk
103 Blk
500C Yel
3
H5 Engine Coolant Temperature Light
2
200 Red
F1 Fusible Link
200 Red
H1 Buzzer
250 Red
M1 Starting Motor
627 Gry
300C Org
X40
J5
Fuel Pump
Lamp Check
Hydraulic OT
Not Used
Fuel Pull
Lower
Raise
Air Preheater
328 Org
V4 Diode Pack
G1 Battery
108 Blk
W3 Battery Ground
300B Org
300A Org
X15 (B)
329 Org
300 Org
328 Org
X15 (D)
B3 Engine Coolant Temperature Switch
329 Org
103 Blk
102 Blk
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Engine Coolant Temperature Light Circuit
Buzzer Circuit
Light Check Circuit

MIF (MX18753)

Engine Coolant Temperature Circuit Diagnosis

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Engine coolant temperature switch connector disconnected.
- Engine at normal operating temperature.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Engine Coolant Temperature Switch

(1) Measure ground circuit for resistance at engine coolant temperature terminal. Is there less than 0.1 ohm of resistance?

Yes - Test temperature switch. (See “Test Engine Coolant Temperature Switch” on page 251.)

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Key switch in RUN position.
- Diode pack disconnected.
- ELectronic control module connector (X40) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Engine Coolant Temperature Light Circuit

(1) Cycle key switch between OFF and RUN positions. Electronic control module (A1) output LED check. Is electronic control module lamp check LED ON for about 5 seconds?

Yes - Go to step (2).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

System: Engine Coolant Temperature Light Circuit

(2) Measure voltage at indicator cluster (A2) - wire 500K yel. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 500K and 500A yel and connections.

(3) Measure voltage at indicator cluster - terminal 2. Is battery voltage present?

Yes - Go to step (4).

No - Test engine coolant temperature light bulb. If bulb is good, replace indicator cluster.

(4) Measure voltage at engine coolant temperature connector - wire 300 org. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 300 and 300C org.

(5) Measure voltage at diode pack connector (X12) - terminal D. Is battery voltage present?

Yes - Go to step (6).

No - Test wires 300B org.

(6) Measure continuity between diode pack connector (X12) - terminal F and electronic control module connector (X40) - terminal B. Is there continuity?

Yes - Go to step (7).

No - Test wires 328 and 329 org and connections.

(7) Diode pack connected. Electronic control module connector (X40) connected. Cycle key switch between OFF and RUN positions. Indicator cluster (A2) light check. Is engine coolant temperature light ON for approximately 5 seconds?

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Electronic control module connector (X40) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Buzzer Circuit

(1) Measure voltage at buzzer (H1) - wire 500C yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 500C and 500A yel and connections.

(2) Measure voltage at buzzer (H1) - wire 627 gry. Is battery voltage present?

Yes - Go to step (3).

No - Replace buzzer.

(3) Measure voltage at diode pack connector (X12) - terminal C. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 627 gry.

(4) With a jumper wire, connect diode pack connector (X12) - terminal C to ground. Buzzer (H1) check. Is buzzer operating?

Yes - Go to step (5).

No - Replace buzzer.

(5) Diode pack connected. Buzzer (H1) check. Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

Hydraulic Oil Filter Restriction Light Circuit Operation

Function

To warn the operator that the hydraulic oil filter needs service.

Operating Conditions

- Key switch in the RUN position

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

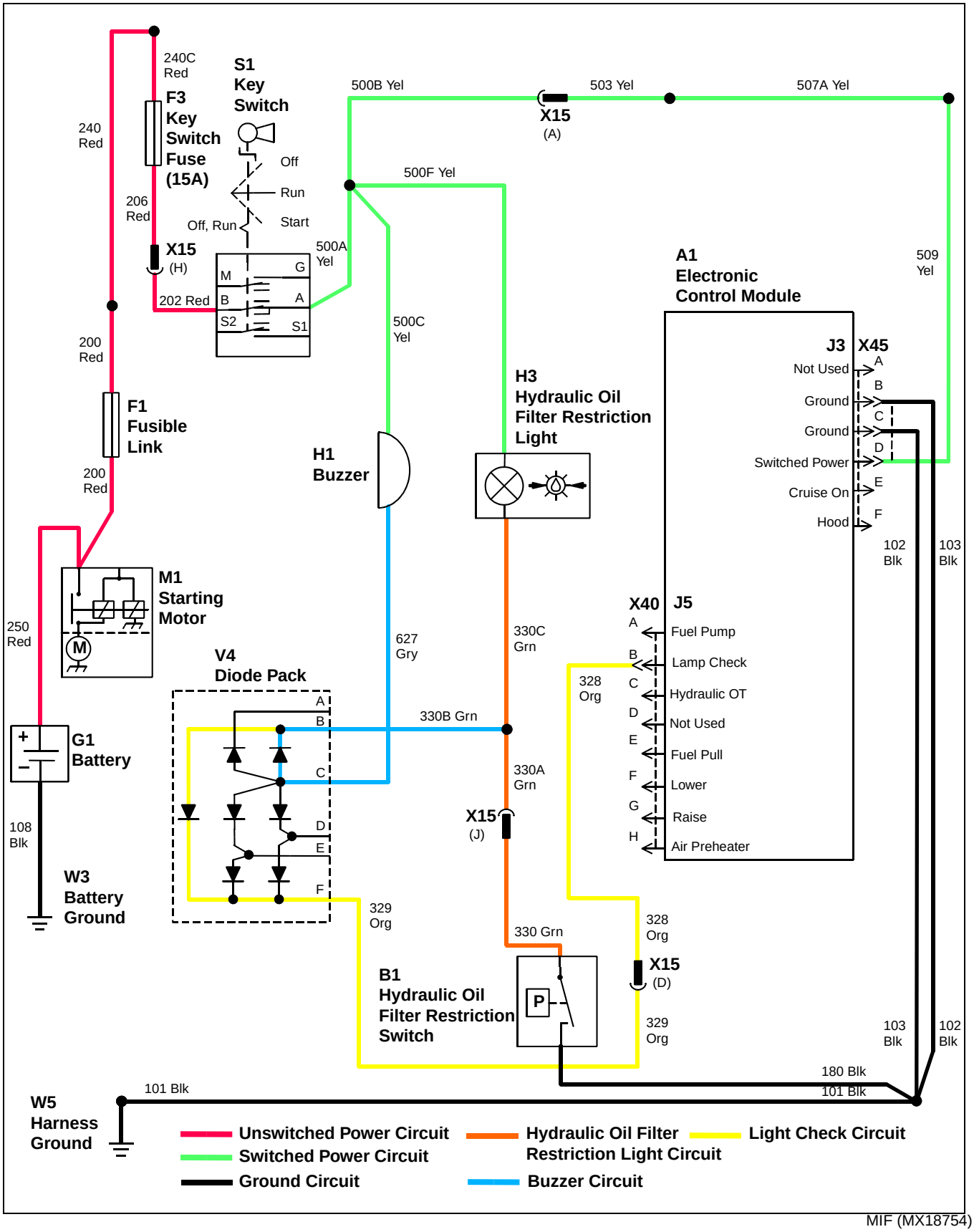
- Buzzer (H1) (wire 500C yel)
- Hydraulic oil filter restriction light (H3) (wire 500F yel)
- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)

When the hydraulic oil pressure reaches 276 ± 28 kPa (40 ± 4 psi), the hydraulic oil filter restriction switch (B1) closes and completes the circuit to ground (wires 330C, 330A and 330 grn and 180 blk), causing the hydraulic oil filter restriction light to come on. The hydraulic oil filter restriction switch also completes the buzzer (H1) ground circuit (wires 330B, 330A and 330 grn and 180 blk), causing the buzzer to come on. Diode pack (V4) is used to isolate the hydraulic oil filter restriction light from other circuits that turn on the buzzer. Hydraulic oil filter restriction switch will not open until hydraulic oil pressure drops to 207 kPa (30 psi).

When the key switch is moved from the OFF to the RUN position, the electronic control module provides a controlled ground to electronic control module connector (X40) - terminal B for approximately five seconds. When this happens, current flows for approximately five seconds through:

- Buzzer (H1) - wire 627 gry.
- Diode pack (V4) - terminal C.
- Hydraulic oil filter restriction light (H3) - wires 330C and 330B grn.
- Diode pack (V4) - terminal B.
- Diode pack (V4) - terminal F.
- Wires 329 and 328 org.

This completes the circuit for the buzzer and hydraulic oil filter restriction light to turn them ON. This serves as a way to check the operation of the buzzer and hydraulic oil filter restriction light.


240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
240 Red
206 Red
X15 (H)
202 Red
Off
Run
Off, Run
Start
M
G
B
A
S2
S1
500A Yel
500B Yel
503 Yel
507A Yel
X15 (A)
500F Yel
500C Yel
509 Yel
A1 Electronic Control Module
J3
X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
200 Red
F1 Fusible Link
200 Red
H1 Buzzer
H3 Hydraulic Oil Filter Restriction Light
102 Blk
103 Blk
M1 Starting Motor
250 Red
627 Gry
330C Grn
X40
J5
Fuel Pump
Lamp Check
Hydraulic OT
Not Used
Fuel Pull
Lower
Raise
Air Preheater
328 Org
V4 Diode Pack
330B Grn
G1 Battery
108 Blk
330A Grn
X15 (J)
W3 Battery Ground
329 Org
330 Grn
328 Org
X15 (D)
B1 Hydraulic Oil Filter Restriction Switch
P
329 Org
103 Blk
102 Blk
180 Blk
101 Blk
101 Blk
W5 Harness Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Hydraulic Oil Filter Restriction Light Circuit
Buzzer Circuit
Light Check Circuit

MIF (MX18754)

Hydraulic Oil Filter Restriction Circuit Diagnosis

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Hydraulic oil filter restriction switch connector disconnected.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Hydraulic Oil Filter Restriction Switch

(1) Measure for continuity between hydraulic oil filter restriction switch connector terminals. Is there continuity?

Yes - Test hydraulic oil filter restriction switch. (See “Test Hydraulic Oil Filter Restriction Switch” on page 250.)

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Hydraulic oil filter restriction switch connector disconnected.
- Key switch in RUN position.
- Diode pack disconnected.
- Electronic control module connector (X40) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Hydraulic Oil Filter Restriction Light Circuit

(1) Cycle key switch between OFF and RUN positions. Electronic control module (A1) output LED check. Is electronic control module lamp check LED ON for about 5 seconds?

Yes - Go to step (2).

No - Test electronic control module circuit. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

System: Hydraulic Oil Filter Restriction Light Circuit

(2) Measure voltage at hydraulic oil filter restriction light (H3) - wire 500F yel. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 500F and 500A yel and connections.

(3) Measure voltage at hydraulic oil filter restriction light (H3) - wire 330 grn. Is battery voltage present?

Yes - Go to step (4).

No - Test light bulb.

(4) Measure voltage at hydraulic oil filter restriction switch connector (X25) - wire 330 grn. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 330, 330A and 330C grn.

(5) Measure ground circuit for resistance at hydraulic oil filter restriction switch connector (X25) - wire 180 blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (6).

No - Test wire 180 blk and connections.

(6) Measure voltage at diode pack connector (X12) - terminal B. Is battery voltage present?

Yes - Go to step (7).

No - Test wires 330B grn.

(7) Measure continuity between diode pack connector (X12) - terminal F and electronic control module connector (X40) - terminal B. Is there continuity?

Yes - Go to step (8).

No - Test wires 328 and 329 org and connections.

(8) Diode pack connected. Hydraulic oil filter restriction switch connector connected. Electronic control module connector (X40) connected. Cycle key switch between OFF and RUN positions. Is hydraulic oil filter restriction light ON for approximately 5 seconds?

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Electronic control module connector (X40) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Hydraulic oil filter restriction switch connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Buzzer Circuit

(1) Measure voltage at buzzer (H1) - wire 500C yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 500C and 500A yel and connections.

(2) Measure voltage at buzzer (H1) - wire 627 gry. Is battery voltage present?

Yes - Go to step (3).

No - Replace buzzer.

(3) Measure voltage at diode pack connector (X12) - terminal C. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 627 gry.

(4) With a jumper wire, connect diode pack connector (X12) - terminal C to ground. Buzzer (H1) check. Is buzzer operating?

Yes - Go to step (5).

No - Replace buzzer.

(5) Diode pack connected. Jumper wire connected between terminals at hydraulic oil filter restriction switch connector (X25) - wires 330 grn and 180 blk. Buzzer (H1) check. Is buzzer operating?

Yes - Go to step (6).

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

System: Buzzer Circuit

(6) Disconnect jumper wire from hydraulic oil filter restriction switch connector. Buzzer (H1) check. Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

Hydraulic Oil Temperature Light Circuit Operation

Function

To warn the operator if the hydraulic oil temperature exceeds the safe operating point.

Operating Conditions

- Key switch in the RUN position, engine OFF

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch terminal A through wire 500A yel to the following:

- Buzzer (H1) (wire 500C yel)
- Hydraulic oil temperature light (H7) (wire 500K yel)
- Electronic control module (A1) (wires 500B, 503, 507A and 509 yel)

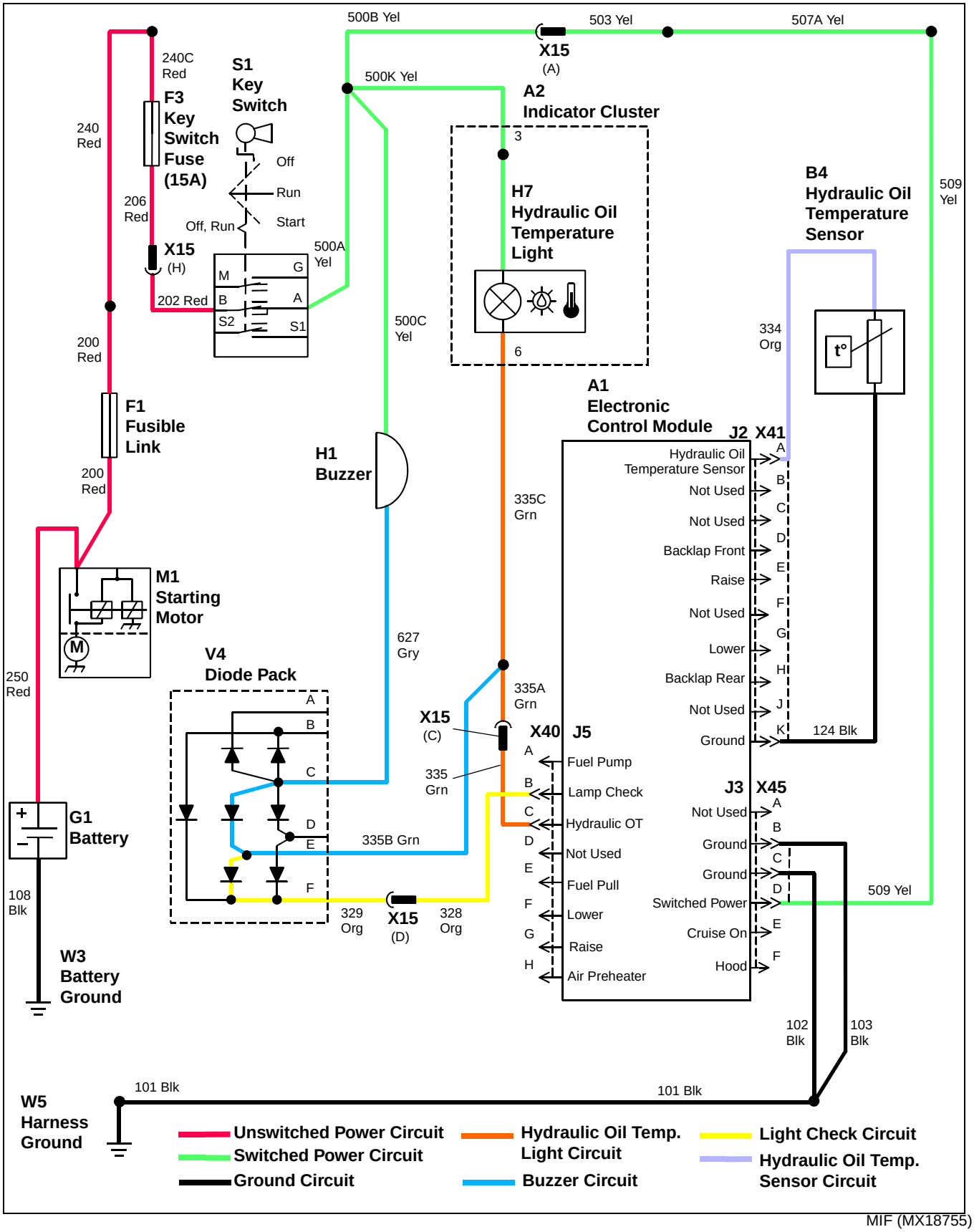
The electronic control module (A1) receives input (wires 334 org and 124 blk) from the hydraulic oil temperature sensor (B4) and monitors the hydraulic oil temperature. When the hydraulic oil temperature rises, the resistance of the hydraulic oil temperature sensor decreases.

When the hydraulic oil temperature sensor (B4) is approximately 150 ohms, the electronic control module senses this and completes a circuit to ground (wires 335, 335A and 335C grn), causing the hydraulic oil temperature light to come on. The electronic control module also completes the buzzer (H1) ground circuit (wires 335, 335A and 335B grn, diode pack [V4] and wire 627 gry), causing the buzzer to come on. Diode pack (V4) is used to isolate the hydraulic oil temperature light from other circuits that turn on the buzzer.

When the key switch is moved from the OFF to the RUN position, the electronic control module provides a controlled ground to electronic control module connector (X40) - terminal B for approximately five seconds. When this happens, current flows for approximately five seconds through:

- Buzzer (H1) - wire 627 gry.
- Diode pack (V4) - terminal C.
- Hydraulic oil temperature light (H7) - wires 335C and 335B grn.
- Diode pack (V4) - terminal E.
- Diode pack (V4) - terminal F.
- Wires 329 and 328 org.

This completes the circuit for the buzzer and hydraulic oil temperature light. This serves as a way to check the operation of the buzzer and hydraulic oil temperature light.


500B Yel
503 Yel
507A Yel
X15
(A)
240C
Red
S1
Key
Switch
500K Yel
A2
Indicator Cluster
F3
Key
Switch
Fuse
(15A)
240
Red
Off
Run
Off, Run
Start
206
Red
X15
(H)
500A
Yel
M
G
B
A
S2
S1
202 Red
3
H7
Hydraulic Oil
Temperature
Light
B4
Hydraulic Oil
Temperature
Sensor
509
Yel
500C
Yel
334
Org
t°
6
200
Red
A1
Electronic
Control Module
J2
X41
F1
Fusible
Link
H1
Buzzer
Hydraulic Oil
Temperature Sensor
Not Used
Not Used
Backlap Front
Raise
Not Used
Lower
Backlap Rear
Not Used
Ground
335C
Grn
200
Red
M1
Starting
Motor
627
Gry
V4
Diode Pack
250
Red
335A
Grn
X15
(C)
X40
J5
Fuel Pump
Lamp Check
Hydraulic OT
Not Used
Fuel Pull
Lower
Raise
Air Preheater
335
Grn
J3
X45
Not Used
Ground
Ground
Switched Power
Cruise On
Hood
124 Blk
G1
Battery
335B Grn
509 Yel
108
Blk
329
Org
X15
(D)
328
Org
W3
Battery
Ground
102
Blk
103
Blk
101 Blk
101 Blk
W5
Harness
Ground
Unswitched Power Circuit
Switched Power Circuit
Ground Circuit
Hydraulic Oil Temp.
Light Circuit
Buzzer Circuit
Light Check Circuit
Hydraulic Oil Temp.
Sensor Circuit

MIF (MX18755)

Hydraulic Oil Temperature Circuit Diagnosis

Test Conditions:

- Key switch in RUN position.
- Engine oil pressure switch wire 620 tan disconnected.
- Electronic control module connector (X41) disconnected.
- Hydraulic oil temperature sensor connector (X24) disconnected.
- Check connections for corrosion and looseness when checking/testing.

System: Hydraulic Oil Temperature Sensor Circuit

(1) Measure wire for resistance between electronic control module connector (X41) - wire 334 org and hydraulic oil temperature sensor (B4) - wire 334 org. Is there less than 0.1 ohm of resistance?

Yes - Go to step (2).

No - Test wire 334 org and connections.

(2) Measure wire for resistance between electronic control module connector (X41) - wire 124 blk and hydraulic oil temperature sensor connector (X24) - wire 124 blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (3).

No - Test wire 124 blk and connections.

(3) Electronic control module connector (X41) connected. Jumper wire connected between hydraulic oil temperature sensor connector (X24) - terminals (wires 334 org and 124 blk). Electronic control module (A1) output LED check. Is hydraulic OT LED ON?

Yes - Test hydraulic oil temperature sensor. (See "Test Hydraulic Oil Temperature Sensor" on page 251.)

No - Test electronic control module circuit. (See "Electronic Control Module Circuit Diagnosis" on page 166.)

Test Conditions:

- Key switch in RUN position, engine OFF.
- Engine oil pressure switch wire 620 tan disconnected.
- Electronic control module connector (X40) disconnected.
- Electronic control module connector (X41) connected.
- Diode pack disconnected.
- Hydraulic oil temperature sensor connector (X24) connected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Hydraulic Oil Temperature Light Circuit

(1) Cycle key switch between OFF and RUN positions. Electronic control module (A1) output LED check. Is electronic control module lamp check LED ON for about 5 seconds?

Yes - Go to step (2).

No - Test electronic control module circuit. (See "Electronic Control Module Circuit Diagnosis" on page 166.)

(2) Measure voltage at indicator cluster (A2) - terminal 3. Is battery voltage present?

Yes - Go to step (3).

No - Test wires 500K and 500A yel and connections.

(3) Measure voltage at indicator cluster (A2) - terminal 6. Is battery voltage present?

Yes - Go to step (4).

No - Test light bulb and connections. If light bulb tests good, replace indicator cluster.

(4) Measure voltage at electronic control module connector (X40) - terminal C. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 335, 335A and 335C grn.

(5) Measure voltage at diode pack connector (X12) - terminal E. Is battery voltage present?

Yes - Go to step (6).

No - Test wires 335B grn.

System: Hydraulic Oil Temperature Light Circuit

(6) Measure continuity between diode pack connector (X12) - terminal F and electronic control module connector (X40) - terminal B. Is there continuity?

Yes - Go to step (7).

No - Test wires 328 and 329 org and connections.

(7) Diode pack connected. Electronic control module connector (X40) connected. Cycle key switch between OFF and RUN positions. Indicator cluster (A2) light check. Is hydraulic oil temperature light ON for approximately 5 seconds?

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

Test Conditions:

- Engine oil pressure switch wire 620 tan disconnected.
- Electronic control module connector (X40) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Hydraulic oil temperature sensor connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Buzzer Circuit

(1) Measure voltage at buzzer (H1) - wire 500C yel. Is battery voltage present?

Yes - Go to step (2).

No - Test wires 500C and 500A yel and connections.

(2) Measure voltage at buzzer (H1) - wire 627 gry. Is battery voltage present?

Yes - Go to step (3).

No - Replace buzzer.

(3) Measure voltage at diode pack connector (X12) - terminal C. Is battery voltage present?

Yes - Go to step (4).

No - Test wire 627 gry.

System: Buzzer Circuit

(4) With a jumper wire, connect diode pack connector (X12) - terminal C to ground. Buzzer (H1) check. Is buzzer operating?

Yes - Go to step (5).

No - Replace buzzer.

(5) Diode pack connected. Jumper wire connected between terminals at hydraulic oil temperature sensor connector (X24) - wires 334 org and 124 blk. Buzzer (H1) check. Is buzzer operating?

Yes - Go to step (6).

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

(6) Disconnect jumper wire from hydraulic oil temperature sensor connector. Buzzer (H1) check. Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No - Test diode pack. (See “Test Diode Pack AMT386” on page 238.)

Light Circuit Operation

Function

To provide power to the headlights, work lights and taillights and provide a means to turn them on and off.

Operating Conditions:

- Key switch in the RUN position
- Light switch in the ON position

Theory of Operation

Unswitched power is supplied to the light relay (K5) from the battery and is protected by a fusible link (F1). Current flows from the battery positive (+) terminal to starting motor (M1) (wire 250 red). From the starting motor, current flows to lights relay, terminal 30 (wires 200, 240 and 240B red).

With the key switch (S1) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 171) flows from key switch, terminal A, to light relay (K5), terminal 85 (wires 500, 500B, 503, 504A and 504D yel). Current flows from the coil (terminal 86) of the light relay to the light switch (S12) (wires 191 and 190 gry).

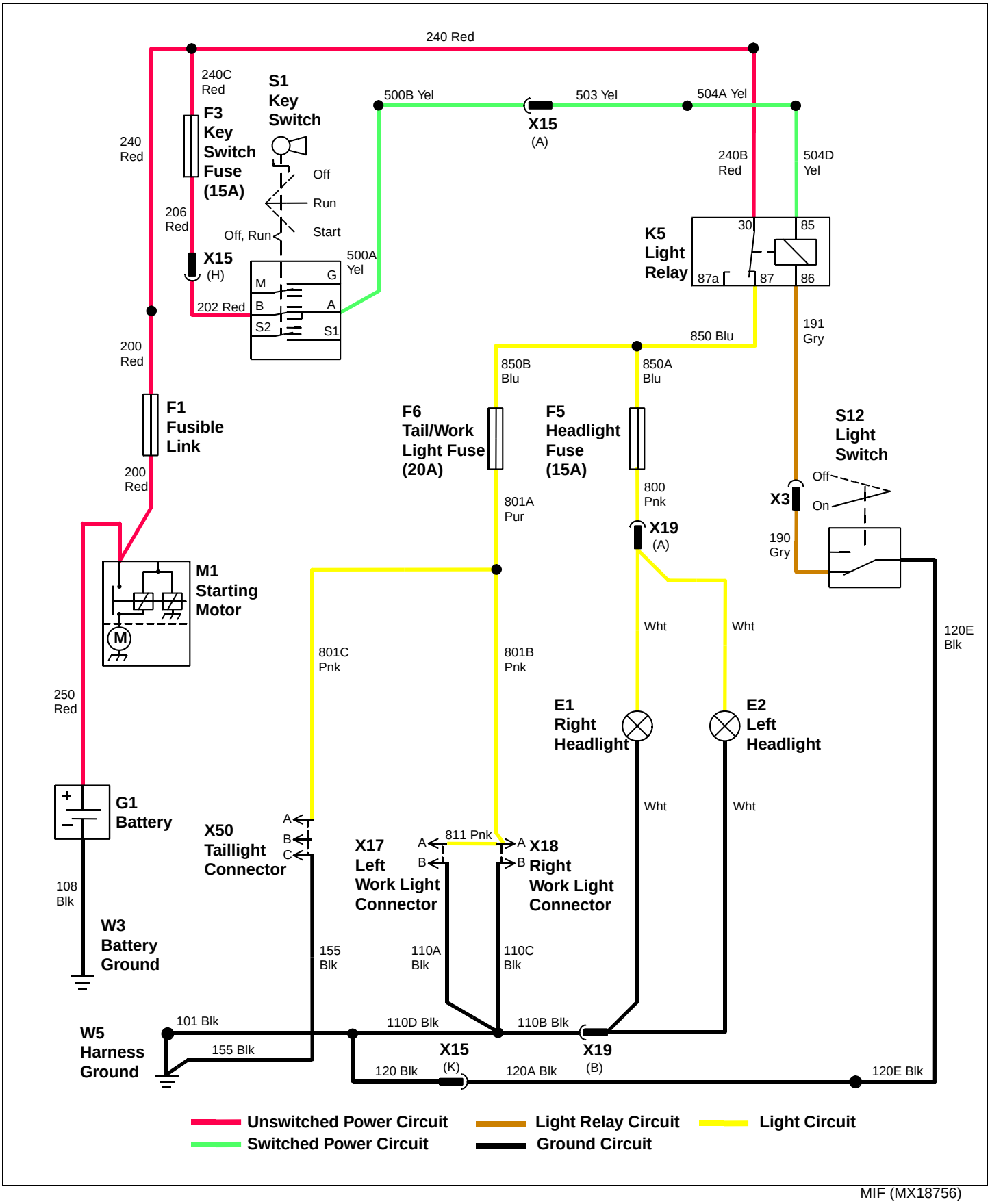
When the light switch is in the ON position, current flows to ground (wires 120E, 120A, 120, and 101 blk), energizing the light relay.

With the light relay energized, current flows to headlight fuse (F5) (wires 850 and 850A yel). From the headlight fuse, current flows to headlight connector (X19) (wire 800 pnk). From headlight connector (X19), current flows to headlight harness (W8), causing right and left headlights (E1 and E2) to come ON.

With the light relay energized, current also flows to tail/work light fuse (F6) (wires 850 and 850B yel). From the tail/work light fuse, current flows to the taillight connector (X50) (wires 801A and 801C pnk) and the right work light connector (X18) (wires 801A and 801B). From the right work light connector, current flows to the left work light connector (wire 811 pnk).

Ground circuits are provided as follows:

- Headlight connector (X19) - wires 110B, 110D and 101 blk
- Right work light connector (X18) - wires 110A, 110D and 101 blk
- Left work light connector (X17) - wires 110C, 110D and 101 blk
- Taillight connector (X50) - wire 155 blk


240 Red
240C Red
S1 Key Switch
F3 Key Switch Fuse (15A)
500B Yel
503 Yel
504A Yel
X15 (A)
240 Red
240B Red
504D Yel
Off
Run
Off, Run
Start
206 Red
X15 (H)
500A Yel
M
G
B
A
S2
S1
202 Red
K5 Light Relay
30
85
87a
87
86
200 Red
850 Blu
191 Gry
850B Blu
850A Blu
F1 Fusible Link
F6 Tail/Work Light Fuse (20A)
F5 Headlight Fuse (15A)
S12 Light Switch
200 Red
801A Pur
800 Pnk
X19 (A)
Off
On
X3
190 Gry
M1 Starting Motor
M
801C Pnk
801B Pnk
Wht
Wht
120E Blk
250 Red
E1 Right Headlight
E2 Left Headlight
Wht
Wht
G1 Battery
X50 Taillight Connector
A
B
C
811 Pnk
X17 Left Work Light Connector
X18 Right Work Light Connector
108 Blk
W3 Battery Ground
155 Blk
110A Blk
110C Blk
101 Blk
110D Blk
110B Blk
W5 Harness Ground
155 Blk
X15 (K)
X19 (B)
120 Blk
120A Blk
120E Blk
Unswitched Power Circuit
Switched Power Circuit
Light Relay Circuit
Ground Circuit
Light Circuit

MIF (MX18756)

Light Circuit Diagnosis

Test Conditions:

- Key switch in OFF position.
- Light switch in ON position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Light Circuit

(1) Measure ground circuit for resistance at light switch connector (X3) - wire 120E blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (2).

No - Test wires 120E, 120A, 120 and 101 blk and connections.

(2) Measure ground circuit for resistance at light switch connector (X3) - wire 190 gry. Is there less than 0.1 ohm of resistance?

Yes - Go to step (3).

No - Test light switch. (See “Bench Test Electrical Switches” on page 244.)

(3) Measure ground circuit for resistance at light relay (K5) - terminal 86. Is there less than 0.1 ohm of resistance?

Yes - Go to step (4).

No - Test wires 191 and 190 gry.

(4) Key switch in RUN position. Measure voltage at light relay (K5) - terminal 30. Is battery voltage present?

Yes - Go to step (5).

No - Test wires 240B, 240, 200 and 250 red and connections.

(5) Measure voltage at light relay (K5) - terminal 85. Is battery voltage present?

Yes - Go to step (6).

No - Test wires 504D, 504A, 503, 500B and 500A yel and connections.

(6) Measure voltage at light relay (K5) - terminal 87. Is battery voltage present?

Yes - Go to step (7).

No - Test relay. (See “Test Electrical Relays” on page 246.)

System: Light Circuit

(7) Measure voltage at headlight fuse (F5) - wire 850A blu. Is battery voltage present?

Yes - Go to step (8).

No - Test wires 850A and 850 blu and connections.

(8) Measure voltage at headlight fuse (F5) - wire 800 pnk. Is battery voltage present?

Yes - Go to step (9).

No - Test headlight fuse and connections.

(9) Measure voltage at headlight connector (X19) - wire 800 pnk. Is battery voltage present?

Yes - Go to step (10).

No - Test wire 800 pnk and connections.

(10) Measure ground circuit for resistance at right headlight connector (X19) - wire 110B blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (11).

No - Test wires 110B, 110D and 101 blk and connections.

(11) Measure voltage at right headlight connector positive terminal - white wire. Is battery voltage present?

Yes - Go to step (12).

No - Test white wire and connections.

(12) Measure ground circuit for resistance at right headlight connector negative terminal - white wire. Is there less than 0.1 ohm of resistance?

Yes - Go to step (13).

No - Test white wire and connections.

(13) Measure voltage at left headlight connector positive terminal - white wire. Is battery voltage present?

Yes - Go to step (14).

No - Test white wire and connections.

(14) Measure ground circuit for resistance at left headlight connector negative terminal - white wire. Is there less than 0.1 ohm of resistance?

Yes - Go to step (15).

No - Test white wire and connections.

System: Light Circuit

(15) Measure voltage at tail/work light fuse (F6) - wire 850B blu. Is battery voltage present?

Yes - Go to step (16).

No - Test wire 850B blu and connections.

(16) Measure voltage at tail/work light fuse (F6) - wire 801A pur. Is battery voltage present?

Yes - Go to step (17).

No - Test tail/work light fuse and connections.

(17) Measure voltage at taillight connector (X50) - wire 801C pnk. Is battery voltage present?

Yes - Go to step (18).

No - Test wire 801C pnk and connections.

(18) Measure voltage at right work light connector (X18) - wire 801B pnk. Is battery voltage present?

Yes - Go to step (19).

No - Test wire 801B pnk and connections.

(19) Measure voltage at left work light connector (X17) - wire 811 pnk. Is battery voltage present?

Yes - Go to step (20).

No - Test wire 811 pnk and connections.

(20) Measure ground circuit for resistance at right work light connector (X18) - wire 110C blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (21).

No - Test wires 110C, 110D and 101 blk and connectors.

(21) Measure ground circuit for resistance at left work light connector (X17) - wire 110A blk. Is there less than 0.1 ohm of resistance?

Yes - Go to step (22).

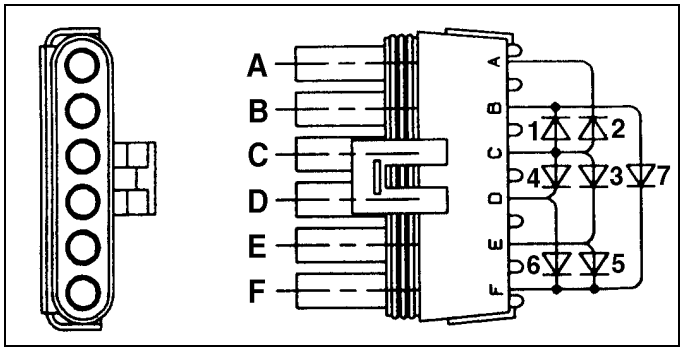
No - Test wires 110A, 110D and 101 blk and connectors.

(22) Measure ground circuit for resistance at taillight connector (X50) - wire 155 blk. Is there less than 0.1 ohm of resistance.

No - Test wire 155 blk and connections.

Tests and Adjustments

Test Diode Pack AMT386



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1. Remove diode pack and test with a diode tester or ohmmeter as follows.

Diode	Red Lead	Black Lead	Result
1	C	B	C
1	B	C	NC
2	C	A	C
2	A	C	NC
3	C	E	C
3	E	C	NC
4	C	D	C
4	D	C	NC
5	E	F	C
5	F	E	NC
5	E	F	C
6	D	F	C
6	F	E	NC
7	F	B	NC
4 and 6 3 and 5	C	F	C
4 and 6 3 and 5	F	C	NC

Test Battery

Reason

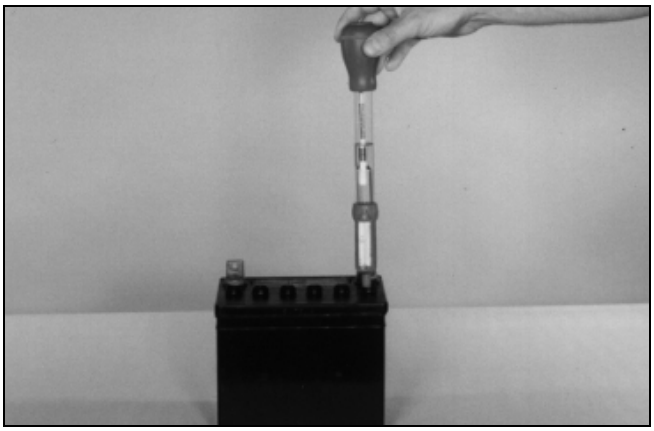
To check condition of battery and determine battery voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to test battery.
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test battery.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Disconnect negative (-) and positive cable clamps from battery. Remove battery hold-down clamps.
5. Remove battery from machine.
6. Clean battery terminals and case.
7. Inspect battery terminals and case for breakage or cracks.
8. Check electrolyte level in each battery cell. Add clean, soft 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.



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10. Use a hydrometer to check for a minimum specific gravity of 1.225 with less than 50-point variation between cells:

- If all cells are less than 1.175, charge battery at

10-amp rate. (See “Charge Battery” on page 239.)

- If all cells are less than 1.225 with less than 50-point variation, charge battery at 10-amp rate. (See “Charge Battery” on page 239.)
- If cells are above 1.225 with less than 50-point variation, load test battery. (See “Test Battery Load” on page 240.)
- 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:

- If battery voltage is less than 12.4 VDC, charge battery.
- If voltage is above 12.4 VDC, test specific gravity (see step 10).

12.Install battery.

Charge Battery

Reason

To increase battery charge after battery has been discharged.

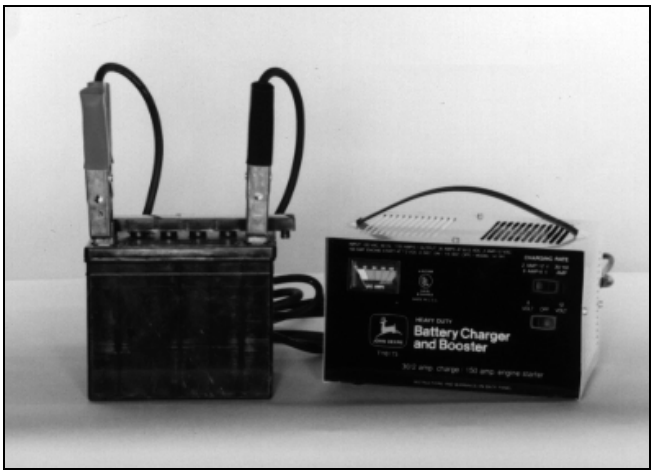
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (variable rate) (use according to manufacturer’s instructions)	NA	Used to charge battery.

Procedure

NOTE: See “Test Battery” on page 238, before charging battery.

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
5. Remove battery from machine.
6. Clean battery terminals and case.



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7. Connect variable rate charger to battery.

NOTE: Maximum charge time at boost is 10 minutes. Allow additional 5 minutes for each 10° below 21°C (70°F).

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 a 10-amp charge after 10 minutes at boost setting:

- If battery WILL NOT accept 10-amp charge after 10 minutes at boost setting, replace battery.
- If battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 10 and 11.
- 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 10 and 11.

10.Set charger at 15-25 amps.

IMPORTANT: Avoid damage! Decrease charge rate if battery gasses or bubbles excessively or if battery becomes too warm to touch.

11.Check specific gravity after 30 minutes:

- If MORE THAN 50 point variation between cells, replace battery.
- If LESS THAN 50 point variation between cells, continue test.

NOTE: If battery was discharged at slow or unknown rate, charge at 10-15 amps for 6-12 hours. If battery was discharged at fast rate, charge at 20-25 amps for 2-4 hours.

12.Continue to charge battery until specific gravity is to specification.

13.Load test battery. (See “Test Battery Load” on page 240.)

14.Install battery.

Specifications

Battery Specific Gravity . . . . . 1.230-1.265 points

Test Battery Load

Reason

To check condition of battery under load.

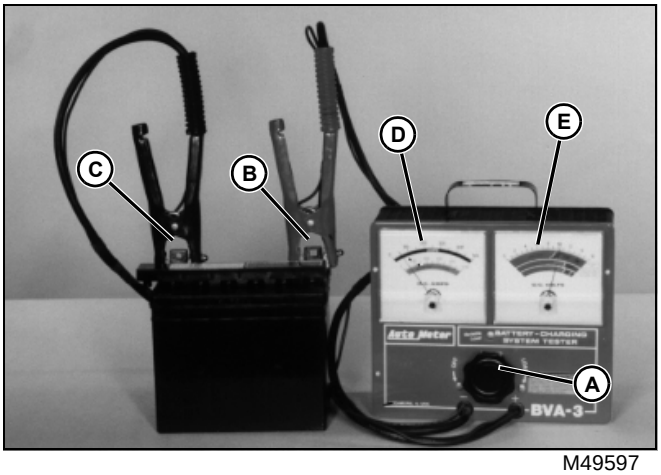
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester (use according to manufacturer’s instructions)	JT05685	Used to test battery.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
5. Remove battery from machine.
6. Clean battery terminals and case.

IMPORTANT: Avoid damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.



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7. Connect tester positive cable (red) to battery positive (+) terminal (B).

8. 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.

9. Turn load knob (A) of tester clockwise (in) 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).

10.Hold for 15 seconds and turn load knob (A) of tester counterclockwise (out) into OFF position.

11.Repeat steps 9 and 10 above and read condition of battery at DC volts scale (E).

12.If battery DOES NOT pass test and HAS NOT been charged, charge battery and retest. (See “Charge Battery” on page 239.)

13.If battery DOES NOT pass test and HAS been charged, replace the battery.

Test Regulated Amperage and Voltage

Reason

To determine regulated charging output of the alternator.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test alternator amperage and voltage.
Ammeter Shunt	JT05792	Used to test alternator amperage and voltage.
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test alternator amperage and voltage.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Remove negative battery cable clamp from battery.

IMPORTANT: Avoid damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.

5. Connect tester positive cable (red) to battery positive (+) terminal.
6. Connect tester negative cable (black) to battery negative (-) terminal.

IMPORTANT: Avoid damage! Perform the following step quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5-10 seconds.

7. Turn load knob clockwise (in) until voltage on tester voltage scale reads **11 volts for 10 seconds only** to partially drain battery.
8. Quickly turn load knob completely counterclockwise (out) into OFF position.
9. Install JT05792 Ammeter Shunt leads as follows:
   - Red male plug to VOLT/OHM socket on JT05791 Digital Multimeter.
   - Black male plug to COM socket on JT05791 Digital Multimeter.
   - Shunt black clamp to the negative (-) battery post (along with JT05685 Battery Tester ground clamp).
   - Shunt red clamp to the negative (-) battery cable clamp.
10. Set JT05791 Digital Multimeter to read 300 mV.
11. Start and run engine at fast idle. Read charging voltage from JT05685 Battery Tester. Voltage should read between **12.2-14.7 volts DC and be steadily rising.**

NOTE: Although the meter is set to read voltage, the meter reading will be the amperage of the circuit through the operation of the shunt. Polarity reading is not relevant. The number (positive or negative) shown on the meter is the amperage of the circuit.

12. Read amperage from JT05791 Digital Multimeter. Amperage should read 40 amps (or less) and decrease as voltage approaches 14.8 volts.
13. If at any time voltage exceeds 14.8 volts DC, replace alternator/regulator assembly.

Test Starter Loaded Amperage Draw

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
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test starter loaded amperage draw.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Load test battery. (See "Test Battery Load" on page 240.)
5. Disconnect fuel shutoff solenoid connector.

IMPORTANT: Avoid damage! Turn knob fully counterclockwise (out) into OFF position before making any test connections.

6. Connect JT05685 Battery Tester to battery.
7. Crank engine. Read and record voltage on DC voltage scale (B) of battery tester.
8. Turn key switch to OFF position.

IMPORTANT: Avoid damage! Perform the following step within 10 seconds to prevent damage to tester and/or machine components.

9. Turn load knob clockwise (in) until DC voltage reads the same as when cranking.

10.Read and record DC amperage.

11.Turn load knob completely counterclockwise (out) into OFF position.

Results

- If amperage is above specification, test starter no-load amperage and rpm (See “Test Starter No-Load Amperage and RPM” on page 242) to determine if starter is binding or damaged.
- If starter passes no-load test but amperage draw remains high, check internal engine components for binding, wear, or damage.

Specifications

Starting Motor Amperage Draw at 300 RPM (Max) . 300 amps

Test Starter No-Load Amperage and RPM

Reason

To determine if starter is binding or has excessive amperage draw under no-load.

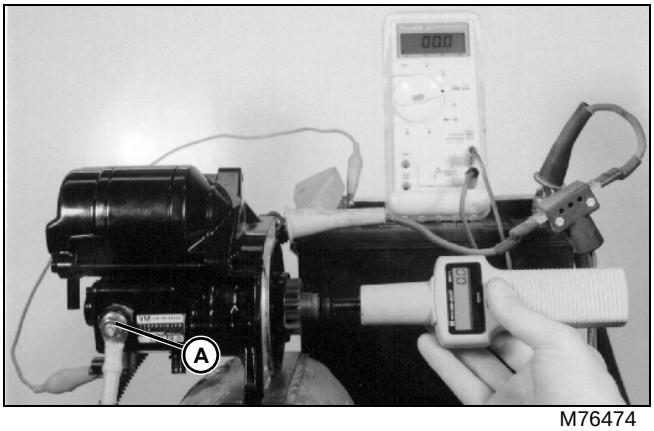
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test starter no-load amperage and rpm.
Ammeter Shunt	JT05792	Used to test starter no-load amperage and rpm.
Hand-Held Digital Tachometer	JT05719	Used to test starter no-load amperage and rpm.
One (1) Jumper Wire	NA	Used to test starter no-load amperage and rpm.
One (1) Jumper Cable	NA	Used to test starter no-load amperage and rpm.
12-V Battery	NA	Used to test starter no-load amperage and rpm.

Procedure

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



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7. Install JT05792 Ammeter Shunt leads as follows:
   - Red male plug to VOLT/OHM socket on JT05791 Digital Multimeter.
   - Black male plug to COM socket on JT05791 Digital Multimeter.
   - Shunt black clamp to the negative (-) battery post.
   - Shunt red clamp to starter case ground.
8. Set JT05791 Digital Multimeter to read 300 mV.
9. Connect positive jumper cable between starter solenoid right terminal (A) and positive battery post.

IMPORTANT: Avoid damage! Complete the following step in 20 seconds or less to prevent starter damage.

10.Momentarily connect a jumper lead from positive battery post to small solenoid spade terminal. Solenoid should pull in and the drive gear and shaft should move out and spin.

11.Record amperage from multimeter.

12.Place JT05719 Hand-Held Digital Tachometer drive cone against end of spinning starter drive gear, and record rpm.

13.Remove jumper from solenoid.

Results

- If amperage is above specification, check for binding or seized bearings, sticking brushes, and dirty or worn commutator. Repair or replace starter.
- If starter passes no-load test but amperage draw remains high when mounted on engine, check internal engine components for binding, wear, or damage.

Specifications

Starting Motor No-Load Amperage Draw at 3000 RPM (Min) . . . . . 120 amps

Test Starter Solenoid

Reason

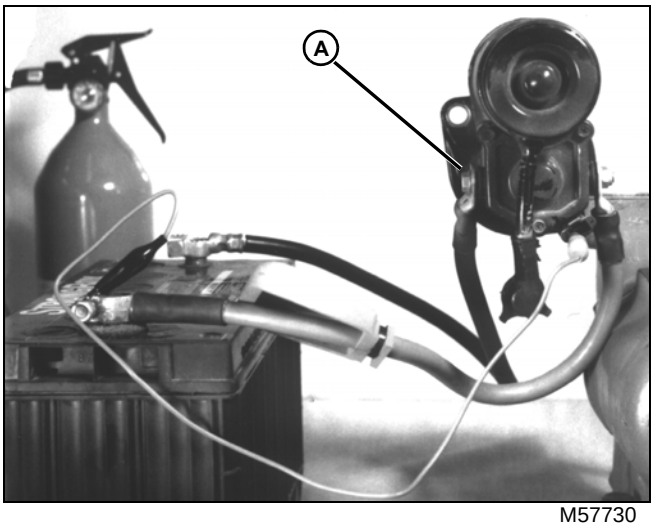
To determine if starter solenoid is defective. The solenoid has separate pull-in and hold-in windings which do not ground together. This test requires two ground jumper cables in order to test each winding.

Special or Required Tools

Tool Name	Tool No.	Tool Use
One (1) Jumper Wire	NA	Used to test starter solenoid.
Two (2) Jumper Cables	NA	Used to test starter solenoid.
12-V Battery	NA	Used to test starter solenoid.

Procedure

1. Park machine on level surface.
2. Turn key OFF and LOCK park brake.
3. Open engine cover.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



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7. Disconnect starter motor lead from left solenoid terminal (A).
8. Connect NEGATIVE jumper cable from left solenoid terminal to NEGATIVE battery post.
9. Connect POSITIVE jumper cable from right solenoid terminal to POSITIVE battery post.
10. Momentarily connect a jumper wire from the positive battery post to the small solenoid spade terminal. The solenoid should pull in and the drive gear and shaft should move out.
11. Remove the positive jumper wire to the solenoid spade terminal. The solenoid drive gear and shaft should move back.

Results

- The solenoid should pull in freely with a loud click when energized. The starter drive gear and shaft should be moved out.
- If solenoid does not move, disconnect jumper leads and try to pull drive gear out by hand by rotating counterclockwise:
  - If drive gear will not turn by hand, check starter motor for bad bearings, frozen armature, or sticking brushes.
  - If drive gear turns but will not pull out, check solenoid plunger and shaft for binding.
  - If drive gear turns and moves out freely, but solenoid does not energize, check continuity from solenoid primary spade terminal to left terminal lug (where starter motor lead attaches). Maximum resistance should be 1.0 ohm through solenoid. Replace open circuit solenoid.

Bench Test Electrical Switches

Reason

To determine if electrical switches are opening and closing as required.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test various switches.

Procedure

1. Disconnect negative battery cable.
2. Tag and mark wires to switch and disconnect.
3. Remove switch from machine.
4. Set meter to read continuity or resistance (ohms).
5. Connect meter to listed test points, set switch to proper position and test for continuity.

Component	Switch Position	Test Points	Normal
Seat Switch	Up	A-B	No Continuity
	Down	A-B	Continuity
Light Switch	On	1-2	Continuity
	Off	1-2	No Continuity
	Up (Work Lights)	C-G-E-F	Continuity
Key Switch	Off	M-G	Continuity
	Off	A, B, S1, S2	No Continuity
	Run	A-B	Continuity
	Run	G, M, S1, S2	No Continuity
	Start	A-B, S1-S2	Continuity
	Start	M, G	No Continuity
Brake Switch	Plunger Released	A-B	Continuity
	Plunger Released	A-C	No Continuity
	Plunger Depressed	A-C	Continuity
	Plunger Depressed	A-B	No Continuity
Neutral Switch	Out	A-B	No Continuity
	In	A-B	Continuity
PTO Switch	Off	1-7	Continuity
	Off	1- 4	No Continuity

Component	Switch Position	Test Points	Normal
	On	1-4, 3-6	Continuity
	On	1-7	No Continuity
Four-Wheel Drive Switch	Off	1-2, 3-7-9	Continuity
	On	2-3-7-9	Continuity
Backlap Switch	In	A-B	No Continuity
	Out	A-B	Continuity
Cruise Control Switch	Off	2, 3, 6	No Continuity
	On	2-6	Continuity
	On	2-3	No Continuity
	Set	2-3	Continuity
	Set	2-6	No Continuity
Reverse Switch	Off	B-C	No Continuity
	On	B-C	Continuity

Results

If switch shows no continuity or resistance higher than 0.05 ohm when contacts are closed, replace switch.

Test Raise and Lower Switch

Reason

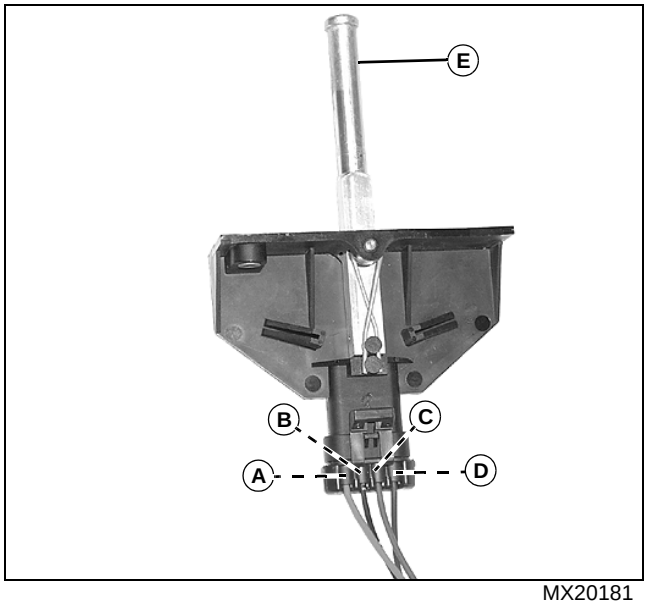
To determine if raise/lower switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test raise/ lower switch.

Procedure

1. Remove wire clip and weather seals at raise/lower switch connector.
2. Turn key switch to RUN position.



MX20181

3. Connect meter negative (-) lead to raise/lower switch connector terminal (B) (wire 120 blk). Connect meter positive (+) lead to raise/lower switch connector terminal (C) (wire 500H yel). There must be battery voltage. If there is NO battery voltage, test raise/lower circuit. (See “Raise and Lower Circuit Diagnosis” on page 214.)
4. Leave meter negative (-) lead connected to raise/lower switch connector terminal (B) (wire 120 blk) for rest of procedure.
5. Connect meter positive (+) lead to raise/lower switch connector terminal (D) (wire 660 blu). Move raise/lower switch lever (E) to RAISE position. There must be battery voltage.
6. Connect meter positive (+) lead to raise/lower switch connector terminal (A) (wire 773 blu). Move raise/lower switch lever (E) to LOWER position. There must be battery voltage.

Results

- If there is NO battery voltage with switch in the RAISE position, replace raise/lower switch.
- If there is NO battery voltage with switch in the LOWER position, replace raise/lower switch.

Test Electrical Relays

Reason

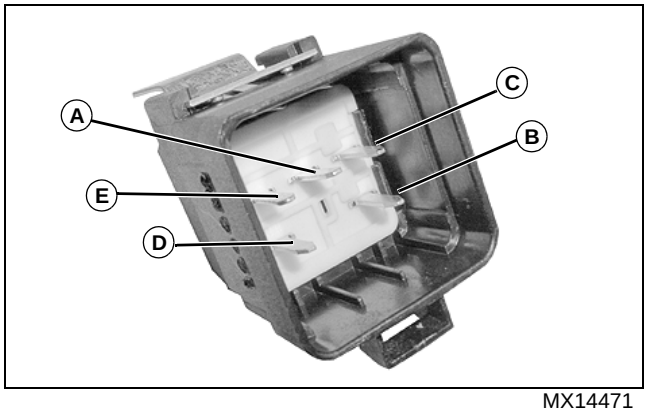
To determine if electrical relay coils are actuating correctly and resistance of relay contact points is correct.

Special or Required Tools

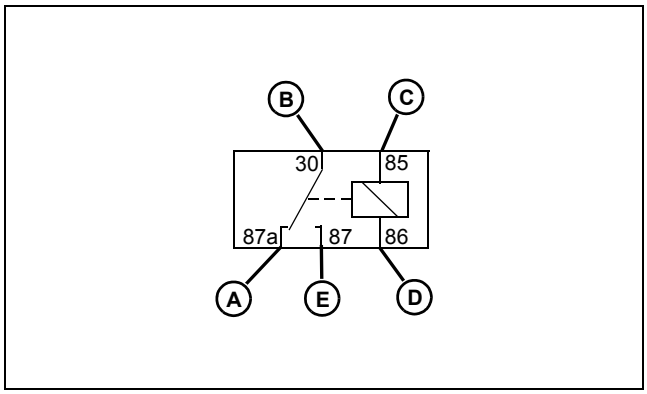
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test relays.
Jumper Wires (2)	NA	Used to test relays.
12-V Battery	NA	Used to test relays.

Procedure

NOTE: All relays function the same. The relay schematic below reflects the operation of the relays.



MX14471



MIF

1. Check terminal continuity using an ohmmeter or continuity tester.

- 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.

Test Fuel Shutoff Solenoid

Reason

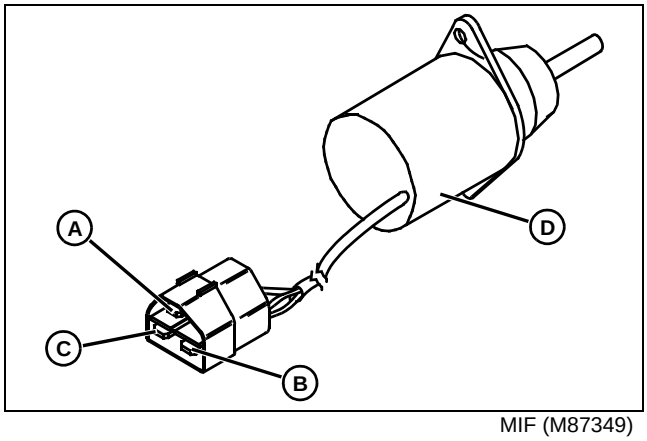
To determine if the fuel shutoff solenoid is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test fuel shutoff solenoid.

Procedure

1. Open engine hood.
2. Disconnect fuel shutoff solenoid connector.



MIF (M87349)

3. Check pull-in coil resistance, terminals (A and B). Resistance must be to specification.
4. Check hold coil resistance, terminals (A and C). Resistance must be to specification.
5. Check resistance of both coils (combined), terminals (A and C). Resistance must be to specification.
6. 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

Test Four-Wheel Drive Solenoid

Reason

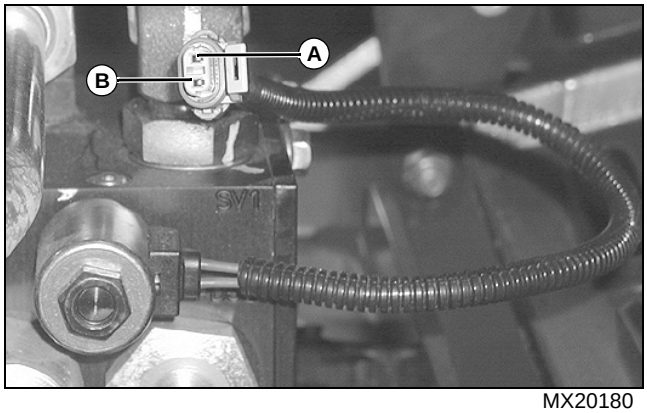
To determine if the four-wheel drive solenoid is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test four-wheel drive solenoid.

Procedure

1. Open engine hood.
2. Disconnect four-wheel drive solenoid connector.



MX20180

3. Check resistance between terminals (A and B). Resistance must be to specification.
4. Check for grounds or shorts between solenoid terminals (A and B) and solenoid housing. There must be NO continuity between terminal (A or B) and solenoid housing.

Results

- If resistance is not to specification, replace four-wheel drive solenoid.
- If continuity exists between connector terminals and solenoid housing, replace four-wheel drive solenoid.

Four-wheel Drive Solenoid

Coil Resistance. . . . . 10 ohms

Test Fuel Pump

Reason

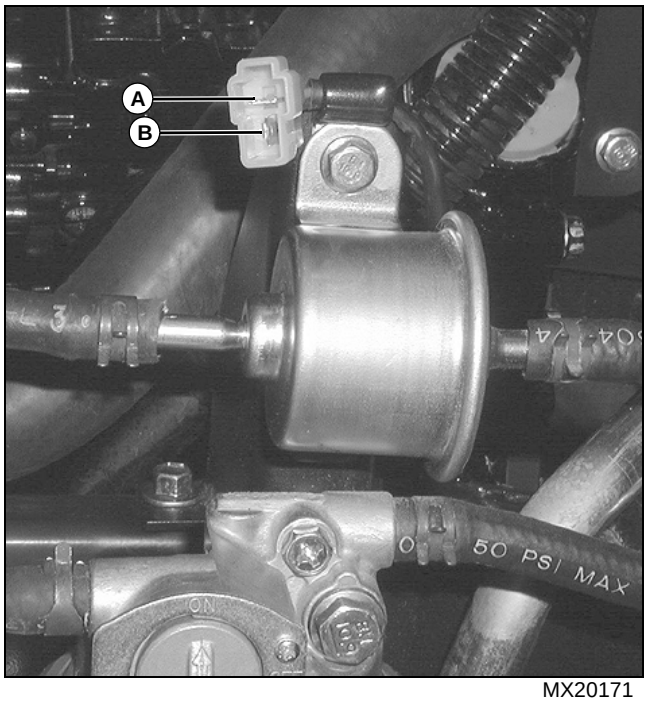
To determine if the fuel pump is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Two (2) Jumper Wires	NA	Used to test fuel pump.

Procedure

1. Open engine hood.
2. Disconnect fuel pump connector.



MX20171

3. Connect jumper wire from battery positive (+) terminal to fuel pump terminal (A).
4. Connect another jumper wire from battery negative (-) terminal to fuel pump terminal (B). Fuel pump must operate.
5. Reverse jumper wire connections, fuel pump terminal (A) to battery negative (-) terminal and terminal (B) to battery positive (+) terminal. Fuel pump must NOT operate.

Results

- If fuel pump does NOT operate with power applied, replace fuel pump.
- If fuel pump operates with reverse polarity, internal diode is shorted, replace fuel pump.

Test Fuse

Reason

To determine if fuse has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test fuse continuity.

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.

Results

If there is no continuity between posts, replace fuse.

Test Diode

Reason

To determine if diode has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test diode.

Procedure

1. Remove diode from connector.
2. Set meter to diode test.
3. Connect meter test lead to each lead of diode. 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.

Test Mow Solenoid

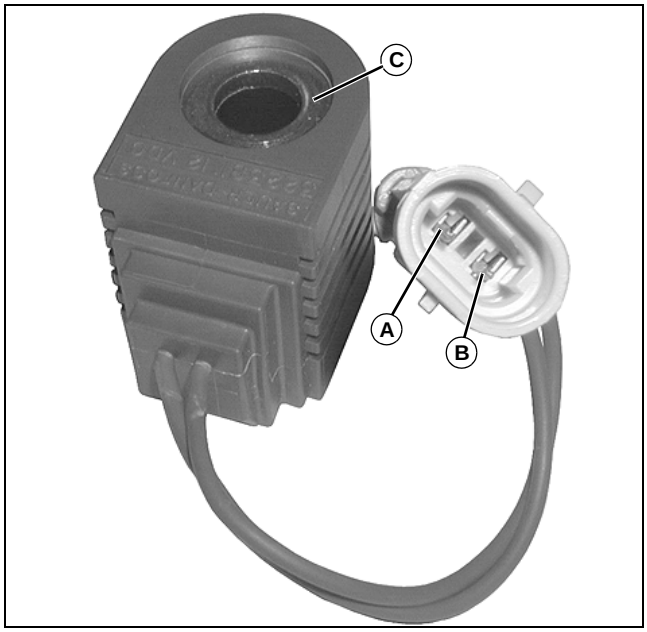
Reason

To determine condition of mow valve solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	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 (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

Test Raise or Lower Solenoid

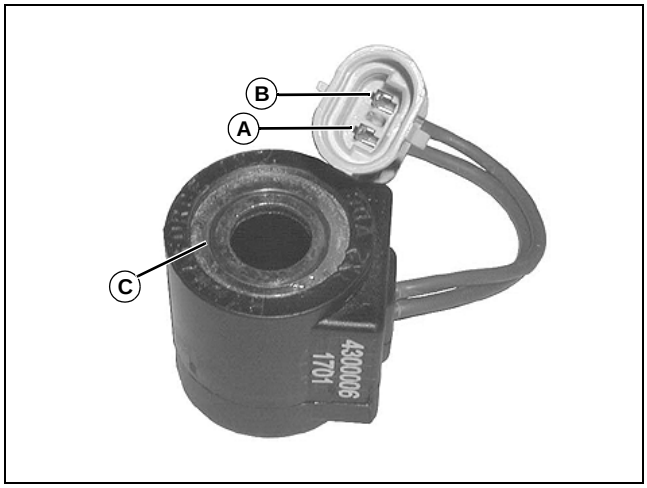
Reason

To determine condition of the raise or lower solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test solenoid.

Procedure



MX20165

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

Test Engine Oil Pressure Switch

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 test engine oil pressure switch.

Procedure

1. Park machine on a level surface.
2. Turn key OFF and lock park brake.
3. Open engine hood.
4. Disconnect wire 620 tan from engine oil pressure switch.
5. Check for continuity between the switch terminal and engine block.
6. Start and run engine at fast idle.
7. Check for continuity between the switch terminal and engine block.

Results

- There should be continuity between the switch terminal and engine block with the engine OFF.
- There should be NO continuity between the switch terminal and engine block with the engine running.
- If there is continuity with the engine running, test engine oil pressure.
- If engine oil pressure is to specifications and there is continuity with the engine running, replace engine oil pressure switch.

Test Hydraulic Oil Filter Restriction Switch

Reason

To determine if the hydraulic oil filter restriction switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test hydraulic oil filter restriction switch.

Procedure

1. Park machine on a level surface.
2. Turn key OFF and lock park brake.
3. Disconnect hydraulic oil filter restriction switch connector from main harness, wires 330 grn and 180 blk.
4. Check for continuity between the switch connector terminals.
5. Start and run engine at fast idle.
6. Check for continuity between the switch terminals.

Results

- There must be NO continuity between the switch terminals when hydraulic oil pressure is 207 kPa (30 psi).
- There must be continuity between the switch terminals when hydraulic oil pressure is 276 ± 28 kPa (40 ± 4 psi).
- If not to specifications, replace hydraulic oil filter restriction switch.

Specifications

Hydraulic Oil Filter Restriction Switch

Closing Pressure . . . . . 276 ± 28 kPa **(**40 ± 4 psi)
Opening Pressure . . . . . 207 kPa **(**30 psi)

Test Hydraulic Oil Temperature Sensor

Reason

To determine if the hydraulic oil temperature sensor is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test hydraulic oil temperature sensor.

Procedure

1. Park machine on a level surface.
2. Turn key OFF and lock park brake.
3. Disconnect hydraulic oil temperature sensor connector from main harness, wires 334 org and 124 blk.
4. Check for continuity between the switch connector terminals.
5. Start and run engine at fast idle.
6. Bring hydraulic oil to normal operating temperature.
7. Check resistance between the sensor terminals.

Results

Resistance must be greater than 180 ohms between sensor terminals when hydraulic oil temperature is at normal operating temperature.

Specifications

Hydraulic Oil Temperature Sensor

Resistance at 128°C (262°F) . . . . . .78.96-85.30 ohms

Test Engine Coolant Temperature Switch

Reason

To check the operation of the engine coolant temperature switch.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test engine coolant temperature switch.

Procedure

1. Park machine on a level surface.
2. Turn key OFF and lock park brake.

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 completely.

3. Allow engine to cool.
4. Open engine hood.
5. Disconnect wire 300 org from engine coolant temperature switch.
6. Check continuity between switch terminal and engine block. If continuity is indicated, replace engine coolant temperature switch.
7. Remove engine coolant temperature switch.
8. Connect digital multimeter between switch terminal and switch housing.

NOTE: Do not submerge the entire switch in coolant mixture. Submerge only to the bottom of the hexagon of the switch.

9. Submerge the switch in coolant mixture up to the bottom of the hexagon body. Slowly heat the coolant mixture and monitor the meter. The temperature at which the switch closes (meter indicates continuity) must be within specifications.
10. Allow the coolant mixture to cool while monitoring the meter. The temperature at which the switch opens (meter indicates NO continuity) must be within specifications.

Results

Replace engine coolant temperature switch if the open and close temperatures are not within specifications.

Specifications

Engine Coolant Temperature Switch

Closing Temperature . . . . . 107-113°C (225-235°F)
Opening Temperature . . . . . 97-103°C (207-217°F)

Test Cruise Control Magnet

Reason

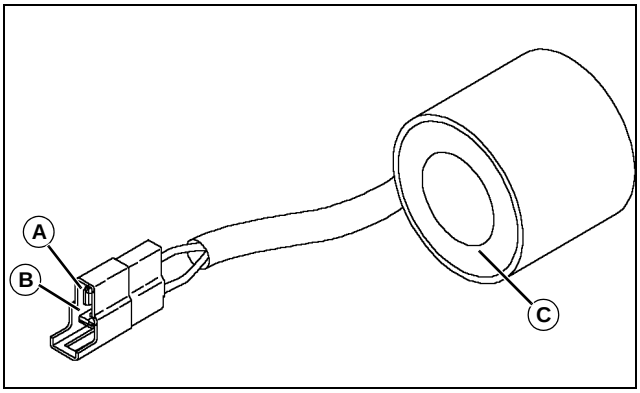
To determine condition of the cruise control magnet.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test cruise control magnet.

Procedure

1. Disconnect cruise control magnet connector from main wire harness.



MX14573

2. Check resistance between cruise control magnet connector terminal (A) and terminal (B). Resistance must be within specification.

3. Check for grounds or shorts between magnet terminal (A and B) and bare metal of the magnet core (C). There must be NO continuity between terminal (A or B) and core.

Results

- If resistance between terminals is not within specification, replace magnet.
- If continuity exists between terminal and core, replace magnet.

Specifications

Cruise Control Magnet

Coil Resistance. . . . . 20 ± 4 ohms

Test Air Preheater

Reason

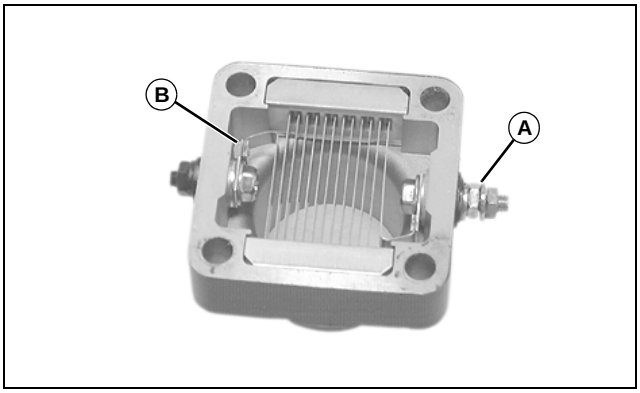
To test the condition of the engine air preheater.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to measure the resistance of the air preheater element.

Procedure

1. Remove air preheater.



MX2344

2. Measure the resistance between terminal (A) and terminal (B). The reading must be to specifications.

Results

If the resistance of the air preheater element is high or completely open, replace the element.

Specifications

Air Preheater

Element Resistance . . . . . 0.4-0.5 ohm

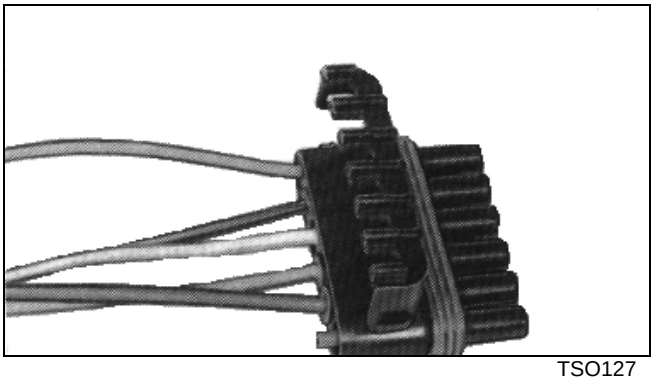
Repair

WEATHER PACK™ Connector Removal

Special or Required Tools

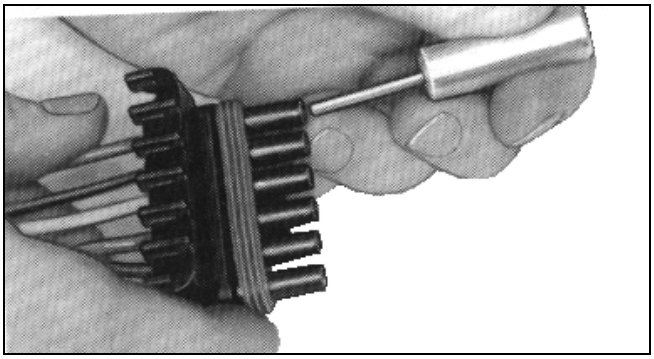
Tool Name	Tool No.	Tool Use
Extraction Tool	JDG364	Used to extract terminals.

IMPORTANT: Avoid damage! Identify wire color locations with connector terminal letters.



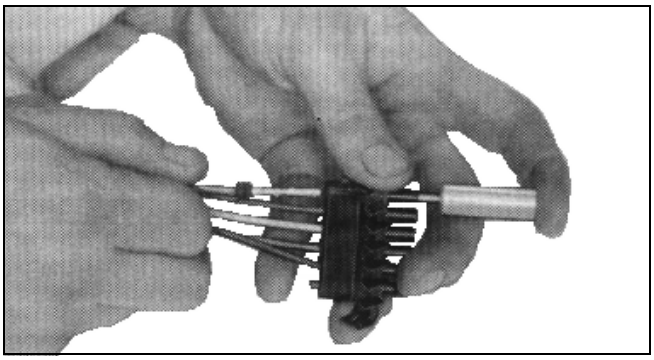
TSO127

1. Open connector body.



TSO128

2. Insert JDG364 Extraction Tool over terminal contact in connector body.



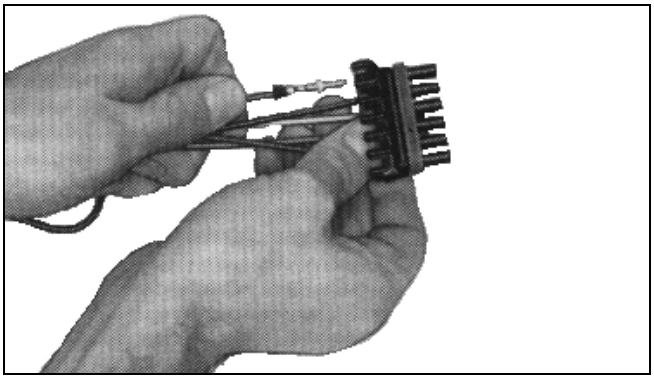
TSO129

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.

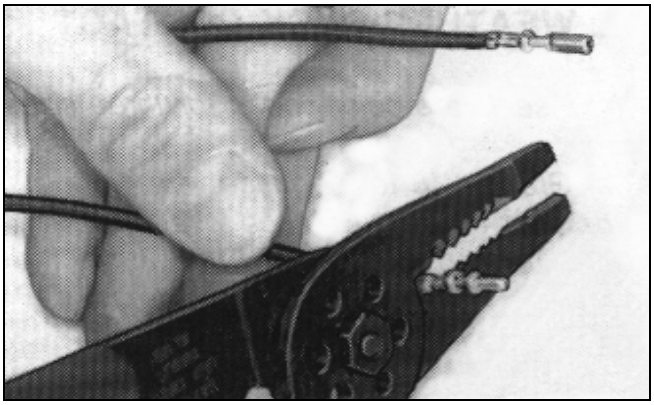
7. Close connector body.

Replace WEATHER PACK™ Connector Terminal

Special or Required Tools

Tool Name	Tool No.	Tool Use
Electrician's Pliers	JDG145	Used to cut and strip wire.
Crimper	JDG776	Used to crimp contact in place on wire. Used to secure cable seal to contact.

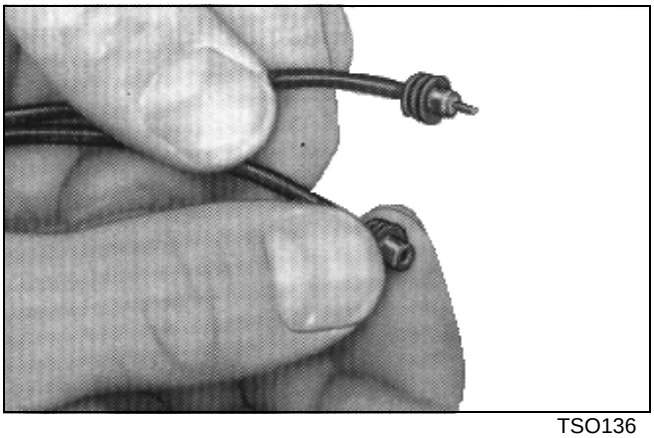
1. Remove wire from connector body as described above.



TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

IMPORTANT: Avoid damage! WEATHER PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.



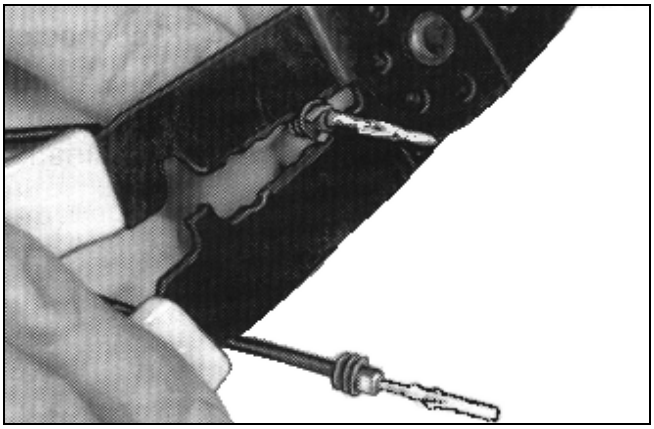
TSO136

3. Install correct size cable seal on wire.

NOTE: Cable seals are color coded for three sizes of wire:

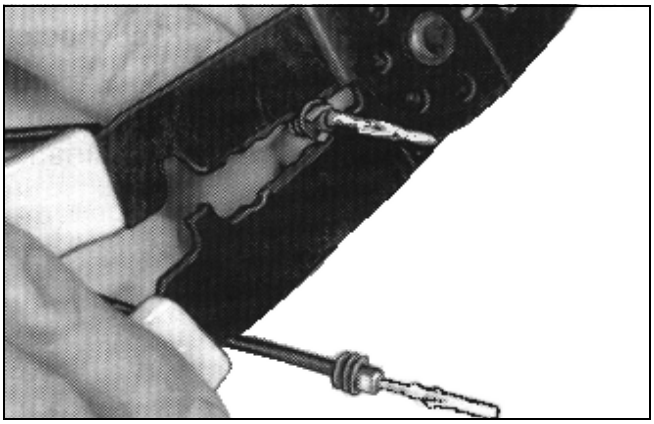
- ***Green - 18 to 20 gauge wire***
- ***Gray - 14 to 16 gauge wire***
- ***Blue - 10 to 12 gauge wire***

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.



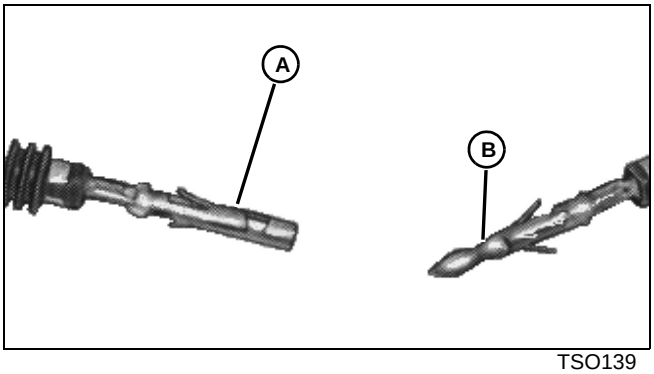
TSO138

5. Place proper size contact on wire and use JDG776 Crimper to crimp contact in place with a "W" type crimp.



TSO138

6. Use JDG776 Crimper to secure cable seal to contact as shown.



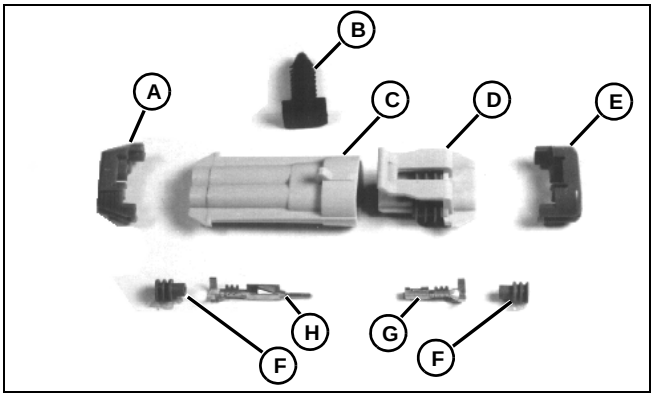
TSO139

IMPORTANT: Avoid damage! Proper contact installation for "sleeve (A) and pin (B)" is shown.

Remove METRI-PACK™ Connector

Special or Required Tools

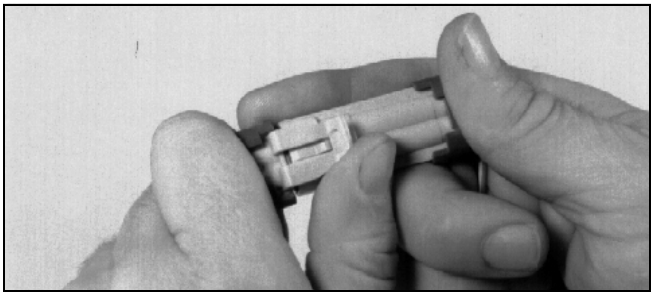
Tool Name	Tool No.	Tool Use
Terminal Removal Tool	JSG777	Used to depress locking tang and remove contact.



M56685

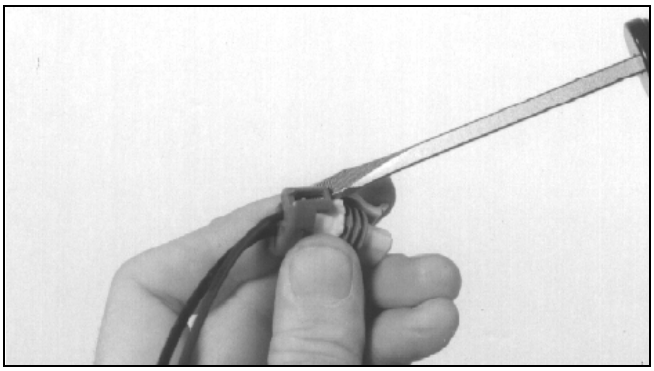
A - Wire Retainer
B - Mounting Post
C - Pin Body
D - Sleeve Body
E - Wire Retainer
F - SHURE-Seal
G - Sleeve
H - Pin

IMPORTANT: Avoid damage! Identify wire number/color locations with connector terminal letters.



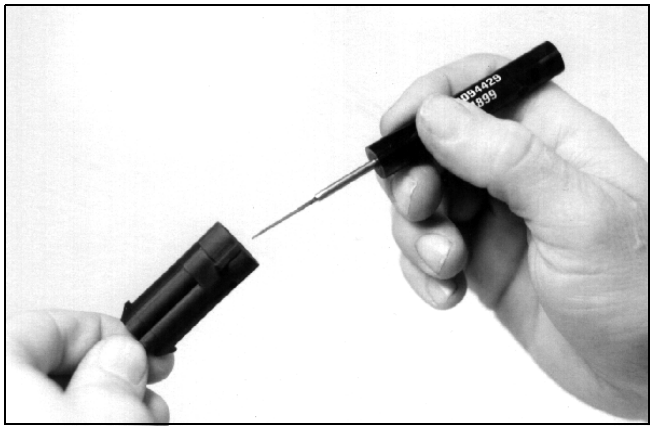
M56682

1. Open connector body.

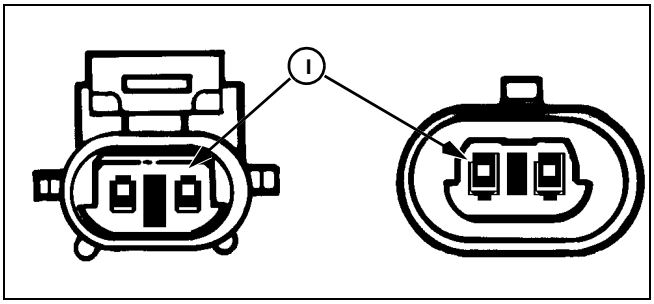


M56684

2. Remove retainer on wire end of connector with a screwdriver.



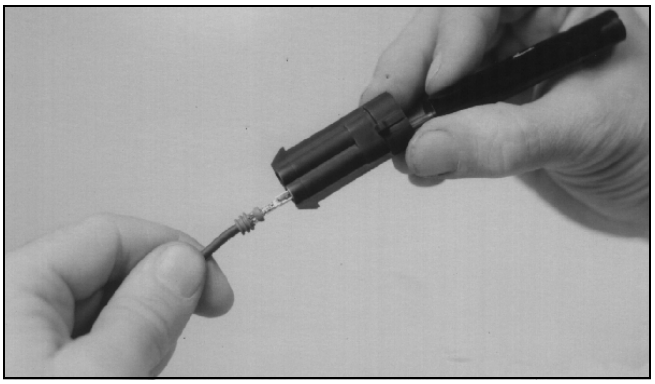
M56690



M56691

3. Use JDG777 Terminal Removal Tool to remove contact from connector body at position (I).

NOTE: To remove sleeve connector from sleeve body (short connector half), insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half), insert tool in center of contact.


M56689

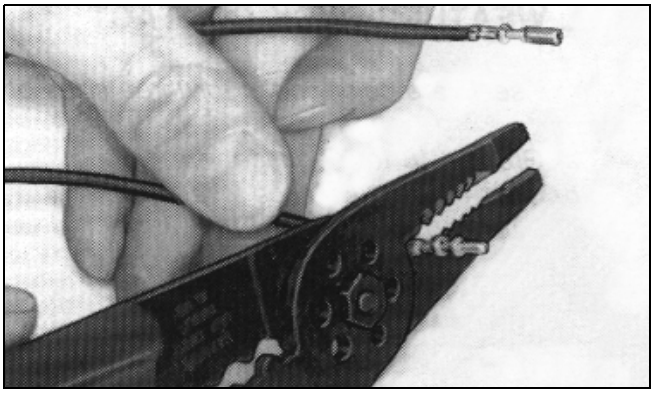
4. Hold the removal tool fully seated and pull wire from connector body.

Replace METRI-PACK™ Connector

Special or Required Tools

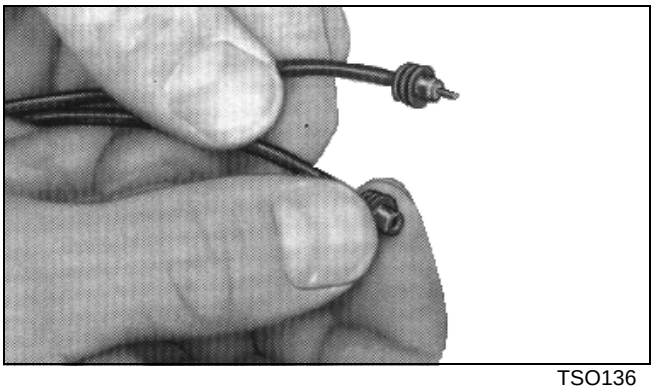
Tool Name	Tool No.	Tool Use
Electrician's Pliers	JDG145	Used to cut and strip wire.
Crimper	JDG776	Used to crimp contact in place on wire. Used to secure cable seal to contact.

1. Remove wire from connector body as described above.


TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

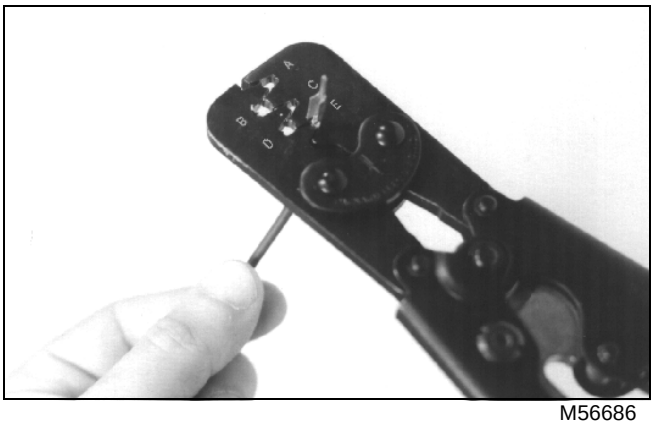
IMPORTANT: Avoid damage! METRI-PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.


TSO136

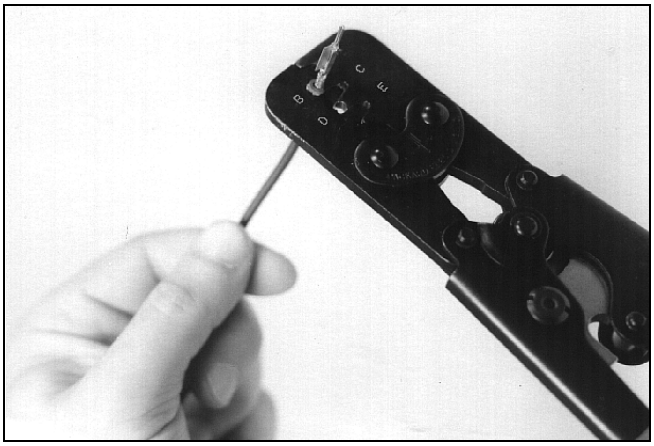
3. Install correct size cable seal on wire.

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***

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.


M56686

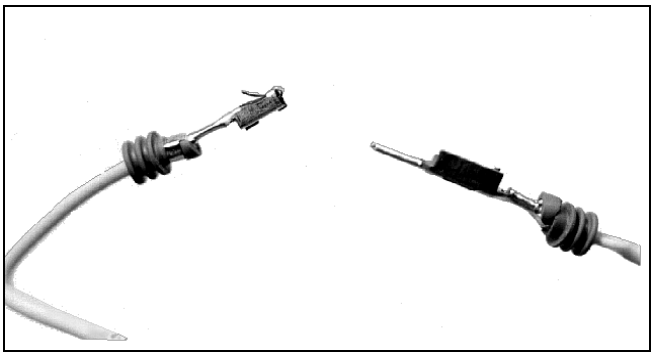
5. Place proper size contact on wire and use JDG776 Crimper to crimp contact in place with a "W" type crimp.


M56687

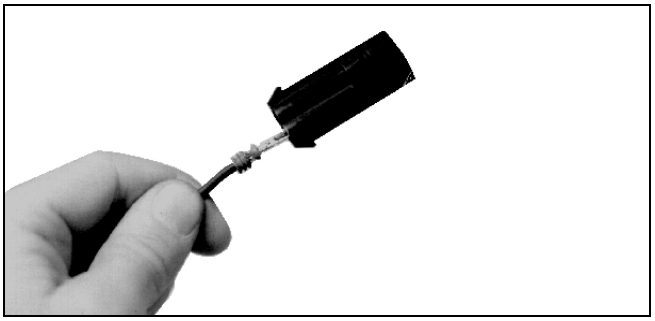
6. Use JDG776 Crimper to secure cable seal to contact as shown.

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.



M56688

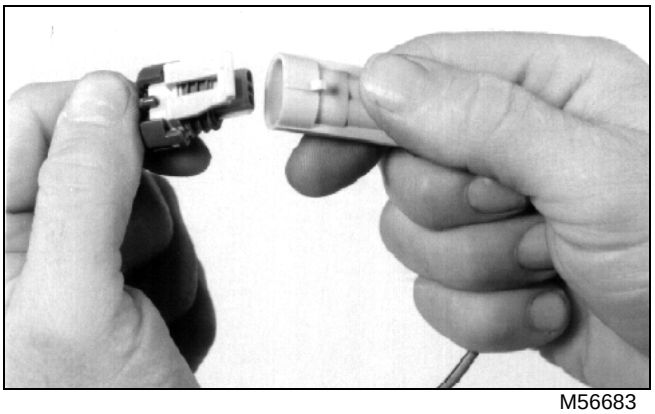


M56689

7. Push contact into new connector body until fully seated.

8. Pull on wire slightly to be certain terminal is locked in place.

9. Install wire retainer.



M56683

10.Transfer remaining wires to correct terminal in new connector.

11.Place retainer on wire end of connector and snap in place.

12.Close connector body.

Table of Contents

Specifications

General Specifications

Triple Pump (Front Gear Set)

Make	Danfoss
Flow	16 L/min (4.25 gpm)
Required Pressure at Hydro Input	414-1103 kPa (60-160 psi)

Filter

Type	Spin on
Clogged Filter Bypasses Fluid to Tank At	345 kPa (50 psi)
Filter Bypass Light Comes On At	276 kPa (40 psi)

Hydrostatic Transmission (3225C)

Make	Eaton
Model	70145
Type	Rotating piston, variable flow
Main Relief Valve Setting	31 026 ± 1379 kPa (4500 ± 200 psi)
Charge Relief Valve Setting	552 kPa (80 psi)

Hydrostatic Transmission (3235C and 3245C)

Make	Eaton
Model	72400
Type	Servo-controlled piston pump
Main Relief Valve Setting	24 132 ± 1379 kPa (3500 ± 200 psi)
Charge Relief Valve Setting	1310 kPa (190 psi)

Front Wheel Motors

Make	Eaton
Model - 3225C	167-0035-001
Model - 3235C and 3245C	167-0036-001

Rear Wheel Motors (3235C and 3245C)

Make	Parker
Model	MB10020BAAGW

Repair Specifications

Hydrostatic Transmission (3225C)

Trunnion Covers Screw Torque	4-5 N•m (35-44 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)
Dump Valve Torque	37-40 N•m (27-30 lb-ft)
Relief Valves Torque	129-142 N•m (95-105 lb-ft)

Hydrostatic Transmission (3235C and 3245C)

Needle Bearing Recessed Inside Bore	1.8 mm (1/16 in.)
Cylinder Cap and Gasket (w/ Piston Screw Hole in Center) Mounting Screw Torque	5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Pump Piston Distance from Edge of Cylinder (Installed)	12.7 mm (0.500 in.)
Outside Jam Nut Torque	17.5 ± 1 N•m (155 ± 5 lb-in.)
Cylinder Cap and Gasket Mounting Screw Torque	5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Servo Valve Feedback Rod Mounting Screw Torque	5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Cradle Mounting Screw Torque	36 ± 2 N•m (26 ± 2 lb-ft)
Wear Plate Retaining Screw Torque	1.7 ± 0.1 N•m (15 ± 1 lb-in.)
Gerotor Bearing Position in Bore	2.29 mm (0.090 in.)
Roll Pin Protrusion from Backplate	4.39 mm (0.173 in.)
Backplate Assembly Resting Position	1.5 mm (0.06 in.)
Gerotor Bearing Race Position in Bore	2.41 mm (0.095 in.)
Gerotor Housing Cap Screw Torque (4 used)	40 ± 2 N•m (29 ± 2 lb-ft)
Main Drive Pressure Relief Valve Torque	143 ± 6 N•m (105 ± 5 lb-ft)
Charge Pump Relief Valve Torque	39 ± 2 N•m (29 ± 1 lb-ft)
Manual Servo Control Set Screw Torque	2-3 N•m (17-25 lb-in.)

Wheel Motors - Front

Valve Housing Cap Screws	50 N•m (37 lb-ft)
Wheel Motor Shaft Nut	508 N•m (375 lb-ft)
Wheel Motor Mount Bolts	142 N•m (105 lb-ft)
Motor Fitting Torque	46 N•m (34 lb-ft)
Large Hydraulic Line Torque	102 N•m (75 lb-ft)
Small Hydraulic Line Torque	50 N•m (37 lb-ft)
Manifold Block Torque	176 N•m (130 lb-ft)
Caliper Mounting Bracket Cap Screw Torque	140 N•m (105 lb-ft)

Wheel Motors - Rear

Valve Housing Cap Screws	50 N•m (37 lb-ft)
Rotor Nut Torque	508 N•m (375 lb-ft)
Wheel Motor Mount Bolts	142 N•m (105 lb-ft)
Motor Fitting Torque	46 N•m (34 lb-ft)
Large Hydraulic Line Torque	102 N•m (75 lb-ft)
Small Hydraulic Line Torque	50 N•m (37 lb-ft)
Manifold Block Torque	176 N•m (130 lb-ft)

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D010744AA	Used to measure hydraulic circuit flow.
Pressure Diagnostic Kit	JDG2031	Used to test hydraulic pressure.
Diagnostic Flow Kit	JDG2032	Used to test hydraulic circuit flow.
Pressure Gage Kit	JDG2033	Used to measure hydraulic pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

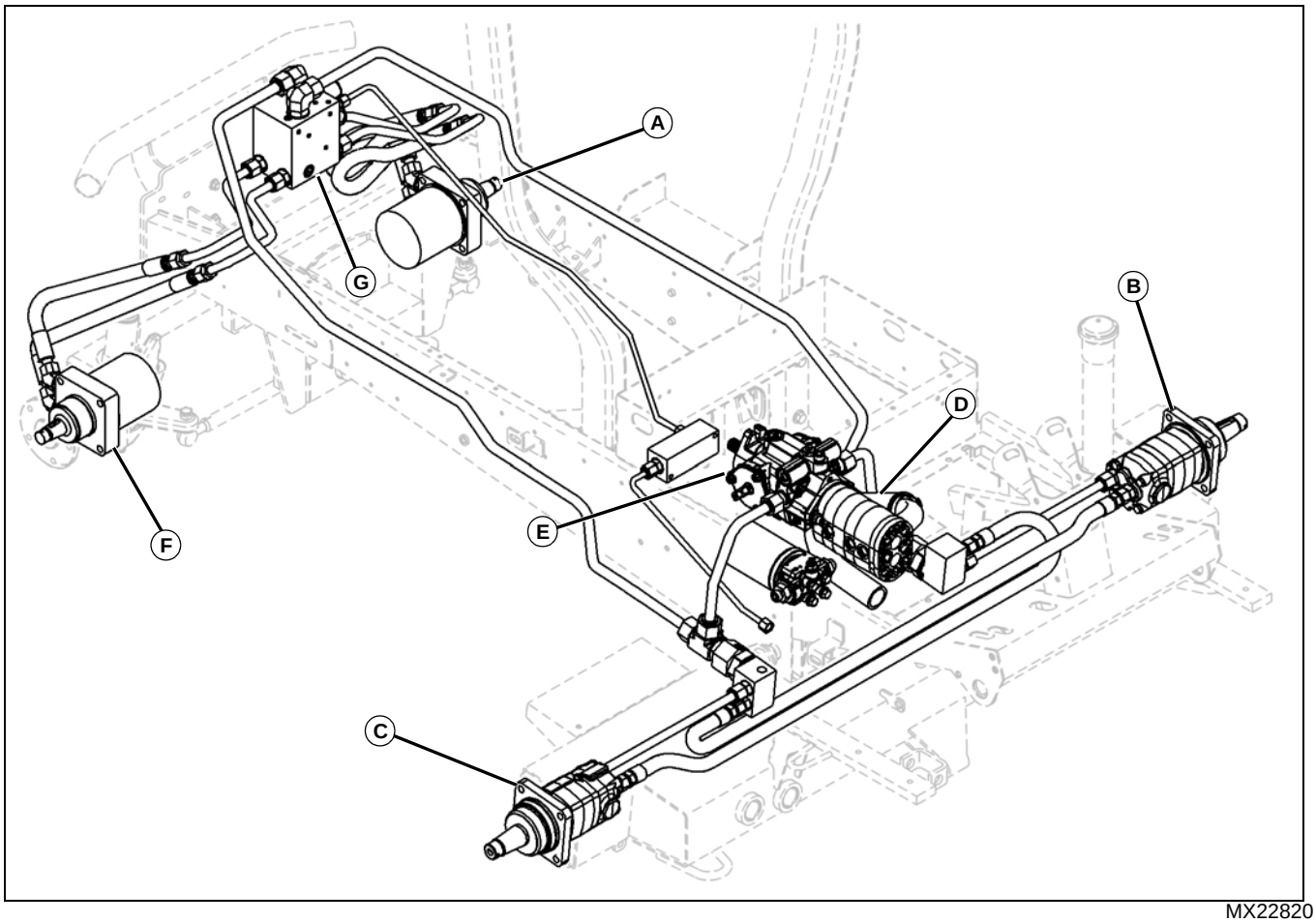
Materials

Other Material

Part No.	Part Name	Part Use
T43512 (US) 242 (Loctite) TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Apply to threads of setscrew.

Component Location

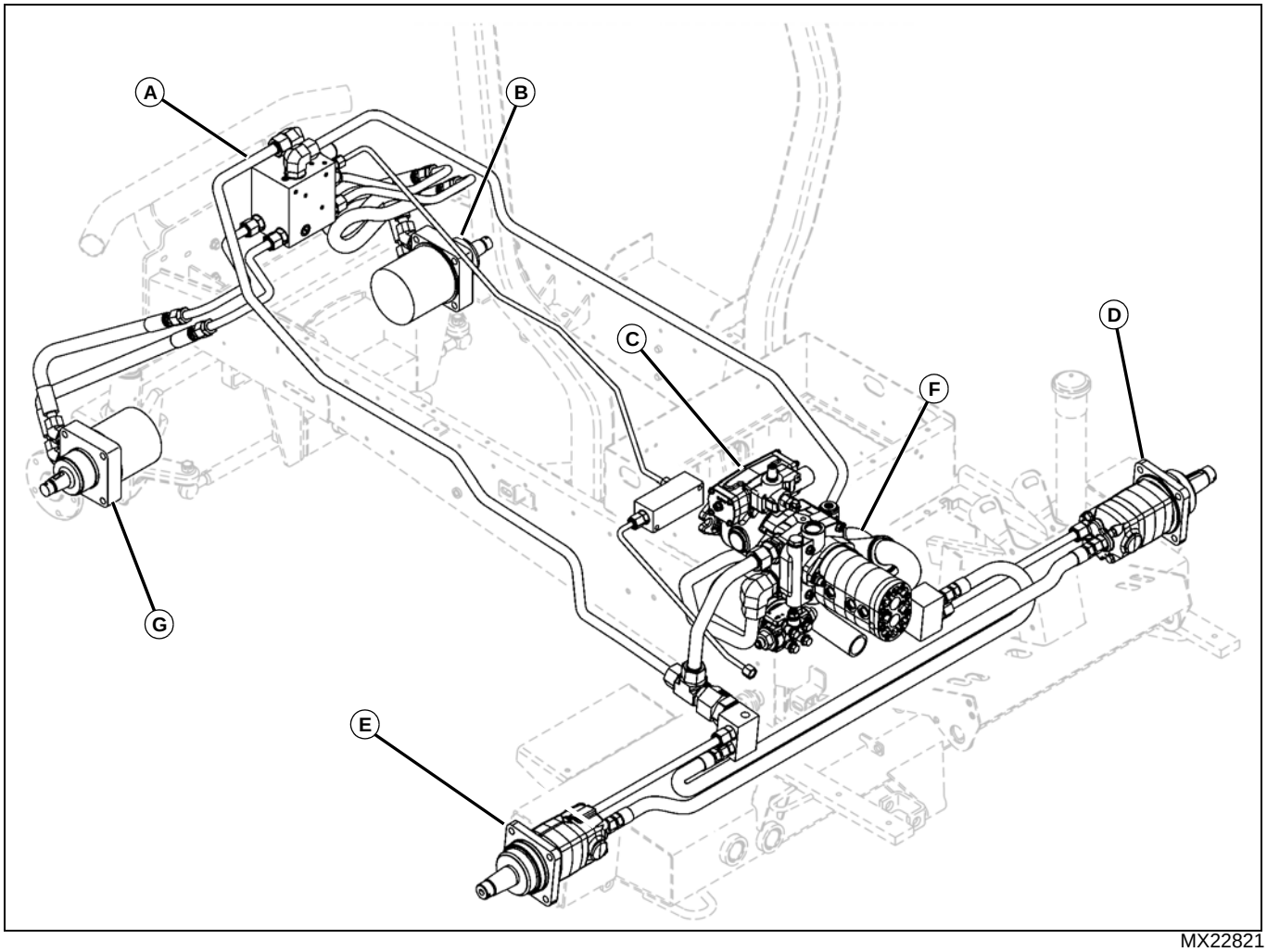
Component Location - 3225C



MX22820

A - Rear Left Motor (Optional)
B - Front Left Motor
C - Front Right Motor
D - Filter/Strainer
E - Pump
F - Rear Right Motor (Optional)
G - Rear Wheel Motor Valve (Optional)

Component Location - 3235C and 3245C

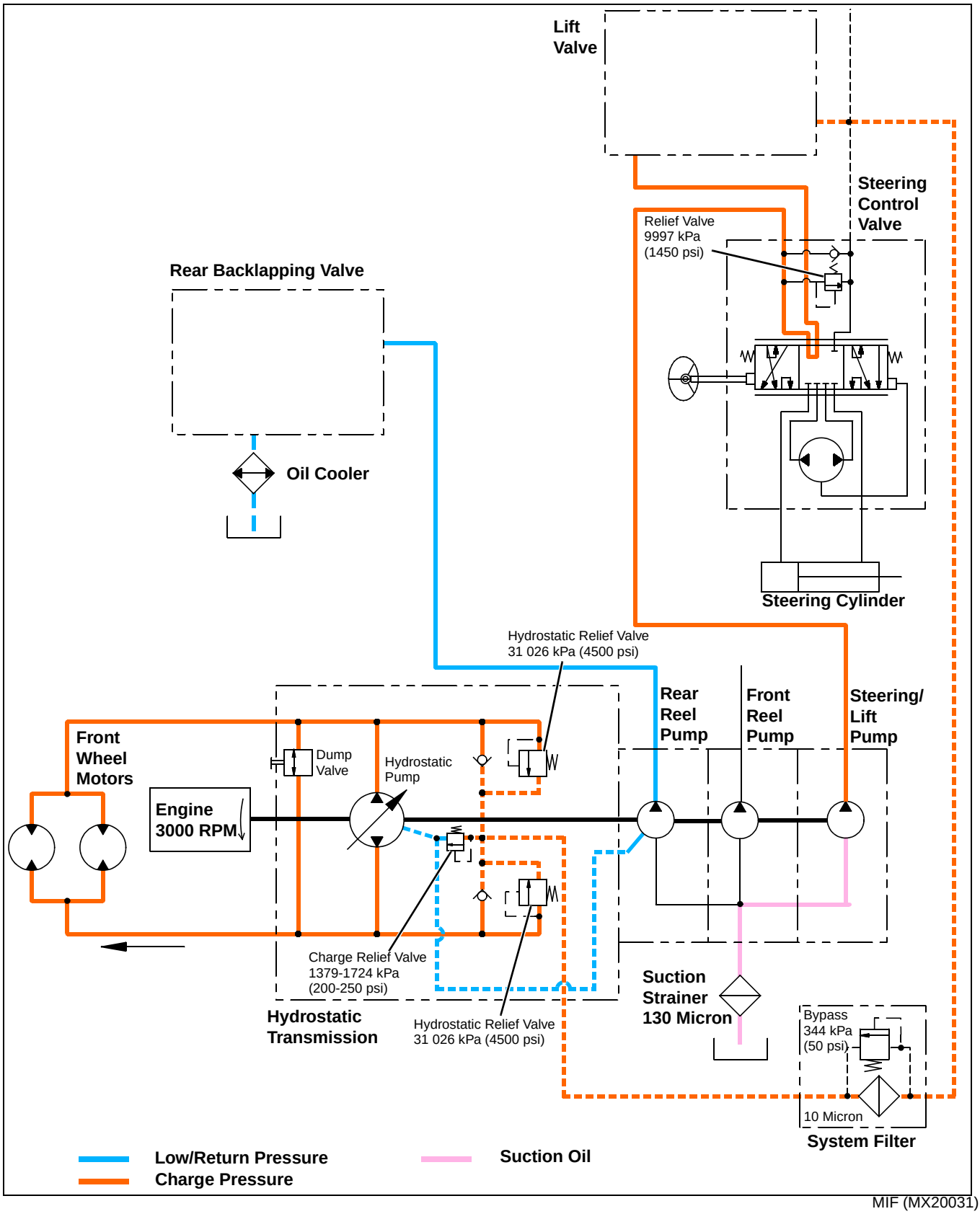


MX22821

A - Rear Wheel Motor Valve
B - Rear Left Motor
C - Pump
D - Front Left Motor
E - Front Right Motor
F - Filter
G - Rear Right Motor

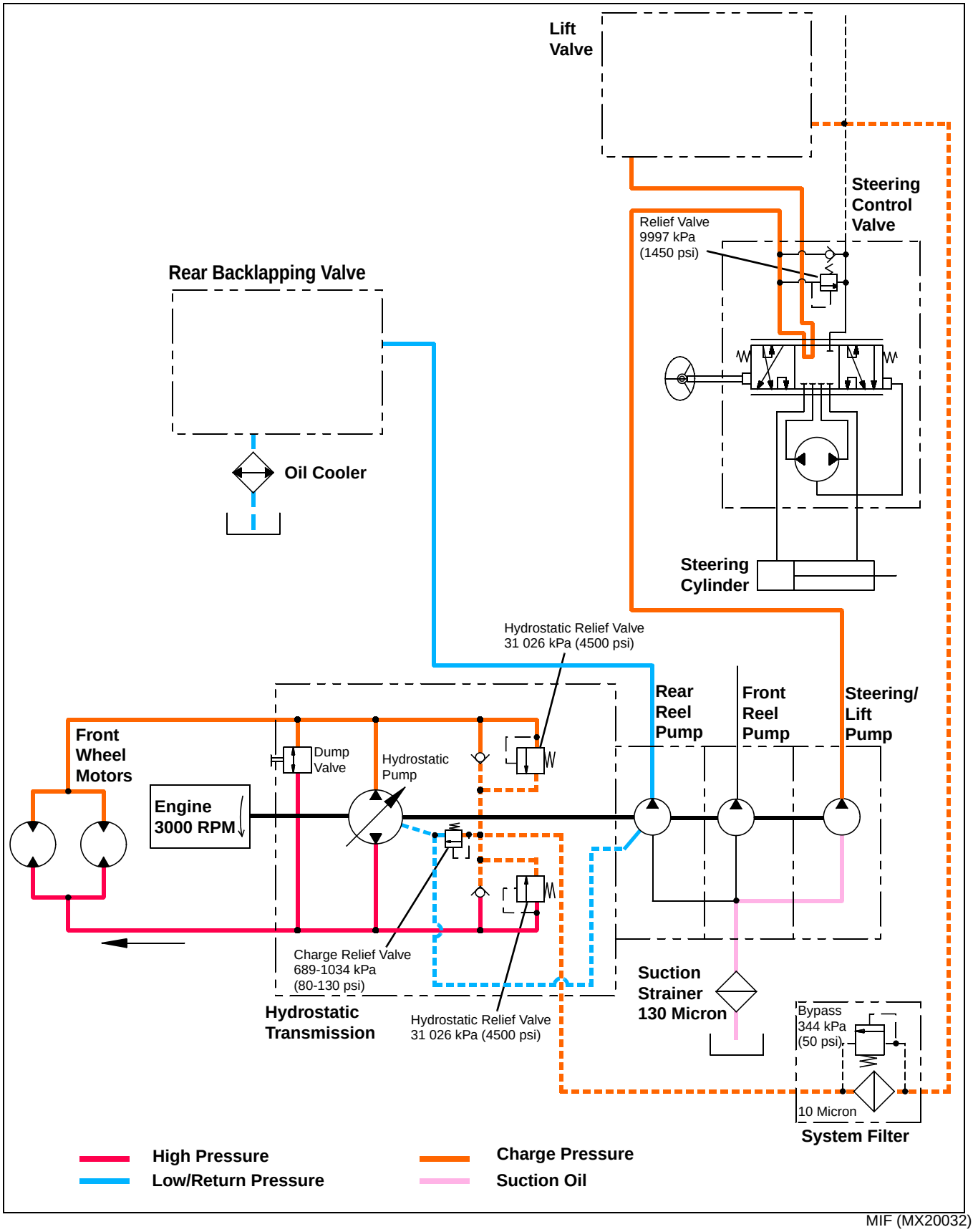
Hydrostatic Schematics

3225C in Neutral



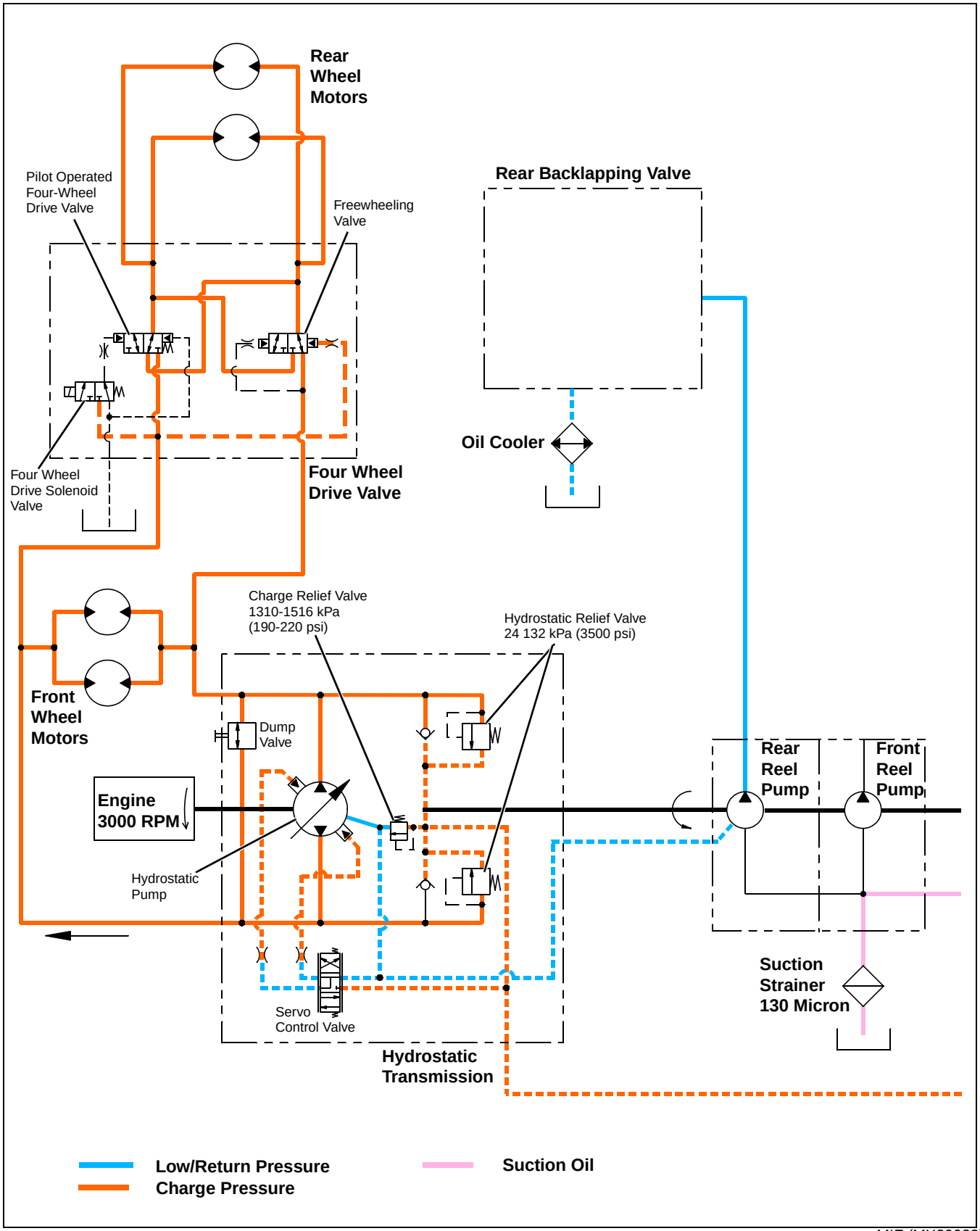
MIF (MX20031)

3225C in Forward

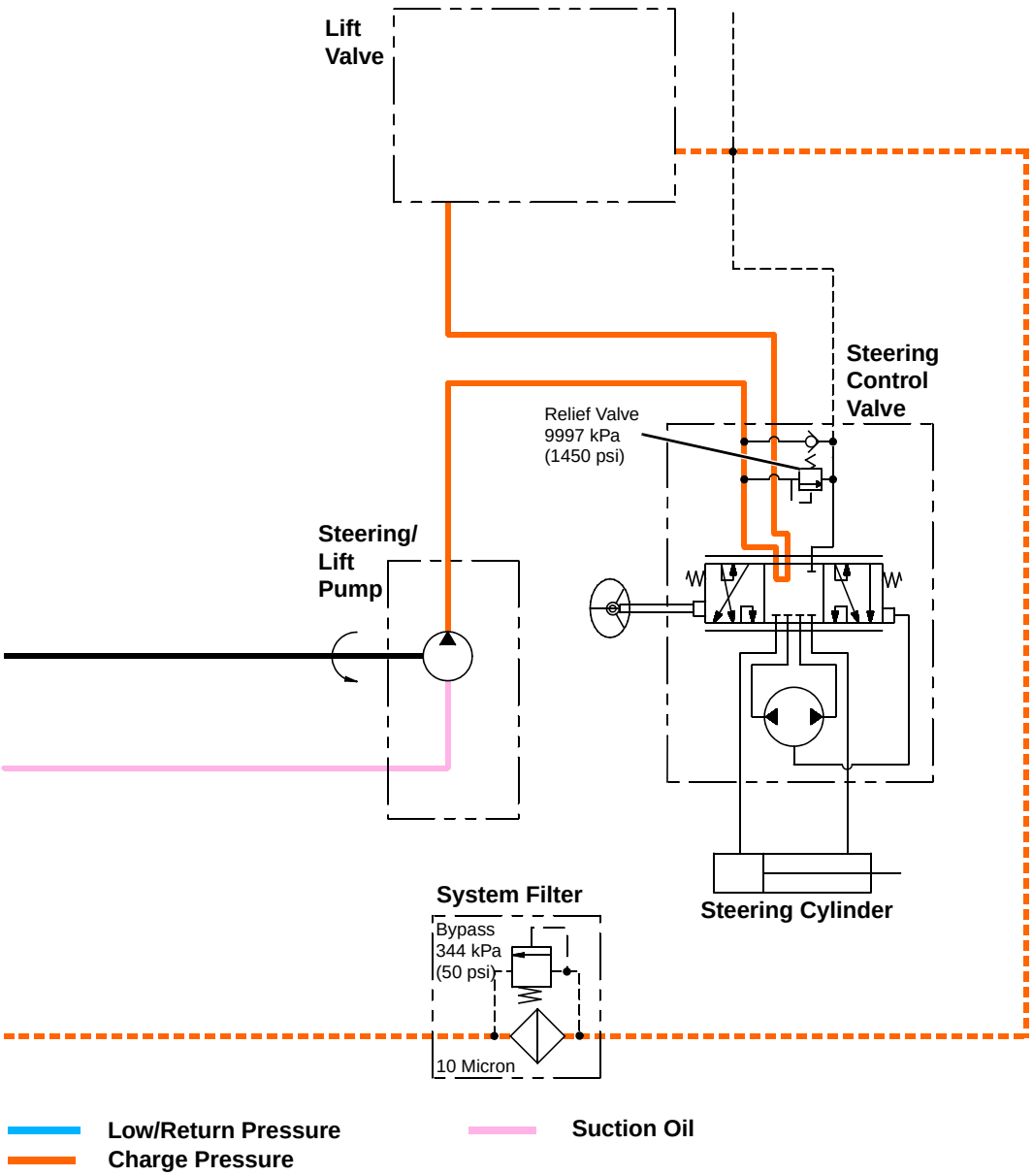


MIF (MX20032)

3235C and 3245C in Neutral

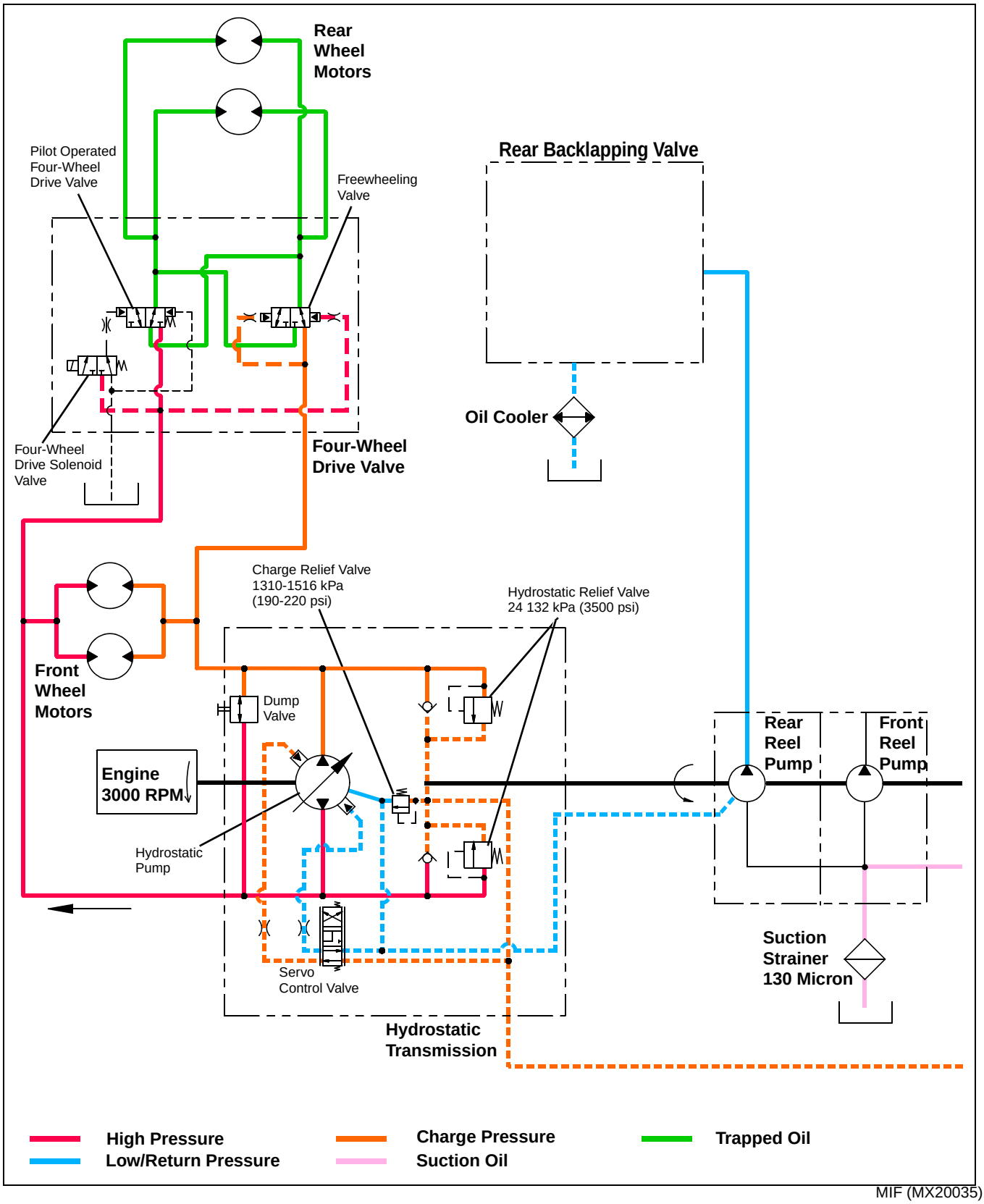


MIF (MX20033)

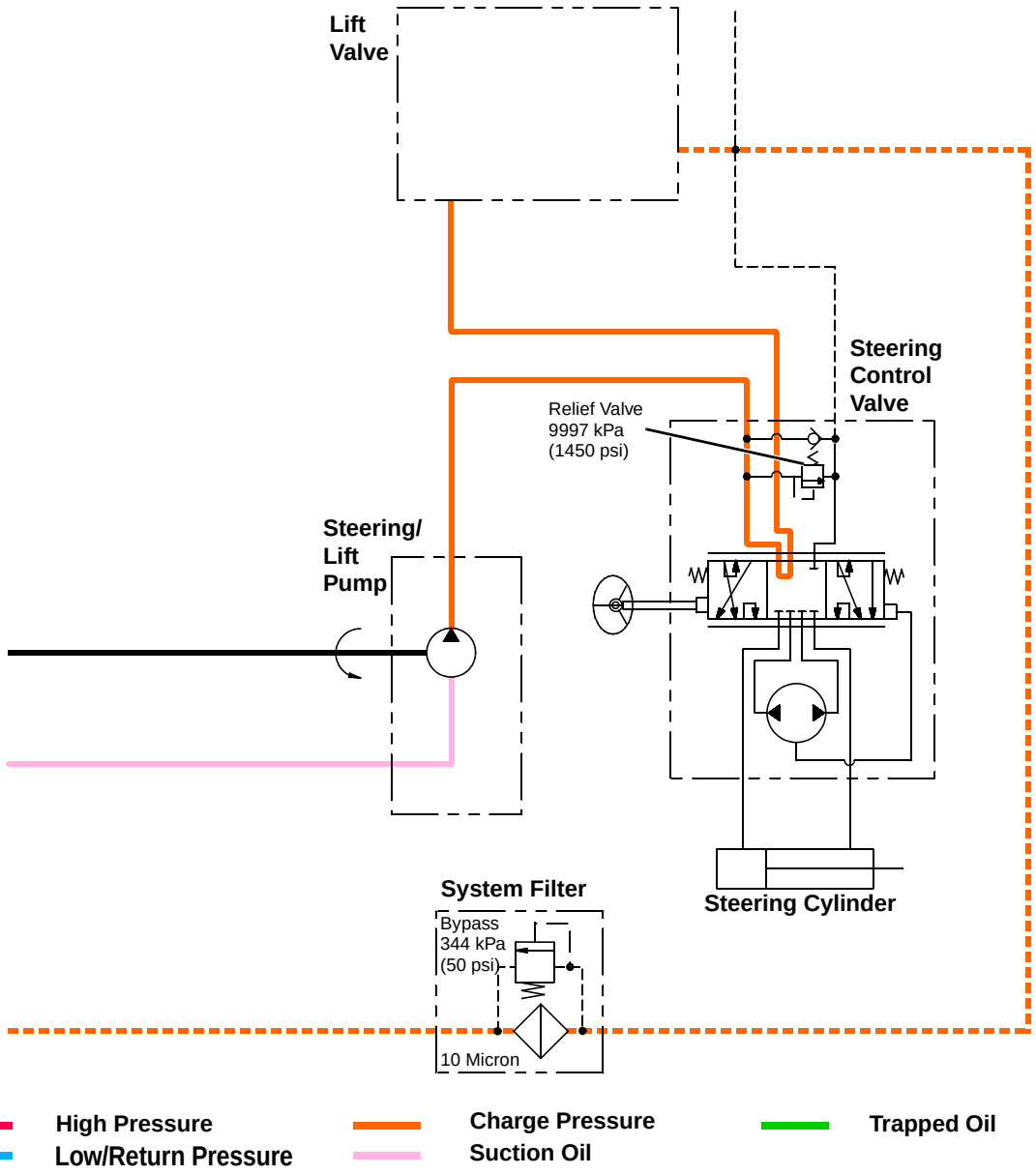

Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
Low/Return Pressure
Charge Pressure
Suction Oil

MIF (MX20034)

3235C and 3245C in Forward - Rear Wheels Disengaged

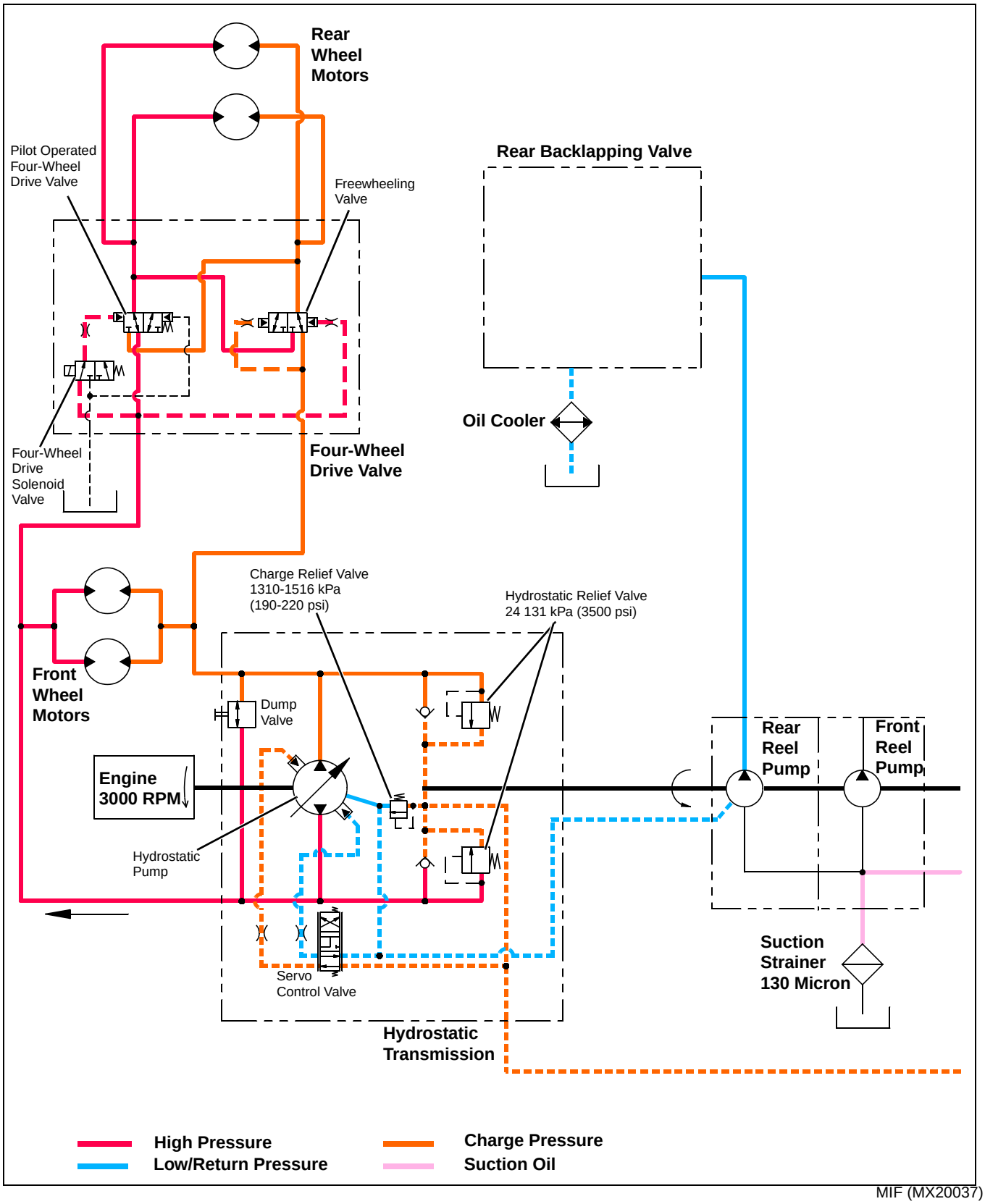


MIF (MX20035)

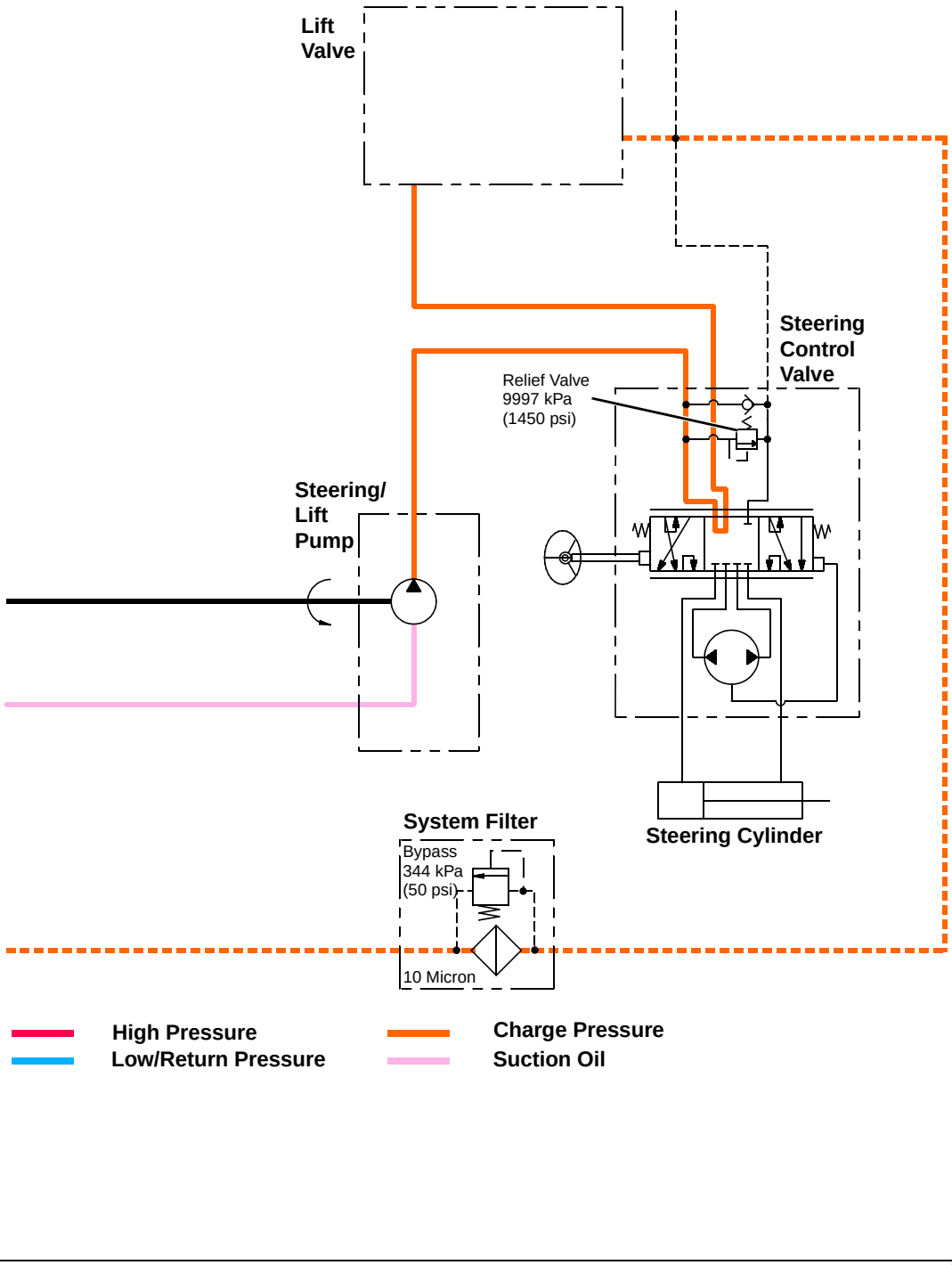

Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
High Pressure
Low/Return Pressure
Charge Pressure
Suction Oil
Trapped Oil

MIF (MX20036)

3235C and 3245C in Forward - Rear Wheels Engaged (Four-Wheel Drive)



MIF (MX20037)


Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
High Pressure
Low/Return Pressure
Charge Pressure
Suction Oil

MIF (MX20038)

Theory of Operation

Hydrostatic Transmission

Function

The hydrostatic system provides a means to transfer power from the engine to the final drive for the wheels. It also provides infinitely variable speed control.

Theory

The hydrostatic system is a closed loop fluid power system that consists of an Eaton piston pump and two (two-wheel drive) or four (four-wheel drive) motors. Speed and direction are controlled by two foot pedals.

Engine power is transferred to the hydrostatic pump by a drive shaft connected to the engine flywheel. The Eaton piston pump, or hydrostatic transmission, is mounted to a bulkhead under the operators platform.

Hydrostatic fluid is provided to the hydrostatic pump from a pressurized charge pump flow. Fluid from the steering/ charge pump is directed through two dual-purpose system relief/check valves located in the pump backplate. An internal charge pump relief valve maintains a minimum charge pressure level. Excess charge fluid is returned to the reservoir.

The hydrostatic pump provides hydraulic fluid in varying amounts to the motors through hydraulic lines and fittings. The hydraulic fluid in the power train circulates in a closed loop. The amount and pressure of the fluid is a result of the displacement of the pump pistons, which are controlled by a variably angled surface called a swash plate or cam plate. Fluid leaves the pump, flows through the motor(s) and is returned to the pump, not the reservoir.

During operation, some fluid intentionally leaves this closed loop circuit, such as case drain, and is replenished by cool filtered fluid from the front gear set (steering/charge pump) of the triple pump assembly. (See Hydraulic section.) This fresh fluid enters through the check valve part of the relief/ check valve assembly. If the pressure going to the wheel motors exceeds a certain preset amount, the relief valve for that circuit will move off its seat and allow some fluid to pass to the low-pressure side of the system.

Hydrostatic Pump - 3225C

The pump is an Eaton Model 70145 axial piston, manually variable displacement pump.

Hydrostatic fluid is provided to the hydrostatic pump from a pressurized charge pump flow. An internal charge pump relief valve maintains a minimum charge pressure level of 758-1103 kPa (110-160 psi). During operation, some fluid is intentionally “leaked” from the hydrostatic circuit and is routed back into the reservoir. This fluid is replaced by charge oil that enters the closed loop through one of the relief/check valves, thereby introducing cool filtered oil into the hydrostatic system.

Directional control, forward or reverse, is controlled by varying the direction of fluid flow through the hydrostatic pump. This is accomplished by varying the direction of rotation of the swash plate in the pump. The direction and the amount of swash plate rotation is controlled by two foot pedals. The left pedal controls forward motion; the right pedal controls reverse motion. The movement of the pump swash plate in either the forward or reverse position controls the direction of the motor rotation. In the reverse position, the pump shaft still rotates in the same direction, but the discharge of oil from the pump is reversed, thus reversing the motor rotation.

Speed is controlled by the displacement of the pistons as controlled by the swash plate. The greater the angle of the swash plate from the center position (neutral), the greater the volume of fluid the pistons will displace and the faster the vehicle travels. Maximum speed is limited by an adjustable stop located under the operator seat. This stop allows presetting optimum ground speed for consistent cutting of turf.

Hydrostatic Pump - 3235C and 3245C

The pump is an Eaton Model 72400 servo-controlled piston pump. It consists of a manual servo-controlled variable piston pump.

Hydrostatic fluid is provided to the hydrostatic pump from a pressurized charge pump flow. An internal charge pump relief valve maintains a minimum charge pressure level of 1724-2068 kPa (250-300 psi). Charge oil pressure is also used to operate the servo control and four-wheel drive control.

During operation, some fluid is intentionally “leaked” from the hydrostatic circuit and is routed back into the reservoir. This fluid is replaced by charge oil that enters the closed loop through one of the relief/check valves, thereby introducing cool filtered oil into the hydrostatic system.

Speed and direction are controlled by the direction of, and angle of, the cam plate rotation, similar to the swash plate in the model 70145 pump. The cam plate is controlled by a hydraulic servo instead of a mechanical linkage. The greater the angle of the cam plate from the center position (neutral), the greater the volume of fluid the pistons will displace and the faster the vehicle travels.

Servo Control Function

Transmission output is initiated by movement of the variable displacement pump control lever. As the lever is rotated, it moves the servo control spool first, from its spring-centered position, allowing pressurized charge pump flow past the spool to one side of the servo piston. The pressurized servo piston pushes against the cam plate causing the cam plate to rotate to a position out of neutral. Fluid on the opposite side of the servo piston is exhausted through the control valve spool to the pump housing.

As the cam plate attains any position selected by the control lever, by the connecting feedback link and servo piston, it relocates the control valve spool to a metering position. The spool meters the fluid between the spool and servo piston to hold the cam plate in its desired position.

As the control lever is slowly moved forward or reverse, the vehicle starts a forward or reverse movement. The movement of the pump cam plate in either the forward or reverse position controls the direction of the motor rotation. In the reverse position, the pump shaft still rotates in the same direction, but the discharge of oil from the pump is reversed, thus reversing the motor rotation. When the cam plate begins to move, the piston assemblies start to reciprocate farther, generating a flow; more oil is being pumped and the speed of the vehicle is increased. Flow rate is determined by length and frequency of stokes. When full cam angle is reached, which also is maximum volume of oil being discharged from the pump, the speed of the motor increases. When the cam plate begins to move, the relief valve on the discharge or pressure side seats because of the higher pressure differential. The other relief valve serves as a charge check, remaining open, on the intake or low-pressure side to continue supplying the closed loop system with cool filtered charge oil.

System Pressure Relief

The pressure relief valves are combination relief and check valves mounted within the hydrostatic pump assembly. One serves the forward pressure loop, and one serves the reverse pressure loop.

The function of the system relief valve is to relieve excess hydrostatic pressure if the vehicle encounters a heavy load or stalls out.

When a preset pressure is reached, the large spring in the relief valve compresses and opens an orifice, allowing oil to bypass into the low-pressure side of the system. The opposite relief valve, serving as a check valve, opens and allows the oil to flow to the intake side of the pump.

Steering/Charge Pump

The steering/charge pump provides several functions to the hydrostatic circuits:

- Provides flow to keep circuits primed and make up internal leakages.
- Provides flow, under pressure, for maintaining back pressure on pump/motors pistons.
- Provides flow, under pressure, for hydraulic control purposes.
- Provides cooled and cleansed fluid for temperature control and flushing.

Wheel Motors

The front wheel motors are Eaton Series 2000, positive displacement geroter motors. The rear wheel motors are Parker positive displacement motors.

Both motors are fixed displacement type delivering a constant output torque for a given pressure throughout the speed range of the motor.

The motors for the front wheels are mounted on the ends of the fluid reservoir. The motors for the rear wheels, with rear wheel drive option only, are mounted on the ends of the control arms.

The drive wheels are mounted on hubs which are keyed onto the output shaft of each motor.

Four-Wheel Drive Solenoid Valve

The four-wheel drive solenoid valve is an electrically operated, spring return shuttle valve. When energized, fluid from the forward side of the pump is directed to the pilot operated, spring return four-wheel drive valve. The spool in the four-wheel drive valve shifts, allowing pressurized fluid to the rear wheel motors for added traction. When de-energized, fluid in the rear motors and lines circulates in a closed loop, allowing the rear wheels to freewheel.

The four-wheel drive solenoid is energized only when moving in the forward direction.

Freewheeling Valve (Four-Wheel Drive Units Only)

The freewheeling valve is a pilot operated, spring return shuttle valve.

During four-wheel drive operation and while descending slopes, it is possible to build higher pressures in the return lines of the rear wheel motors. This happens when the machine's momentum develops more pressure in the reverse lines of the hydraulic system than the hydrostatic pump develops in the forward lines. Effectively, the wheel motors try to drive the hydrostatic pump. Higher pressure in the return lines can cause the rear wheels to stop turning or start them turning in the reverse direction. Either case will result in loss of steering control. The freewheeling valve is installed in the rear wheel drive circuit to counteract this effect.

The freewheeling valve compares the pressure in the forward and reverse lines of the wheel motors. If reverse pressure is higher than forward pressure, the valve shifts and sets up a bypass circuit in the rear wheel drive system. When a higher pressure is sensed in the forward side of the wheel motors, the freewheeling valve returns to normal position and allows full four-wheel drive again.

The freewheeling valve also shifts to a bypass position when the machine is operated in reverse, effectively disengaging four-wheel drive until the machine is again moving forward.

Dump Valve

IMPORTANT: Avoid damage! Serious damage to the hydrostatic drive will result if the vehicle is towed.

The purpose of the dump valve is to allow the movement of a disabled vehicle, or if you want to just push it a short distance, without starting the engine. If an attempt is made to push the vehicle, the hydrostatic motor becomes a pump, trying to pump oil to the hydrostatic pump. This creates a hydraulic lock between the motor and pump. To overcome this condition, a dump valve has been installed between the high-pressure relief valves in the backplate of the piston pump.

The dump valve is a plug that contains a rotating stem with a flat spade end that fits between the two ends of the high-pressure relief valves. When the dump valve is in the closed position, the relief valves are also in the closed position. When the dump valve stem is rotated 90°, the flat spade end spreads the relief valves to the open position. This allows the oil in the hydrostatic closed loop to bypass around the high-pressure relief valves inside the pump backplate. The bypassing of oil inside the pump backplate will allow the motor to rotate freely when the vehicle is moved a short distance. The dump valve is intended only for moving a vehicle a very short distance and not intended for towing a vehicle behind a truck or tractor.

Diagnostics

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, clogged filter, or insufficient fluid in the system.

Before testing the hydrostatic pump, check the charge pump pressure. (See Hydraulics section.) Once you are satisfied that charge pressure is sufficient, test the hydrostatic pump efficiency (forward and reverse) with a flow meter. If the hydrostatic pump is delivering the required flow at full output pressure, the problem is probably with a wheel motor.

Hydrostatic Power Train Troubleshooting

Symptom: Mower Will Not Move in Forward or Reverse

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes - Go to step (3).

No - Replace hydraulic oil with correct grade of proper viscosity.

(3) Is dump valve closed?

Yes - Go to step (4).

No - Close dump valve.

(4) Do the pedals move freely down and back? Is the linkage connected properly?

Yes - Go to step (5).

No - Check linkage for bent or broken components. Repair or replace parts as necessary.

(5) Is the suction strainer clear of restrictions?

Yes - Go to step (6).

No - Clean suction strainer.

Symptom: Mower Will Not Move in Forward or Reverse

(6) Check charge pressure. (See "Test Charge Pressure - Static" on page 281.) Is charge pressure within specifications?

Yes - Go to step (7).

No - If pressure does not meet specification, follow results of procedure.

(7) Is the driveshaft secure?

No - Secure, repair or replace driveshaft.

Symptom: Mower Will Not Reach Full Speed

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes - Go to step (3).

No - Replace hydraulic oil with correct grade of proper viscosity.

(3) Is dump valve closed?

Yes - Go to step (4).

No - Close dump valve.

(4) Do the pedals move freely down and back? Is the linkage connected properly?

Yes - Go to step (5).

No - Check linkage for bent or broken components. Repair or replace parts as necessary.

(5) Is the suction strainer clear of restrictions?

Yes - Go to step (6).

No - Clean suction strainer.

(6) Is hydraulic fluid free from air bubbles?

Yes - Go to step (7).

No - Check suction line for air leaks. Repair as necessary.

(7) Check charge pressure. (See "Test Charge Pressure - Static" on page 281.) Is charge pressure within specifications?

Yes - Go to step (8).

No - If pressure does not meet specification, follow results of procedure.

Symptom: Mower Will Not Reach Full Speed

(8) Perform hydrostatic transmission flow test. (See “Test Hydrostatic Transmission Pump Flow” on page 283.) Is hydrostatic transmission flow within specifications?

Yes - Go to step (9).

No - Check and/or replace relief valves. Repair or replace pump as necessary.

(9) Remove drive motors and bench check. (See “Disassemble Front Wheel Motor” on page 312.) Repair or replace as necessary.

Symptom: Sluggish Response to Acceleration or Deceleration

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes - Go to step (3).

No - Replace hydraulic oil with correct grade of proper viscosity.

(3) Is dump valve closed?

Yes - Go to step (4).

No - Close dump valve.

(4) Is the suction strainer clear of restrictions?

Yes - Go to step (5).

No - Clean suction strainer.

(5) Is hydraulic fluid free from air bubbles?

Yes - Go to step (6).

No - Check suction line for air leaks. Repair as necessary.

(6) Check charge pressure. (See “Test Charge Pressure - Static” on page 281.) Is charge pressure within specifications?

Yes - Go to step (7).

No - If pressure does not meet specification, follow results of procedure.

Symptom: Sluggish Response to Acceleration or Deceleration

(7) Perform hydrostatic transmission flow test. (See “Test Hydrostatic Transmission Pump Flow” on page 283.) Is hydrostatic transmission flow within specifications?

No - Replace relief valve(s).

Symptom: Hydrostatic System Operating Hot

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level with hydraulic fluid.

(2) Are oil cooler fins free of dirt and debris?

Yes - Go to step (3).

No - Clean oil cooler fins of dirt and debris.

(3) Check charge pressure. (See “Test Charge Pressure - Static” on page 281.) Is charge pressure within specifications?

Yes - Go to step (4).

No - If pressure does not meet specification, follow results of procedure.

(4) Perform hydrostatic transmission forward and reverse relief valve tests. (See “Test Hydrostatic System Relief Pressure” on page 280.) Are the hydrostatic transmission forward and reverse relief valves opening at the correct pressure?

No - Replace relief valve(s).

Symptom: Noisy Pump

(1) Is hydraulic fluid at proper level in reservoir?

Yes - Go to step (2).

No - Fill reservoir to proper level.

(2) Is dump valve closed?

Yes - Go to step (3).

No - Close dump valve.

(3) Is hydraulic fluid free from air bubbles?

Yes - Go to step (4).

No - Check suction line for air leaks. Repair as necessary.

Symptom: Noisy Pump

(4) Is oil filter clean (free from restrictions)?

Yes - Go to step (5).

No - Replace filter. Find source of any excess contamination.

(5) Perform hydrostatic transmission forward and reverse relief valve tests. (See “Test Hydrostatic System Relief Pressure” on page 280.) Are the hydrostatic transmission forward and reverse relief valves opening at the correct pressure?

Yes - Go to step (6).

No - Replace relief valve(s).

(6) Disassemble and inspect pump for damage. (See “Disassemble Hydrostatic Pump - 3225C” on page 287.) (See “Disassemble Hydrostatic Pump - 3235C and 3245C” on page 298.) Was any damage found?

No - Repair or replace as necessary.

Tests and Adjustments

Test Hydrostatic System Relief Pressure

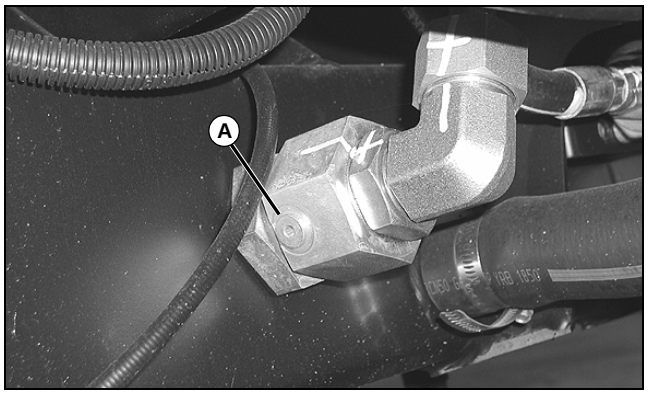
Reason

To ensure that the hydrostatic system forward and reverse relief valves are operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydrostatic system relief pressure.
Pressure Gage Kit	JDG2033	Read hydrostatic system pressure.
Diagnostic Flow Kit	JDG2032	Connect flow meter to hydrostatic system.
Pressure Diagnostic Kit	JDG2031	Connect pressure gage for hydrostatic system pressure test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure



MX20343

1. Install fitting into test port (A) located on axle bulkhead fitting. Use left bulkhead fitting for forward test and right bulkhead fitting for reverse test.
2. Connect pressure gage to diagnostic fitting.
3. Secure machine to an immovable object.

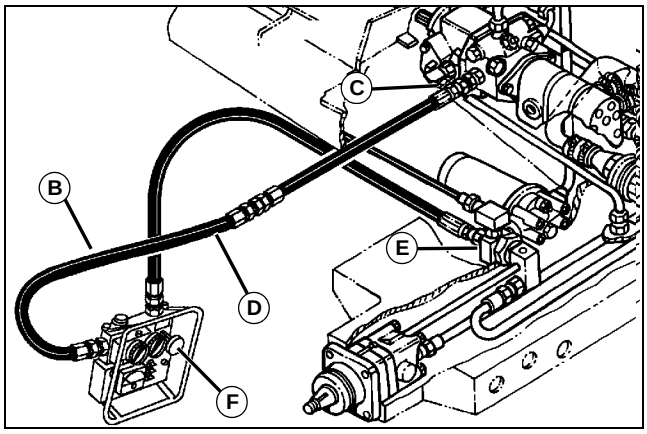
NOTE: Check engine rpm with electronic tachometer.

4. Start engine and set throttle to fast idle (3000 ± 50 rpm).
5. Disengage four-wheel drive (if equipped).
6. Charge pressure reading on gage must be:
   - 3225C - 552 kPa (80 psi) (Minimum)
   - 3235C and 3245C - 1310 kPa (190 psi) (Minimum)
7. Slowly depress forward or reverse pedal, depending on direction being tested, while observing the pressure gage reading.
8. Depress pedal until maximum pressure is reached. Relief pressure reading should be:
   - 3225C - 31 026 ± 1379 kPa (4500 ± 200 psi)
   - 3235C and 3245C - 24 132 ± 1379 kPa (3500 ± 200 psi)
9. Repeat test in opposite direction.

If relief pressures are reached, test is complete. If relief pressures are not reached, there are possibilities of leakage in the wheel motors, hoses, relief valves, or pump. Proceed to next step to determine origin of leakage.

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands.

10. Raise machine so wheels are off the ground. Support machine with suitable jackstands.



MX20408

11.Remove axle bulkhead-to-pump line. Use left axle bulkhead line for forward test and right axle bulkhead line for reverse test.

12.Connect flow gage inlet hose (B) to the pump (C), and outlet hose (D) to the axle bulkhead fitting (E).

13.Turn flow control knob (F) completely open (counterclockwise).

NOTE: Check engine rpm with electronic tachometer.

14.Start engine and set throttle to fast idle (3000 ± 50 rpm).

15.For reverse test, depress the reverse pedal and read right axle bulkhead fitting pressure gage. For forward test, depress the forward pedal and read left axle bulkhead fitting pressure gage.

16.Slowly close flow control knob (clockwise) until maximum pressure is reached.

17.Pressure reading should be:

- 3225C - 31 026 ± 1379 kPa (4500 ± 200 psi)
- 3235C and 3245C - 24 132 ± 1379 kPa (3500 ± 200 psi)

Results

If machine is four-wheel drive, inspect four-wheel drive cartridge for worn O-rings.

If relief pressure is reached, remove and inspect wheel motors and associated hoses.

If relief pressure is not reached, remove and inspect relief valves and replace as necessary. If problem persists, repair or replace pump.

Specifications

Engine Speed at Fast Idle . . . . . 3000 ± 50 rpm
Hydrostatic Charge Pressure 3225C (Minimum) . . . . . 552 kPa (80 psi)
Hydrostatic Charge Pressure 3235C and 3245C (Minimum) . . . . . 1310 kPa (190 psi)
Hydrostatic System Relief Pressure 3225C. . . . . 31 026 ± 1379 kPa (4500 ± 200 psi)
Hydrostatic System Relief Pressure 3235C and 3245C . . 24 132 ± 1379 kPa (3500 ± 200 psi)

Test Charge Pressure - Static

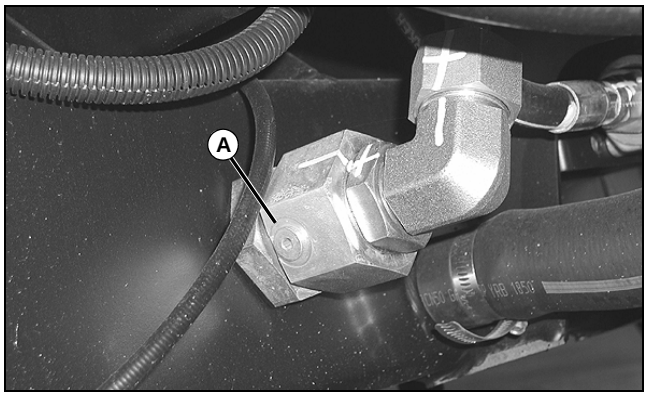
Reason

To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit-4	JDG2033	Used to measure hydrostatic pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure



MX20343

1. Install diagnostic fitting into test port (A) located on right or left axle bulkhead fitting.

2. Connect pressure gage to diagnostic fitting.

NOTE: Check engine rpm with electronic tachometer.

3. Start engine and set throttle to fast idle (3000 ± 50 rpm).

NOTE: DO NOT move steering wheel or actuate lift arms while performing this test. Inaccurate readings will result.

4. Note reading on gage. Charge pressure reading should be:

- 3225C - 552 kPa (80 psi) (Minimum)
- 3235C and 3245C - 1310 kPa (190 psi) (Minimum)

Results

If charge pressure is within specification, perform dynamic charge pressure test to determine if there is system leakage under load. (See “Test Charge Pressure - Dynamic” on page 282.)

If charge pressure is below specification, perform a lift/steering pump flow test and check hydraulic filter for restrictions. (See “Test Lift and Steering Pump Flow” on page 357.)

If flow test and filter are good, remove and inspect hydrostatic pump. Repair or replace as necessary.

Specifications

Hydrostatic Pump Charge Pressure
3225C (Minimum) . . . . . 552 kPa (80 psi)
Hydrostatic Pump Charge Pressure
3235C and 3245C (Minimum). . . . . 1310 kPa (190 psi)

Test Charge Pressure - Dynamic

Reason

To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged under load.

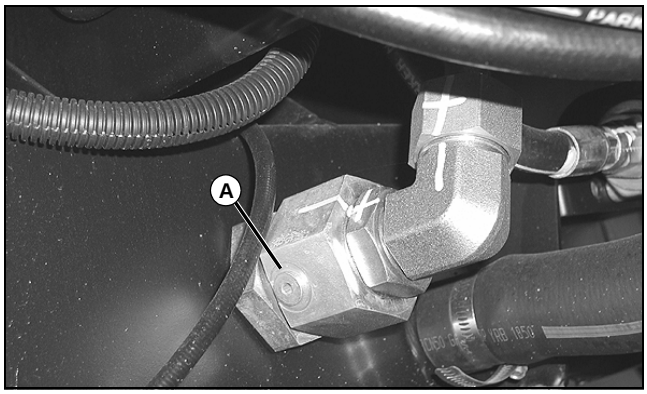
Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit-4	JDG2033	Used to measure hydrostatic pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine RPM.

Procedure

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands.

1. Raise machine so wheels are off the ground and support with suitable jackstands.



MX20343

2. Install diagnostic fitting into test port (A) located on right or left axle bulkhead fitting.
3. Connect pressure gage to diagnostic fitting.
4. Disconnect brake switch located under operator platform.

NOTE: Check engine rpm with electronic tachometer.

5. Start engine and set throttle to fast idle (3000 ± 50 rpm).
6. Depress brake pedal to apply a load to the hydrostatic drive system.
7. Note reading on gage and compare to specifications.

Results

If charge pressure meets specification in the static test but is below specification in the dynamic test, this indicates that system leakage develops under a loaded condition.

Perform latter part of hydrostatic system relief pressure test to determine origin of leakage. (See “Test Hydrostatic System Relief Pressure” on page 280.)

Specifications

Hydrostatic Pump Charge Pressure
3225C (Minimum) . . . . . 552 kPa (80 psi)
Hydrostatic Pump Charge Pressure
3235C and 3245C (Minimum) . . . . . 1310 kPa (190 psi)

Test Hydrostatic Transmission Pump Flow

Reason

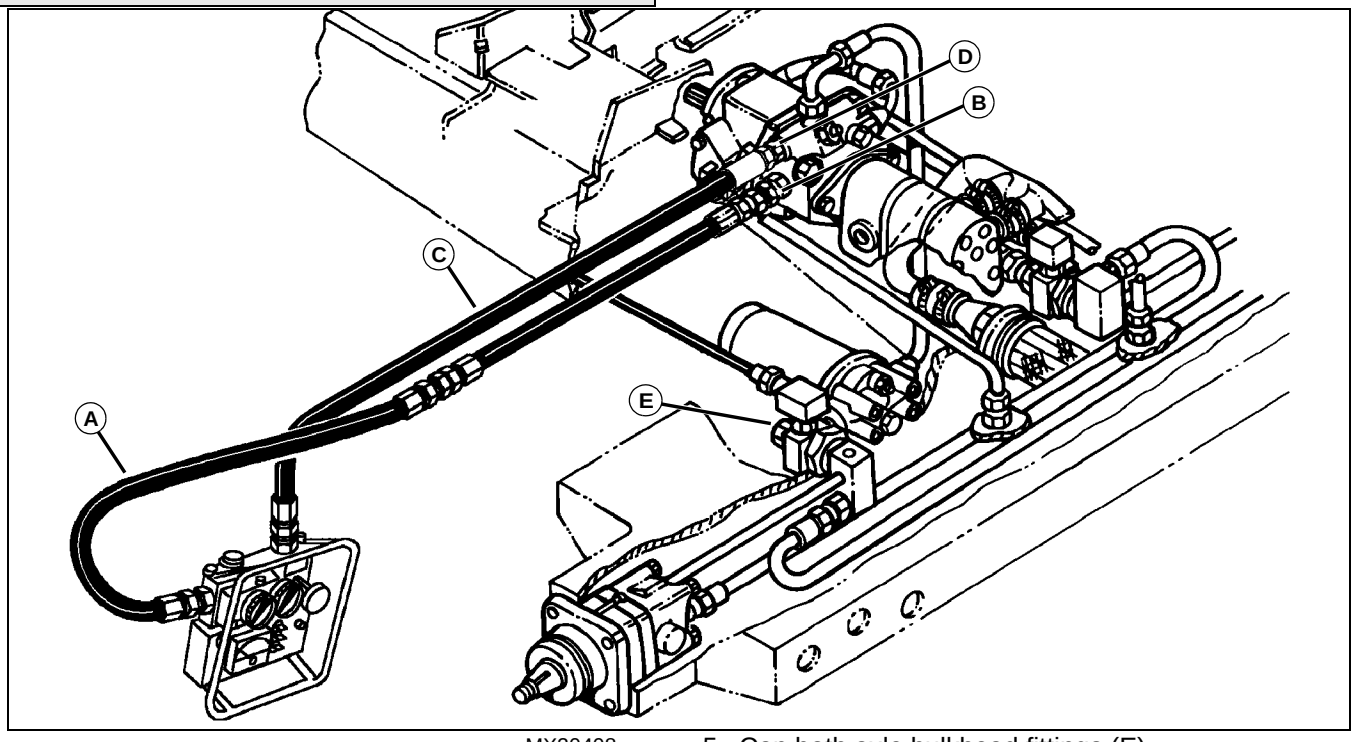
To verify that hydrostatic pump is operating at optimum efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydrostatic circuit flow.
Diagnostic Flow Kit	JDG2032	Connect flow gage for hydrostatic pump flow test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands.



MX20408

1. Raise machine so wheels are off the ground. Support machine with suitable jackstands.
2. Remove axle bulkhead-to-pump lines.
3. Connect flow meter inlet hose (A) to pump fitting (B).
4. Connect flow meter outlet hose (C) to pump fitting (D).
5. Cap both axle bulkhead fittings (E).
6. Depress forward pedal completely and secure into position. Pump must be fully stroked. Adjust traction rod if necessary.
7. Connect inductive electronic tachometer.
8. Start engine and set throttle to fast idle (3000 ± 50 rpm).

9. Record free-flow gpm and engine rpm. Flow meter knob must be adjusted to have no restriction (knob turned fully counterclockwise).

IMPORTANT: Avoid damage! Make sure that pressure control valve on tester is screwed out completely (counterclockwise). Be careful not to screw handle completely out of valve.

10.Adjust flow control knob clockwise until pressure reading is 13 790 kPa (2000 psi). Record gpm and engine rpm.

11.Calculate pump efficiency:

- Pump Free Flow x 231 ÷ Engine RPM = Displacement A
- Pump Flow at 13 790 kPa (2000 psi) x 231 ÷ Engine RPM = Displacement B
- Displacement B ÷ Displacement A x 100 = Pump Efficiency
- Example:
- Pump Free Flow = 114 L/min (30 GPM) @ 2985 Engine RPM
- Pump Flow at 13 790 kPa (2000 psi) = 91 L/min (24 GPM) @ 2432 Engine RPM
- 114 x 231 ÷ 2985 = 8.82 (Displacement A)
- 91 x 231 ÷ 2432 = 8.64 (Displacement B)
- 8.64 ÷ 8.82 x 100 = 97.95 or 98% Efficiency

Results

If pump efficiency is below the minimum specification, verify charge pressure is within specification. (See “Test Charge Pressure - Static” on page 281.)

If charge pressure is to specification, repair or replace hydrostatic pump.

Specifications

Pump Efficiency (Minimum) 80%

Adjust Transmission Neutral Position - 3225C

Reason

To ensure that the machine does not creep when pedals are released.

Procedure

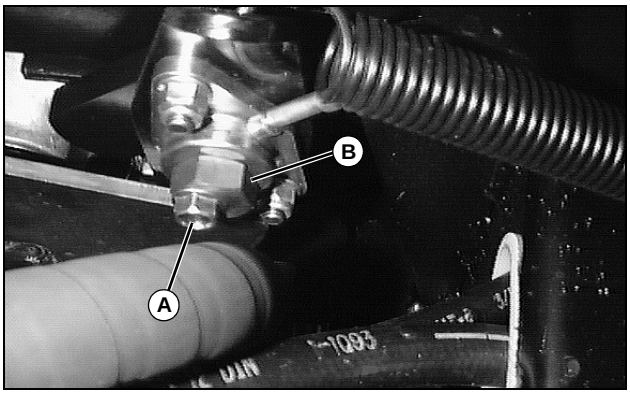
IMPORTANT: Avoid damage! This adjustment should be done only if the machine creeps when pedals are in neutral position. If creep is intermittent, inspect transmission control linkage for wear or damage or return-to-neutral linkage for binding before adjusting transmission neutral.

NOTE: The eccentric mechanism is located under the operator seat and is accessible from the right side of the hydrostatic transmission.

1. Perform a thorough visual inspection of linkages and return springs for damage before making any adjustment. Repair as necessary.
2. Stop engine and lower cutting units to floor.
3. Shut off 4WD if installed on machine.

CAUTION: Avoid injury! Use only a safe lifting devise for raising machine.

4. Raise machine until front wheels are off the ground. Support front axle with jackstands.



M56258

5. Loosen shoulder bolt (A).
6. Place a 9 kg (20 lb) weight on the seat to activate the seat safety switch.

CAUTION: Avoid injury! Use extreme caution when adjusting for neutral creep. Drive wheels are free to spin when machine is raised off the floor and the engine is started.

7. Start engine and run at slow idle.

8. Turn eccentric nut (B) forward and backward until drive wheels stop turning.

9. Hold adjustment and tighten shoulder bolt (A). Make sure adjustment did not change.

10.Put pedals in neutral. Depress both forward and reverse speed pedals, then release.

11.Check neutral adjustment. Repeat adjustment until drive wheels stop turning.

12.Lower machine to the ground and test drive the machine to make sure the machine is not moving while in neutral.

Results

Drive wheels should stop turning when pedals are released. If not, repeat adjustment.

Adjust Transmission Neutral Position - 3235C and 3245C

Reason

To ensure that the machine does not creep when pedals are released.

Procedure

IMPORTANT: Avoid damage! This adjustment should be done only if the machine creeps when pedals are in neutral position. If creep is intermittent, inspect transmission control linkage for wear or damage or return-to-neutral linkage for binding before adjusting transmission neutral.

1. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage. Repair as necessary.

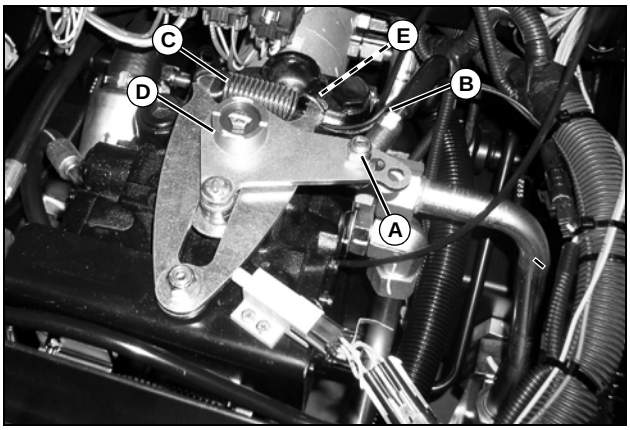
2. Stop engine and lower cutting units to floor.

3. Place 4WD switch in OFF position.

4. Raise seat platform.

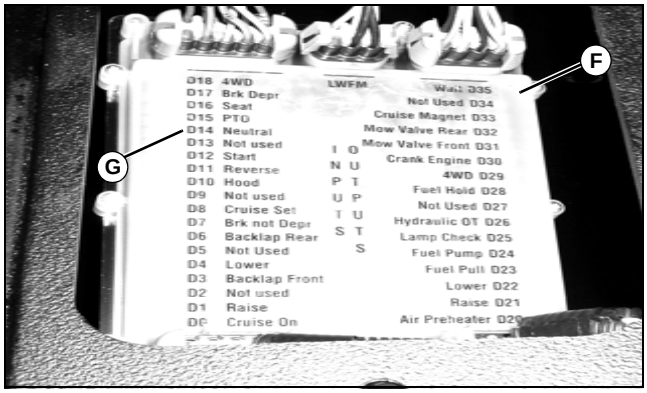
NOTE: Observe location of spacers on traction rod (B).

5. Remove nut (A) and traction rod (B).



MX22790

6. Remove spring (C). Pump control arm (D) will move to neutral position.



MX22791

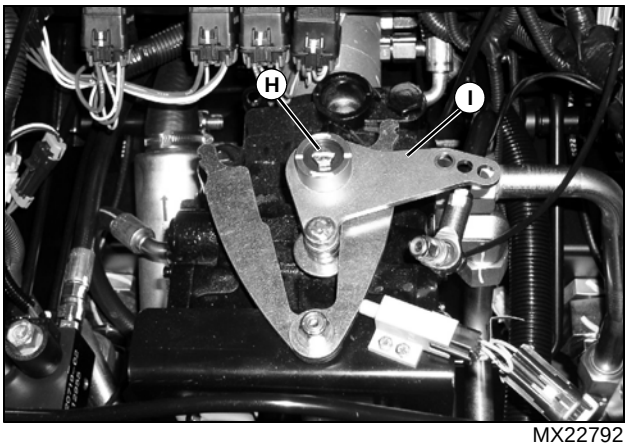
7. Access electronic control module (F). When pump control arm is in neutral position and key switch is turned on, input D14 (G) should be illuminated.

NOTE: Removal of pump control arm will enable tapered pump shaft to return to the neutral position.

8. If input D14 is not illuminated when pump control arm is in released position, check adjustment of neutral switch (E).

NOTE: Adjustment of neutral switch is unlikely unless switch was removed or replaced.

9. Loosen setscrew on neutral switch (E) and turn in small increments until D14 input stays illuminated.



MX22792

10.If D14 input will not stay illuminated after the previous steps, remove cap screw (H). Using a three-jaw puller, remove pump control arm (I).

11.Loosely place pump control arm (I) on pump tapered shaft.

12.Install spring. Use cap screw (H) to install pump control arm in pump neutral position.

13.Turn key on; D14 input should be illuminated.

14.Install traction control rod and two spacers UNDER the pump control arm, and secure with nut.

15.Lower the seat platform and test drive machine.

Results

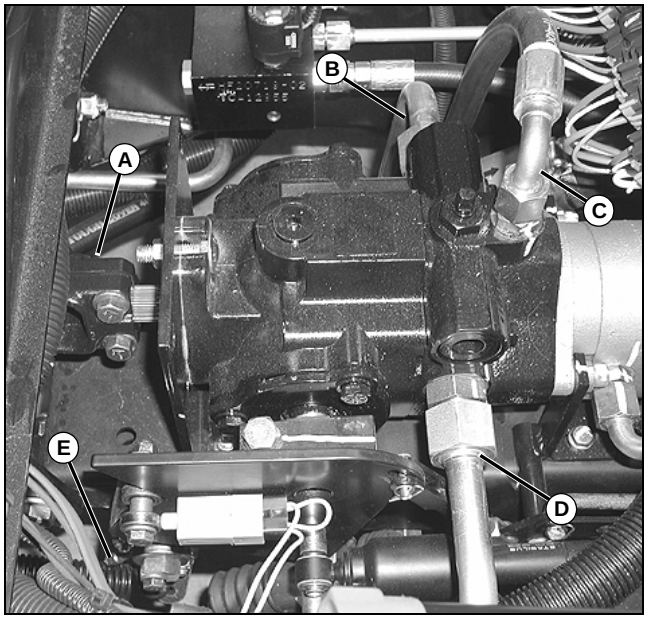
Machine should remain stationary while in neutral. If not, repeat adjustment.

Repair

Remove Hydrostatic Pump - 3225C

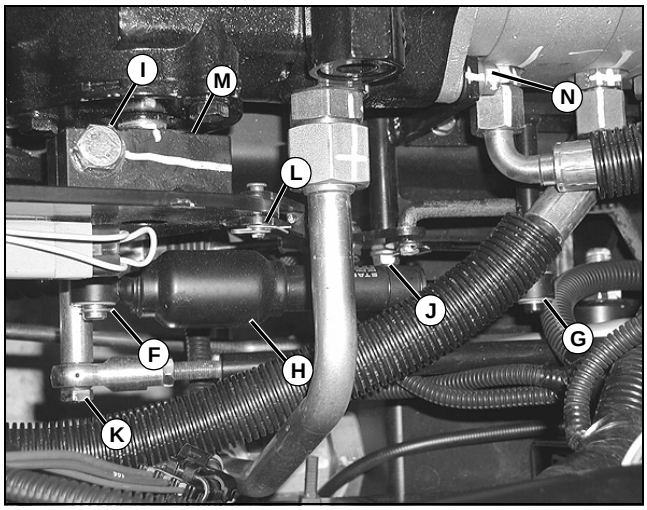
CAUTION: Avoid injury! Lower cutting units to the ground and relieve all pressure prior to removing any hydraulic lines or fittings.

1. Park vehicle on a level surface, reels lowered, park brake locked, engine off. Block wheels to prevent movement of machine.
2. Disconnect battery.
3. Remove operator seat and deck.



MX20339

4. Remove driveshaft shield and driveshaft (A).
5. Mark hydraulic lines (B-D) and disconnect from hydraulic pump.
6. Remove neutral cam return spring (E) from cam follower.

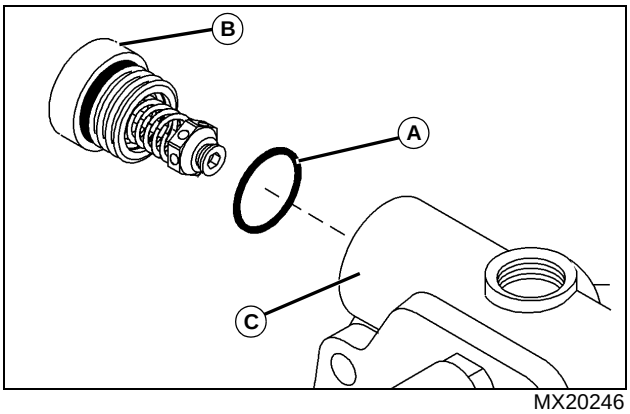


MX20340

7. Remove snap rings (F and G) and shock absorber (H).
8. Remove cap screws (I-K), spring pin (L), clevis pin, and clevis.
9. Remove cam plate (M) from shaft.
10. Remove triple pump mounting screws (N) and washers.
11. Remove hydrostatic pump mounting plate-to-frame cap screws and nuts.
12. Separate triple pump from hydrostatic pump.
13. Remove hydrostatic pump from machine.
14. Rebuild or replace pump as necessary.

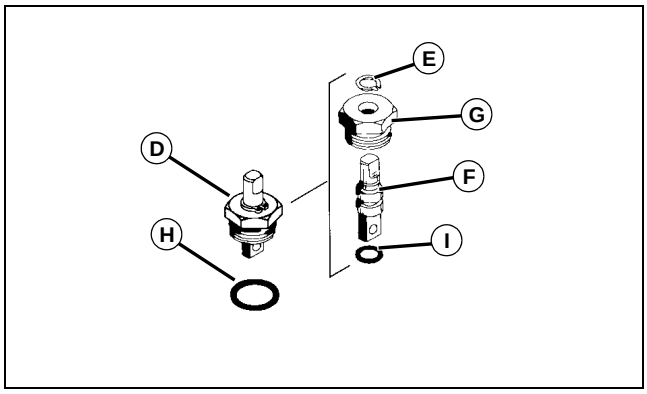
Disassemble Hydrostatic Pump - 3225C

IMPORTANT: Avoid damage! Plug all ports and thoroughly clean the outside of the pump. Remove plugs and drain oil.



MX20246

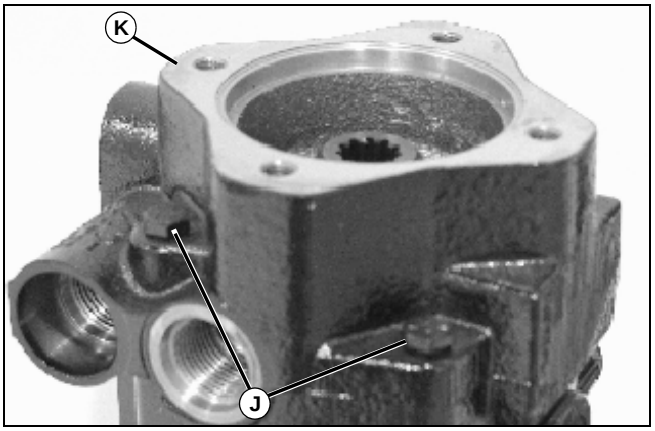
1. Remove O-ring (A) and relief valve (B) from backplate (C). Repeat step for other relief valve.



M56542

2. Remove dump valve assembly (D) from backplate.

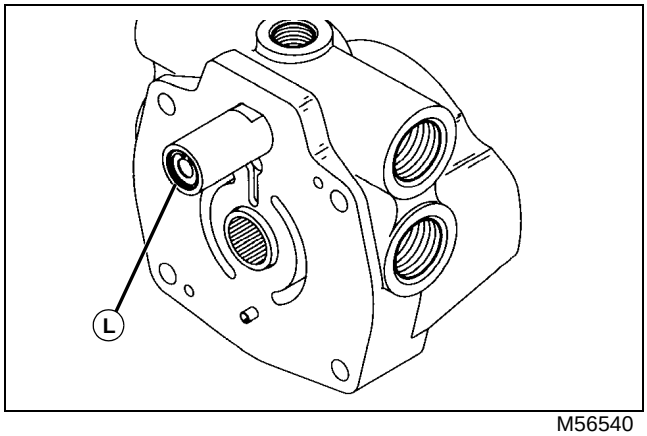
3. Disassemble dump valve by removing retaining ring (E) and pulling the spreader (F) from the spreader plug (G). Remove O-rings (H and I).



MX20247

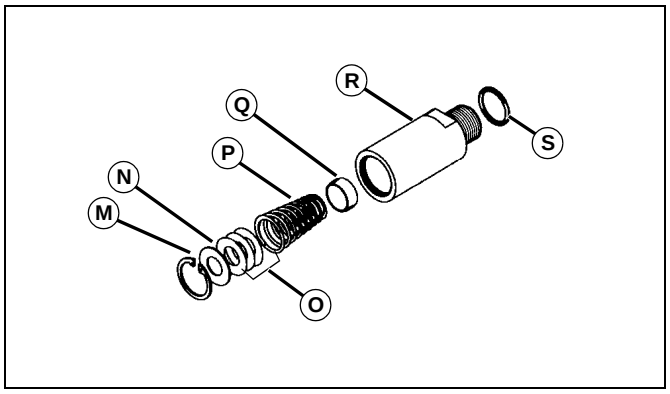
4. Remove four cap screws (J) from the backplate (K).

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.



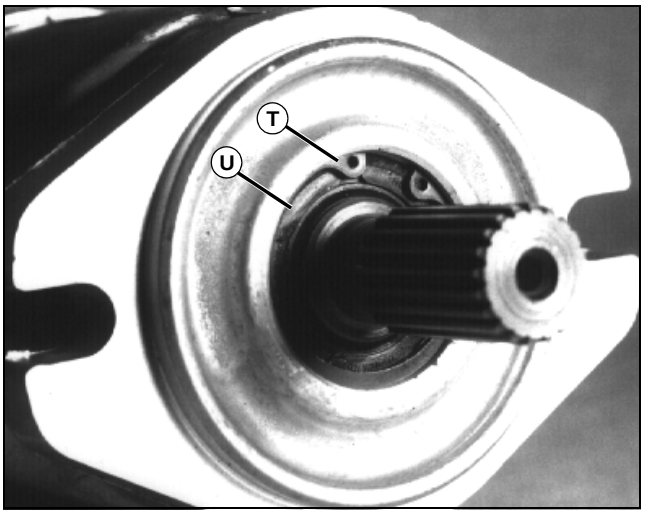
M56535

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.

IMPORTANT: Avoid damage! Try to keep the pistons and piston block together as an assembly when removing the rotating assembly.

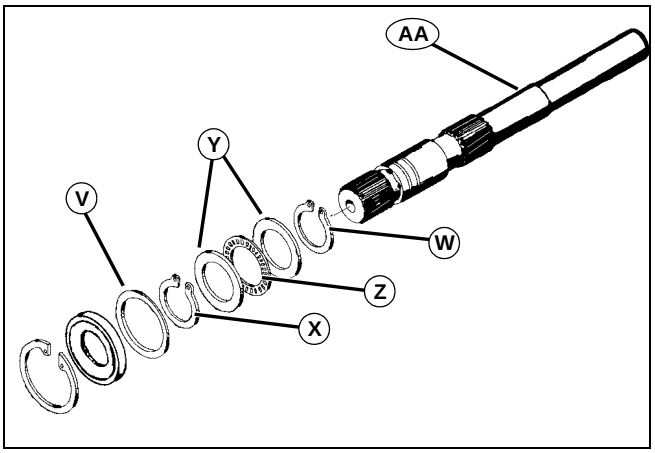
MX20248

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.



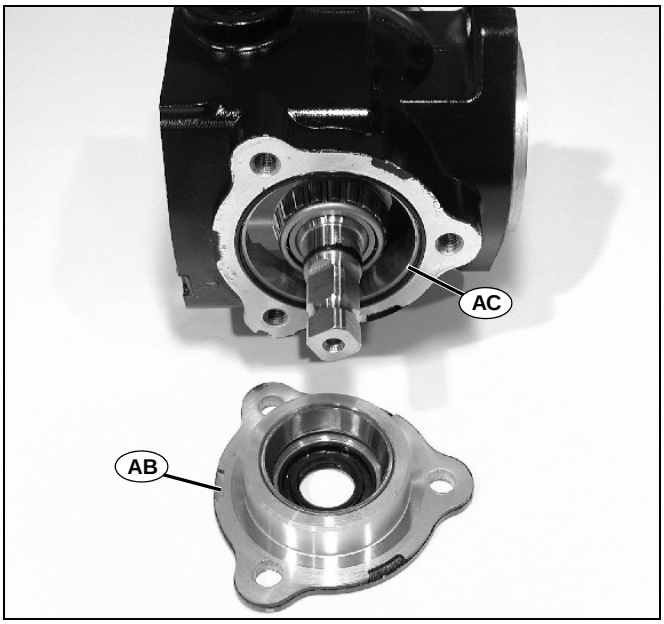
M56564

9. Remove snap ring (T) and tap the shaft and oil seal (U) from the housing with a soft-faced mallet.



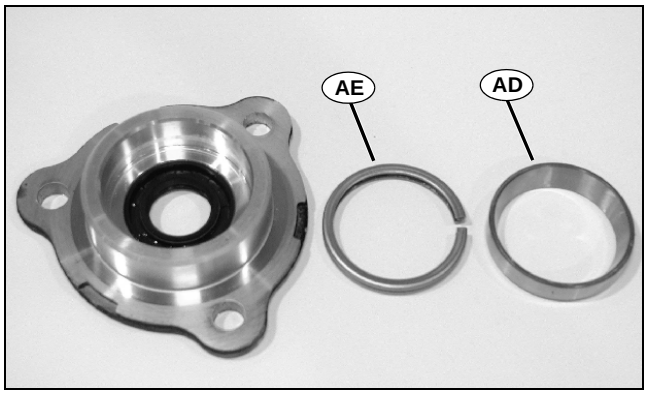
M57918

10.Remove washer (V), snap rings (W and X), thrust washers (Y), and thrust bearing (Z) from main pump shaft (AA).



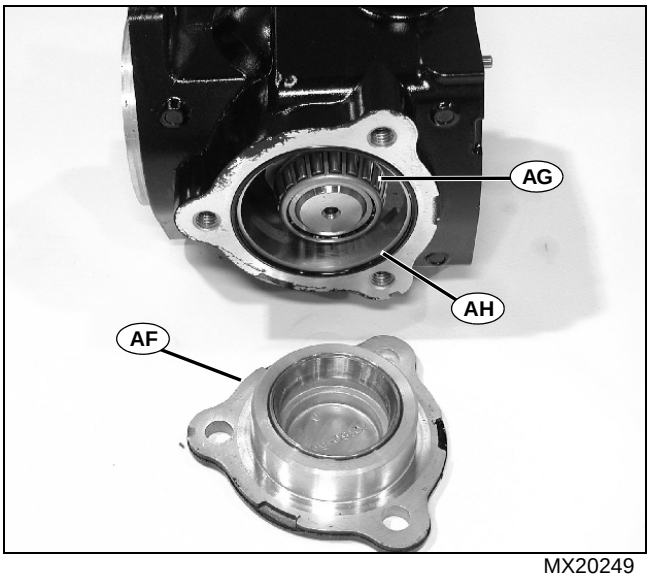
M56562

11.Remove bearing cover (AB) and O-ring (AC).



MX20259

12.Remove bearing race (AD) and crush ring (AE).

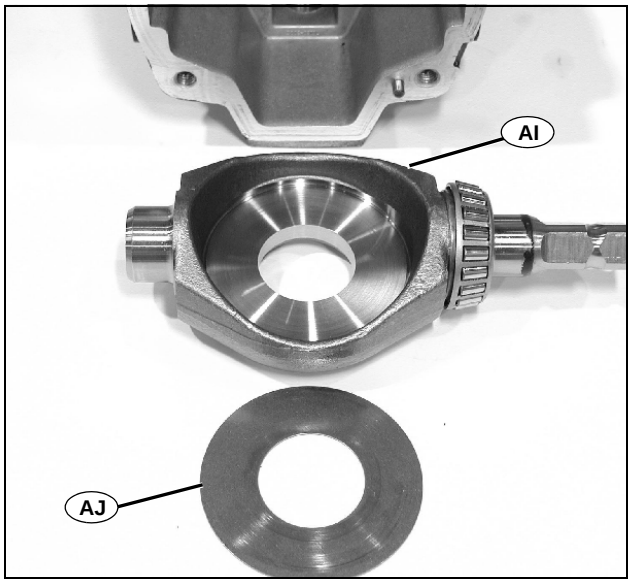


MX20249

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.



MX20251

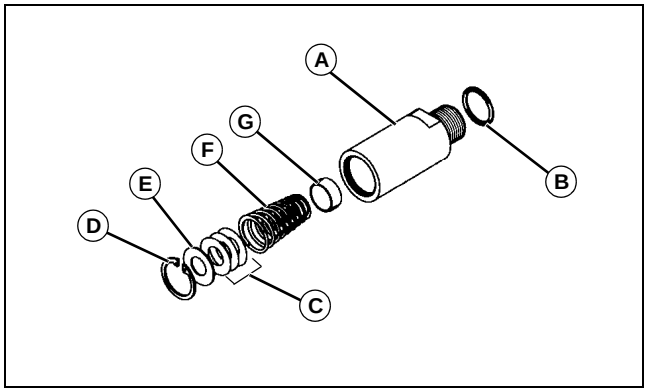
15.Remove cam plate (AI) from housing.

16.Remove thrust plate (AJ).

Inspect Hydrostatic Pump - 3225C

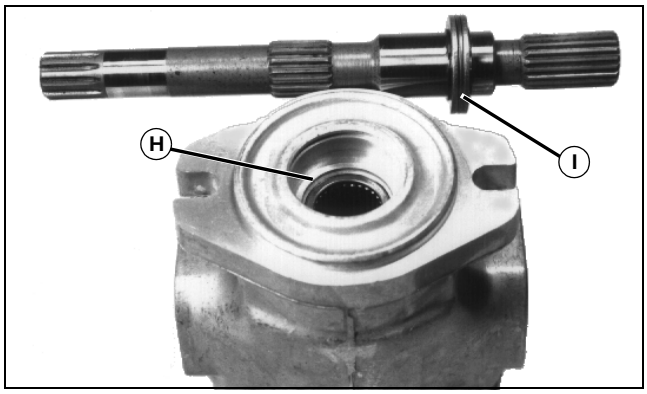
IMPORTANT: Avoid damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection.

1. Inspect the main pressure relief valves for condition and wear. Replace if necessary.



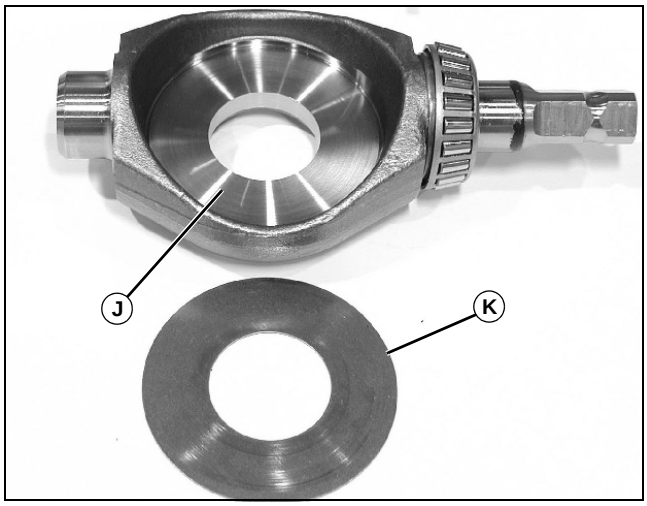
M56535

2. Inspect the charge pump relief valve components (A-G) for wear. Replace the entire relief valve if worn.



M56557

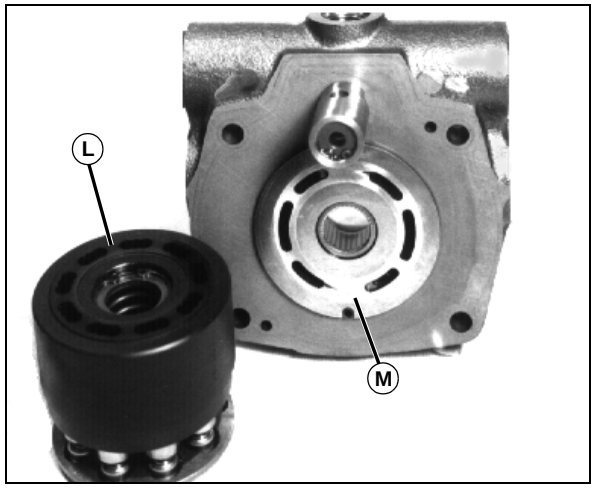
3. Inspect the needle bearings (H) in the housing and backplate assemblies, making sure bearings remain in bearing cage. Inspect the complete shaft, thrust bearing (I), and thrust washers for wear.



MX20264

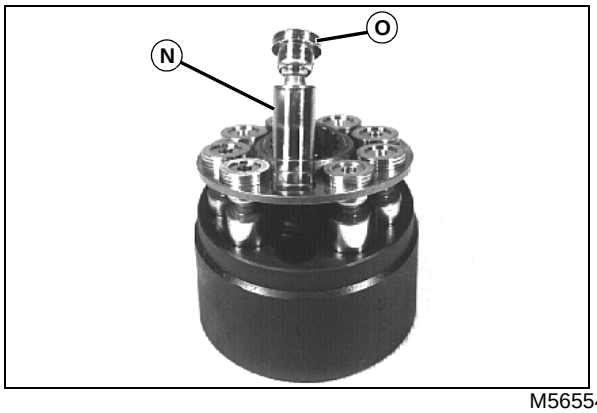
4. Inspect the polished surface (J) of the cam plate for scoring, galling or fretting. Replace if necessary.

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.

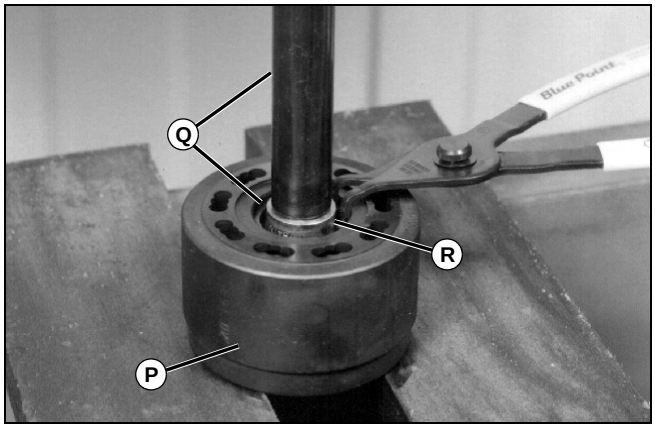


M56554

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.



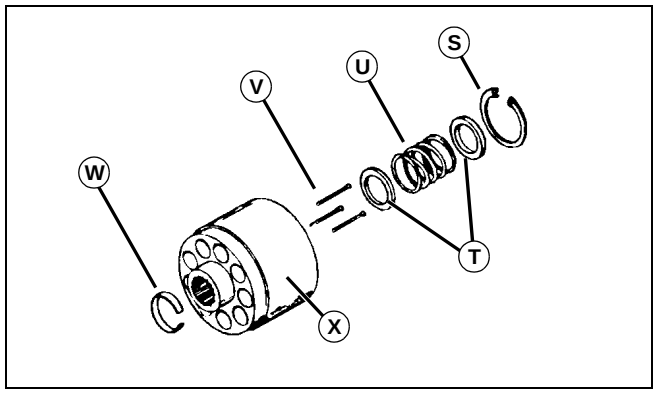
M76495

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.

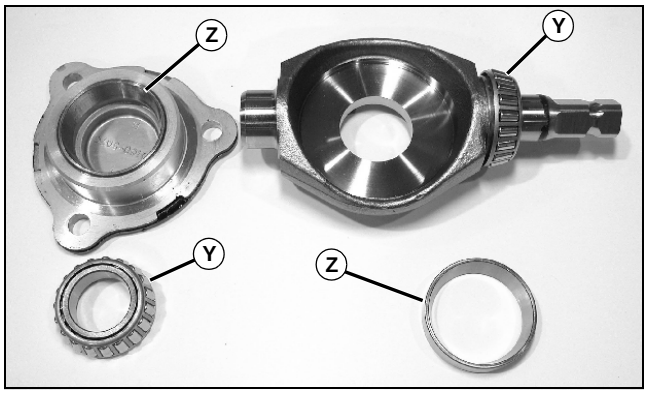
9. Use a seal driver (Q) to compress spring (R) inside piston block.

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).



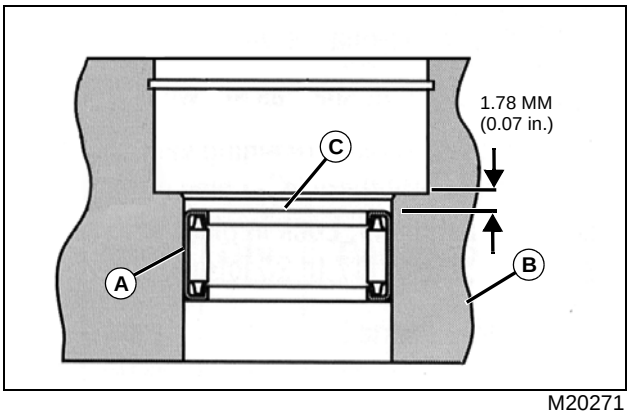
MX20270

12.Inspect the cam plate bearings (Y) and races (Z) for wear or galling. Replace if necessary.

Assemble Hydrostatic Pump - 3225C

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.

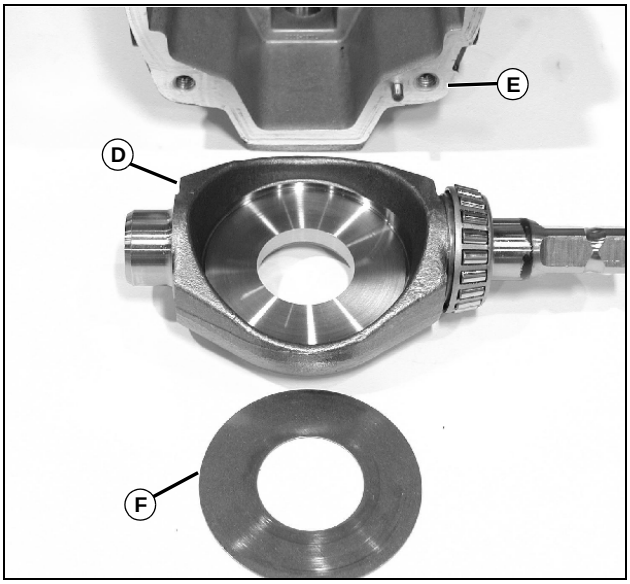
Always replace O-rings and seals. Old O-rings and seals will leak. Lubricate new seals and O-rings with petroleum jelly when assembling.



M20271

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.

NOTE: Install cam plate with long control shaft end through side of housing as previously noted in disassembly.

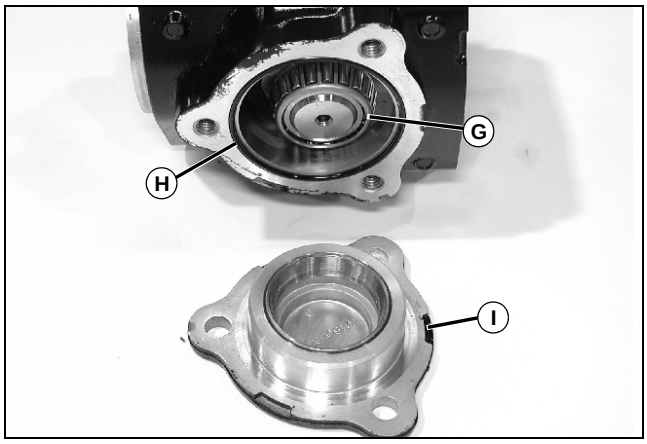


MX20251

2. Install cam plate (D) in housing (E), long end first.

NOTE: Thrust plate may be installed with either face against cam plate.

3. Install thrust plate (F) in cam plate.

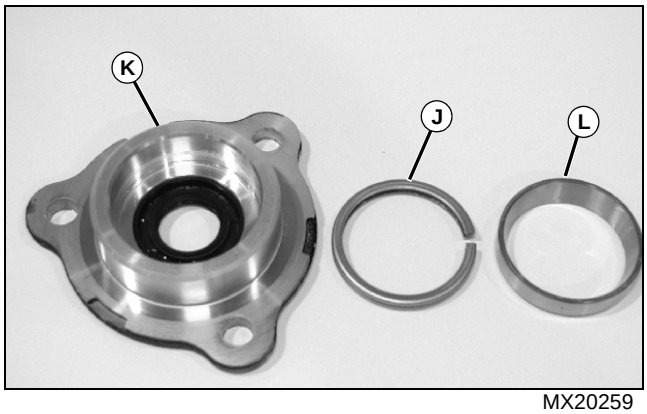


MX20249

4. Install bearing (G), O-ring (H), and bearing cover (I). Use plenty of hydraulic fluid to lubricate bearings.

5. Tighten bearing cover screws to specification.

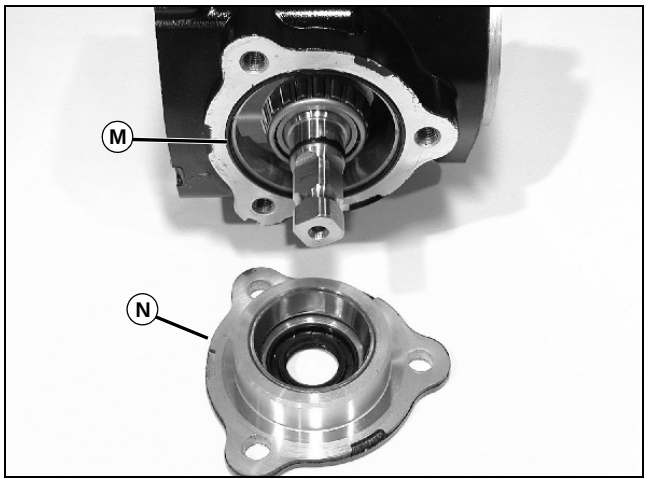
NOTE: If bearing covers, cam plate or pump housing have been replaced, do not use crush ring. A new shim kit must be installed in its place. See parts catalog for shim kit.



MX20259

6. Install crush ring (J) in bearing cover (K).

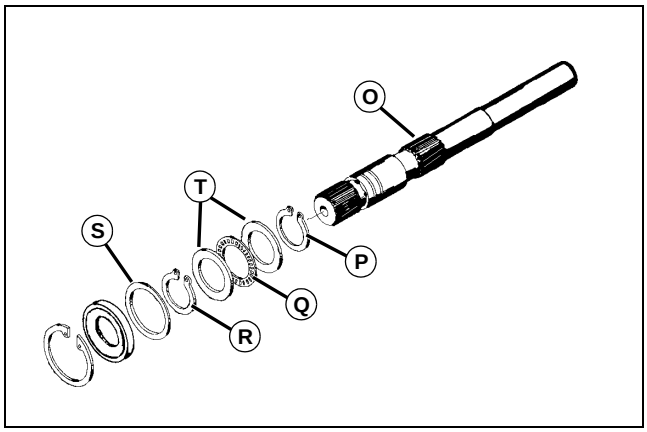
7. Install bearing race (L) with bevel toward cam plate.



MX20250

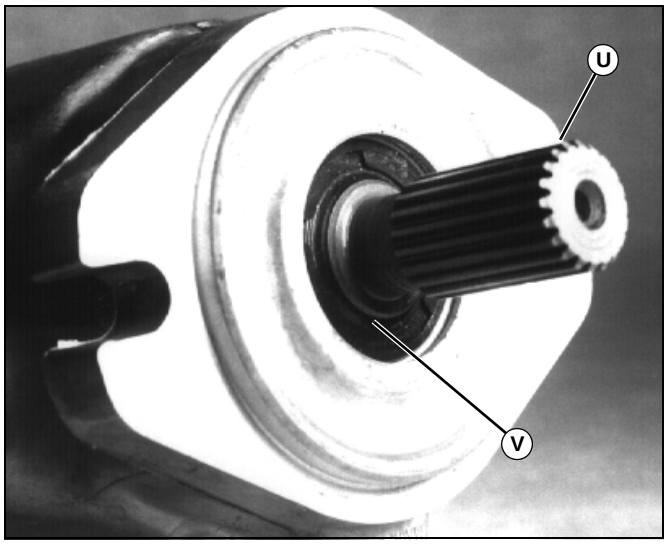
8. Assemble O-ring (M) and bearing cover (N). Use plenty of hydraulic fluid to lubricate bearings. Ensure cam plate has full travel and moves freely.

9. Tighten bearing cover screws to specification.



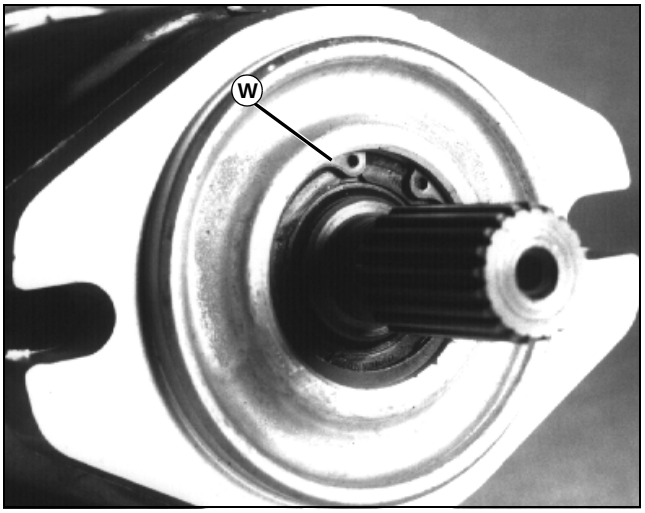
M57918

10.If main shaft (O) was disassembled, assemble parts (P-T) to main shaft.



M56560

11.Install shaft (U) and shaft seal (V). 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.

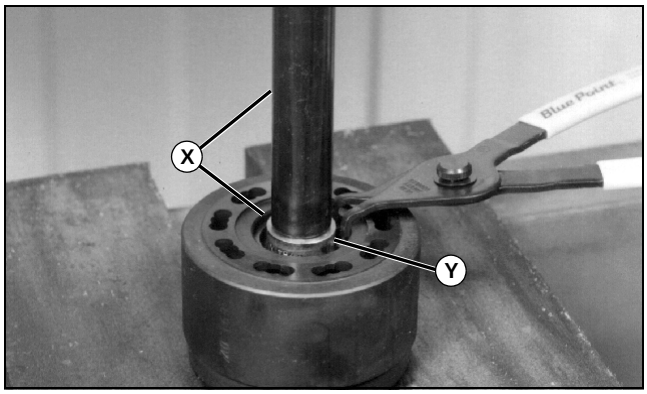


M56564

12.Install retaining ring (W) with sharp edge of ring facing the outside of the case. The sharp edge can be felt with your finger.

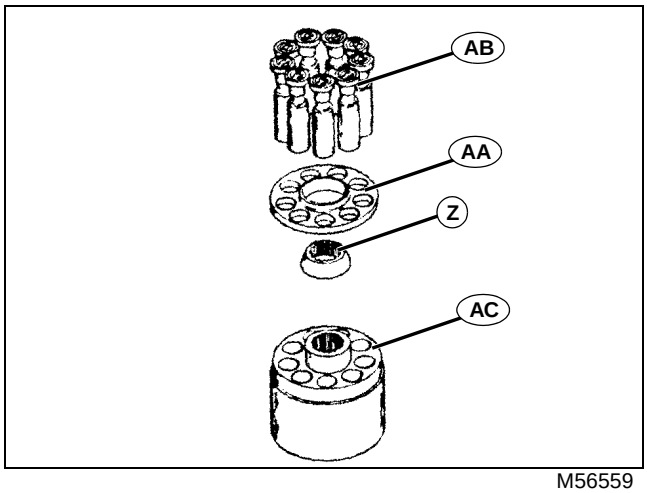
13.If the piston block assembly was disassembled, complete the following.

- 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.



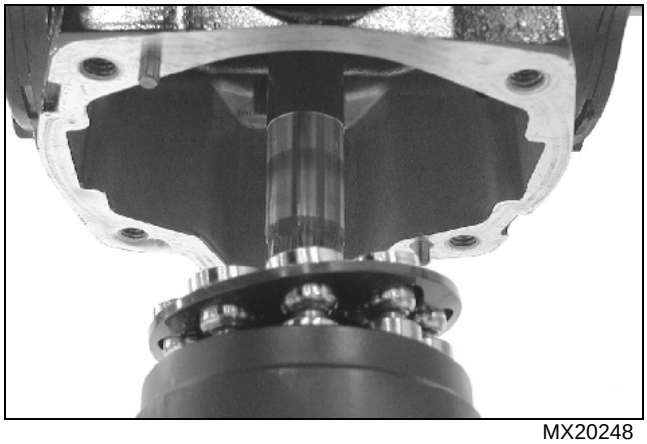
M76495

- Compress the spring with the arbor press and seal driver (X) used to compress the spring during disassembly.
- Install the retaining ring (Y). Ensure the sharp edge of the retaining ring faces away from the spring.

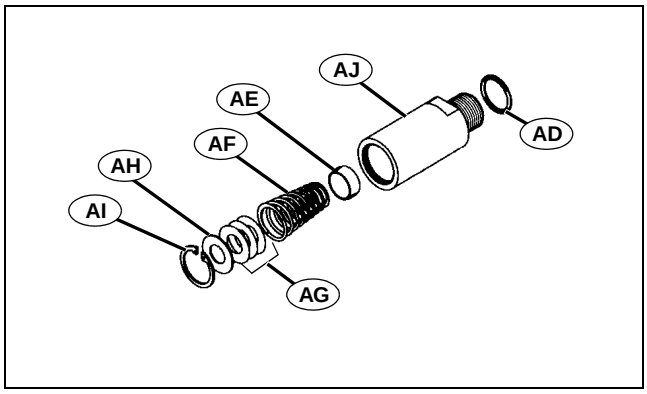


M56559

14.Assemble spider pivot (Z), spider plate (AA), and pistons (AB) to piston block (AC).

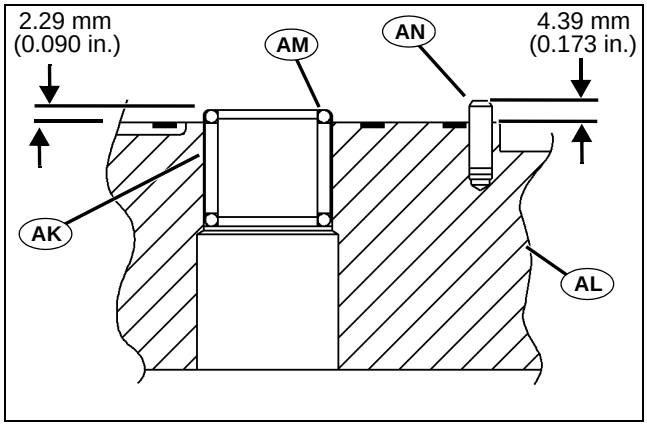

MX20248

15.Hold the housing upside down and install the rotating assembly. Make sure the rotating assembly shoes are seated against the cam plate.



M56535

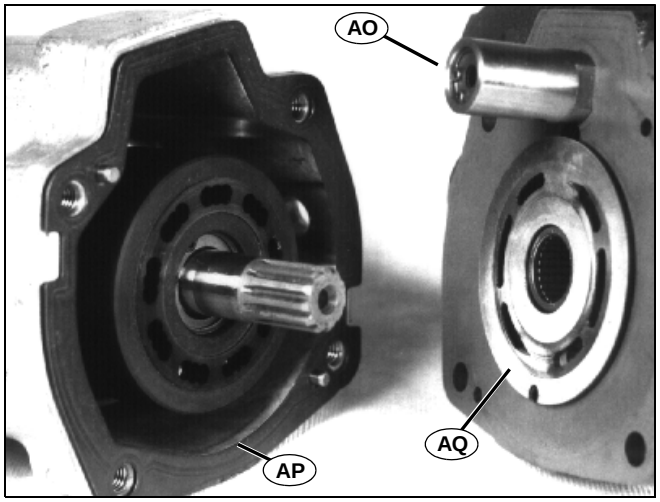
16.Assemble O-ring (AD), plunger (AE), spring (AF), shim(s) (AG) (use the same number and thickness of shims as removed), washer (AH), and retaining ring (AI) into relief valve body (AJ).



MX20272

17.If replacing main shaft bearing (AK) in backplate (AL), install bearing with numbered side (AM) facing valve plate side of housing. Press bearing to specified depth.

18.If locating pin (AN) was removed, install new pin to specified depth.

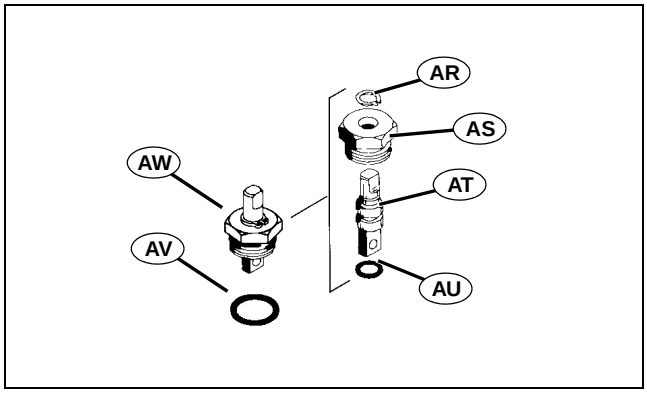


M56567

19.Install charge relief valve (AO), gasket (AP) and valve plate (AQ). Be sure valve plate bronze side faces piston block. Tighten relief valve to specification.

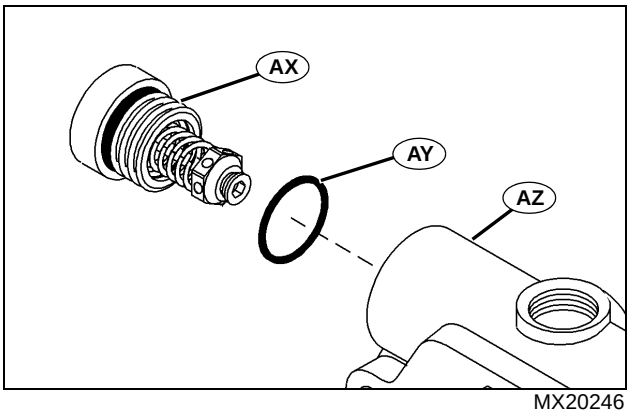
20.Assemble the backplate and housing. Secure with four cap screws and tighten to specifications.

IMPORTANT: Avoid damage! DO NOT use the bolts to force the parts to mate when assembling backplate to housing.



M56551

21.Assemble and install dump valve parts (AR-AW) and tighten to specifications.



MX20246

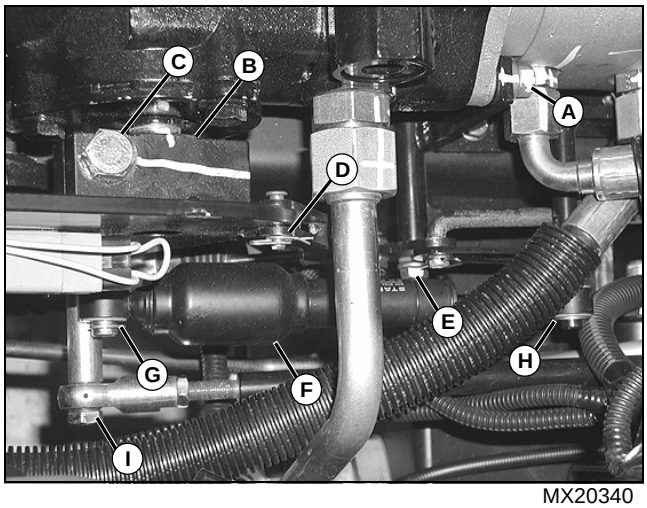
22.Install each relief valve (AX) and O-ring (AY) into backplate (AZ). Tighten plug to specifications.

Specifications

Pump Housing Bearing Depth . . . . . 1.78 mm (0.07 in.)
Bearing Covers 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)
Dump Valve Torque . . . . . 37-40 N•m (27-30 lb-ft)
Relief Valves Torque . . . . . 129-142 N•m (95-105 lb-ft)
Backplate Bearing Depth. . . . . 2.29 mm (0.09 in.)
Locating Pin Depth . . . . . 4.39 mm (0.17 in.)

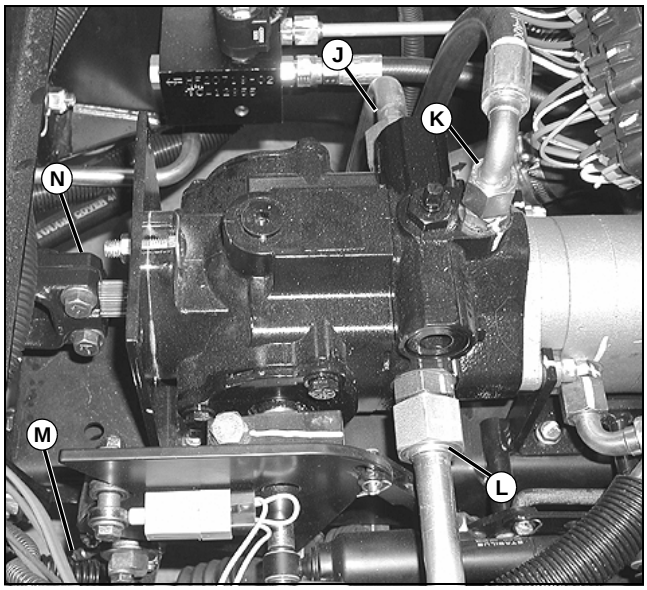
Install Hydrostatic Pump - 3225C

1. Install hydrostatic pump mounting bracket to pump.
2. Place the hydrostatic pump into position in machine.
3. Install a new O-ring between hydrostatic and triple pump.



MX20340

4. Install washers and cap screws (A) through mounting bracket and triple pump, and into hydrostatic pump.
5. Install hydrostatic pump mounting plate cap screws and nuts.
6. Install cam plate (B) on pump shaft and install cap screw (C) and nut.
7. Install clevis on cam plate, pin, spring pin (D), and cap screw (E).
8. Install shock absorber (F) and snap rings (G and H).
9. Install forward and reverse linkage, spacer, and cap screw (I) on cam plate.



MX20339

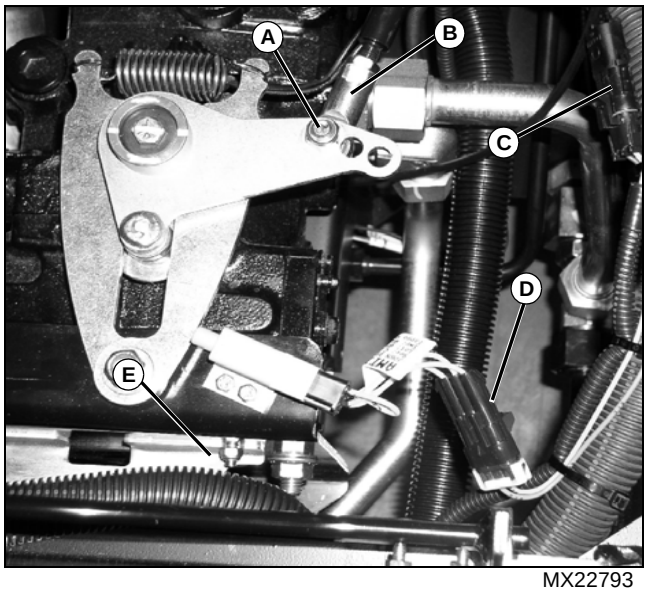
10. Install hydraulic lines (J-L) as marked during removal.
11. Install neutral cam return spring (M), tightening lock nut on eyebolt completely to the shoulder.
12. Install drive shaft (N) and drive shaft shield.
13. Fill hydraulic reservoir.
14. Install operator seat and deck.
15. Connect battery.
16. Perform start-up procedure. (See “Start-Up Procedure” on page 323.)
17. Adjust neutral position. (See “Adjust Transmission Neutral Position - 3225C” on page 284.)
18. If pump was removed for either replacement or rebuild, check forward and reverse relief pressures. (See “Test Hydrostatic System Relief Pressure” on page 280.)

Remove Hydrostatic Pump - 3235C and 3245C

CAUTION: Avoid injury! Lower cutting units to the ground and relieve all pressure prior to removing any hydraulic lines or fittings.

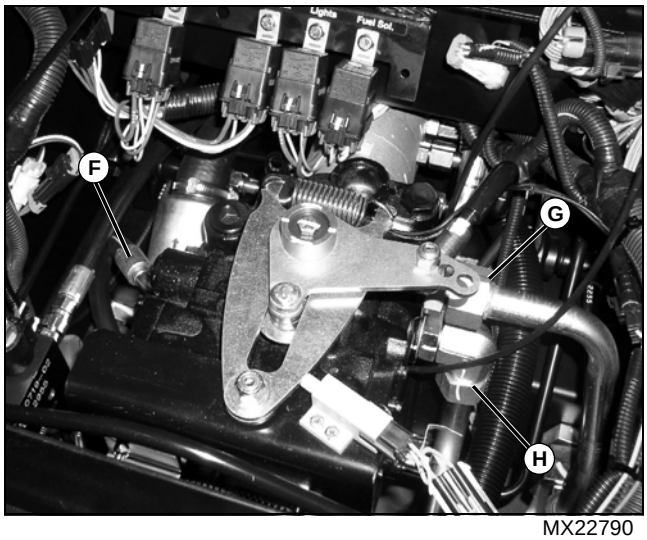
1. Park vehicle on a level surface, cutting units lowered, park brake locked, engine OFF. Block wheels to prevent movement of machine.
2. Disconnect battery.
3. Remove operator seat and deck.
4. Remove operator foot platform.

NOTE: Observe location of spacers on traction rod (B).



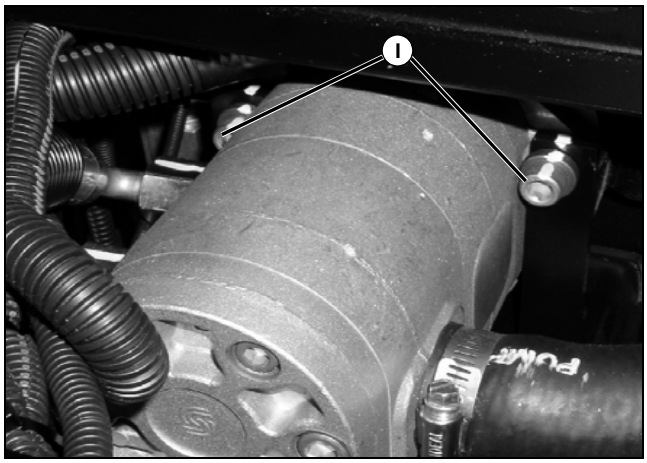
MX22793

5. Remove nut (A) and traction rod (B).
6. Disconnect neutral and reverse switch connectors (C and D).
7. Remove driveshaft shield (E).



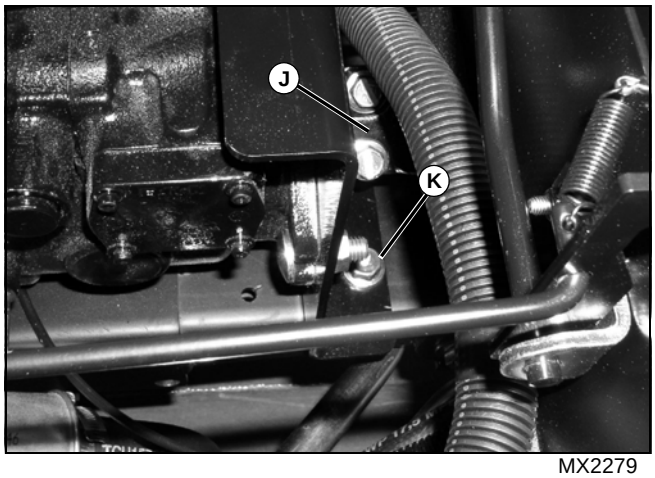
MX22790

8. Remove hydraulic hose (F) and hydraulic lines (G and H).



MX22795

9. Remove triple pump mounting screws and washers (I).



MX2279

10. Remove driveshaft (J).
11. Remove hydrostatic pump mounting plate-to-frame cap screws and nuts (K).

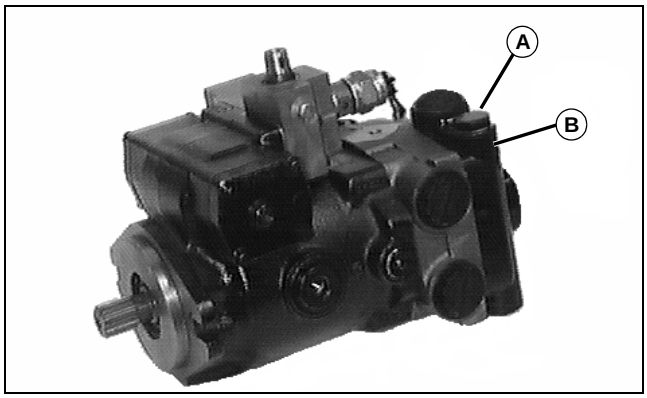
12.Lift rear of hydrostatic pump to disconnect pump mounting plate from bracket (E), while separating from triple pump.

13.Remove hydrostatic pump from machine.

14.Rebuild or replace pump as necessary.

Disassemble Hydrostatic Pump - 3235C and 3245C

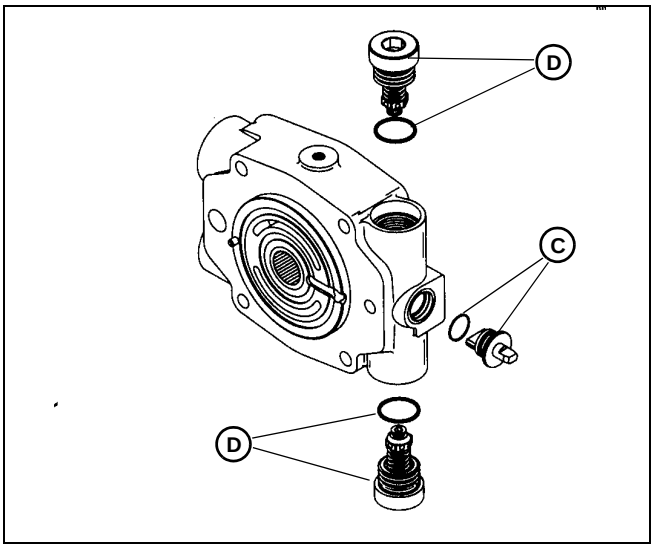
1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the cap screws up. Mark the relationship of the working ports (for reassembly identification) to the servo control assembly with a scribe.



MX20281

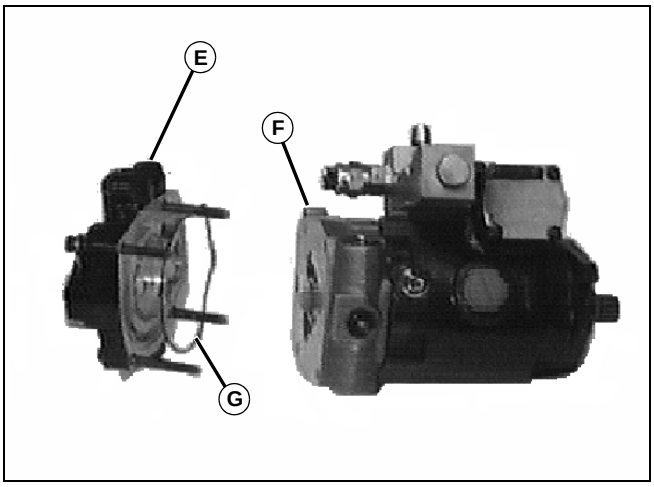
2. Remove charge pump relief valve (A) from charge pump housing (B).

IMPORTANT: Avoid damage! Mark the relief valve in relation to the cavity it was removed from, for reassembly purposes.



MX20282

3. From backplate, remove dump valve (C) and relief valve assemblies (D).



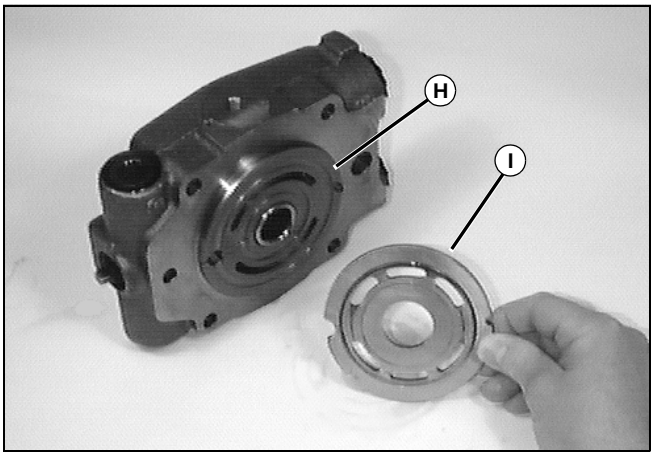
MX20279

4. Remove the four cap screws that hold the charge pump housing (E) to the backplate (F).

5. Pull the housing away from the backplate and remove the O-ring (G).

6. Tap the backplate with a plastic mallet to loosen it from the housing.

7. Remove the backplate and gasket from the hydrostatic pump housing.

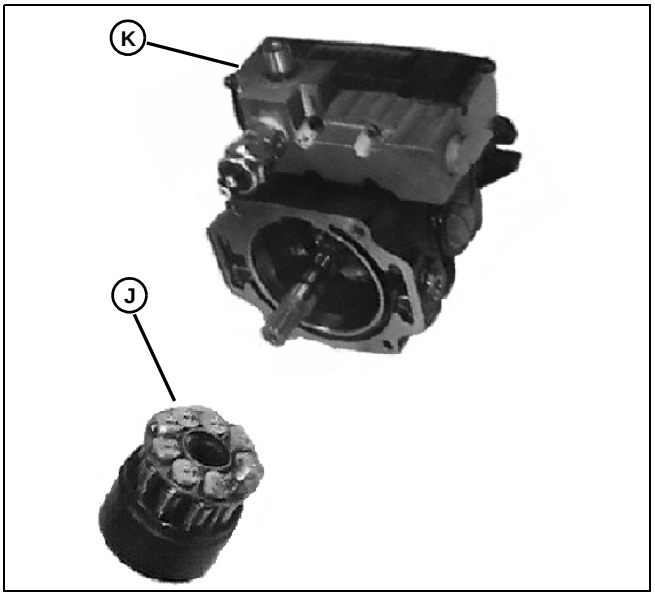


M86012

8. Remove the valve plate (I) from the backplate. The valve plate is not fastened to the backplate, but may adhere slightly due to oil between machined surfaces.

9. In most cases it should not be necessary to remove the spring pin (H) that is used to keep the valve plate located. However, if the spring pin is damaged, remove it, being extremely careful not to scratch the surface of the backplate.

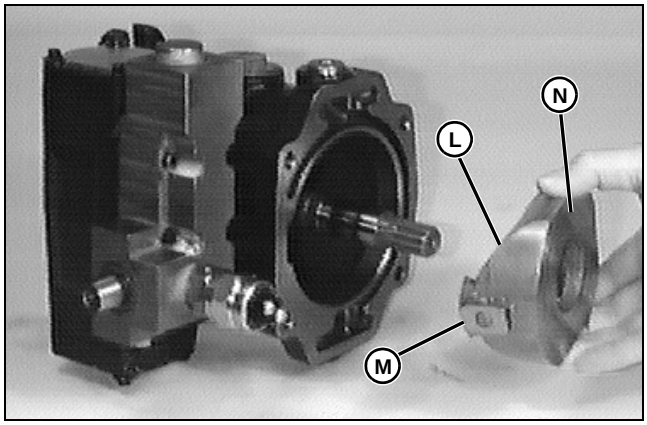
NOTE: Cam plate and follower may stay in pump housing. Remove separately if necessary.



MX20280

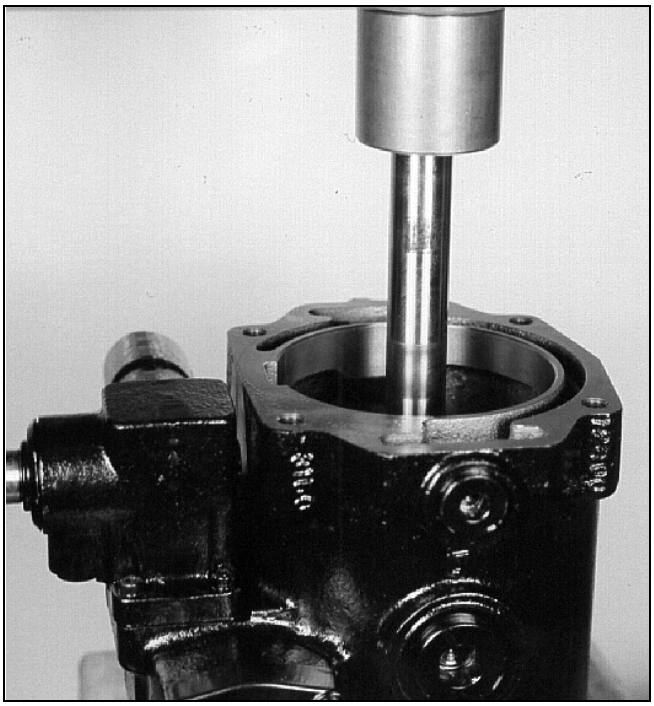
10.Remove pump from vise and lay it on its side. Hold rotating assembly (J) with hand and carefully stand pump up on output end of main shaft. Lower rotating assembly, cam plate, and follower to bench and lift pump housing (K) away.

11.If the pistons did not come out with the piston block, remove the pistons along with the spider and pivot.

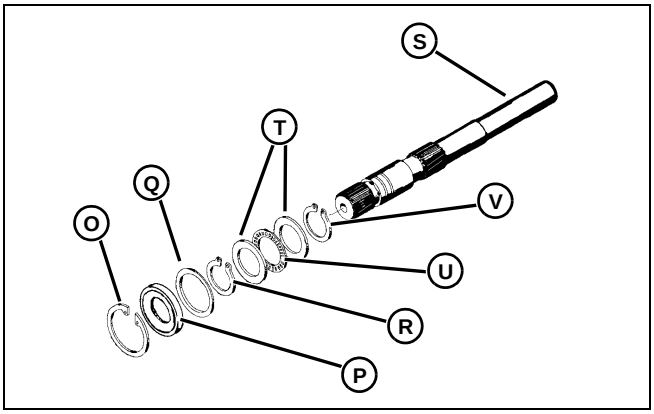


M86015

12.If needed, remove the cam plate (L) and follower (M) from the housing. When removing the cam plate, be sure not to damage the shoe surface (N).



M76157

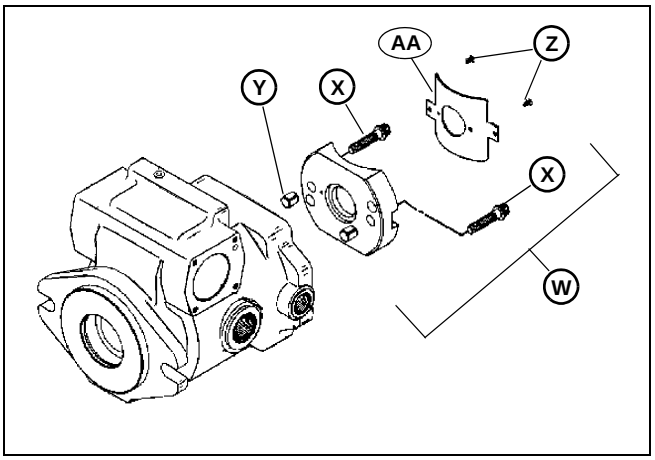


M57918

13.Remove retaining ring (O) and press the shaft out of the housing as shown until the rubber seal (P) releases from the bore. Be sure that the shaft is supported below so that it does not drop and become damaged when it releases from the housing.

14.Remove the seal (P) and washer (Q).

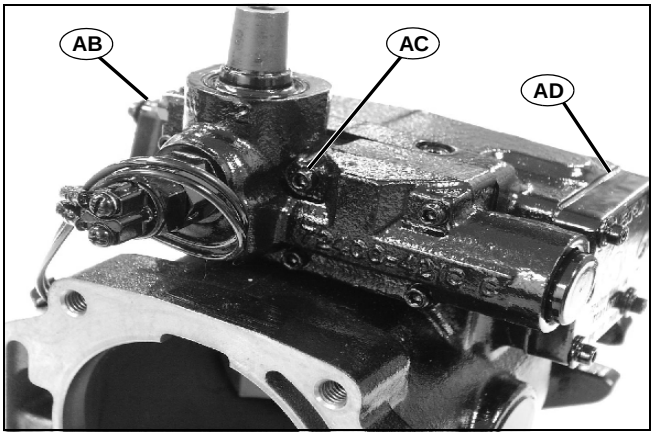
15.Remove the retaining ring (R) from the main shaft (S) and remove the thrust washers (T), thrust bearing (U), and retaining ring (V).



MX20283

16.Remove the cradle sub-assembly (W) by removing two retaining screws (X), retaining cradle inside housing. Move the cradle back and forth to release the dowel bushings (Y) and remove the cradle sub-assembly from the housing.

17.Remove the button head cap screws (Z) to remove the bushing (AA).

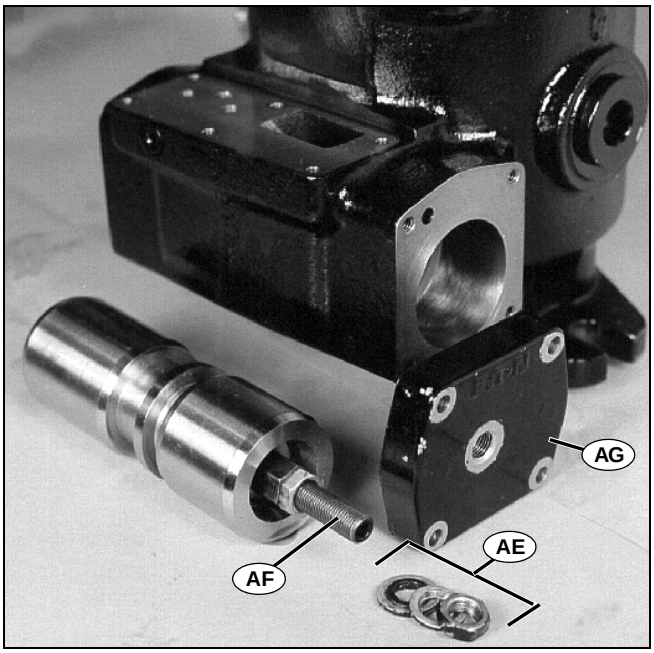


MX20285

18.Remove the servo valve (AB) and gasket by removing the six socket head cap screws (AC) that fasten the valve to the housing.

19.Remove the cylinder cap (AD) that does not have the screw and locknut through the center.

NOTE: Do not disassemble the piston any farther than specified. The piston spring tension is preset at the time of manufacture. The service piston assembly is sold only as an assembled unit.



M76165

20.Remove the locknut, flat washer, and rubber washer (AE) from the piston screw (AF).

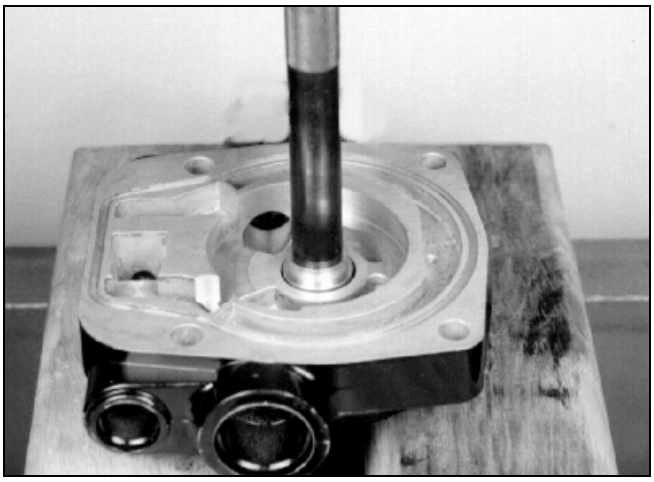
21.Using a hex key wrench in the end of the piston screw, turn it clockwise until it threads completely out of the cover.

22.Remove the cap (AG) with the piston screw hole through the center.

23.Push the piston out of the piston bore.

Inspect Hydrostatic Pump - 3235C and 3245C

1. Inspect the needle bearings and bushing in the charge pump adapter housing, the backplate, and the pump housing. If the needles remain in the cage and spin freely, there is no need to replace them. Check bushing for excessive scoring; replace if necessary.



M76153A

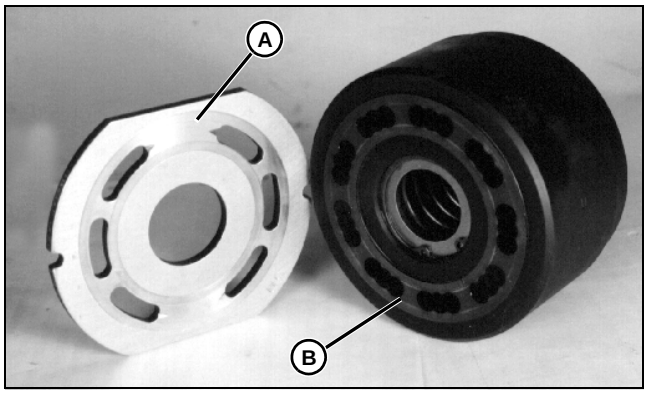
2. If it is necessary to remove the bushing from the charge pump adapter housing, it can be pressed from the inside of the housing to the outside as shown.

IMPORTANT: Avoid damage! The charge pump adapter housing is aluminum and the machined surfaces can be easily damaged. Do not press the housing against unprotected steel surfaces.

3. If the bearing in the backplate needs to be replaced, it can be pressed out in the same fashion as that of the charge pump adapter housing.

IMPORTANT: Avoid damage! When removing bearing from backplate, be extremely careful not to damage machined surfaces.

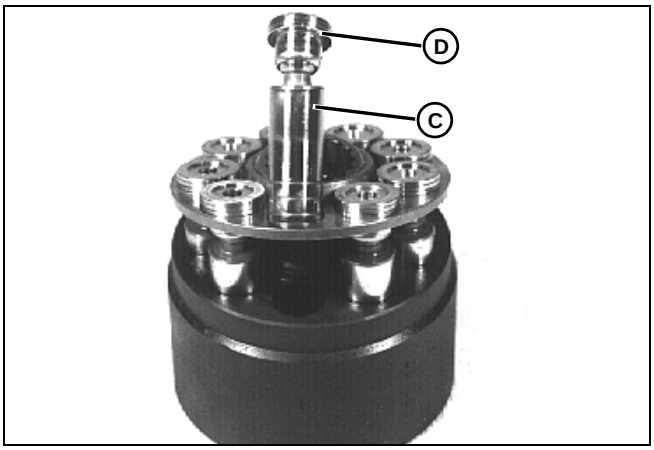
4. Inspect the charge pressure relief valve and valve seat in the charge pump adapter housing. Be sure that there are no burrs, excessive wear, or defects on the relief valve or valve seat.



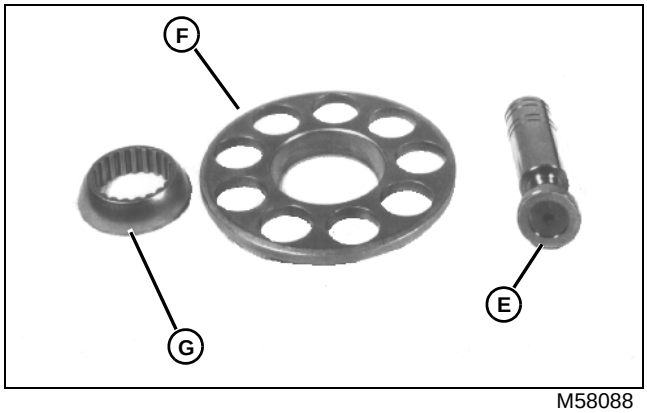
M76105

5. Inspect the valve plate (A) on the bronze side next to the piston block for wear. Replace the valve plate if any wear, scoring, or scratches exist.

6. Inspect the piston block surface (B) that makes contact with the valve plate. This surface should be smooth and free of deep scratches.



M56554



M58088

7. Check the piston (C) movement in the block bore. If the pistons are sticky in the bore, examine the bore for scoring or contamination.

8. Examine the OD of the pistons for finish condition. They should not show wear or deep scratches.

9. Inspect each piston shoe (D) for a snug fit on the ball end of the pistons. Check the shoe face (E) for a flat smooth surface.

10.Examine the spider (F) for wear in the pivot area.

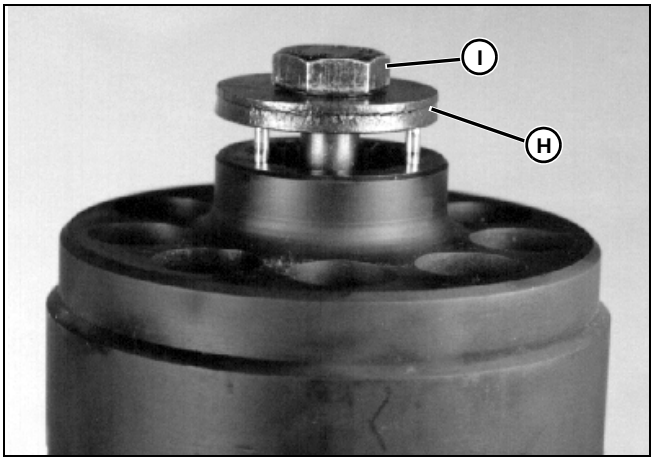
11.Examine the pivot (G) to ensure smoothness and no signs of wear.

The following parts will be needed to disassemble the piston block:

- 3/8 in. ID x 1-1/4 in. OD flat washers (2 ea)
- 3/8 in. x 5 in. NC cap screw (1 ea)
- 3/8 in. NC nut (1 ea)
- 1/2 in. drive socket with 1-1/8 in. OD (1 ea)

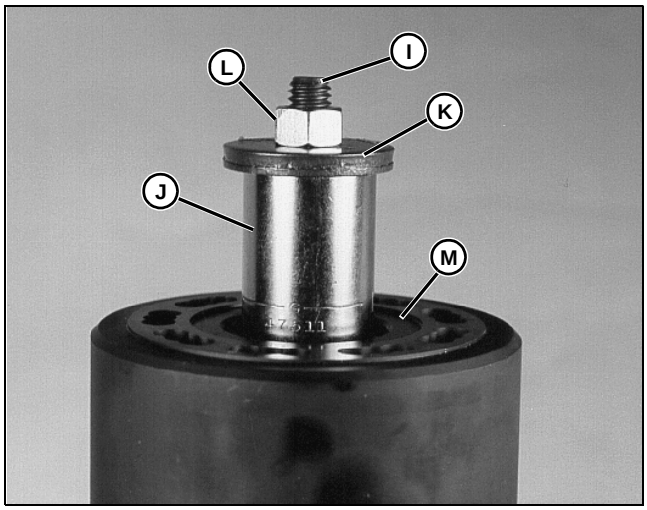
CAUTION: Avoid injury! The spring inside the piston block is compressed and should not be removed without compressing the spring first. Use the following procedure to remove the spring safely.

NOTE: Disassembling the piston block assembly is not necessary unless the pins are damaged.



M76099

12.Place one of the flat washers (H) over the 3/8 in. x 5 in. cap screw (I). Install cap screw through spline end of piston block so that the washer rests on the three pins.



M58132

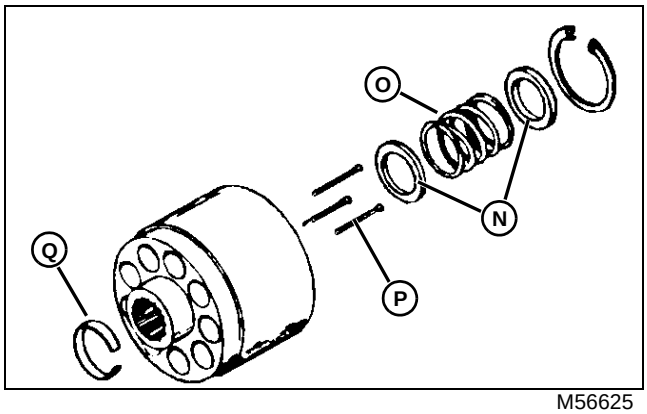
13.Place the socket (J) and then the washer (K) over the end of the cap screw (I).

14.Screw the nut (L) on and slightly compress the spring inside the piston block.

15.Use retaining ring pliers to remove the internal retaining ring (M).

16.Carefully back off tension on nut until spring is slack.

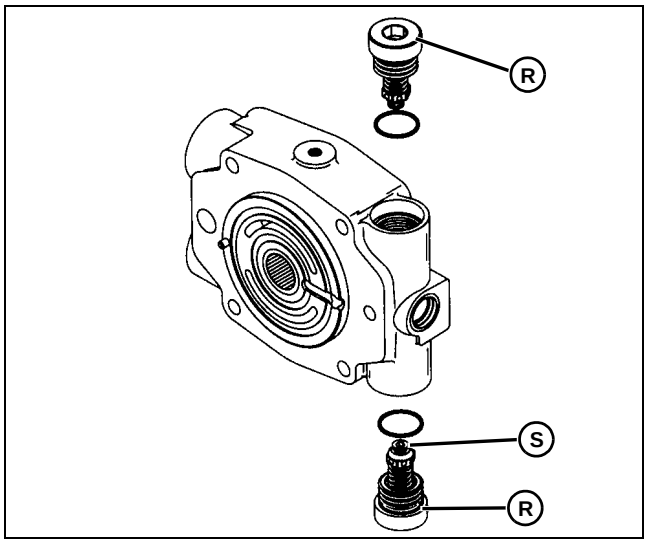
17.Remove the nut, washer, and cap screw.



M56625

18.Remove washers (N), spring (O), pins (P), and pin retainer (Q).

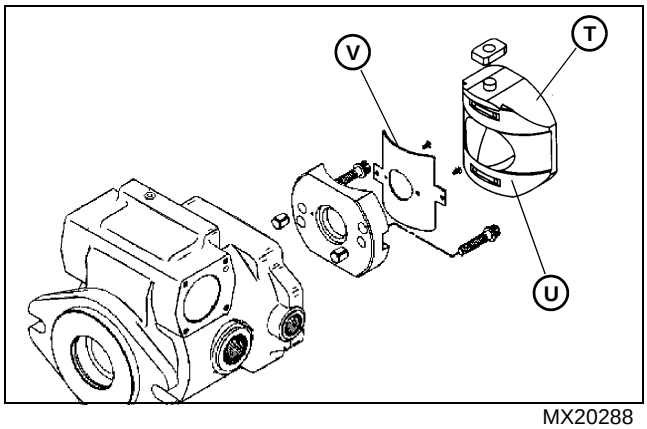
19.Replace pins as needed.



MX20287

20.Examine the main drive pressure relief valves (R) and seats. Inspect the check valve (S) at the end of the relief valve. The check valve at the end of the relief valve should be loose and easily operated. The seat for the check valve should be free of burrs and defects.

21.Examine the machined surfaces of the backplate.

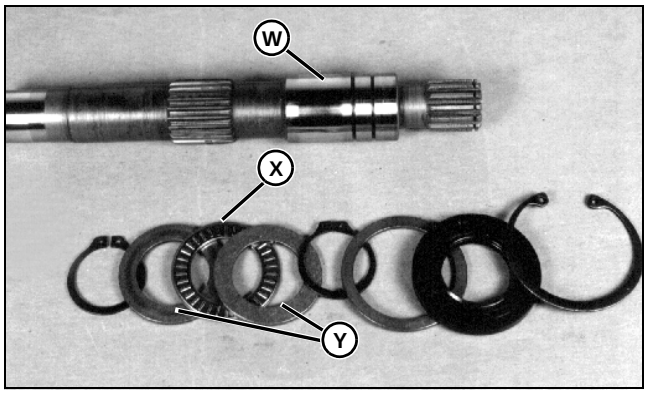


MX20288

22.Examine the shoe surface (T) of the cam plate. Be sure that there are no scratches, grooves, or excessive wear on the shoe surface. Check that the lubrication holes in the cam plate are open.

23.Inspect the cradle surface (U) on the back side of the cam plate for excessive wear.

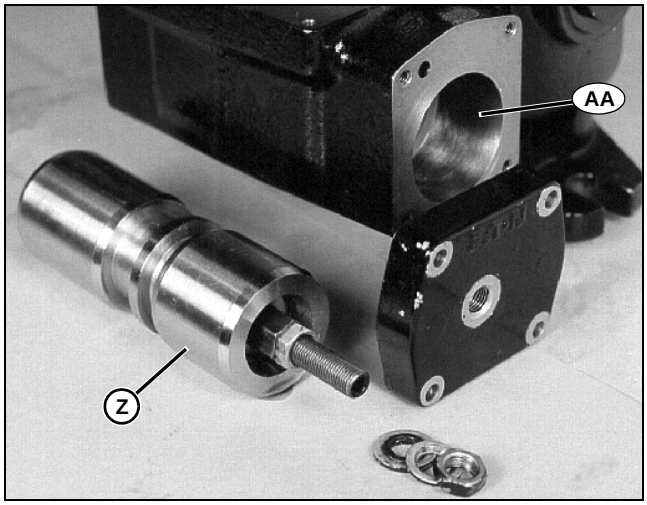
24.Examine the wear plate (V); if the fiber surface of the wear plate is worn, replace the wear plate.



M76112

25.Inspect the shaft (W) for fretting in the bearing and spline area.

26.Inspect thrust bearing (X) and washers (Y) for wear.



M76165

27.Inspect the servo piston (Z) for scratches and wear.

28.Examine the servo piston cylinder (AA) in the pump housing.

Assemble Hydrostatic Pump - 3235C and 3245C

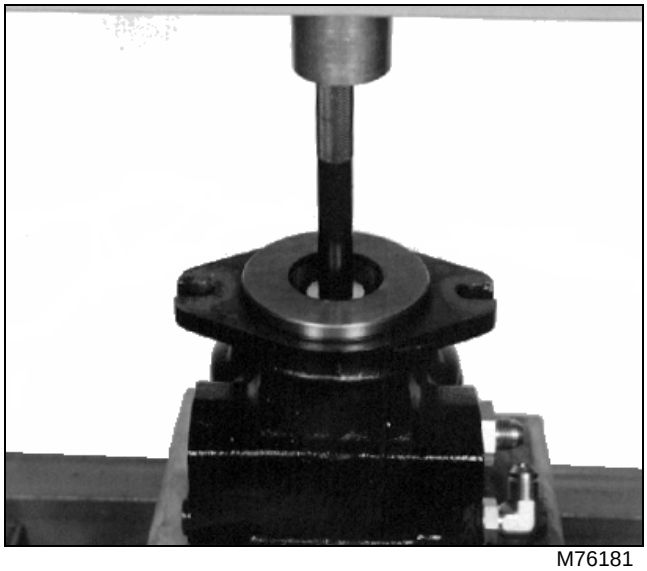
Other Material

Part No.	Part Name	Part Use
T43512 (US) 242 (Loctite) TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Apply to threads of setscrew.

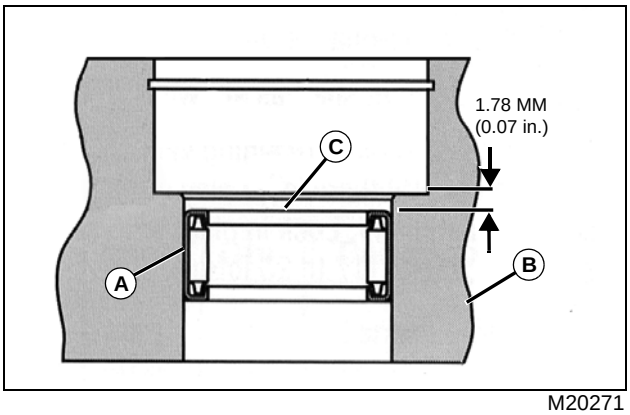
IMPORTANT: Avoid damage! Due to extremely tight tolerances and finish of pump internal surfaces, it is very important to maintain absolute cleanliness during the assembly of the pump. Coat all internal surfaces with clean hydraulic fluid when assembling the pump.

Clean all parts in a suitable solvent and dry with a lint-free rag.

Always replace O-rings and seals. Old O-rings and seals will leak. Lubricate new seals and O-rings with petroleum jelly when assembling.

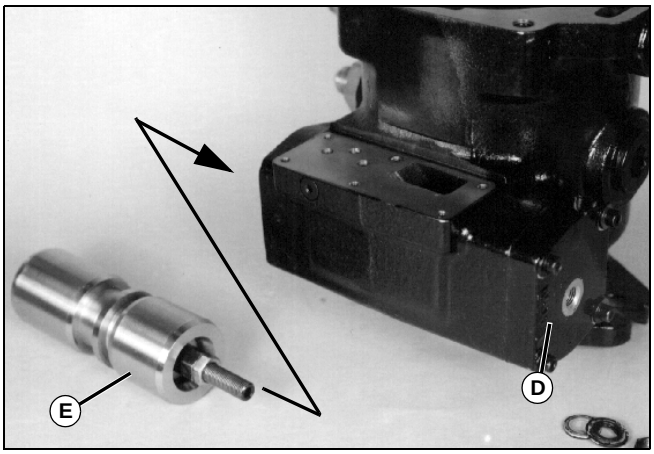


M76181



M20271

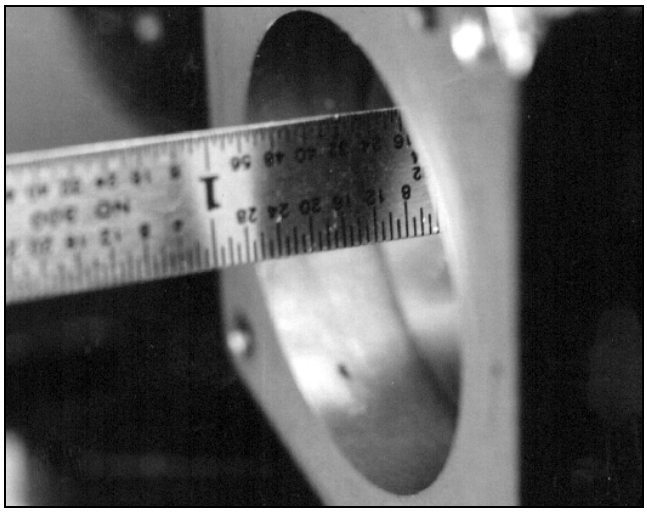
1. If the needle bearing (A) was removed from the housing (B), the new one can be pressed from the outside inward until the bearing race is recessed in the bore according to specifications. Be sure that the numbers on the bearing race (C) are facing to the outside of the housing.



M76182

2. Install the gasket and cylinder cap (D) that has the piston screw hole through the center. Tighten the mounting screws to specifications.

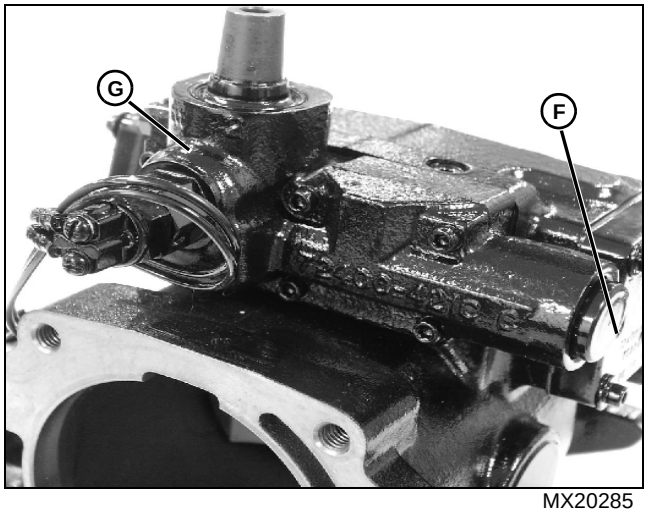
3. Install the piston (E) into the cylinder as indicated above.



M76186

4. Insert a hex key wrench into the end of the piston screw and thread it through the cover until the opposite end of the piston is located according to specification from the edge of the cylinder.

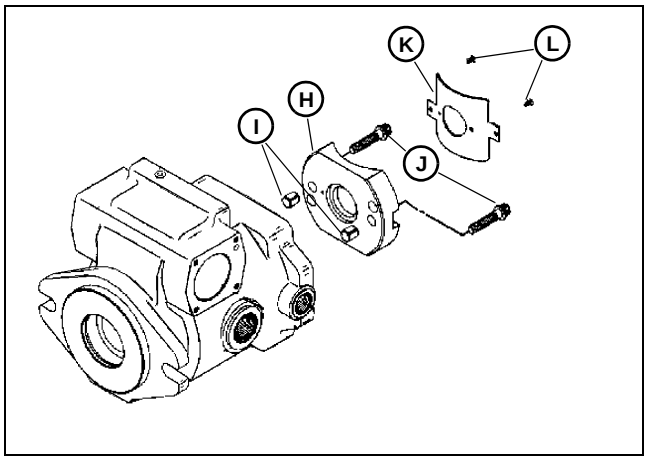
5. Install the rubber washer, flat washer, and outside jam nut onto the piston screw. Tighten the jam nut to specification.



MX20285

6. Install the remaining cylinder cap (F) and gasket. Tighten the mounting screws to specification.

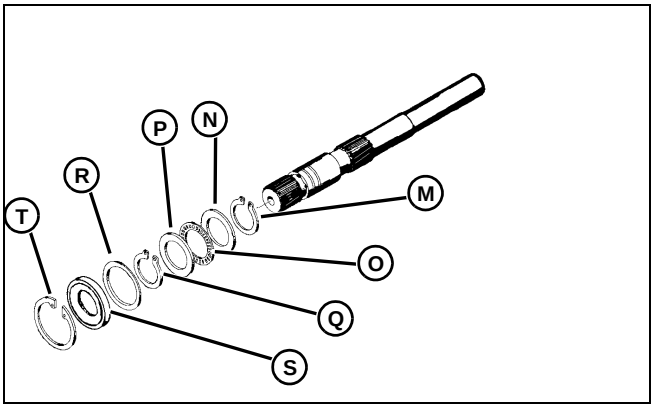
7. Install the servo valve (G) and gasket onto the housing. Be sure the servo valve feedback rod is positioned into the narrow groove on the servo piston. Tighten the mounting screws to specification.



MX20283

8. Place the cradle (H) into the housing, being sure that the dowel bushings (I) are located in the holes in the housing. Draw the cradle tight by evenly torquing the two mounting screws (J) to specification.

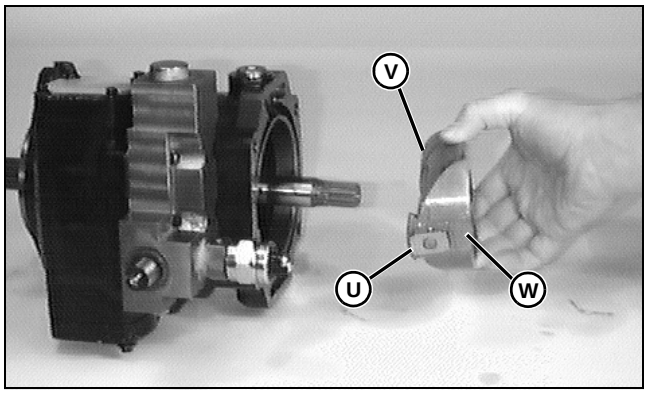
9. Install the wear plate (K) onto the cradle and tighten the retaining screws (L) to specification.



M57918

10. Install the inside retaining ring (M), thrust washer (N), and thrust bearing (O) on the shaft. Install the outside thrust washer (P) and retaining ring (Q).

11. Install the shaft into the housing. Install the washer (R) and a new shaft seal (S). Secure it with the retaining ring (T).



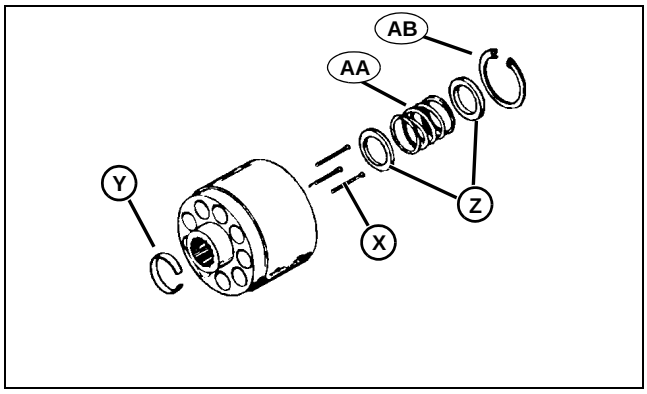
M79113

12.Install the cam plate follower (U) onto the cam plate (V).

13.Place the camplate over the shaft with the shoe surface (W) outward.

14.Use a long screwdriver to guide the cam plate follower into the large groove in the servo piston.

15.If the piston block assembly was disassembled, complete the following. If not, skip to step 23.



M56625

16.Install three pins (X) in oversize grooves in spline end of piston block with the heads facing inside of the block.

17.Install pin retainer (Y).

18.Install washers (Z) and spring (AA).

19.Using same tools used to compress spring during disassembly of block, install washer, spring, second washer, cap screw, and nut in the piston block.

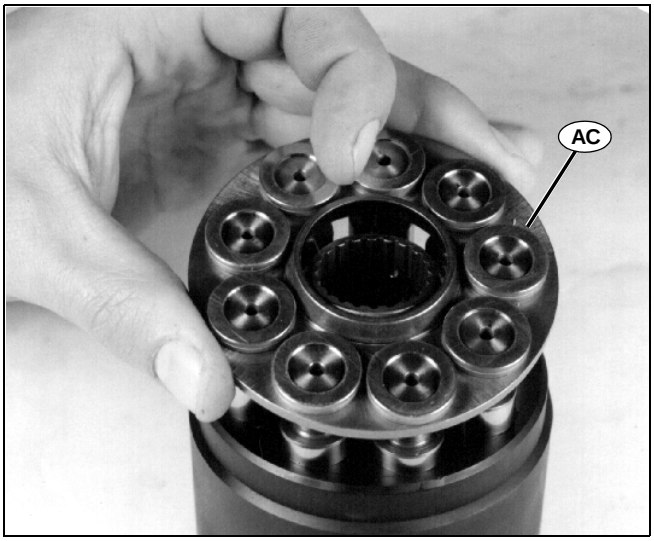
20.Compress spring.

21.Install retaining ring (AB).

22.Remove spring compression tools from the piston block.

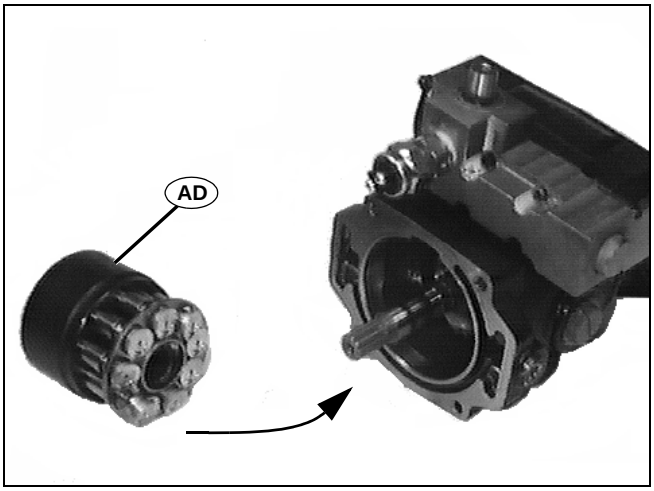
23.Place the pivot so that the flat side rests on the top of the three pins.

NOTE: It is not necessary to put the pistons in the original positions. Any piston can be installed in any hole.



M76117

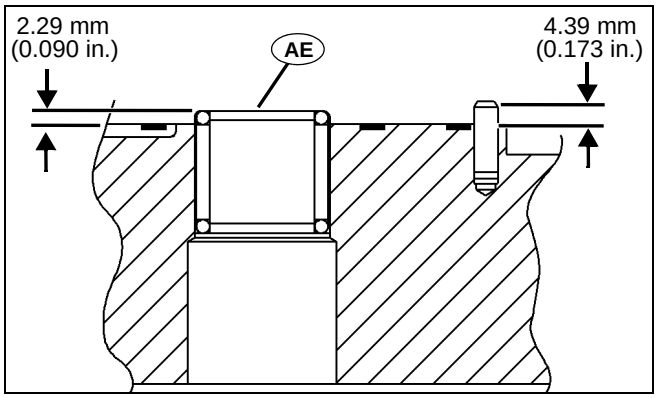
24.With each piston (AC) in place in the spider, lower the pistons into the piston block.



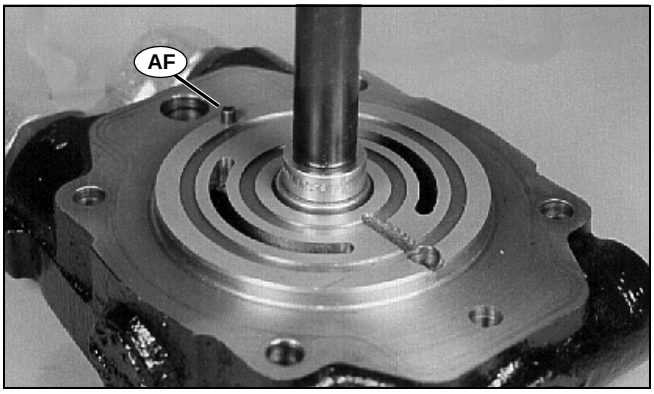
M86014

25.Tilt the pump housing so that the open end is facing slightly downward, but not so much that the cam plate falls out of position.

26.Slide the rotating unit (AD) up the shaft until it meshes with the splines on the shaft.



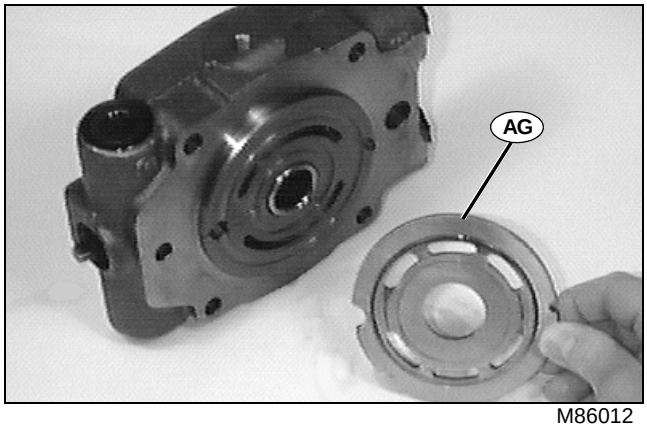
MX20272



M76203

27.If the bearing was removed from the backplate, press new one into position as shown. The numbers (AE) on the bearing should be positioned toward the inside of the pump housing. Press the bearing in until the race remains above the surface of the backplate according to specification.

28.Install the roll pin (AF) (if removed) that is used to position the valve plate. Allow the pin to protrude from the backplate to specification.

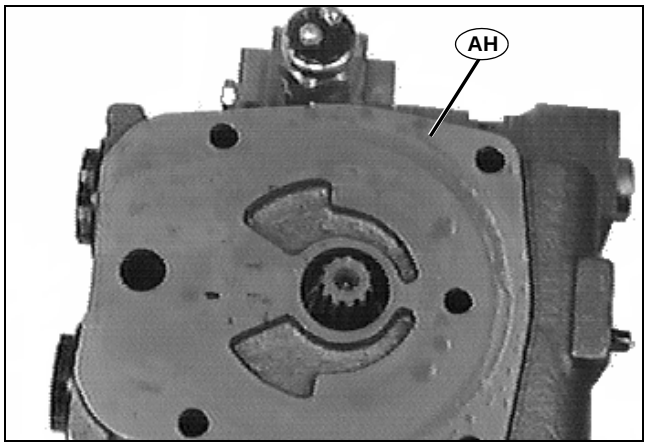


M86012

29.Apply a small amount of clear petroleum jelly to the steel side of valve plate (AG) to hold it in place for installation.

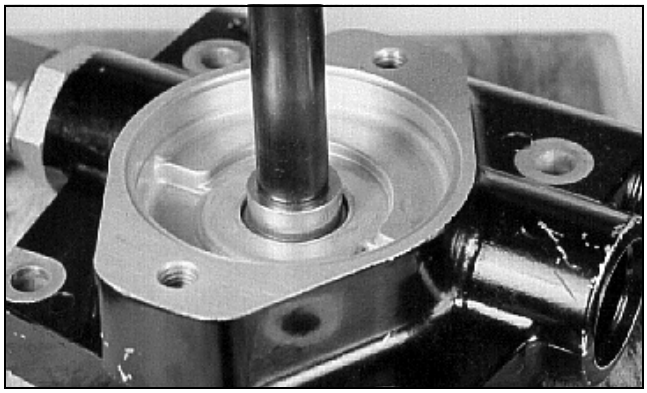
30.Install the valve plate onto the backplate with the steel side facing the backplate and the bronze side facing the inside of the housing.

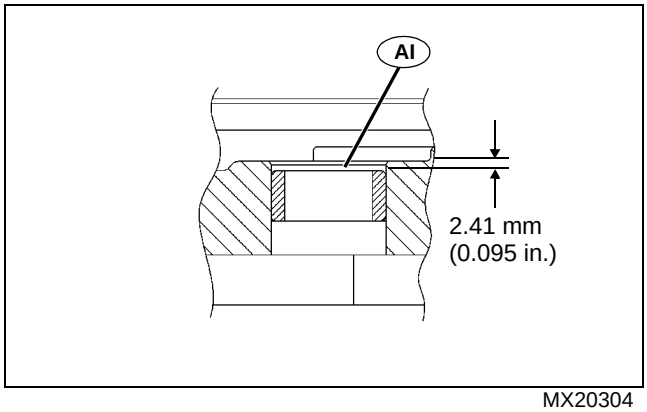
31.Place a new gasket on the housing.



M79115

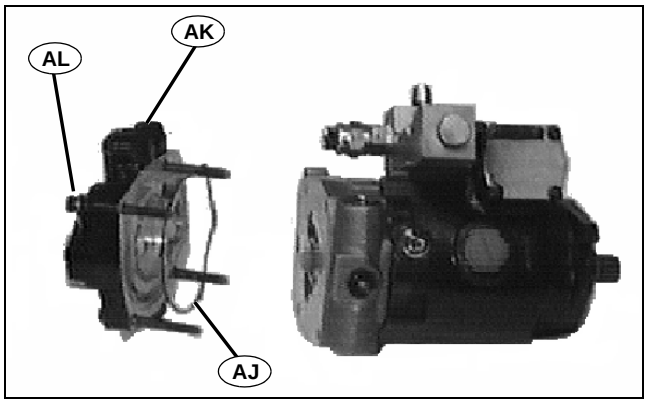
32.Install the backplate assembly (AH) onto the housing assembly, making sure valve plate stays in position. The backplate should rest off of the housing at the backplate assembly resting position specification until it is tightened down. This is due to the spring tension within the rotating assembly.


M76207



MX20304

33.If necessary, press a new bushing (AI) into the charge pump adapter housing. Press the bearing into the housing from the outside inward. Press the top of the bushing until it is positioned below the top edge of the bore to specification (as shown).

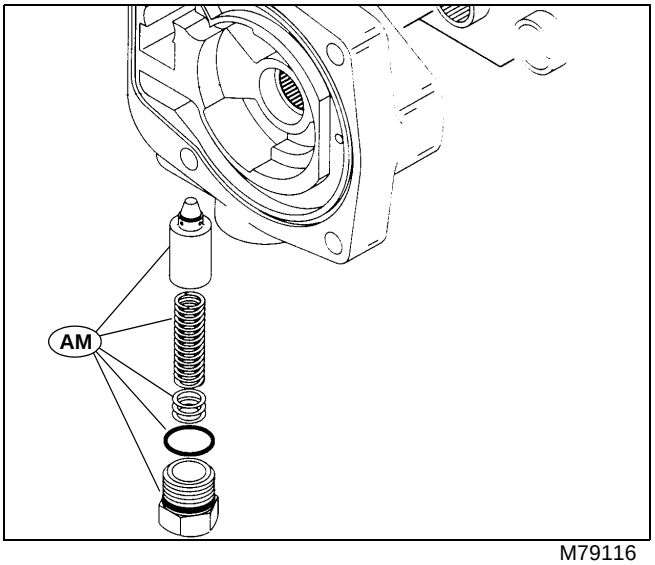


MX20279

34.Install the O-ring (AJ) into the charge pump adapter housing. Use petroleum jelly to lubricate and hold the O-ring in place in the housing (AK).

35.Place the charge pump adapter housing over the shaft. Insert the four cap screws (AL) and tighten evenly to specification.

36.After installing new O-rings, install the main drive pressure relief valves in the same cavities in the backplate from which they were removed. Tighten to specification.



M79116

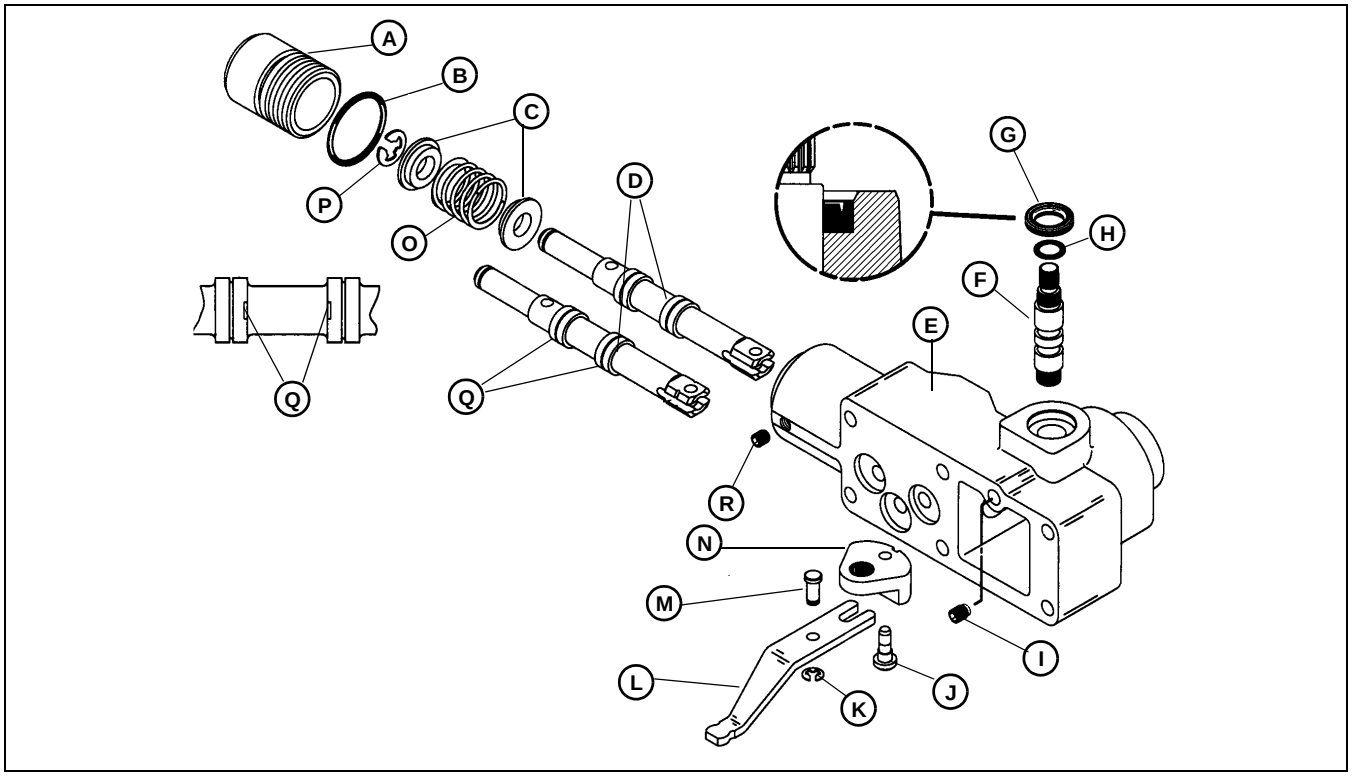
37.Install the charge pressure relief valve assembly (AM). Tighten to specification.

Specifications

Main Shaft Needle Bearing Position
(Below Surface) . . . . . 1.78 mm (0.070 in.)
Servo Piston Cover Mounting Screw
Torque . . . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Servo Piston Distance from Edge of Cylinder
(Installed) . . . . . 12.7 mm (0.500 in.)
Outside Jam Nut Torque . 17.5 ± 1 N•m (155 ± 5 lb-in.)
Servo Control Mounting Screw
Torque . . . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Cradle Mounting Screw
Torque . . . . . 36 ± 2 N•m (26 ± 2 lb-ft)
Wear Plate Retaining Screw
Torque . . . . . 1.7 ± 0.1 N•m (15 ± 1 lb-in.)
Backplate Bearing Position
(Above Surface) . . . . . 2.29 mm (0.090 in.)
Roll Pin Protrusion from Backplate 4.39 mm (0.173 in.)
Backplate Assembly Resting Position 1.5 mm (0.06 in.)
Charge Pump Adapter Bushing Position
(Below Surface) . . . . . 2.41 mm (0.095 in.)
Main Drive Pressure Relief Valve
Torque . . . . . 143 ± 6 N•m (105 ± 5 lb-ft)
Charge Pump Adapter Assembly
Torque . . . . . 39 ± 2 N•m (29 ± 1 lb-ft)

Disassemble and Assemble Servo Control Valve

Disassemble



MX20305

A - Plug
B - O-Ring
C - Spring Retainer
D - Valve Spool
E - Control Housing
F - Input Shaft
G - Wiper Seal
H - O-Ring
I - Setscrew
J - Head Pin (press fit)
K - Retaining Ring
L - Feedback Link
M - Dowel Pin
N - Bellcrank
O - Spool Centering Spring
P - Retaining Ring
Q - Metering Notches
R - Setscrew

1. Remove wiper seal (G) with a screwdriver. Remove setscrew (I) retaining input shaft (F) and remove input shaft from control housing (E).

2. Remove setscrew (I) retaining plug (A) in control housing and remove plug.

3. Remove retaining ring (K) from pin retaining feedback link (L) and valve spool (D), and bellcrank (N) from control housing.

4. Compress spool centering spring (O) and remove retaining ring (P), spring retainer (C), spool centering spring, and second spring retainer (C) from valve spool.

5. Remove O-rings (B and H) from plug and input shaft. Clean all parts and lubricate before reassembly.

Assemble

1. Install one spring retainer (C), spool centering spring (O), and second spring retainer (C) onto valve spool (D). Compress the spool centering spring with retainer and install retaining ring (P) onto valve spool.

2. Install valve spool (D) into control housing (E), making sure that the metering notches on the valve spool can be seen in the metering ports.

3. Position bellcrank (N) in control housing (E). Slide feedback link (L) into position in clevis on valve spool, aligning holes, and install dowel pin (M), retaining with retaining ring (K).

4. Install new O-ring (H) onto input shaft (F). Hold bellcrank (N) in position with feedback link slot and align splined hole of bellcrank with input shaft cavity. Install input shaft into control housing and bellcrank.

5. Apply LOCTITE #242 or equivalent to setscrew (I) and install, retaining input shaft. Adjust setscrew until it bottoms out on input shaft and back out one-quarter turn.

6. Install wiper seal (G) on input shaft.

7. Install new O-ring (B) onto plug (A), retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with setscrew (R). Tighten setscrew to specifications.

Specifications

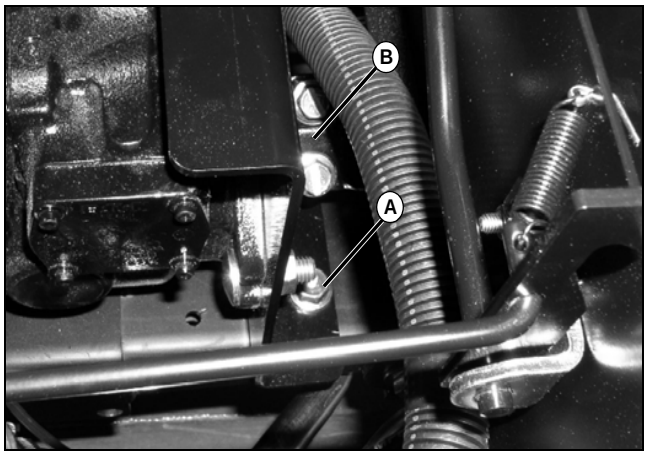
Manual Servo Control Plug Setscrew Torque . 2-3 N•m (17-25 lb-in.)

Install Hydrostatic Pump - 3235C and 3245C

1. Install hydrostatic pump mounting bracket and control linkage (if removed) to pump.

2. Place the hydrostatic pump into position in machine.

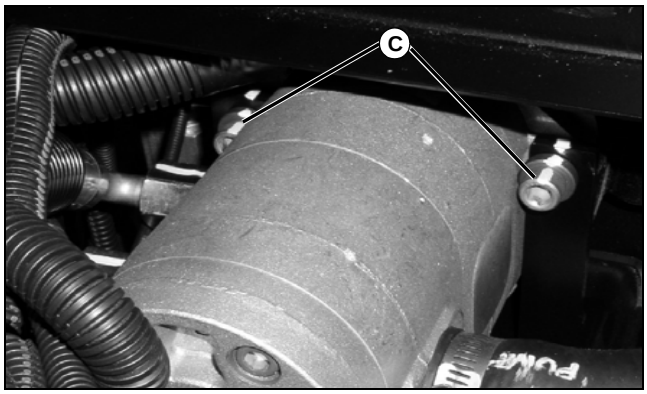
3. Install a new O-ring between hydrostatic and triple pump.



MX22796

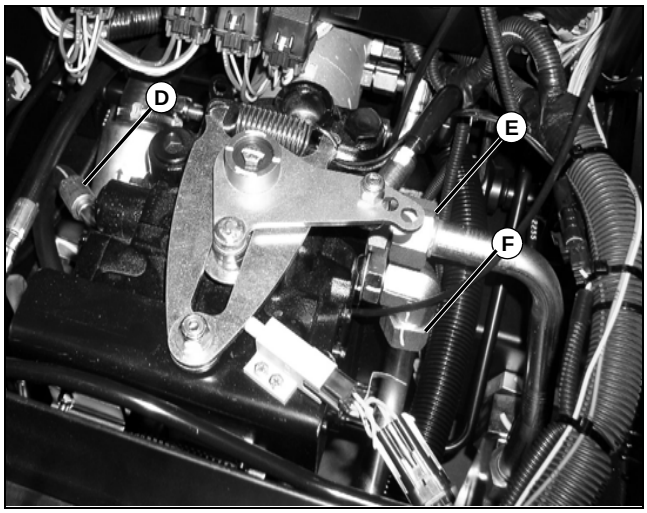
4. Install hydrostatic pump mounting plate-to-frame cap screws and nuts (A).

5. Install driveshaft (B).



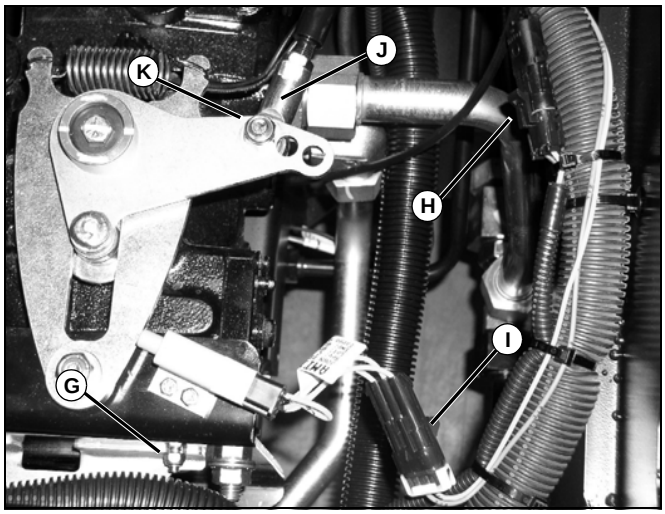
MX20416

6. Install triple pump mounting screws and washers (C).



MX22790

7. Connect hydraulic hose (D) and hydraulic lines (E and F).



MX22790

8. Install driveshaft shield (G).

9. Connect neutral and reverse switch connectors (H and I).

10. Install traction rod and spacers (J) and nut (K).

11. Fill hydraulic reservoir.

12. Install operator seat and deck.

13. Install operator foot platform.

14. Connect battery.

15. Perform start-up procedure. (See “Start-Up Procedure” on page 323.)

16. Adjust neutral position. (See “Adjust Transmission Neutral Position - 3235C and 3245C” on page 285.)

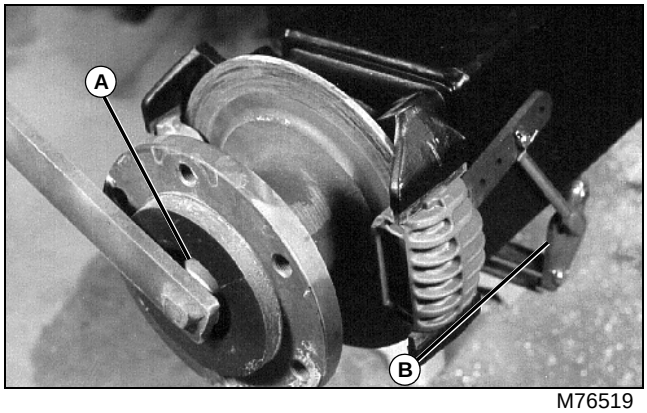
17. If pump was removed for either replacement or rebuild, check forward and reverse relief pressures. (See “Test Hydrostatic System Relief Pressure” on page 280.)

Remove Front Wheel Motor

NOTE: Hydraulic reservoir contains approximately 45 L (12 gal).

1. Drain hydraulic reservoir.

2. Raise vehicle and install jackstands under the front axle/ reservoir assembly.



M76519

3. Remove wheel from side of motor removal.

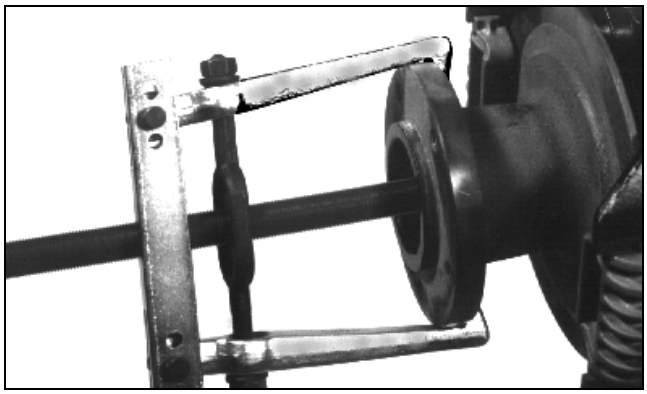
4. Apply park brake. Remove nut securing disk to wheel motor using a 1-7/16 in. socket (A).

5. Release park brake.

6. Remove cotter keys from lower end of brake linkage arms and remove linkage arms from lower linkage pivot (B).

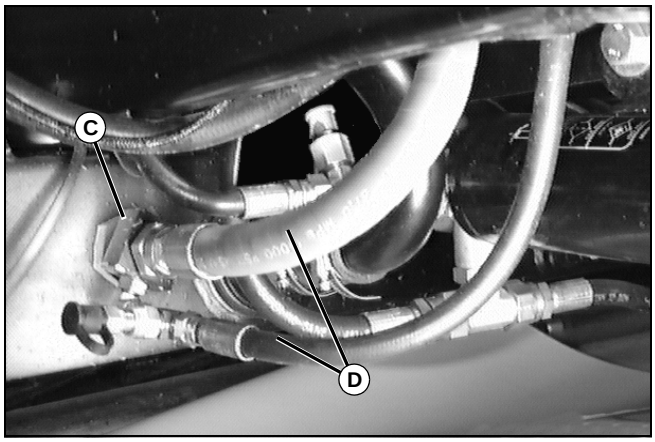
CAUTION: Avoid injury! With tension on disk from puller, disk will release from tapered motor shaft with force. Stand to one side when tapping on puller with hammer.

NOTE: Calipers will be removed with rotor.



M56621

7. Remove rotor from motor shaft using a puller as shown. Apply pressure with puller and tap with hammer.

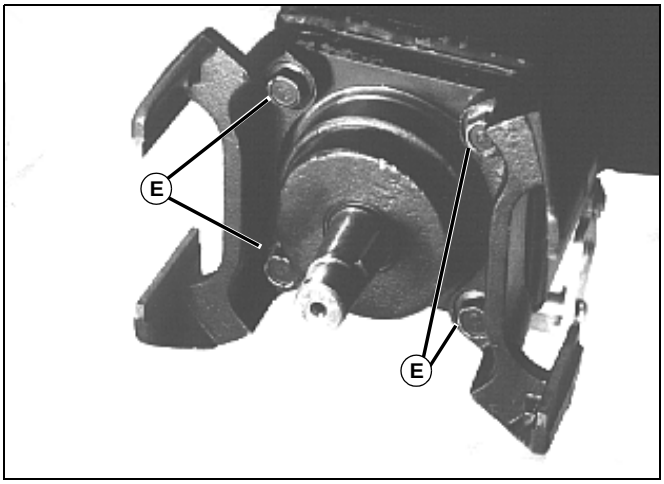


M58756

8. Disconnect hoses (D) from block (C) on back of axle/ reservoir.

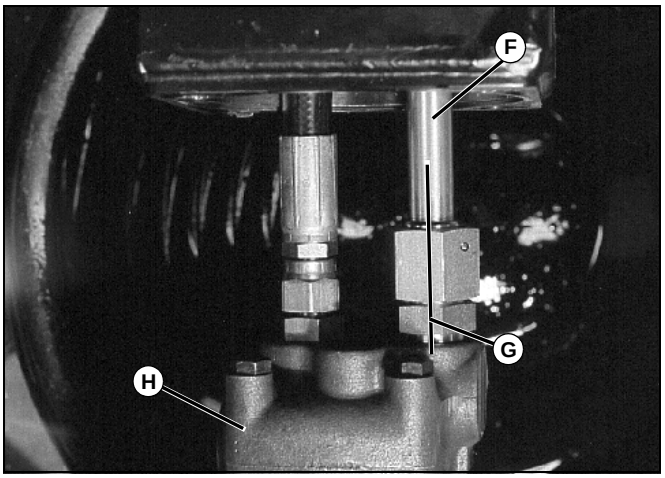
9. Loosen jam nut on block.

10. Remove block from reservoir. Block is threaded into another block inside the reservoir.



M56623

11. Remove four cap screws (E) securing motor to front axle/reservoir.



M76520

12.Slide motor (H) out from axle/reservoir.

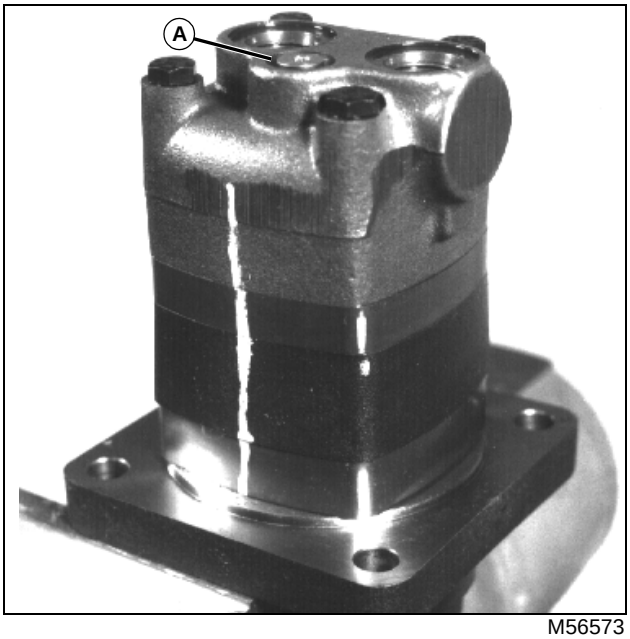
NOTE: Threaded hole of manifold block on opposite end of hard line must line up with opening in reservoir for reinstallation.

13.Mark an index line (G) before disconnecting hard line (F) from motor to aid in alignment during assembly.

IMPORTANT: Avoid damage! Before disconnecting the lines, clean the port area of the motor and use a wire brush to remove foreign material from the joint areas and burrs that could damage seals when reassembling.

14.Disconnect hydraulic lines from motor and remove motor.

Disassemble Front Wheel Motor



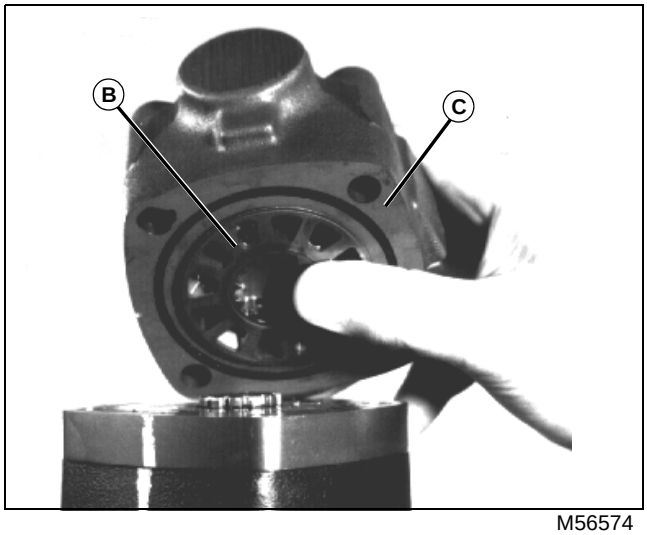
M56573

1. Remove fittings from backplate of motor.

2. Remove case drain plug (A) and seal (rear motor only).

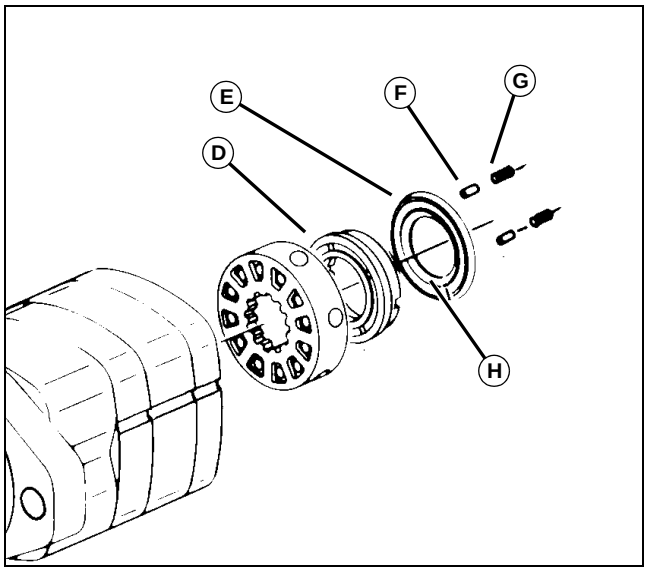
3. Place the motor in a vise with output shaft facing down. Use a soft-jaw vise or wood between the jaws and avoid excessive clamping pressure. Clamp across the mounting flange of the motor, not the housing.

NOTE: If the valve cannot be removed with the valve housing, be careful not to lose the two pins and springs that may fall from the housing during removal.



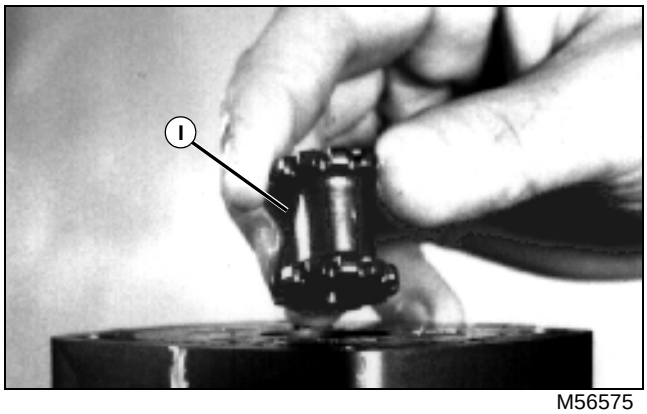
M56574

4. Remove the four cap screws from the valve housing (C). Lift the valve housing just enough to place your finger under the valve (B) and remove the housing with the valve. Place the housing and valve upside down on the bench. Remove valve from housing.



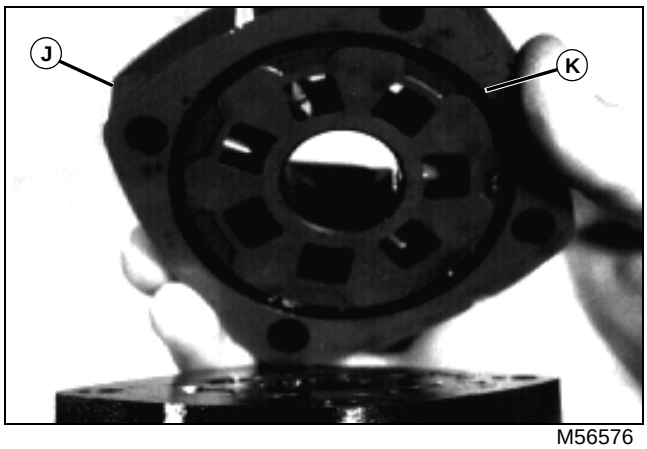
M76529

5. Remove balance ring (D), two pins (F) and springs (G), and inner and outer face seals (H and E).



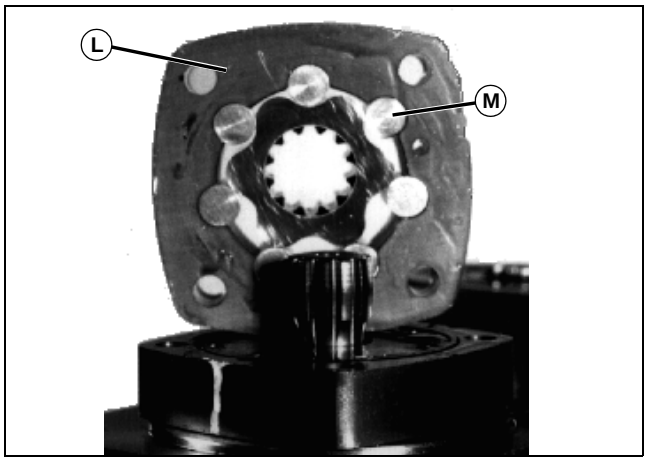
M56575

6. Remove the valve drive (I).



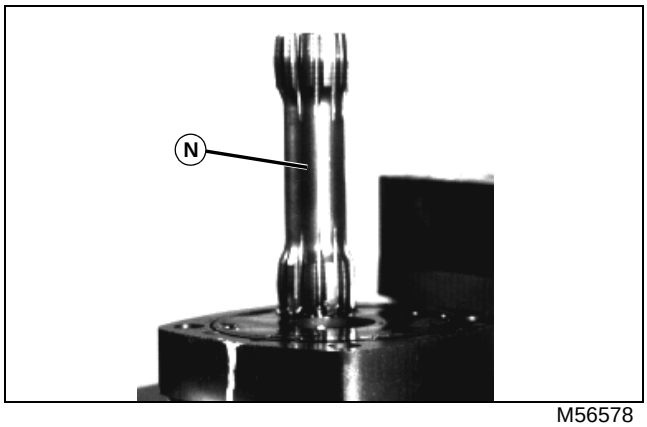
M56576

7. Remove valve plate (J) and seal (K).



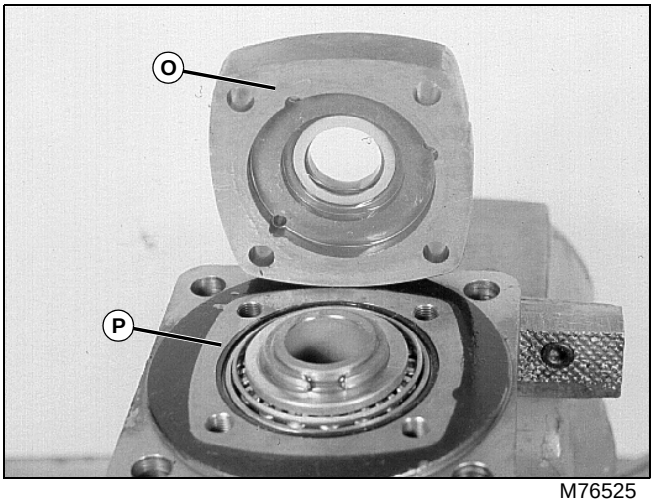
M56577

8. Remove the geroler (L). Be sure to retain the rollers (M) if they are loose.



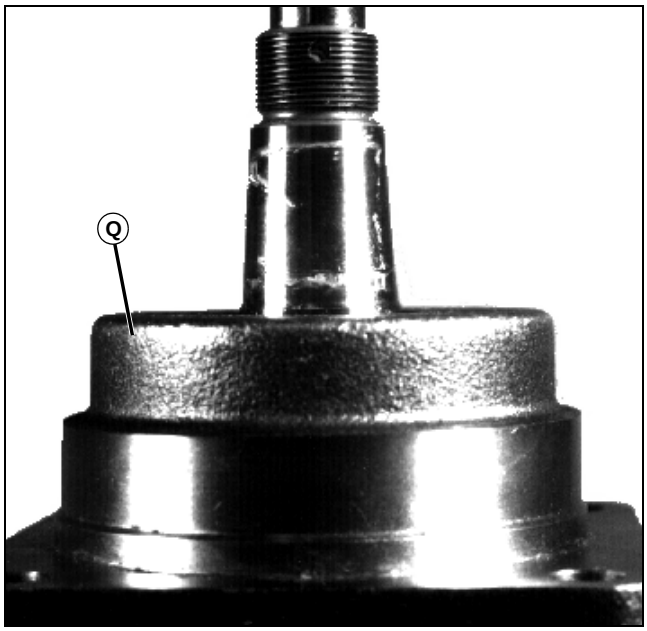
M56578

9. Remove the drive (N).



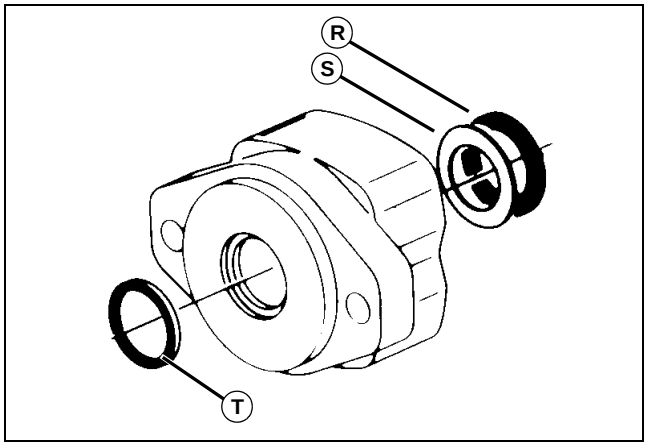
M76525

10.Remove wear plate (O) and seal (P).



M56602

11.Remove drive key and press shaft and bearing assembly from the bearing housing (Q).



M76532

12.Use a small screwdriver and remove the shaft seal (R), backup washer (S), and exclusion seal (T). Be careful not to damage housing bore.

Inspect Front Wheel Motor

IMPORTANT: Avoid damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection. DO NOT use coarse grit or try to file or grind these parts.

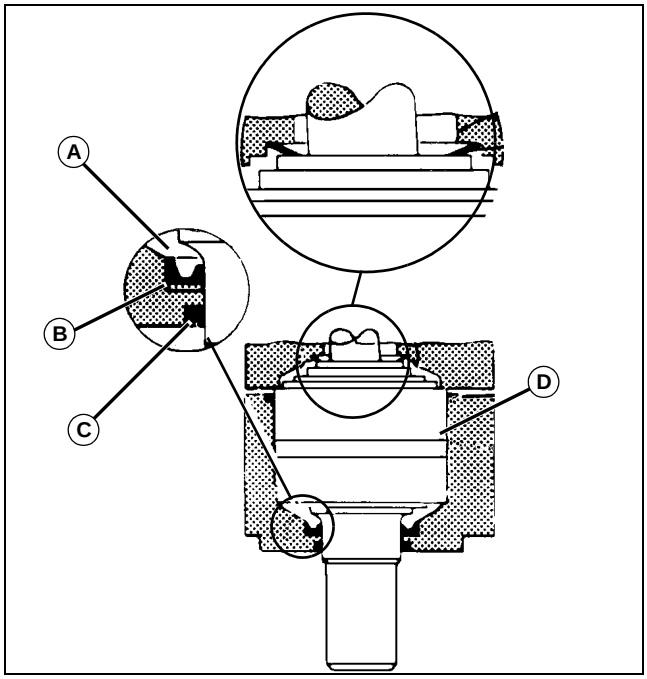
Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage.

Assemble Front Wheel Motor

Special or Required Tools

Tool Name	Tool No.	Tool Use
Balance Ring Tool	JDG859	Used to install balance ring.

NOTE: Always use new seals. Lubricate all seals with petroleum jelly prior to installation.



M56583

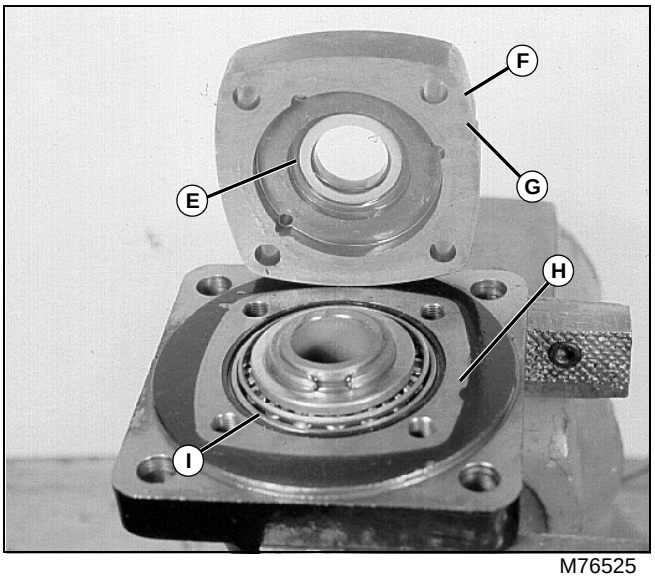
1. Use a press to install exclusion seal (C) in outer bore of bearing housing. Lip of seal must face outward. If a press is not available, use a plastic or rubber hammer. Be careful not to damage or cock seal in bore.

2. Place backup washer (B) into seal bore.

3. Press shaft seal (A) in housing bore with a suitable seal driver.

4. Apply petroleum jelly to inside diameter of dust and shaft seal.

5. Press bearing assembly (D) into housing. DO NOT distort shaft seal.

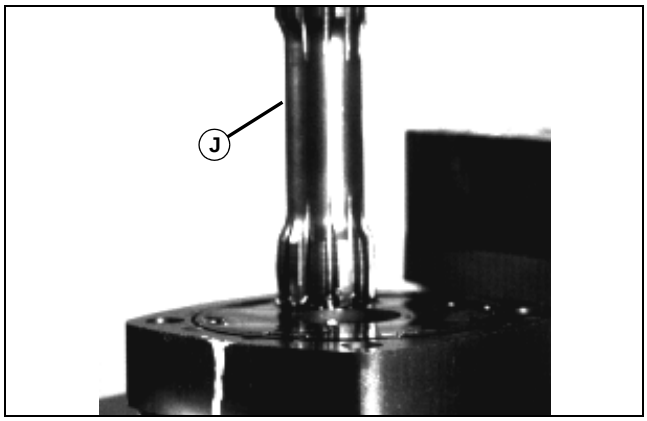


M76525

6. Apply petroleum jelly to diameter seal (I) and install into seal groove.

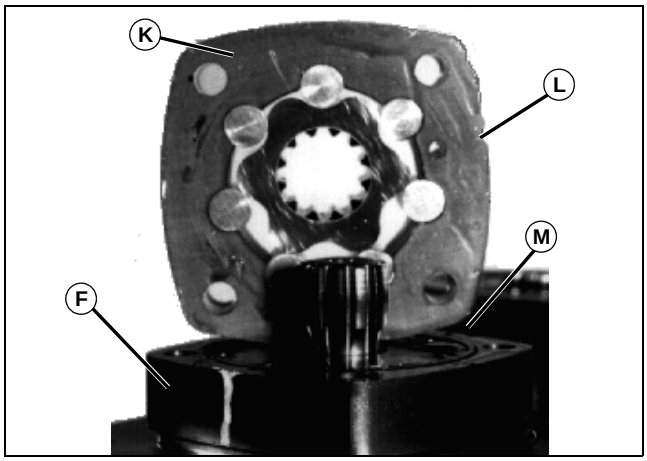
7. Install shaft face seal (E) in wear plate (F). Inner diameter edge of shaft face seal must contact shaft and bearing assembly when assembled.

8. Install wear plate. Align notch (G) in wear plate with housing by looking for matching paint mark (H).



M56578

9. Install driveshaft (J).

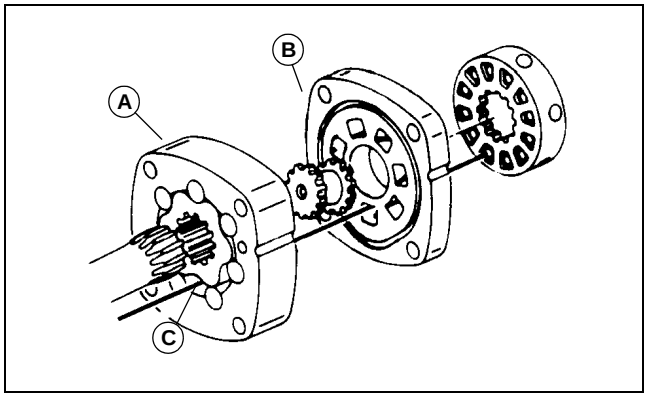


M56577

10.Align the notch (L) on the geroler (K) with the notch (M) on the wear plate (F). Install the geroler against the wear plate. Ensure the rollers stay with the outer ring if loose.

Timing

IMPORTANT: Avoid damage! Installation now involves timing in three steps. Timing determines the direction of rotation of the output shaft. All motors, regardless if left side or right side, will be timed the same way.



M56584

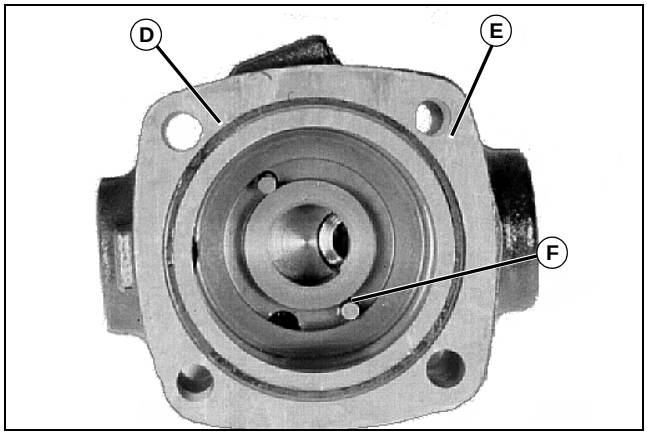
1. **Timing Step #1 -** Locate the largest open pocket (C) in the geroler (A) and mark it on the outside edge of the geroler.

2. Apply a light film of petroleum jelly to the diameter seal. Install seal in groove of valve plate (B).

3. Align the notch on the outside of the valve plate with the notch on the geroler. Place valve plate on geroler.

4. **Timing Step #2 -** Locate the slot opening in the valve plate that is in line with the largest open pocket of the geroler.

5. **Timing Step #3 -** Locate any one of the side openings of the valve. Then align the opening with the open slot of the valve plate that is in line with the largest open pocket of the geroler. Install the valve by rotating it clockwise until the spline teeth engage (1/2 spline tooth maximum).

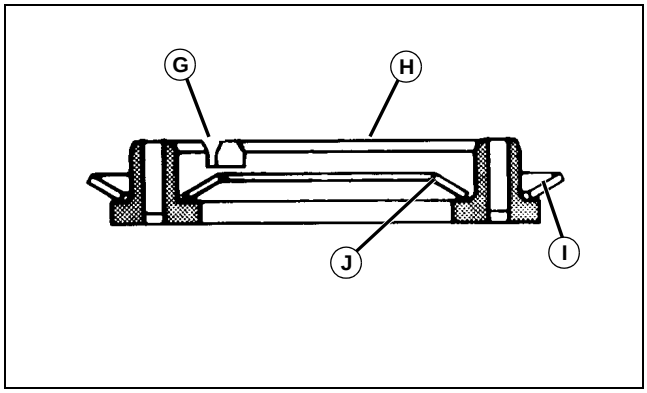


M76527

6. Install two springs and two pins (F) in the holes located in the bore of the valve housing (E).

7. Apply a light film of petroleum jelly to the diameter seal (D) and install seal in valve housing.

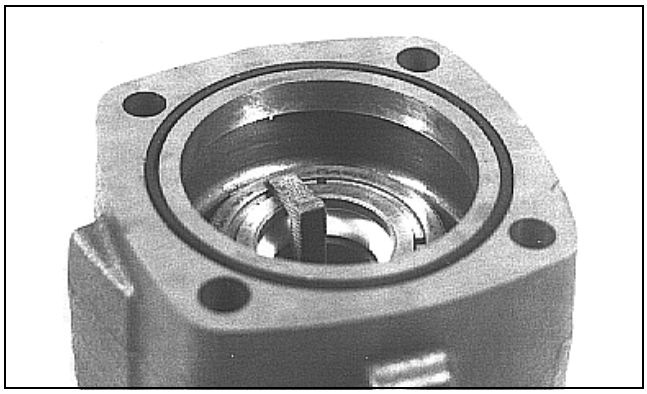
IMPORTANT: Avoid damage! Install face seals in the positions shown or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.



M76533

8. Apply petroleum jelly to inner and outer face seals (J and I) and install seals on balance ring (H) as shown.

9. Align pin notches (G) in balance ring with pins in valve housing.



M56600

10.While holding the balance ring in position with your fingers, insert the foot of the balance ring tool through the port that leads to the center of the valve housing.

M56601

11.Rotate the foot of the tool over the balance ring and gently pull the tool back to hold the balance ring in position.

12.Install the valve housing on the motor, rotate the foot of the tool, and remove it from the valve housing port.

13.Check for proper alignment by pushing down on the valve housing. A slight spring action should be felt. If not, repeat steps 9-12.

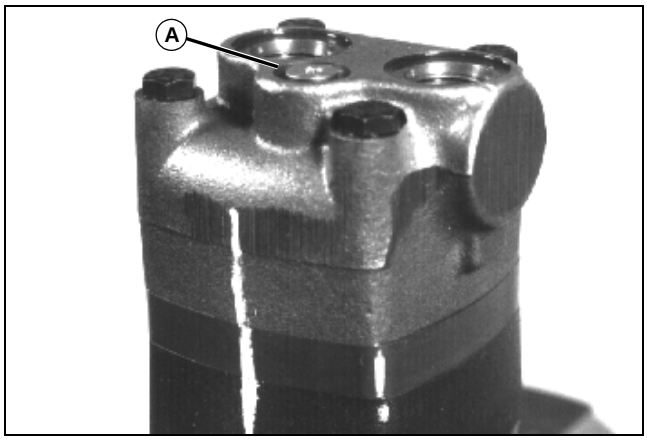
14.Install the tie bolts evenly and tighten to specifications.

Specifications

Motor Housing Cap Screw Torque . . . . 50 N•m (37 lb-ft)

Install Front Wheel Motor

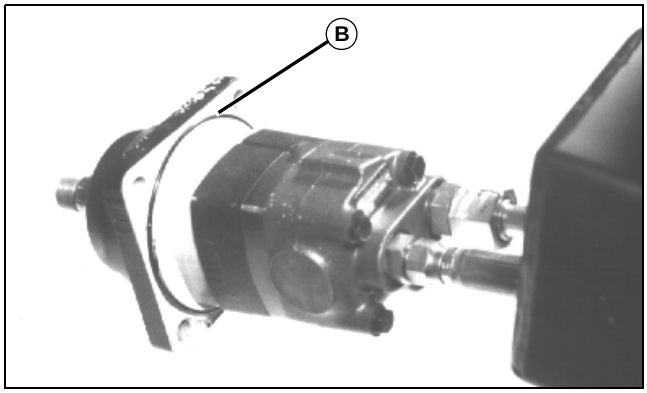
IMPORTANT: Avoid damage! Hydraulic reservoir and associated plumbing should be flushed to remove any contamination before installing wheel motors. This is especially critical following internal failure of wheel motors.



M56573

IMPORTANT: Avoid damage! Make sure that motor does not have a drain plug in the case drain port. If plug is present on unit being rebuilt, remove it. If new unit has a plug, remove it.

See Specifications and Information section before installing O-ring boss fittings and O-ring face seal fittings.



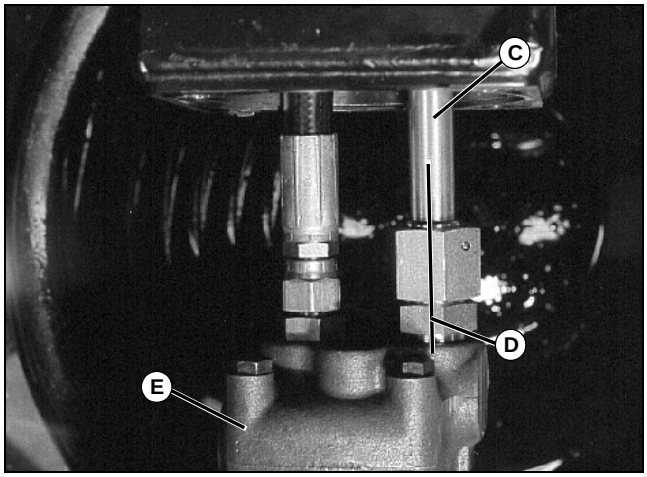
M56622

1. Remove plug (A) if installed.

2. Lubricate large O-ring (B) with petroleum jelly and install O-ring.

3. Lubricate small O-rings and install on fittings. Install fittings on motor end. Tighten fittings to specifications.

4. Lubricate small O-rings with petroleum jelly. Install O-rings; connect hydraulic lines. Tighten the larger line and the smaller line to specifications.

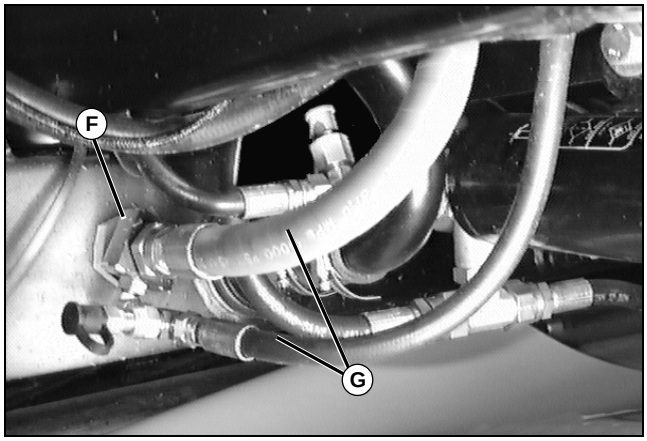


M76520

5. Index line (D) made during removal will aid in alignment of manifold block on opposite end of hard line (C).

NOTE: Threaded hole of manifold block on opposite end of hard line must line up with opening in reservoir for installation of block on rear of reservoir.

6. Position motor (E) into housing. Ensure that the female end of the hard line aligns with opening at rear of axle housing.

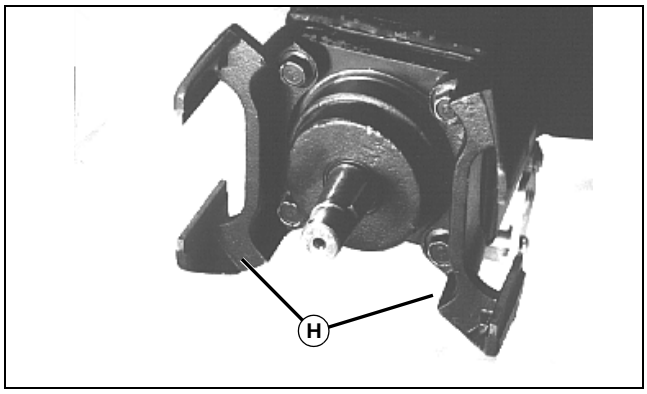


M58756

7. Thread block (F) into manifold block in reservoir, which is on the end of hard line from hydrostatic motor. Tighten block to specifications.

8. Tighten jam nut on block to secure block to axle/ reservoir. Tighten until flush plus 1/4 turn.

9. Attach hoses (G) from rear hydrostatic motors and hydrostatic pump to block.



M56623

10.Install caliper mounting brackets (H) and secure with four cap screws. Tighten to specifications. Install key.

11.Position calipers onto disk with arms facing up in relaxed position. Install disk and calipers onto keyed shaft as an assembly.

12.Install linkage arms and cotter pins.

13.Apply park brake.

14.Install nut and tighten to specifications.

Specifications

Motor Fitting Torque. . . . . 46 N•m (34 lb-ft)
Large Hydraulic Line Torque . . . . . 102 N•m (75 lb-ft)
Small Hydraulic Line Torque . . . . . 50 N•m (37 lb-ft)
Manifold Block Torque . . . . . 176 N•m (130 lb-ft)
Caliper Mounting Bracket Bolt Torque 140 N•m (105 lb-ft)
Rotor Nut Torque . . . . . 508 N•m (375 lb-ft)

Remove Rear Wheel Motor - Four-Wheel Drive Only

1. Park vehicle on a level surface and lock park brake.

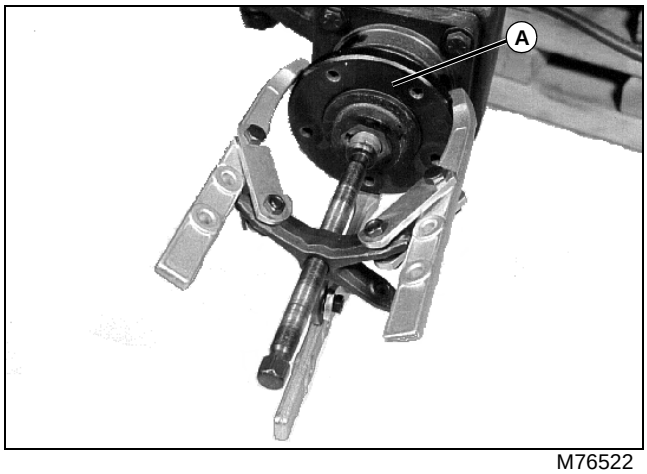
2. Raise rear of vehicle and support safely with jackstands or wood blocks.

3. Remove rear wheel from side of machine requiring motor removal.

NOTE: Pipe wrench is used to prevent disk from rotating when removing nut without air tools.

4. Remove nut from keyed motor shaft with 1-7/16 in. socket.

CAUTION: Avoid injury! Disk will release from motor shaft with force. Stand out of the way of disk when tapping with hammer.



M76522

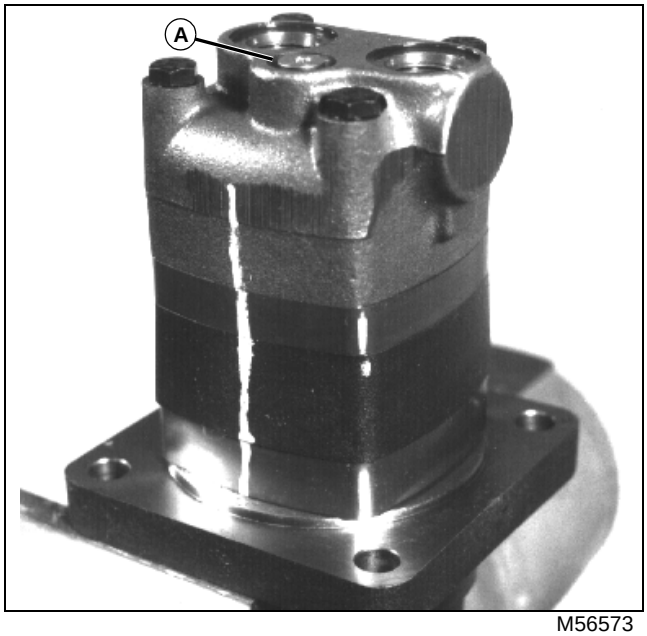
5. Remove rotor (A) from motor shaft using a three-jaw puller by applying tension and tapping with a hammer.

6. Remove hydraulic lines from motor.

7. Remove four mounting bolts from hydraulic mounting flange.

8. Remove motor from rear axle housing.

Disassemble Rear Wheel Motor



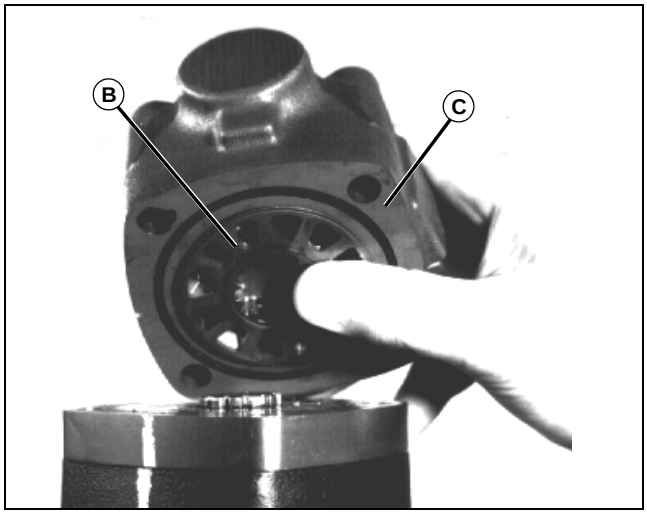
M56573

1. Remove fittings from backplate of motor.

2. Remove case drain plug (A) and seal.

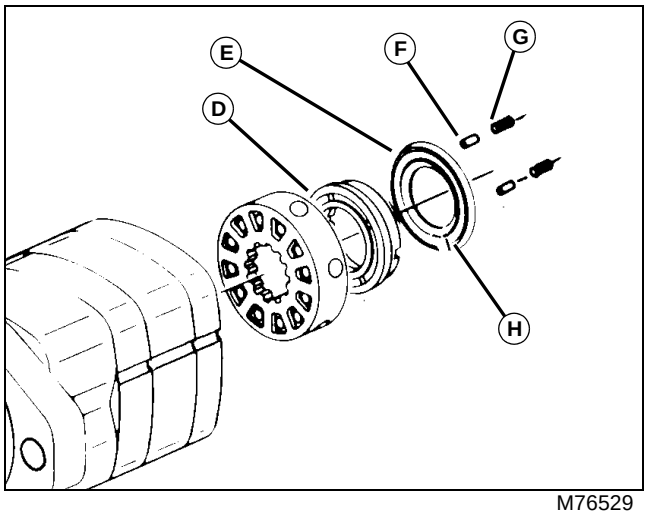
3. Place the motor in a vise with output shaft facing down. Use a soft-jaw vise or wood between the jaws and avoid excessive clamping pressure. Clamp across the mounting flange of the motor, not the housing.

NOTE: If the valve cannot be removed with the valve housing, be careful not to lose the two pins and springs that may fall from the housing during removal.



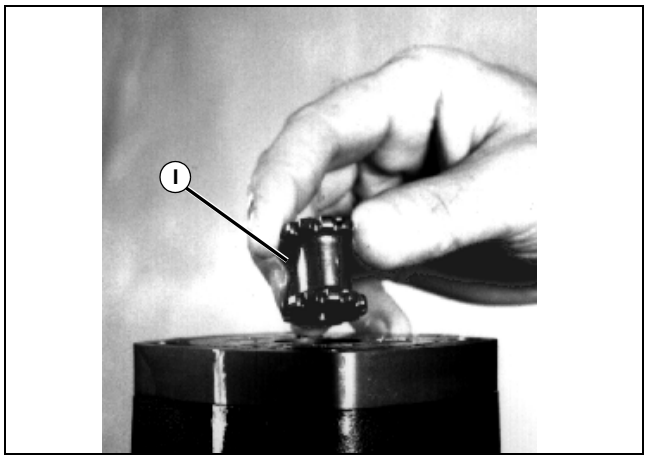
M56574

4. Remove the four cap screws from the valve housing (C). Lift the valve housing just enough to place your finger under the valve (B) and remove the housing with the valve. Place the housing and valve upside down on the bench. Remove valve from housing.



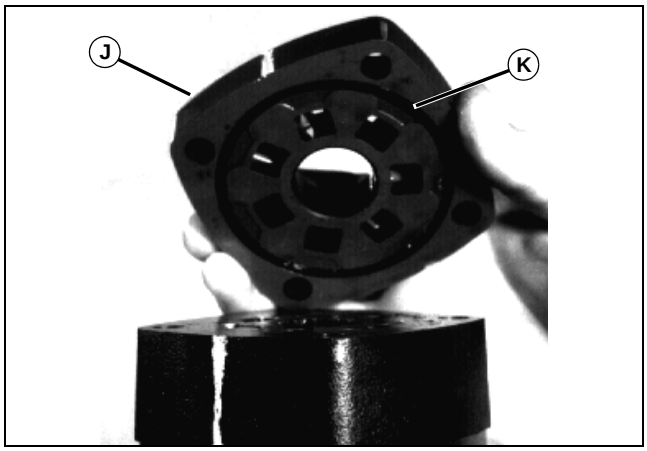
M76529

5. Remove balance ring (D), two pins (F) and springs (G), and inner and outer face seals (H and E).



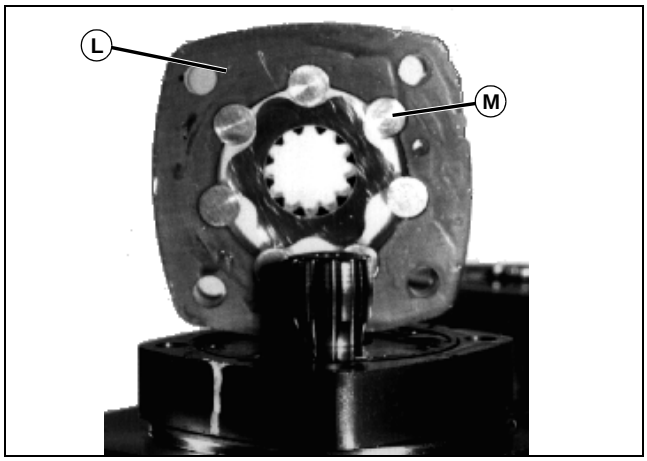
M56575

6. Remove the valve drive (I).



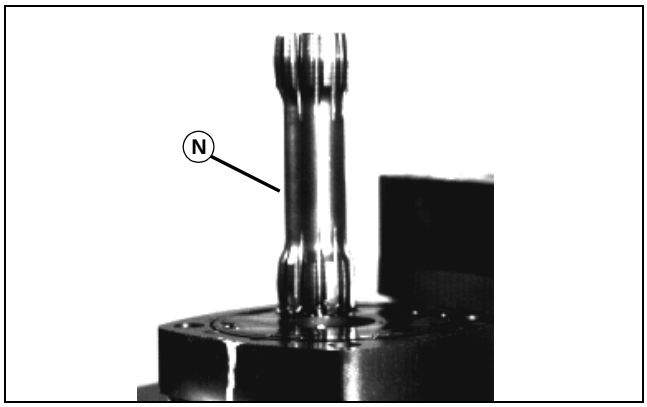
M56576

7. Remove valve plate (J) and seal (K).



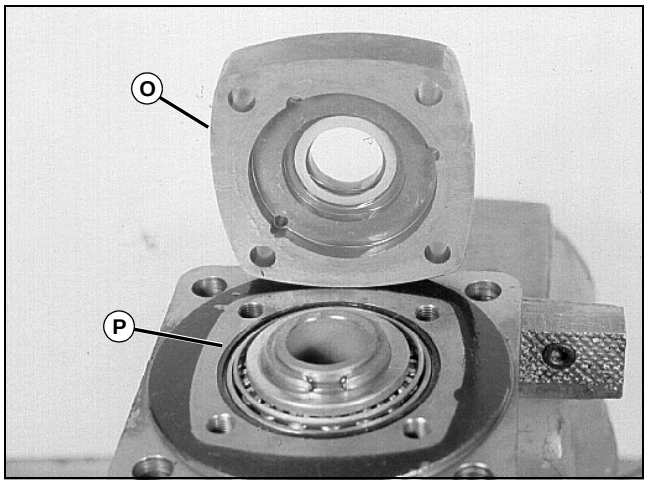
M56577

8. Remove the geroler (L). Be sure to retain the rollers (M) if they are loose.



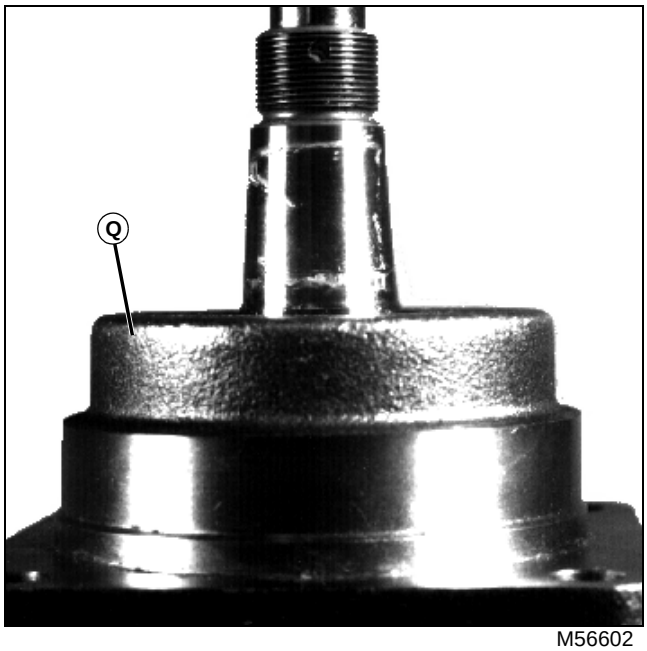
M56578

9. Remove the drive (N).



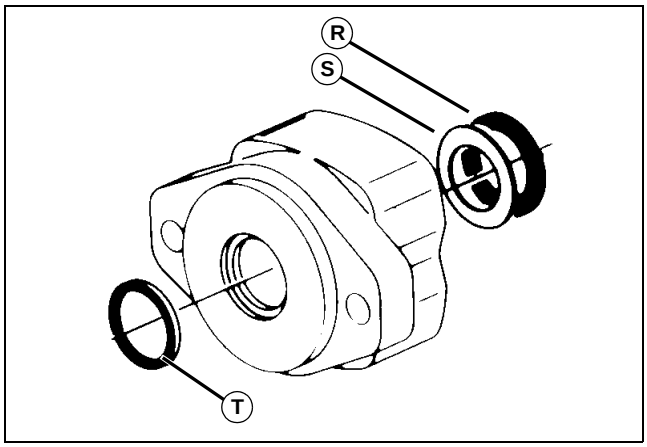
M76525

10.Remove wear plate (O) and seal (P).



M56602

11.Remove drive key and press shaft and bearing assembly from the bearing housing (Q).



M76532

12.Use a small screwdriver and remove the shaft seal (R), backup washer (S), and exclusion seal (T). Be careful not to damage housing bore.

Inspect Rear Wheel Motors

IMPORTANT: Avoid damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection. DO NOT use coarse grit or try to file or grind these parts.

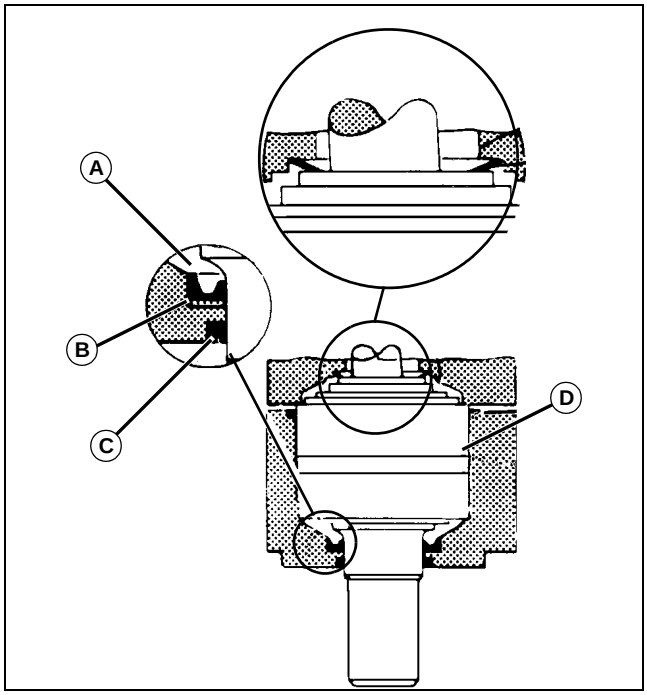
Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage.

Assemble Rear Wheel Motor

Special or Required Tools

Tool Name	Tool No.	Tool Use
Balance Ring Tool	JDG859	Used to install balance ring.

NOTE: Always use new seals. Lubricate all seals with petroleum jelly prior to installation.



M56583

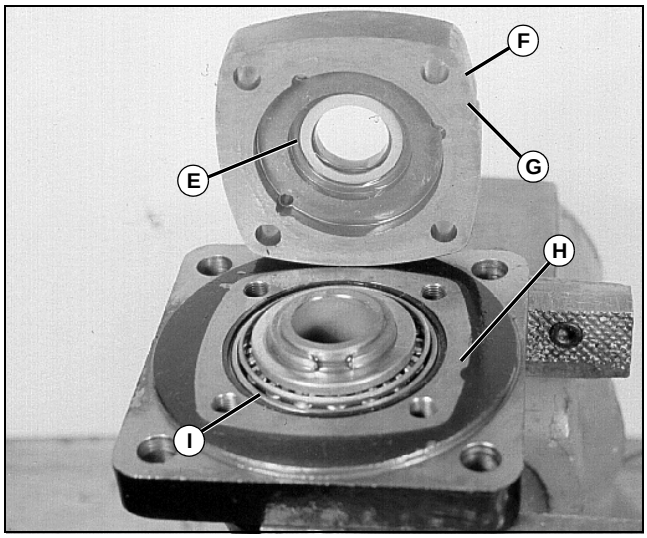
1. Use a press to install exclusion seal (C) in outer bore of bearing housing. Lip of seal must face outward. If a press is not available, use a plastic or rubber hammer. Be careful not to damage or cock seal in bore.

2. Place backup washer (B) into seal bore.

3. Press shaft seal (A) in housing bore with a suitable seal driver.

4. Apply petroleum jelly to inside diameter of dust and shaft seal.

5. Press bearing assembly (D) into housing. DO NOT distort shaft seal.

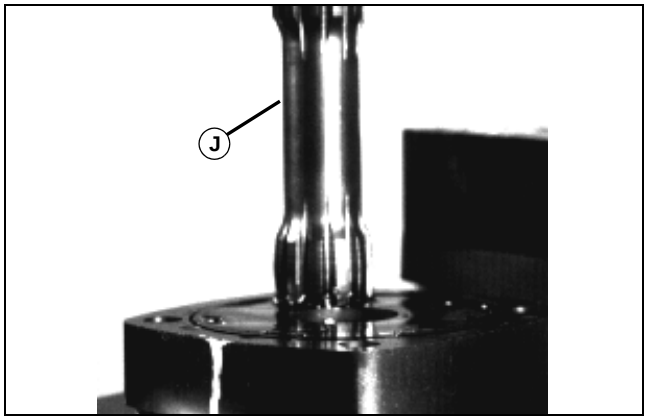


M76525

6. Apply petroleum jelly to diameter seal (I) and install into seal groove.

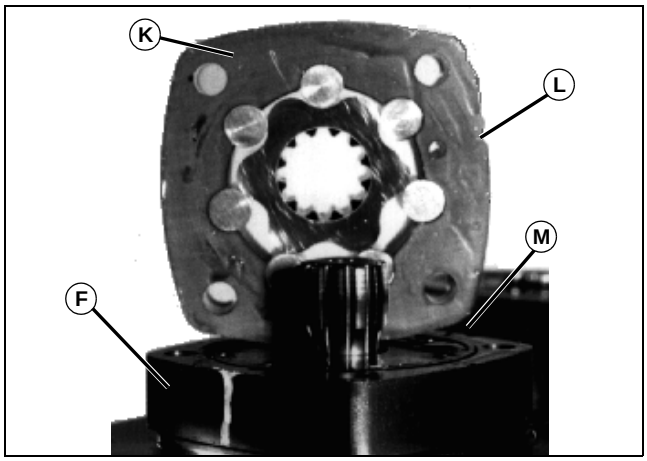
7. Install shaft face seal (E) in wear plate (F). Inner diameter edge of shaft face seal must contact shaft and bearing assembly when assembled.

8. Install wear plate. Align notch (G) in wear plate with housing by looking for matching paint mark (H).



M56578

9. Install driveshaft (J).

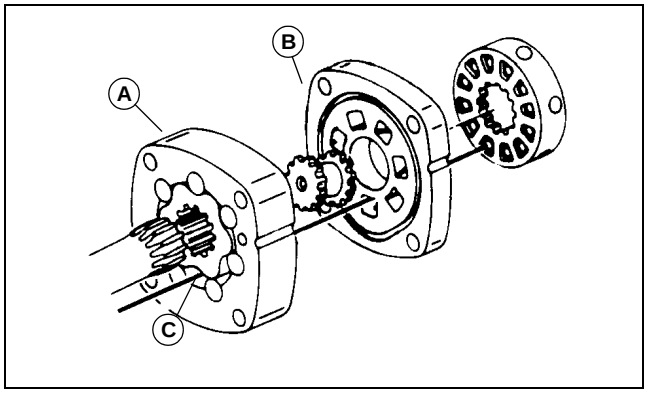


M56577

10.Align the notch (L) on the geroler (K) with the notch (M) on the wear plate (F). Install the geroler against the wear plate. Ensure the rollers stay with the outer ring if loose.

Timing

IMPORTANT: Avoid damage! Installation now involves timing in three steps. Timing determines the direction of rotation of the output shaft. All motors, regardless if left side or right side, will be timed the same way.



M56584

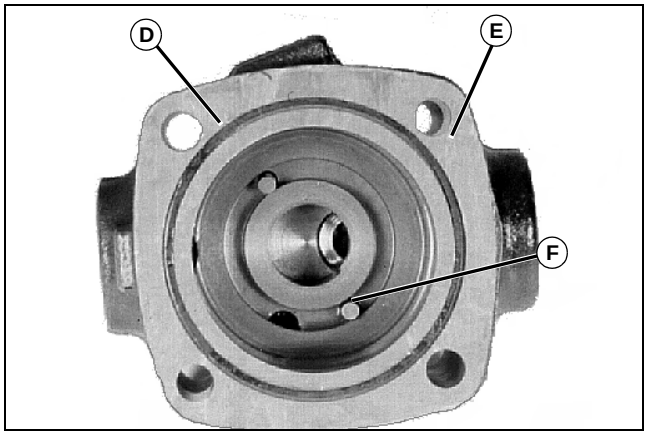
1. **Timing Step #1 -** Locate the largest open pocket (C) in the geroler (A) and mark it on the outside edge of the geroler.

2. Apply a light film of petroleum jelly to the diameter seal. Install seal in groove of valve plate (B).

3. Align the notch on the outside of the valve plate with the notch on the geroler. Place valve plate on geroler.

4. **Timing Step #2 -** Locate the slot opening in the valve plate that is in line with the largest open pocket of the geroler.

5. **Timing Step #3 -** Locate any one of the side openings of the valve. Then align the opening with the open slot of the valve plate that is in line with the largest open pocket of the geroler. Install the valve by rotating it clockwise until the spline teeth engage (1/2 spline tooth maximum).

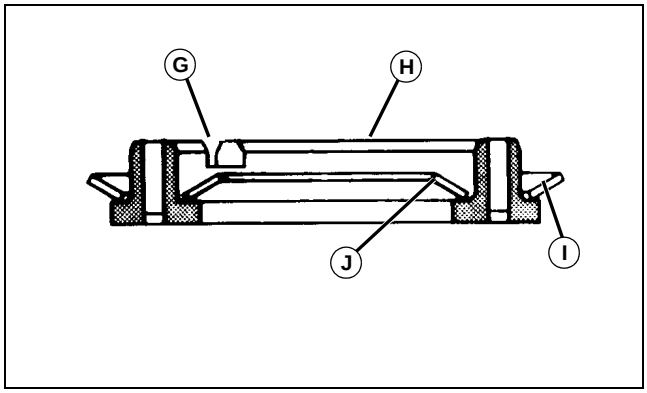


M76527

6. Install two springs and two pins (F) in the holes located in the bore of the valve housing (E).

7. Apply a light film of petroleum jelly to the diameter seal (D) and install seal in valve housing.

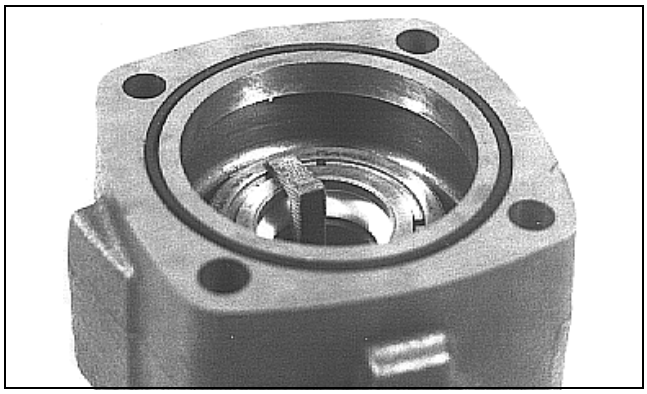
IMPORTANT: Avoid damage! Install face seals in the positions shown or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.



M76533

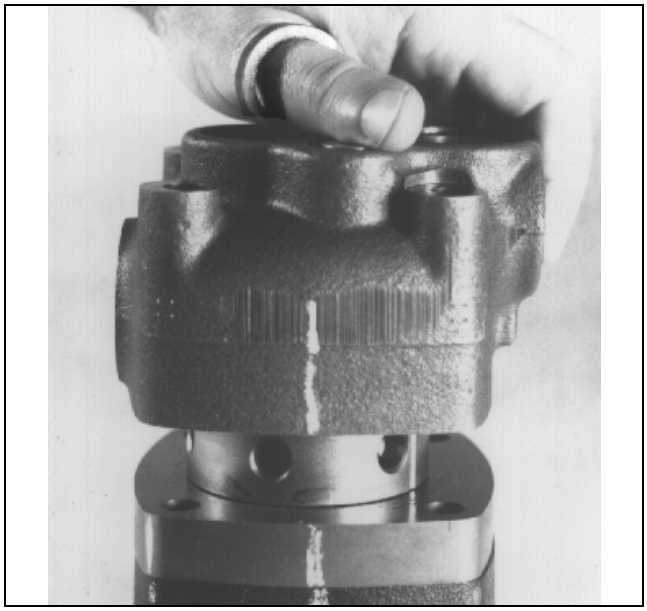
8. Apply petroleum jelly to inner and outer face seals (J and I) and install seals on balance ring (H) as shown.

9. Align pin notches (G) in balance ring with pins in valve housing.



M56600

10.While holding the balance ring in position with your fingers, insert the foot of the balance ring tool through the port that leads to the center of the valve housing.



M56601

11.Rotate the foot of the tool over the balance ring and gently pull the tool, back to hold the balance ring in position.

12.Install the valve housing on the motor, rotate the foot of the tool and remove it from the valve housing port.

13.Check for proper alignment by pushing down on the valve housing. A slight spring action should be felt. If not, repeat steps 9-12.

14.Install the tie bolts evenly and tighten to specifications.

Specifications

Motor Housing Cap Screw Torque . . . 50 N•m (37 lb-ft)

Install Rear Wheel Motor - Four-Wheel Drive Only

1. Place hydrostatic motor in rear axle housing.

2. Position motor so the fittings on the backplate of the motor face rear of the machine.

3. Install four bolts through motor mounting flange and into rear axle housing. Tighten to specifications.

4. Install hydraulic lines on motor.

5. Place rotor on motor shaft and install nut. Use pipe wrench to keep disk from turning if not using air tools. Tighten to specifications.

6. Install wheel and tire assembly.

7. Start machine and operate motor to determine if motor rotates in the proper direction.

If motor rotates in wrong direction, the hydraulic lines are reversed or timing procedure of the motor is incorrect. (See “Assemble Rear Wheel Motor” on page 321) for timing procedure.

Specifications

Rear Axle Housing Bolt Torque . . . . 140 N•m (105 lb-ft)
Rotor Nut Torque . . . . . 508 N•m (375 lb-ft)

Start-Up Procedure

IMPORTANT: Avoid damage! Follow this procedure to properly purge the hydrostatic drive system before returning the machine to service.

1. Ensure hydraulic reservoir is full.

2. Disconnect fuel shutoff solenoid connector and crank engine for 15 seconds.

3. Reconnect fuel shutoff solenoid connector.

4. With transmission in neutral, start engine and run at slow idle.

5. Operate steering and lift system through several cycles. Slowly operate the machine in forward and reverse to purge the air from the system.

6. Check and replenish the reservoir.

7. Check all connections for leaks and tighten if necessary.

8. Short hour filter changes are recommended for the first two changes after returning the machine back to service. Change the first filter after 3-5 hours of operation and the second after 50 hours.

HYDRAULICS TABLE OF CONTENTS

Table of Contents

Specifications

General Specifications

Triple Pump (Front Gear Set)

Make	Danfoss
Flow	17 L/min (4.5 gpm)
Required Pressure at Hydrostatic Pump Input	414-1103 kPa (60-160 psi)
Relief Valve Setting - 3225C (In Hydrostatic Pump)	690-1034 kPa (100-150 psi)
Relief Valve Setting - 3235C and 3245C (In Hydrostatic Pump)	1310-1517 kPa (190-220 psi)

Reel Pumps

Make	Danfoss
Flow	32.6 L/min (8.6 gpm)
Type	Gear, positive displacement

Rotary Mower Pumps

Make	Danfoss
Flow	38 L/min (10 gpm)
Type	Gear, positive displacement

Reel Motors

Make	Danfoss
Displacement (Standard Reels)	13.9 cm^3 (0.85 cu in.)
Displacement (Heavy Duty Reels)	19 cm^3 (1.16 cu in.)
Type	Gear, with case drain flow

Rotary Mower Motors

Make	Danfoss
Displacement	12.6 cm^3 (0.77 cu in.)
Type	Gear, with case drain flow

Reel Speeds @ 3000 Engine RPM (Engine Not Loaded)

3225C and 3235C Reels (Standard)	2200 ± 150 rpm
3225C and 3235C Reels (Heavy Duty)	1700 ± 150 rpm

Rotary Mower Speeds @ 3000 Engine RPM (Engine Not Loaded)

3245C Mowers	2800 ± 150 rpm

Front Inboard and Rear Lift Cylinders

Stroke	152 mm (6 in.)
Compressed Length	289 mm (6 in.)

Front Outer Lift Cylinder

Stroke	203 mm (8 in.)
Compressed Length	975 mm (38-3/8 in.)

Hydraulic Filter

Type	**10 micron spin-on**
Clogged Filter Bypasses Fluid to Tank At	**344.74 kPa (50 psi)**
Filter Bypass Light Comes On At	**275.79 kPa (40 psi)**

Test and Adjustment Specifications

Specifications

Front and Rear Mower Motor Circuit Relief Pressure	**20 684 ± 1380 kPa (3000 ± 200 psi)**
Reel Circuit Pump Flow at 13 790 kPa (2000 psi) and 3000 Engine rpm (Minimum)	**24.6 L/min (6.5 gpm)**
Rotary Mower Circuit Pump Flow at 13 790 kPa (2000 psi) and 3000 Engine rpm (Minimum)	**30.3 L/min (8.0 gpm)**
Cutting Unit Motor Case Drain @ 13 790 kPa (2000 psi) (Maximum)	**3.8 L/min (1.0 gpm)**
Lift System Relief Valve Pressure	**11 721-13 790 kPa (1700-2000 psi)**
Lift/Steering System Pump Flow at 6895 kPa (1000 psi) and 3000 Engine rpm (Minimum)	**13.2 L/min (3.5 gpm)**

Repair Specifications

Lift Valve

Mounting Cap Screw Torque	**43 N•m (32 lb-ft)**
Check Valve Torque	**26-28 N•m (19-21 lb-ft)**
Spool Torque	**26-28 N•m (19-21 lb-ft)**
Retaining Nut Torque	**5-7 N•m (48-60 lb-in.)**

Triple Pump - 3225C, 3235C, and 3245C

Hex Head Screw (3/8-in.) Torque	**40-43 N•m (30-32 lb-ft)**
Hex Head Screw (5/16-in.) Torque	**21-24 N•m (190-210 lb-in.)**

Rotary/Reel Mower Motor

Standard Duty, Cap Screw Torque	**45 N•m (33 lb-ft)**
Rotary/Reel Heavy Duty, Hex Head Screw (5/16-in.) Torque	**21-24 N•m (190-210 lb-in.)**
Rotary/Reel Heavy Duty, Hex Head Screw (3/8-in.) Torque	**40-43 N•m (30-32 lb-ft)**

Backlapping Valve - 3225C and 3235C

Forward/Reverse Switch Torque	**4-7 N•m (36-60 lb-in.)**
Forward/Reverse Valve Torque	**108-136 N•m (80-100 lb-ft)**
Filter Screen (Installation Below Spot Face) Torque	**16-17 mm (0.64-0.68 in.)**
Solenoid Valve Torque	**27-34 N•m (20-25 lb-ft)**
Coil Nut Torque	**7-9 N•m (65-75 lb-in.)**
Flow Control Knob Screw Torque	**2-3 N•m (18-24 lb-in.)**
Flow Control Valve Torque	**34-41 N•m (25-30 lb-ft)**
Check Valve Plug Torque	**47-54 N•m (35-40 lb-ft)**
Logic Element Torque	**41-47 N•m (30-35 lb-ft)**

Mow Valve - 3245C

Relief Valve Torque	**47-54 N•m (35-40 lb-ft)**
Mower Control Valve Cap Screws Torque	**5-6 N•m (40-53 lb-in.)**
Mower Control Valve Plug Torque	**27-34 N•m (20-25 lb-ft)**
Mower Control Solenoid Valve Torque	**27-34 N•m (20-25 lb-ft)**
Solenoid Coil Nut Torque	**7-9 N•m (65-75 lb-in.)**
Check Valve Torque	**47-54 N•m (35-40 lb-ft)**

Tools and Materials

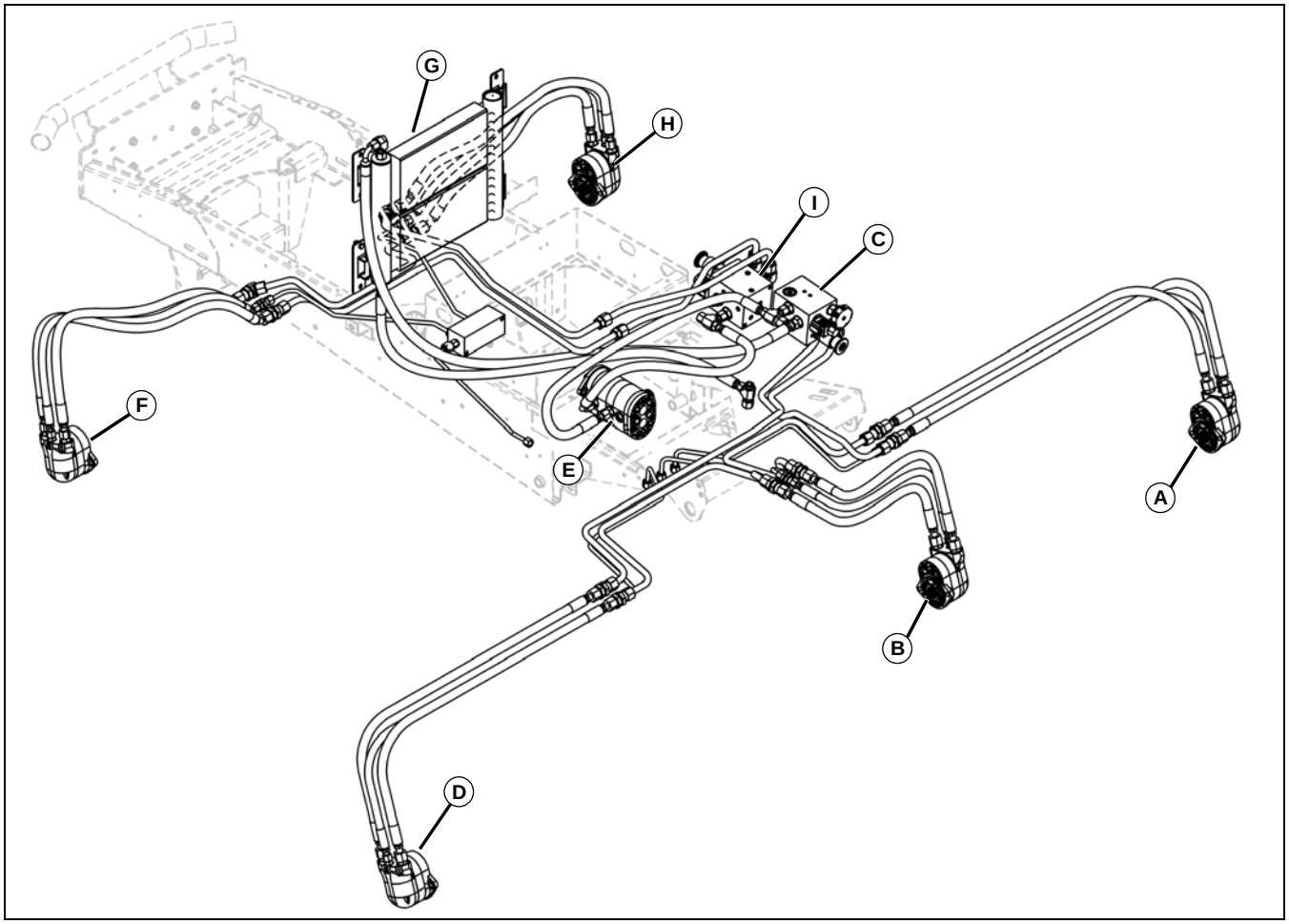
Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Pressure Diagnostic Kit	JDG2031	Used to test mower motor relief, lift system relief and to adjust optional down pressure valve.
Diagnostic Flow Kit	JDG2032	Used to measure hydrostatic pump, mow circuit and case drain hydraulic oil flow.
Pressure Gage Kit	JDG2033	Used to test mower motor relief and lift system relief and to adjust optional down pressure valve.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Component Location

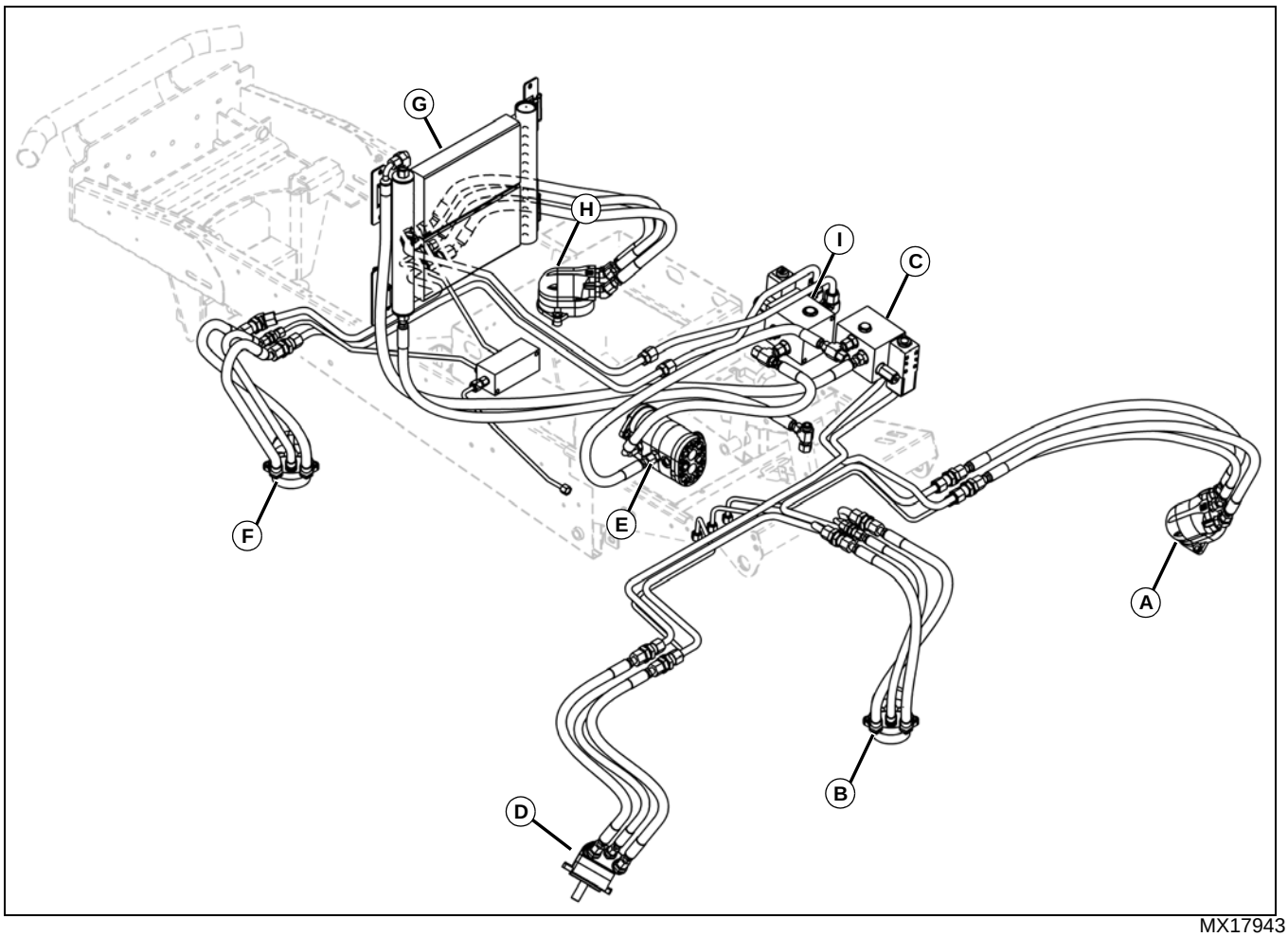
Reel Mower Circuit Component Location - 3225C and 3235C



MX17942

A - Left Front Reel Motor
B - Center Front Reel Motor
C - Backlapping Valve (Front)
D - Right Front Reel Motor
E - Triple Pump Assembly
F - Right Rear Reel Motor
G - Hydraulic Oil Cooler
H - Left Rear Reel Motor
I - Backlapping Valve (Rear)

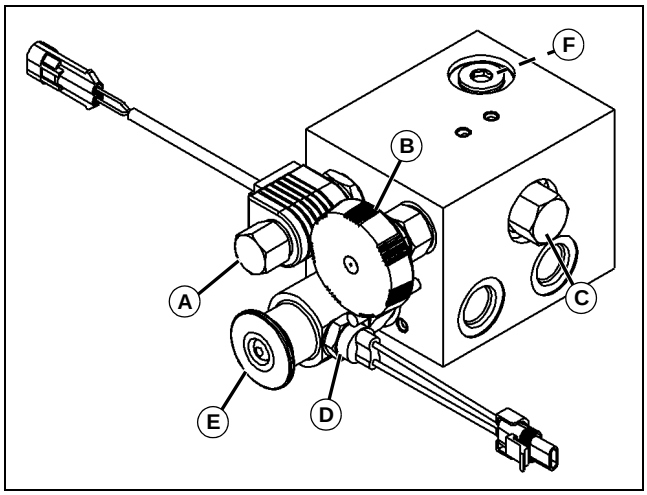
Rotary Mower Circuit Component Location - 3245C



MX17943

A - Left Front Rotary Mower Motor
B - Center Front Rotary Mower Motor
C - Mow Valve (Front)
D - Right Front Rotary Mower Motor
E - Triple Pump Assembly
F - Right Rear Rotary Mower Motor
G - Hydraulic Oil Cooler
H - Left Rear Rotary Mower Motor
I - Mow Valve (Rear)

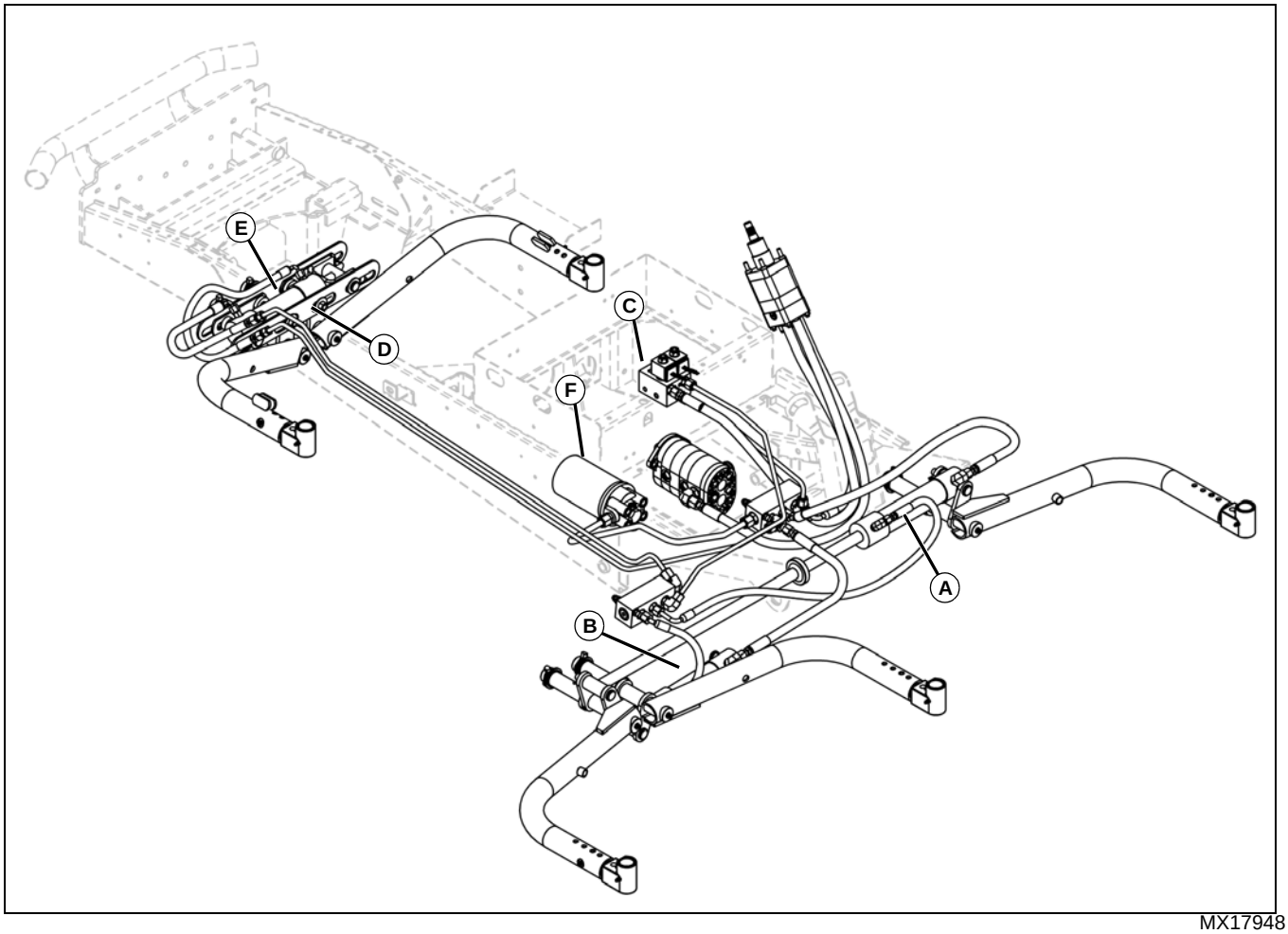
Backlapping Valve Component Location - 3225C and 3235C



MX17944

- **A - Mow Valve**
- **B - Flow Control Valve**
- **C - Logic Element**
- **D - Switch**
- **E - Forward/Reverse Valve**
- **F - Check Valve**

Lift Circuit Component Location



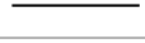
MX17948

A - Left/Right Wing Lift Cylinder
B - Center Lift Cylinder
C - Lift Valve
D - Lost Motion Linkage
E - Rear Lift Cylinder
F - System Filter

Schematics and Harnesses

JIC Hydraulic Circuit Symbols

Lines

1		Working (Main) Lines
2		Pilot Control Lines
3		Drain Line
4		Hydraulic/Pneumatic Flow Direction
5		Crossing Lines
6		Joining Lines
7		Flexible Line

Pumps

8		Fixed Displacement
9		Variable Displacement

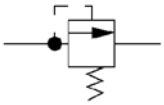
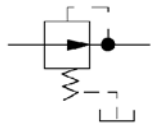
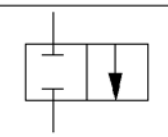
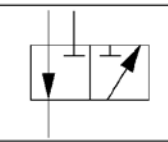
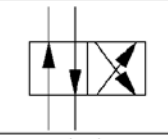
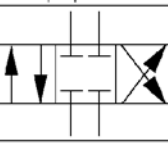
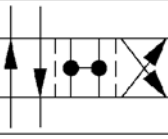
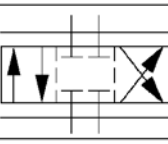
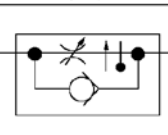
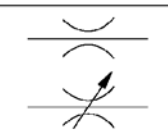
Motors

10		Fixed Displacement
11		Variable Displacement

Reservoir

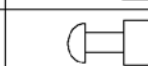
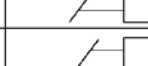
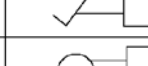
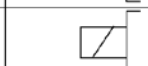
12		Vented Reservoir
13		Pressurized Reservoir
14		Reservoir Return -Above Fluid Level
15		Reservoir Return -Below Fluid Level

Valves

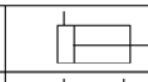
16		Check Valve
17		Manual On/Off Valve
19		Pressure Relief Valve
20		Pressure Reduction Valve
21		Two-Position, Two-Connection Valve
22		Two-Position, Three-Connection Valve
23		Two-Position, Four-Connection Valve
24		Three-Position, Four-Connection Valve
25		Two-Position, Four-Connection Valve with Transmission
26		Three-Position, Four-Connection Valve with Infinite Positioning
27		Adjustable Flow Control Valve (Temperature and Pressure Compensated)
18		Fixed/Variable Orifice

MX30024

Valve Operators

28		Spring
29		Manual
30		Push Button
31		Push/Pull Lever
32		Pedal or Treadle
33		Mechanical
34		Detents
35		Pressure Compensated
36		Solenoid Single Winding
37		Reversing Motor
38		Pilot Pressure Remote Supply
39		Pilot Pressure Internal Supply

Cylinders

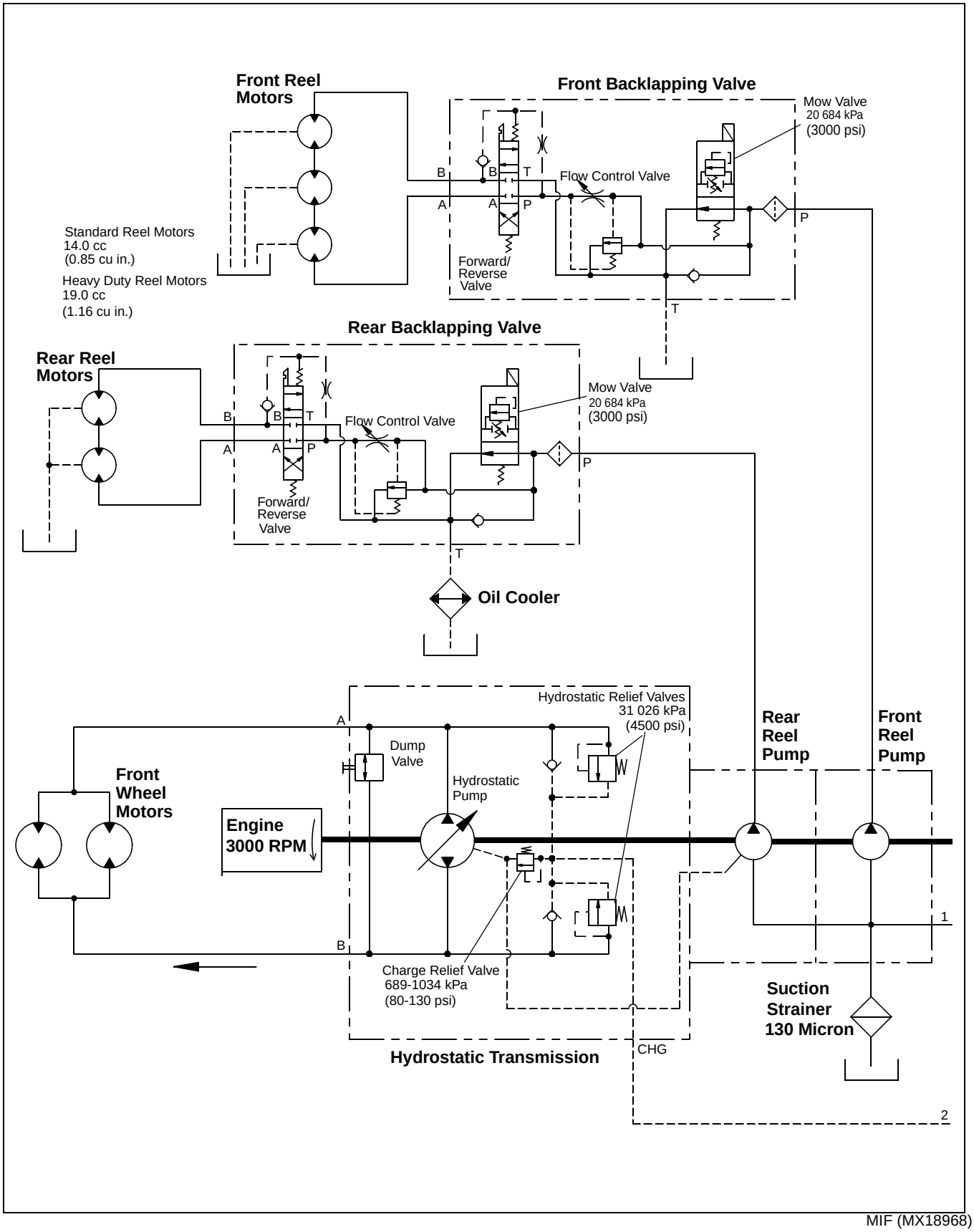
40		Single Acting
41		Double Acting Single Rod
42		Double Acting Double Rod
43		Double Acting, Adj. Cushion, Extend Only
44		Double Acting Differential Piston

Miscellaneous

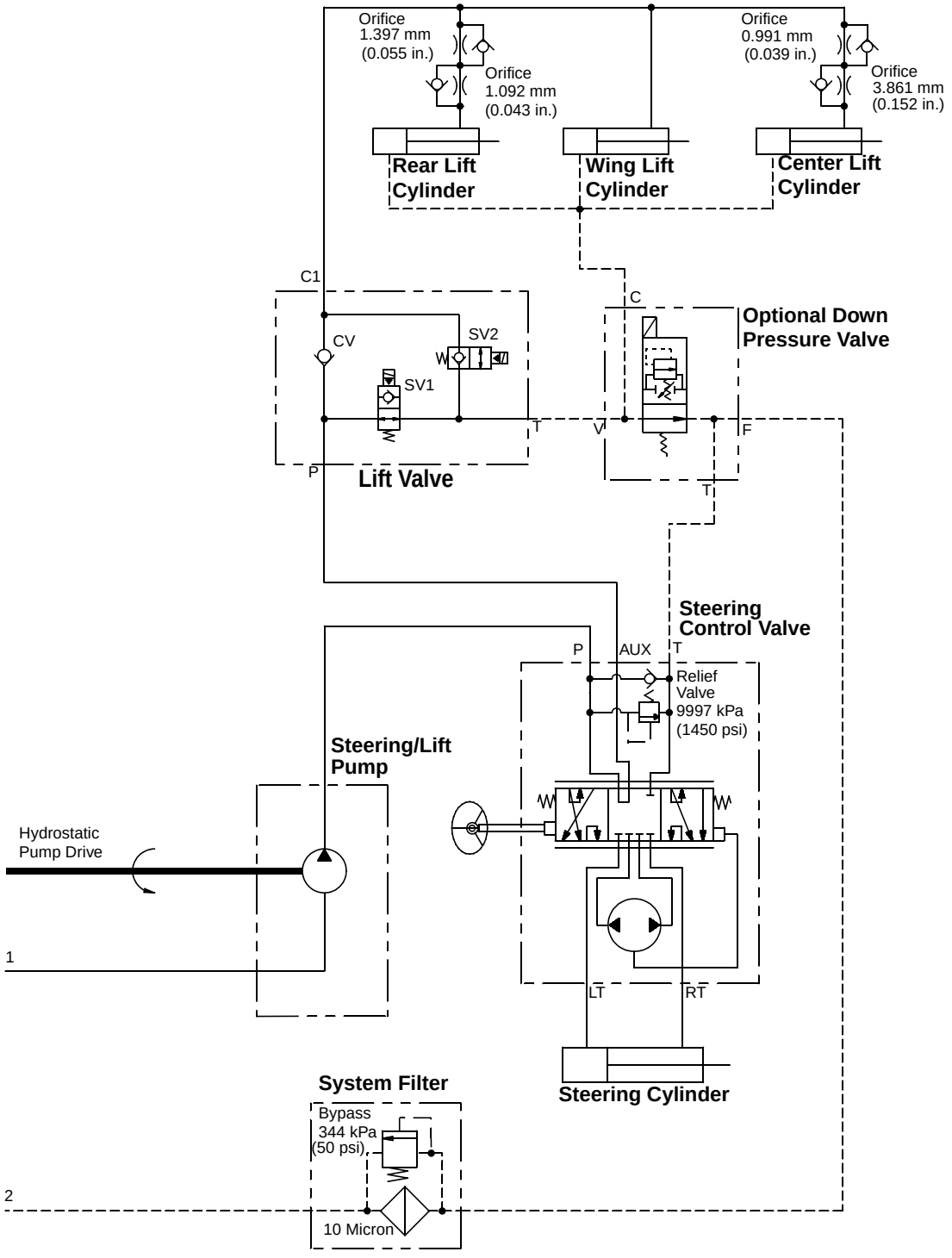
45		Cooler
46		Filter, Strainer
47		Heater
48		Temperature Controller
49		Pressure Switch
50		Pressure Indicator
51		Temperature Indicator
52		Pressure Compensated Variable Component
53		(Symbol Through Component)
54		Plug, Test Port, Pressure Supply Test
55		Gas Charged Accumulator
56		Spring Loaded Accumulator
57		Electric Motor
58		Shaft Rotation (Arrow on Near Side of Shaft)
59		Component Outline

MX30025

Hydraulic Schematic - 3225C

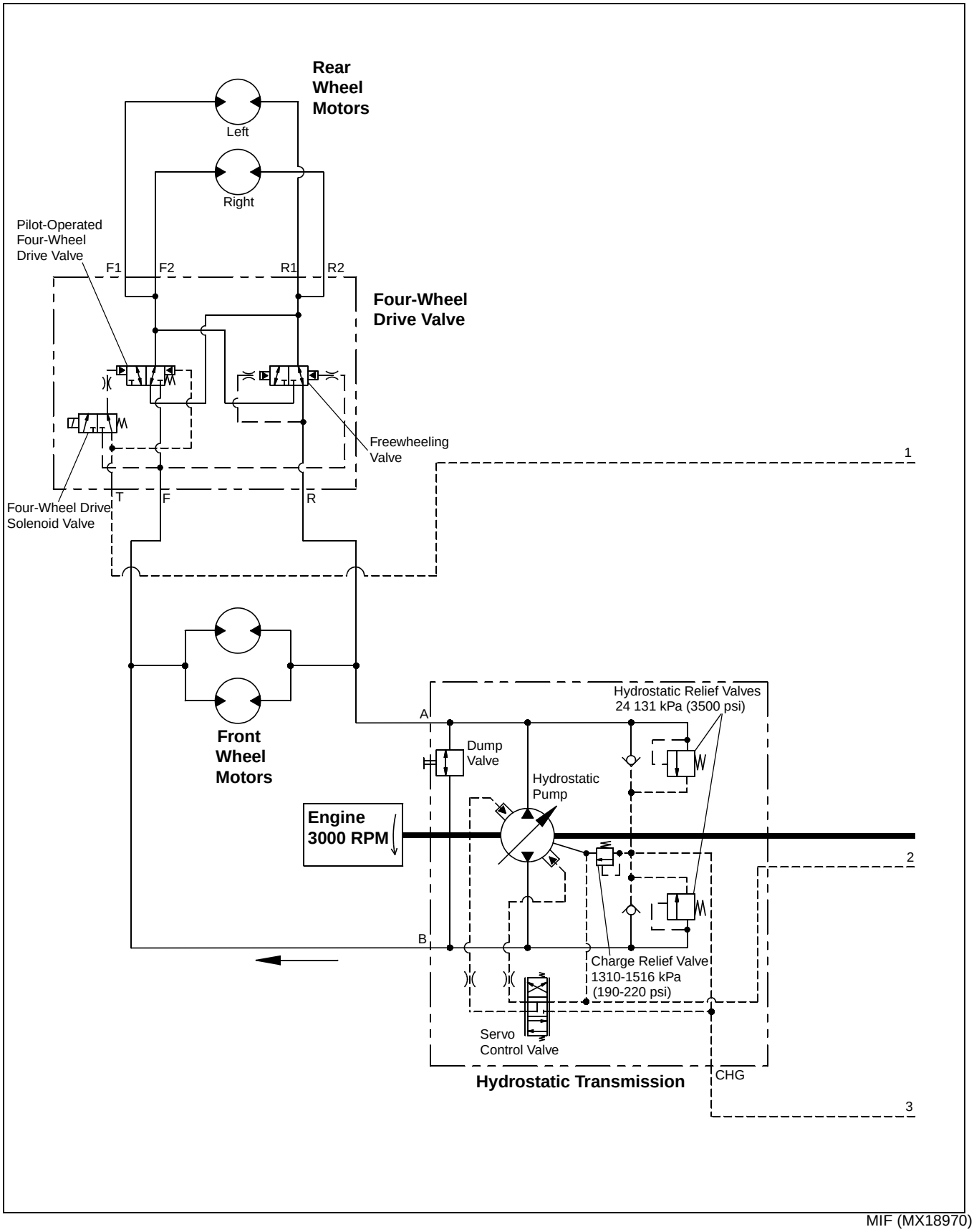


MIF (MX18968)


Orifice
1.397 mm
(0.055 in.)
Orifice
1.092 mm
(0.043 in.)
Orifice
0.991 mm
(0.039 in.)
Orifice
3.861 mm
(0.152 in.)
Rear Lift
Cylinder
Wing Lift
Cylinder
Center Lift
Cylinder
C1
CV
SV2
SV1
T
P
Lift Valve
C
V
F
T
Optional Down
Pressure Valve
Steering
Control Valve
P
AUX
T
Relief
Valve
9997 kPa
(1450 psi)
Steering/Lift
Pump
Hydrostatic
Pump Drive
1
LT
RT
Steering Cylinder
System Filter
Bypass
344 kPa
(50 psi)
2
10 Micron

MIF (MX18969)

Hydraulic Schematic - 3235C



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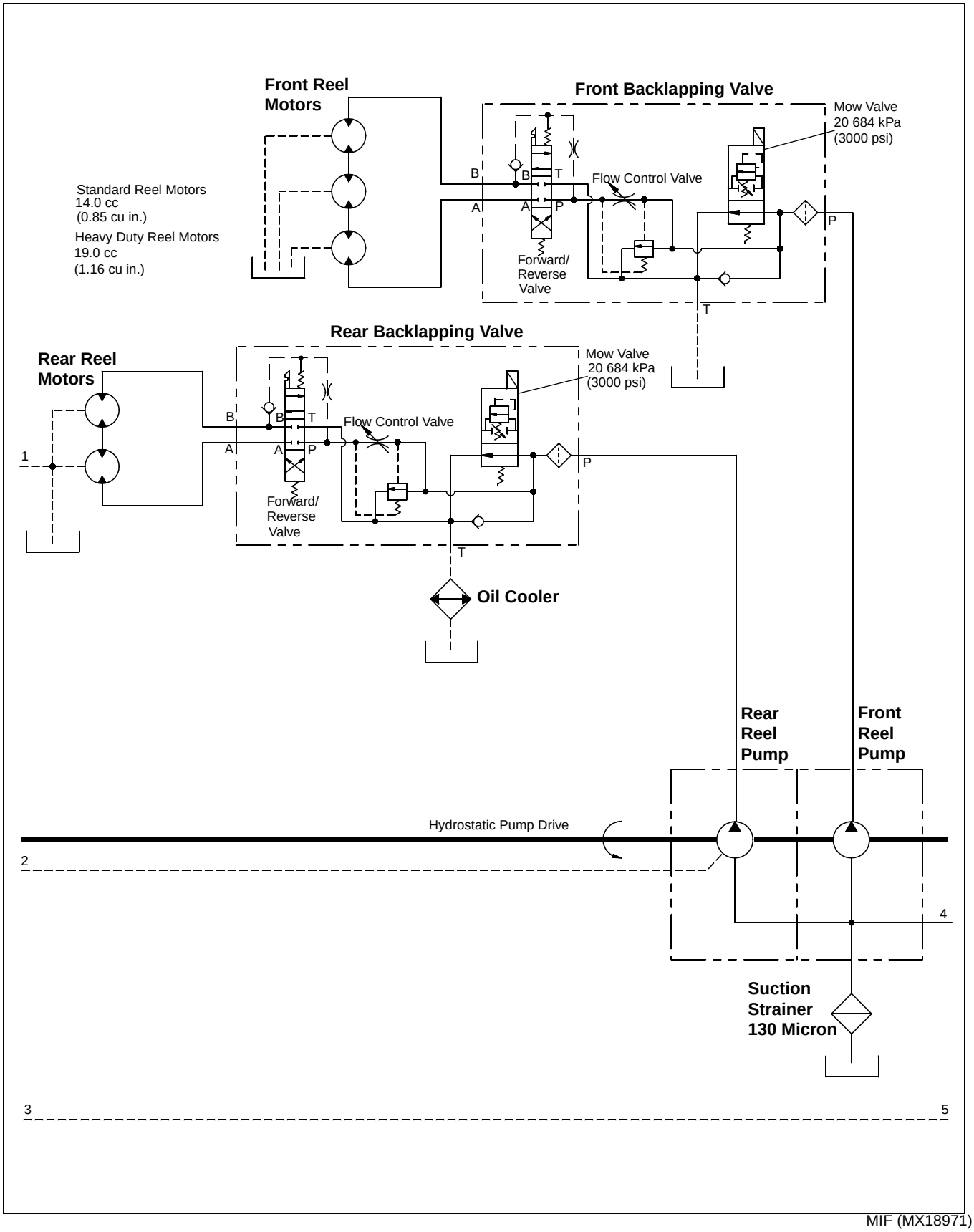
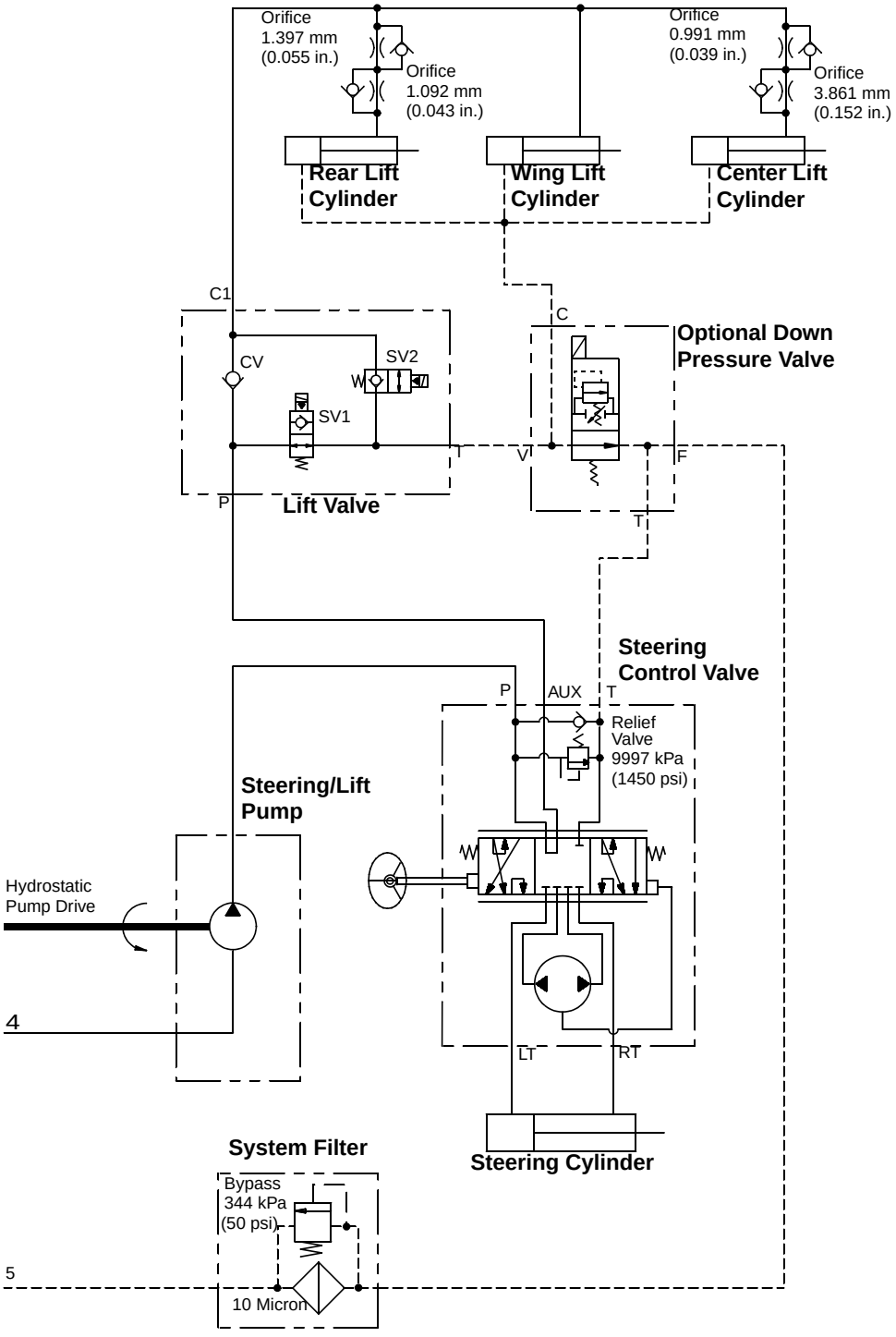
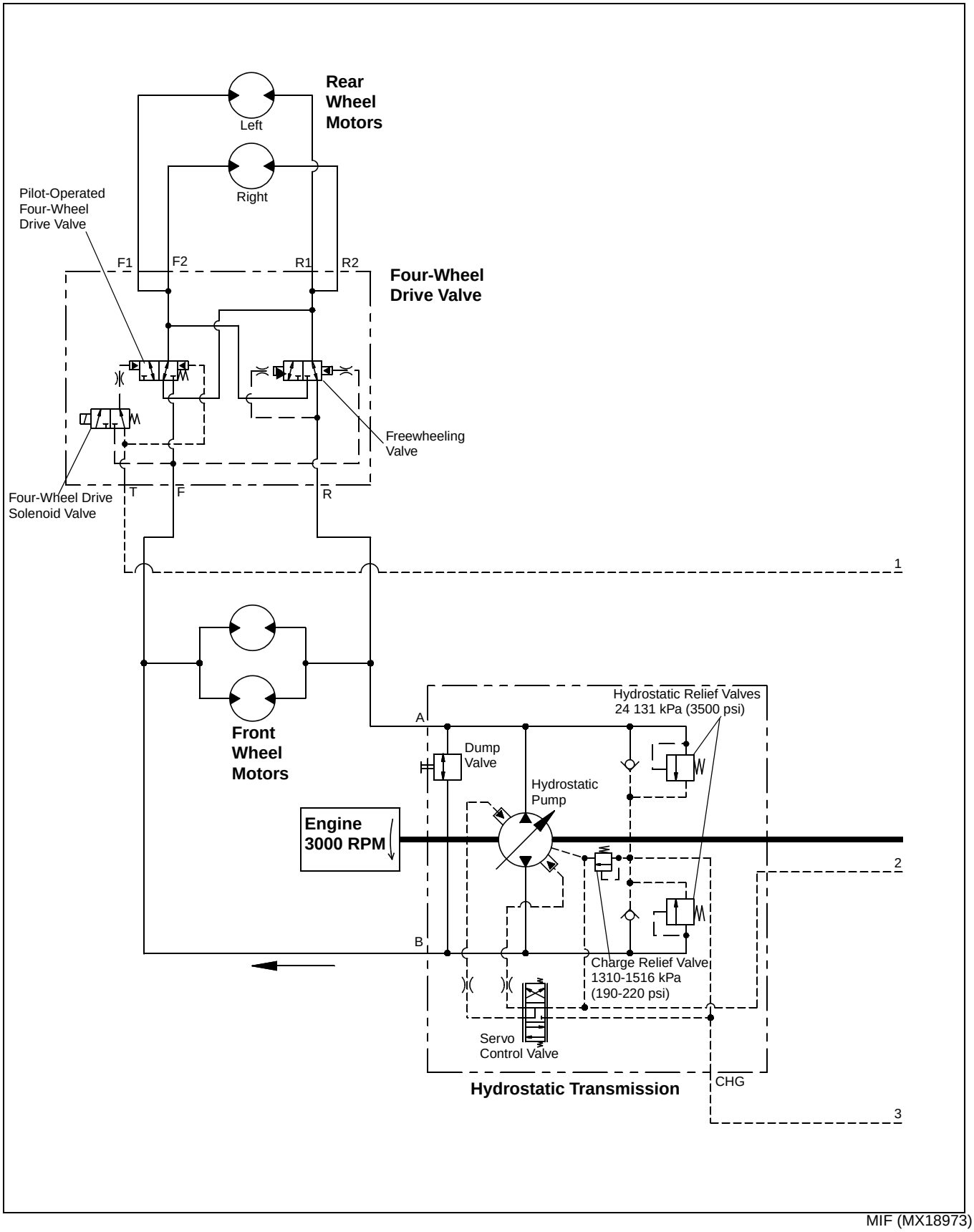

Front Reel Motors
Front Backlapping Valve
Mow Valve 20 684 kPa (3000 psi)
Standard Reel Motors 14.0 cc (0.85 cu in.)
Heavy Duty Reel Motors 19.0 cc (1.16 cu in.)
B
T
A
P
Flow Control Valve
Forward/ Reverse Valve
Rear Backlapping Valve
Rear Reel Motors
Oil Cooler
Rear Reel Pump
Front Reel Pump
Hydrostatic Pump Drive
Suction Strainer 130 Micron
1
2
3
4
5

MIF (MX18971)

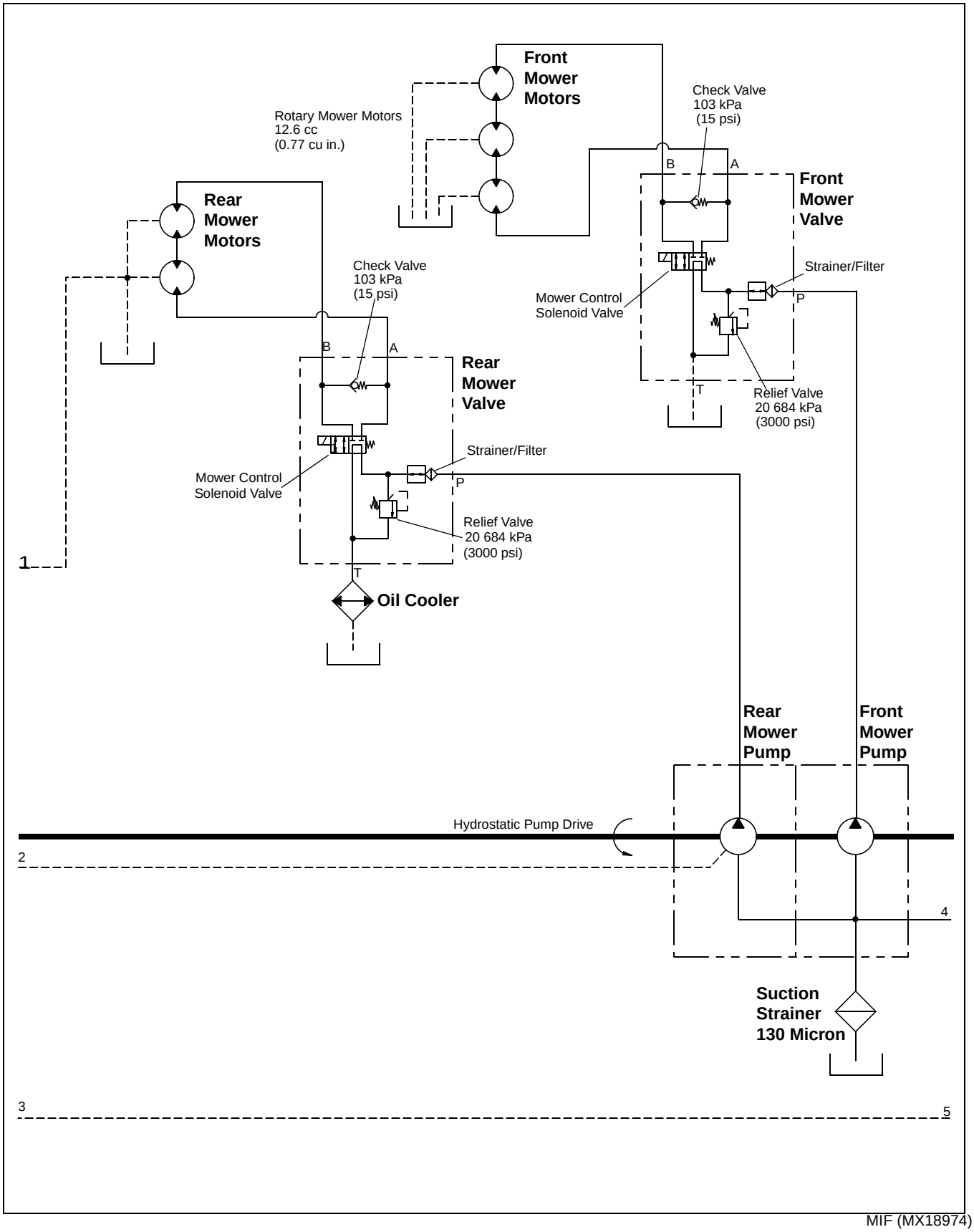

Orifice
1.397 mm
(0.055 in.)
Orifice
1.092 mm
(0.043 in.)
Orifice
0.991 mm
(0.039 in.)
Orifice
3.861 mm
(0.152 in.)
Rear Lift Cylinder
Wing Lift Cylinder
Center Lift Cylinder
C1
CV
SV2
W
SV1
T
P
Lift Valve
C
V
F
T
Optional Down Pressure Valve
Steering Control Valve
P
AUX
T
Relief Valve
9997 kPa
(1450 psi)
Steering/Lift Pump
Hydrostatic Pump Drive
4
LT
RT
Steering Cylinder
System Filter
Bypass
344 kPa
(50 psi)
5
10 Micron

MIF (MX18972)

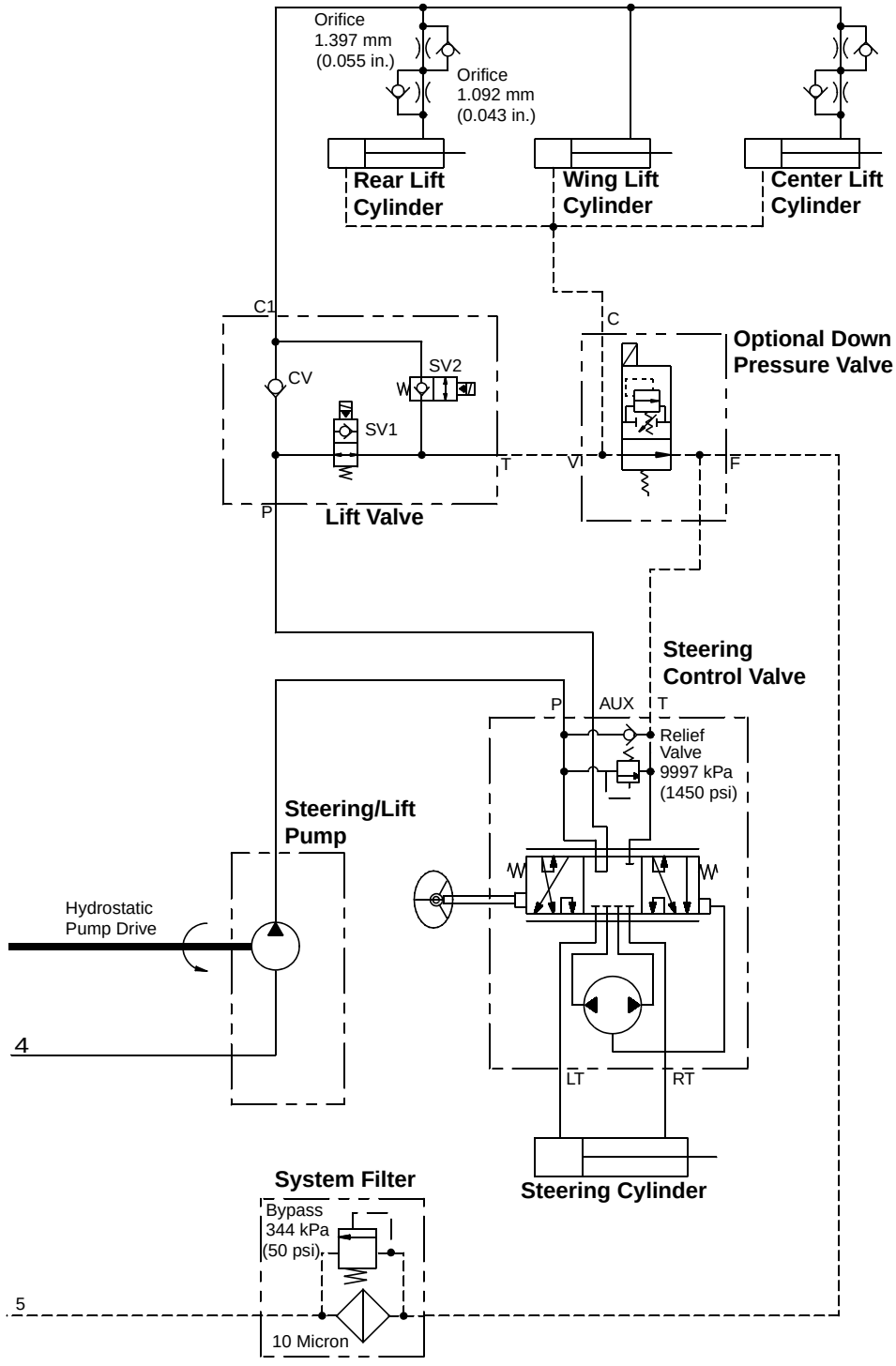
Hydraulic Schematic - 3245C



MIF (MX18973)


Front
Mower
Motors
Rotary Mower Motors
12.6 cc
(0.77 cu in.)
Check Valve
103 kPa
(15 psi)
B
A
Front
Mower
Valve
Rear
Mower
Motors
Check Valve
103 kPa
(15 psi)
Strainer/Filter
Mower Control
Solenoid Valve
P
T
Relief Valve
20 684 kPa
(3000 psi)
B
A
Rear
Mower
Valve
Strainer/Filter
Mower Control
Solenoid Valve
P
Relief Valve
20 684 kPa
(3000 psi)
1
T
Oil Cooler
Rear
Mower
Pump
Front
Mower
Pump
Hydrostatic Pump Drive
2
4
Suction
Strainer
130 Micron
3
5

MIF (MX18974)


Orifice
1.397 mm
(0.055 in.)
Orifice
1.092 mm
(0.043 in.)
Rear Lift
Cylinder
Wing Lift
Cylinder
Center Lift
Cylinder
C1
CV
SV2
W
SV1
T
P
Lift Valve
C
V
F
Optional Down
Pressure Valve
Steering
Control Valve
P
AUX
T
Relief
Valve
9997 kPa
(1450 psi)
Steering/Lift
Pump
Hydrostatic
Pump Drive
4
LT
RT
Steering Cylinder
System Filter
Bypass
344 kPa
(50 psi)
5
10 Micron

MIF (MX18975)

Operation and Diagnostics

Reel Drive System Theory of Operation - 3225C and 3235C

System Function

Rotates the cutting reels for forward mowing and reverses for backlapping operations.

Reel Pump

The reel pumps are part of the triple pump assembly that is mounted to the hydrostatic pump. The rear cutting units are powered by the rear pump section, and the front cutting units are powered by the middle section of the triple pump assembly.

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 control 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.

Flow Control Valve

The flow control valve, located in the backlapping valve, is a manually operated flow restrictor. It is used to control reel speed when backlapping. It is adjusted by rotating the knob clockwise to restrict and counterclockwise to increase flow.

Forward/Reverse Valve

The forward/reverse valve, located in the backlapping valve, is a manually operated, three-position, four-way 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 engine to run with the operator off the seat and the PTO switch in the MOW position.

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).

Pressure and flow are now routed to the flow control valve. 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 spring-centered and is equipped with a detent to hold the valve in the forward position.

A soft start feature is used in the reel circuit 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 starting with the left front, center, and right front motor.

Rotary Mower Drive System Theory of Operation - 3245C

System Function

Rotates the cutting blades for forward mowing operation.

Rotary Mower Pump

The rotary mower pumps are part of the triple pump assembly that is mounted to the hydrostatic pump. The rear rotary mowers are powered by the rear pump section, and the front rotary mowers are powered by the middle section of the triple pump assembly.

Mow Valve

The mow valve is a solenoid-activated, two-position, four-way valve. It is used to control the flow to the rotary mower motors. Incoming oil flows through the valve's strainer/filter. The mow valve is activated through the control module during mowing operations. The pressure relief valve limits pressure in the rotary mower drive circuit to 20 684 kPa (3000 psi). A 103 kPa (15 psi) check valve is located at the rotary motor return side, which allows the mower blades to coast to a controlled stop when the mow valve solenoid is deactivated. The check valve also allows the mower blades to be manually turned when mow valve is deactivated.

Theory

When the mow valve solenoid is activated, the pressure relief valve limits pressure in the mow circuit to a maximum of 20 684 kPa (3000 psi).

Pressure and flow are now routed to the rotary mower motors. The rotary mower motors are connected in series.

Lift System Theory of Operation

Function

Provides a means to raise or lower the cutting units for three operating modes:

- Transport
- Mowing and Backlapping (Reel Mowers Only)
- Service

Steering/Lift Pump

The steering/lift pump is the front pump section of the triple pump assembly. The triple pump operates in an “open center” type hydraulic system consisting of the steering, lift, down pressure (if equipped), and hydrostatic charging 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 Valve

The lift valve is a solenoid-operated, spring-returned valve. The raise solenoid, when momentarily energized, will hold the valve in the raise position for three seconds, then release it. When the raise solenoid is energized and held, the lift cylinders will stay in the raised position. When the lower solenoid valve is energized, the lift cylinders will go to the lower (cutting) position.

Down Pressure Valve (Optional Equipment)

The down pressure valve is used to maintain downward force on the cutting units when mowing. The valve is operated by the rear mow solenoid. Hydraulic pressure is routed through the neutral position of the lift valve and to the down pressure valve. The down pressure valve regulates pressure to the fixed end of the lift cylinder. Pressure is set at the factory to 1724 kPa (250 psi) and can be adjusted to a maximum of 4826 kPa (700 psi). Pressure must be adjusted while the system is pressurized.

Lift System Theory

The lift system receives pressure from the charge pump through the steering valve. The steering valve will take first priority, and limited pressure will be available to the lift system during steering operations.

The lift system has two different raised positions, which are controlled by the PTO switch as follows:

- With the PTO switch up in the MOW position, the raise/lower lever will raise the cutting units slightly to allow for turning the machine during mowing operations.
- With the PTO switch in the TRANSPORT position, the raise/lower lever will raise the cutting units to the full up position for transport or servicing operations.

The lower position is the same for both of the above conditions, and the cutting units will be lowered completely to the ground for cutting or backlapping operations.

The lift valve is solenoid-operated and timed to allow lift for three seconds before disengaging. This allows the operator to only tap the lift lever before entering a turn.

The lift system is timed to allow a “clean-up cut” transition off the fairway. As the mower leaves the fairway and the operator moves the raise/lower lever to the raise position, the front cutting units rise first. This allows the rear cutting units to continue cutting until the end of the fairway. Conversely, when the operator is approaching the fairway to begin cutting and moves the raise/lower lever to the lower position, the front cutting units lower first, keeping the rear cutting units raised until they are over the fairway.

Delay of the rear lift arms is accomplished by the use of orifices and check valves on the rod end of the rear lift cylinder, which limits flow and slows the lowering and raising of the rear lift arm.

A series of orifices are used on the rod end of the center lift cylinder, for the 3225C and 3235C only, to time its movement with the wing lift cylinder.

Reel Drive Troubleshooting - 3225C and 3235C

NOTE: The front three cutting units and the rear two cutting units are driven by separate hydraulic systems. Problems that affect both systems are either electrical or lift system related.

Symptom: One Reel Turns Slowly

(1) Is reel-to-bed knife clearance adjusted properly?

Yes - Go to step (2).

No - Adjust reel-to-bed knife clearance to specification. (See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423), for heavy duty cutting unit. (See “Adjust Reel-to-Bed Knife - 2500M” on page 429), for 2500M cutting unit.

(2) Is reel motor operating properly?

Yes - Go to step (3).

No - Check reel motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 354.)

(3) Are cutting unit bearings in good condition?

No - Inspect cutting unit bearings; replace if necessary.

Symptom: All Reels in One System Are Turning Slowly

(1) Is flow control knob in the fully open position?

Yes - Go to step (2).

No - Move flow control knob to position “6.”

(2) Is reel-to-bed knife clearance adjusted properly?

Yes - Go to step (3).

No - Adjust reel-to-bed knife clearance to specification. (See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423), for heavy duty cutting unit. (See “Adjust Reel-to-Bed Knife - 2500M” on page 429), for 2500M cutting unit.

(3) Is backlap valve inlet screen clean and free of debris?

Yes - Go to step (4).

No - Clean backlap valve inlet screen.

Symptom: All Reels in One System Are Turning Slowly

(4) Is system relief pressure adjusted properly?

Yes - Go to step (5).

No - Perform reel motors pressure relief test. (See “Test Front and Rear Mower Circuit Relief Pressure” on page 350.)

(5) Is reel drive pump operating properly?

Yes - Go to step (6).

No - Check pump for wear. (See “Test Reel Circuit Pump Flow - 3225C and 3235C” on page 351.)

(6) Are reel motors operating properly?

No - Check reel motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 354.)

Symptom: One Cutting Unit Is Not Turning

(1) Are hydraulic motor spline and coupler in good condition?

Yes - Go to step (2).

No - Repair or replace as necessary.

(2) Are cutting unit bearings in good working condition?

Yes - Go to step (3).

No - Replace cutting unit bearings.

(3) Is reel drive motor operating properly?

No - Check reel motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 354.)

Symptom: One System Will Not Backlap

(1) Is backlap knob in the up secured position?

Yes - Go to step (2).

No - Place backlap knob in the up secured position.

(2) Is flow control valve fully open?

Yes - Go to step (3).

No - Move control knob to the open position.

(3) Is mow solenoid operating?

Yes - Go to step (4).

No - Check if 12 V is present at solenoid.

(4) Is mow solenoid valve operating properly?

No - Remove solenoid valve and check function.

Symptom: Pump is Noisy

(1) Is hydraulic oil reservoir at proper level?

Yes - Go to step (2).

No - Fill reservoir to proper level with recommended oil.

(2) Is reel drive pump operating properly?

Yes - Go to step (3).

No - Check pump for wear. (See “Test Reel Circuit Pump Flow - 3225C and 3235C” on page 351.)

(3) Is backlap valve inlet screen clean and free of debris?

No - Clean backlap valve inlet screen.

Rotary Mower Drive Troubleshooting

NOTE: The front three cutting units and the rear two cutting units are driven by separate hydraulic systems. Problems that affect both systems are either electrical or lift system related.

Symptom: One Rotary Mower Turns Slowly

(1) Are blade coupler and bolt properly installed with key?

Yes - Go to step (2).

No - Install parts as necessary.

(2) Is hydraulic drive motor operating properly?

No - Check cutting unit motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 354.)

Symptom: All Rotary Mowers in One System Are Turning Slowly

(1) Is drive pump operating properly?

Yes - Go to step (2).

No - Check pump for wear. (See “Test Rotary Mower Circuit Pump Flow - 3245C” on page 353.)

(2) Is mow valve inlet screen clean and free of debris?

Yes - Go to step (3).

No - Remove and clean screen.

(3) Is system relief valve operating properly?

Yes - Go to step (4).

No - Perform rotary mower motor pressure relief test. (See “Test Front and Rear Mower Circuit Relief Pressure” on page 350.)

(4) Is mow solenoid operating properly?

No - Check function of solenoid spool.

No - Check voltage to solenoid.

Symptom: One Rotary Mower Is Not Turning

(1) Are blade coupler and bolt properly installed with key?

Yes - Go to step (2).

No - Install parts as necessary.

(2) Is mower drive motor operating properly?

No - Check cutting unit motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 354.)

Symptom: Pump is Noisy

(1) Is hydraulic oil reservoir at proper level?

Yes - Go to step (2).

No - Fill reservoir to proper level with recommended oil.

(2) Is mower drive pump operating properly?

Yes - Go to step (3).

No - Check pump for wear. (See “Test Rotary Mower Circuit Pump Flow - 3245C” on page 353.)

(3) Is mow valve inlet screen clean and free of debris?

No - Remove and clean screen.

Lift System Troubleshooting - All Machines

Symptom: Front and Rear Lift Arms Will Not Rise

(1) Is 12 V present at (SV1) lift solenoid?

Yes - Go to step (2).

No - Check control module for proper function. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Is (SV1) lift solenoid working properly?

Yes - Go to step (3).

No - Remove and inspect SV1 solenoid cartridge. Replace if necessary.

(3) Is engine speed to specification?

Yes - Go to step (4).

No - Perform fast idle adjustment.

(4) Is steering system leakage within specification?

Yes - Go to step (5).

No - Perform steering system leakage test. (See “Test Steering System Leakage” on page 392.)

(5) Is lift system free of air?

Yes - Go to step (6).

No - Start engine and cycle lift arms to purge air from system.

(6) Are lift system hydraulic fittings tight and free from leaks?

Yes - Go to step (7).

No - Tighten fittings and replace O-rings as needed.

(7) Is charge pressure within specification?

Yes - Go to step (8).

No - Perform lift system relief valve pressure test. (See “Test Lift System Relief Pressure” on page 356.)

(8) Is lift valve operating properly?

Yes - Go to step (9).

No - Repair or replace as needed.

(9) Is down pressure valve operating properly?

No - Perform down pressure valve test. (See “Test Optional Down Pressure Valve” on page 359.)

Symptom: Front and Rear Lift Arms Will Not Lower

(1) Is 12 V present at (SV2) lift solenoid?

Yes - Go to step (2).

No - Check control module for proper function. (See “Electronic Control Module Circuit Diagnosis” on page 166.)

(2) Is lift valve operating properly?

Yes - Go to step (3).

No - Repair or replace lift valve as required.

(3) Is down pressure valve operating properly?

No - Perform down pressure valve test. (See “Test Optional Down Pressure Valve” on page 359.)

Symptom: 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 step (2).

No - Tighten fittings and replace O-rings as needed.

(2) Is lift valve operating properly?

Yes - Go to step (3).

No - Perform lift system leakage test. (See “Test Lift System Leakage” on page 358.)

(3) Is down pressure valve operating properly?

No - Perform down pressure valve test. (See “Test Optional Down Pressure Valve” on page 359.)

Tests and Adjustments

Test Front and Rear Mower Circuit Relief Pressure

Reason

To make sure that front and rear mower circuit relief valves are functioning properly and adjusted correctly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit	JDG2033	Measure mower circuit relief.

Procedure

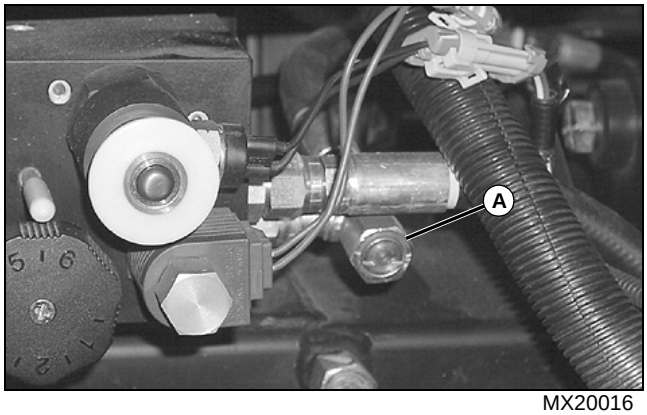
CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

IMPORTANT: Avoid damage! Check and adjust service brake, if necessary, prior to performing this test.

NOTE: Procedure is shown testing rear mower motor circuit. Procedures for the front mower motor circuit are the same except where noted.

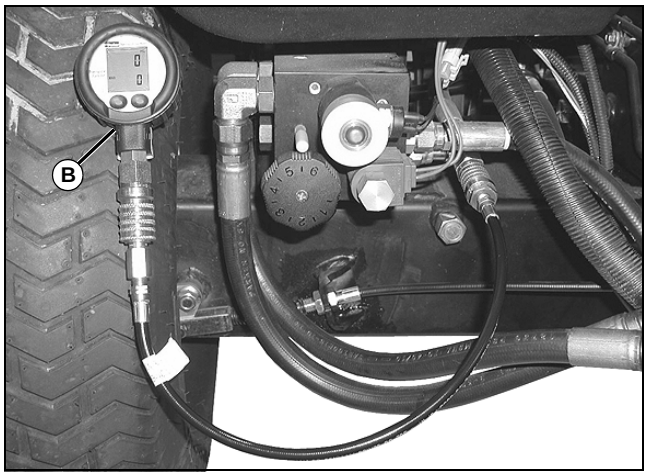
Test is performed by reading circuit pressure between rear section of triple pump and rear mow/backlapping valve.

For front mower motor circuit, pressure is read between center section of triple pump and front mow/backlapping valve.



MX20016

1. Remove cap (A) from tee fitting at mow/backlapping valve “P” port.



MX20017

2. Install pressure gage kit (B).

3. With cutting units lowered to ground, place wooden block in a cutting unit to prevent rotation.

4. For reel mowers, place valve in backlap mode.

5. Start engine and set engine speed to a minimum of 2000 rpm.

NOTE: If the engine stalls while performing this test, set the engine speed to fast idle and repeat test.

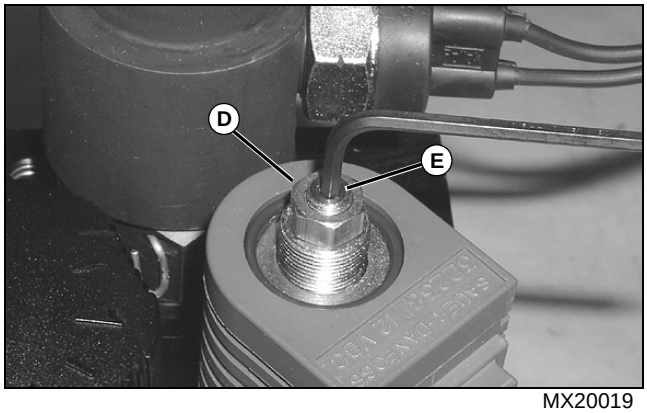
6. Pull PTO knob up (MOW position) and push lift/lower lever forward to engage mowers.

7. Note reading on gage.

Results

Relief valve pressure reading should be 20 684 ± 1380 kPa (3000 ± 200 psi); if necessary, adjust relief valve as follows:

NOTE: Counterclockwise rotation of the setscrew will decrease pressure relief setting, and clockwise rotation will increase pressure relief setting.



MX20019

- Remove backlap solenoid retaining nut.
- Loosen jam nut (D) and turn setscrew (E) with hex key wrench to adjust pressure relief setting while watching gage.

If adjustment does not meet specifications, replace solenoid cartridge.

Specifications

Engine Speed (Minimum). . . . . .2000 rpm

Front and Rear Mower Motor Circuit Relief Pressure . . . . . 20 684 ± 1380 kPa (3000 ± 200 psi)

Test Reel Circuit Pump Flow - 3225C and 3235C

Reason

To determine if front and rear reel circuit pumps are worn by testing hydraulic flow at reel motors.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to measure reel circuit flow.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

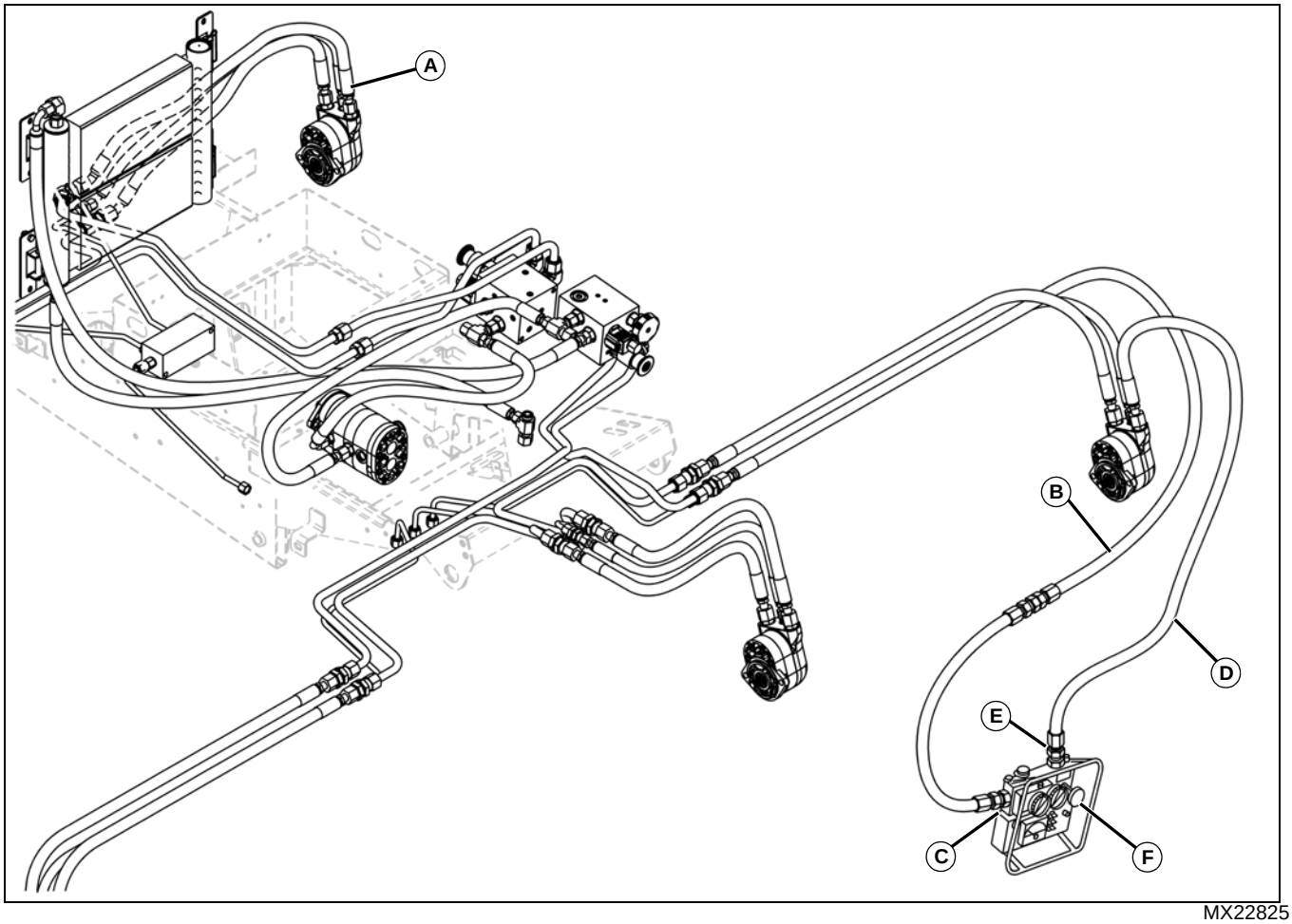
Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on level surface, reels lowered, engine OFF.

CAUTION: Avoid injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

NOTE: Procedure is shown testing front reel motor circuit. Procedures for the rear reel motor circuit are the same except where noted.



MX22825

2. Remove reel motor inlet hose:

   • For rear reel circuit, disconnect hose (A) from left rear motor.

   • For front reel circuit, disconnect hose (B) from left front motor.

3. Connect hose (A or B) to flow gage inlet (C).

4. Attach a hose (D) from flow gage outlet (E) to open port of motor circuit being tested.

5. Turn tester control knob (F) out (counterclockwise) completely.

6. Set backlapping valve of circuit being tested, to forward (mow) position.

NOTE: Check engine rpm with electronic tachometer.

7. Have a helper technician start engine, run at 3000 ± 50 rpm, and engage reels.

8. Slowly turn tester control knob in (clockwise) until pressure reaches 13 790 kPa (2000 psi). Note flow reading.

Results

The reel circuit pump flow must be a minimum of 24.6 L/min (6.5 gpm). If not, repair or replace pump as necessary.

Specifications

Engine Fast Idle . . . . . .3000 ± 50 rpm
Reel Circuit Pump Flow at 13 790 kPa (2000 psi) (Minimum) . . . . . 24.6 L/min (6.5 gpm)

Test Rotary Mower Circuit Pump Flow - 3245C

Reason

To determine if front and rear rotary mower circuit pumps are worn by testing hydraulic flow at rotary mower motors.

Special or Required Tools

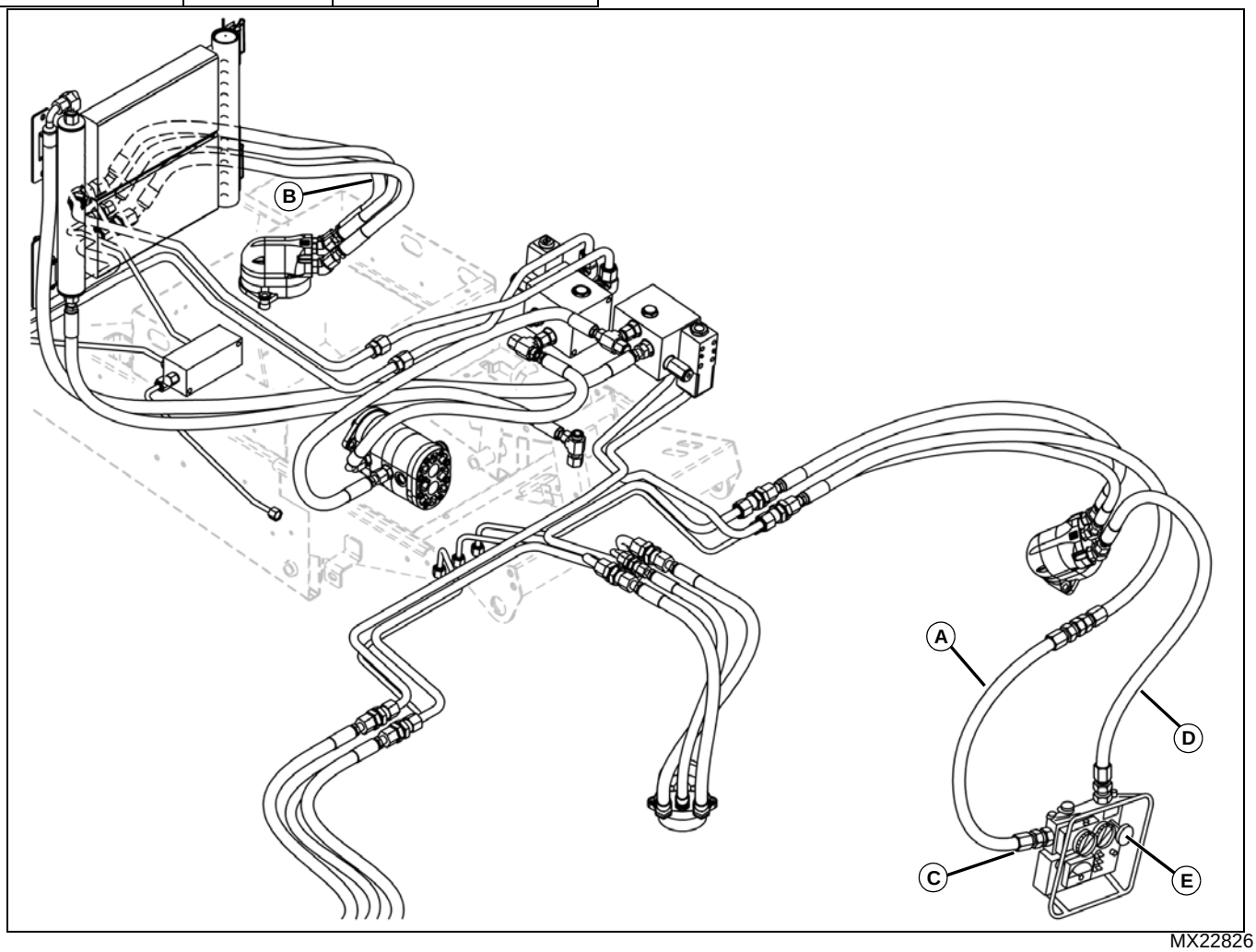
Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to measure mower circuit flow.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on level surface, cutting units lowered, engine OFF.

NOTE: Procedure is shown testing front mower motor circuit. Procedures for the rear mower motor circuit are the same except where noted.



MX22826

2. Remove mower motor inlet hose:
   - For front mower circuit, disconnect hose (A) from left front motor.
   - For rear mower circuit, disconnect hose (B) from left rear motor.
3. Connect hose (A or B) to flow gage inlet (C).
4. Attach a hose (D) from outlet of flow gage to open port of motor circuit being tested.
5. Turn tester control knob (E) out (counterclockwise) completely.

CAUTION: Avoid injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

NOTE: Check engine rpm with electronic tachometer.

6. Have a helper technician start engine, run at 3000 ± 50 rpm, and engage mowers.

7. Slowly turn tester control knob in (clockwise) until pressure reaches 13 790 kPa (2000 psi). Note flow reading.

Results

The rotary mower circuit pump flow must be a minimum of 30 L/min (8.0 gpm). If not, repair or replace pump as necessary.

Specifications

Engine Fast Idle . . . . . 3000 ± 50 rpm

Rotary Mower Circuit Pump Flow at 13 790 kPa (2000 psi) (Minimum) . . . . . 30 L/min (8.0 gpm)

Test Cutting Unit Motor Case Drain

Reason

To test the cutting unit motor internal leakage to case drain. As the motor gears wear, more case drain oil is bypassed to the hydraulic reservoir.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to test hydraulic case drain.

Procedure

Procedure is shown testing front reel mower motor circuit.

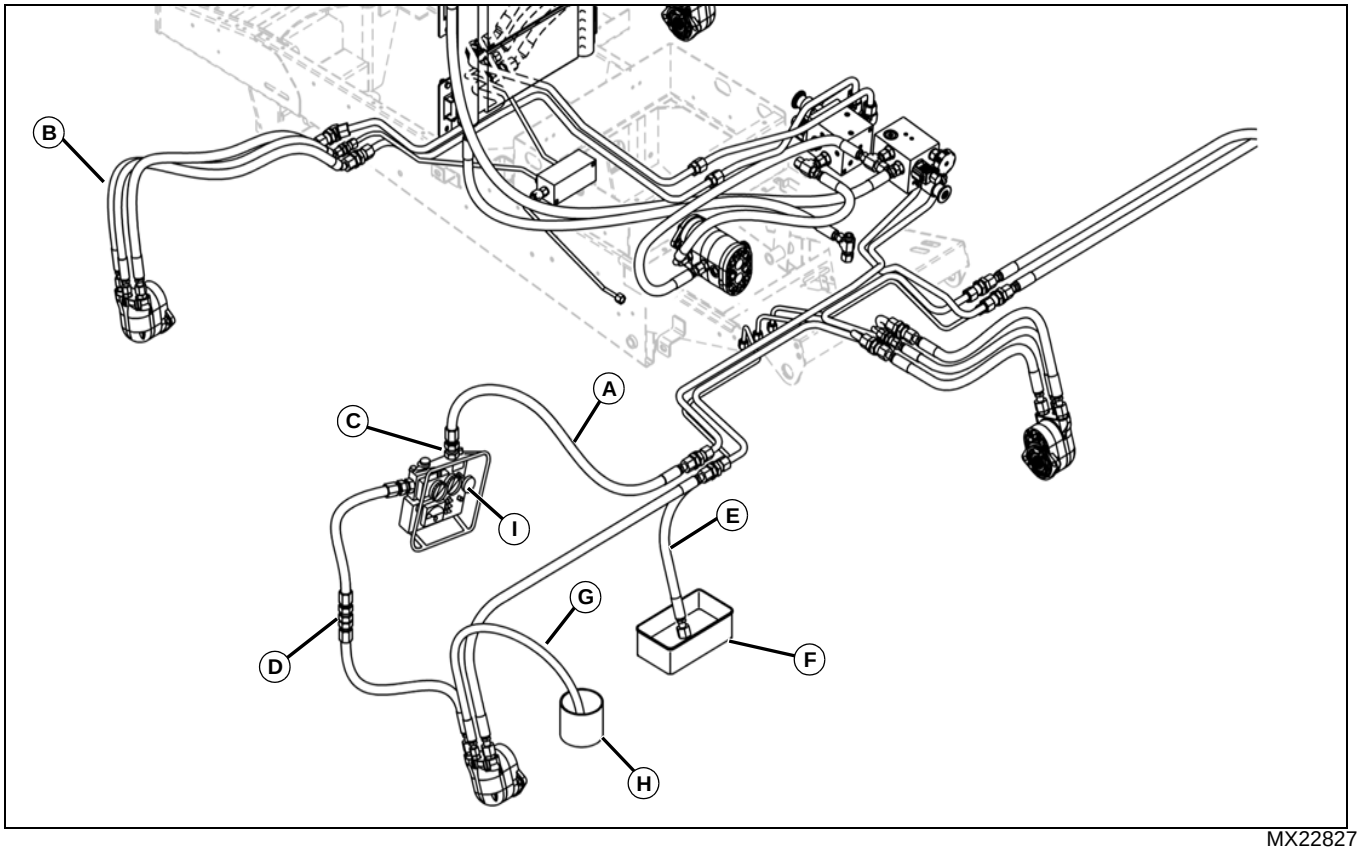
Procedures for the rear circuit are the same except where noted.

Procedures for the front and rear rotary mower motor circuit are also the same except where noted.

Case drain from all three front cutting unit motors can be tested with hydraulic flow tester connected to right front cutting unit motor. All rear cutting unit motors can also be tested with hydraulic flow tester connected to right rear cutting unit motor.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on level surface, cutting units lowered, engine OFF.



MX22827

2. Remove mower motor return hose:

   • For front mower circuit, disconnect hose (A) (return hose to mow valve) from right front motor.

   • For rear mower circuit, disconnect hose (B) (return hose to mow valve) from right rear motor.

3. Connect hose (A or B) to flow gage outlet port (C).

4. Attach a hose (D) from flow gage inlet port to open port of motor circuit being tested.

5. Disconnect center case drain hose (E) from cutting unit being tested and place open end into a clean drain pan (F).

6. Connect a hose (G) on center port fitting of cutting unit motor and place open end of hose into drain pan (F).

7. Place a clean container (H) next to drain pan (F).

8. Turn tester control knob (I) fully counterclockwise.

9. For reel mower circuits, set rear backlapping valve to forward (mow) position (knob pushed in).

CAUTION: Avoid injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

10. Have an assistant start machine, run engine at fast idle, and engage cutting units.

11. Turn tester control knob in (clockwise) until pressure reaches 13 790 kPa (2000 psi).

12. Move open end of hose (G) from drain pan (F) to container (H) for 15 seconds, then return to drain pan (F).

13. Measure amount of oil in container (H). Multiply volume of oil by 4 to arrive at amount of motor case drain in one minute.

14. Leaving flow gage at right front or right rear hydraulic motor, repeat steps 6-14 on remaining motors of circuit being tested.

Results

The cutting unit motor case drain from any motor should not exceed 3.8 L/min (1.0 gpm). If case drain exceeds specifications, rebuild or replace motor.

Specifications

Cutting Unit Motor Case Drain @ 13 790 kPa (2000 psi) (Maximum) . . . . . 3.8 L/min (1.0 gpm)

Test Lift System Relief Pressure

Reason

To verify triple pump (front gear set) pressure is maintained at correct level for steering and lift systems without causing damage to the system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit	JDG2033	Used to test lift system relief pressure.
Pressure Diagnostic Kit	JDG2031	Used to test lift system relief pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

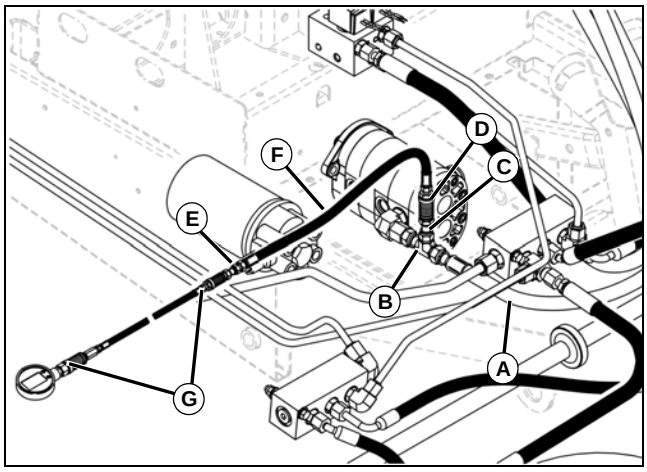
1. Operate hydraulic system until fluid is at a minimum temperature of 43°C (110°F).

2. Park machine on level surface, cutting units lowered, engine OFF.

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.

3. Relieve system pressure by operating the lift system.



MX20040

4. Disconnect steering supply hose (A) from front section of triple pump. Install a tee fitting (B) and reconnect hose to fitting.

5. Connect pressure gage and hose to tee fitting.

NOTE: Check engine rpm with electronic tachometer.

6. Apply park brake, start engine, and run at 3000 ± 50 rpm.

7. Pull lift lever back to raise cutting units and hold. Record steady pressure reading.

Results

Pressure should be 11 721-13 790 kPa (1700-2000 psi). If pressure is not within specification, replace steering valve.

Specifications

Lift System Relief Valve Pressure . . 11 721-13 790 kPa (1700-2000 psi)

Check and Adjust Wing Cutting Units Upstop

Reason

To make sure wing lift arms cylinder and upstop casting are properly aligned.

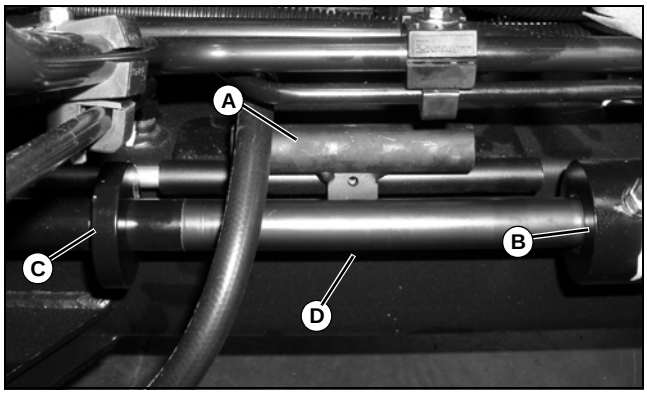
Check

1. Before adjusting wing cutting units upstop, a thorough inspection of the upstop and linkage should be performed.

2. Lock park brake.

3. Start engine.

4. Move mow/transport lever to TRANSPORT position.



MX22811

Picture Note: 3245C shown

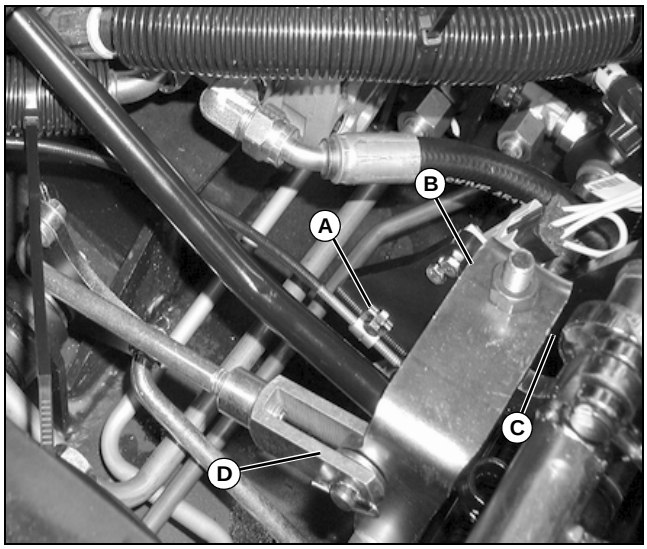
5. Raise cutting units until lift stop (A) contacts wing cutting unit cylinder barrel (B) and cylinder washer (C).

6. Check for clearance between upstop and cylinder rod (D).

7. Stop the engine.

8. If upstop contacts cylinder rod, proceed to adjustment procedure.

Adjust



MX20830

1. Move mow/transport lever to MOW position. Remove operator foot platform.

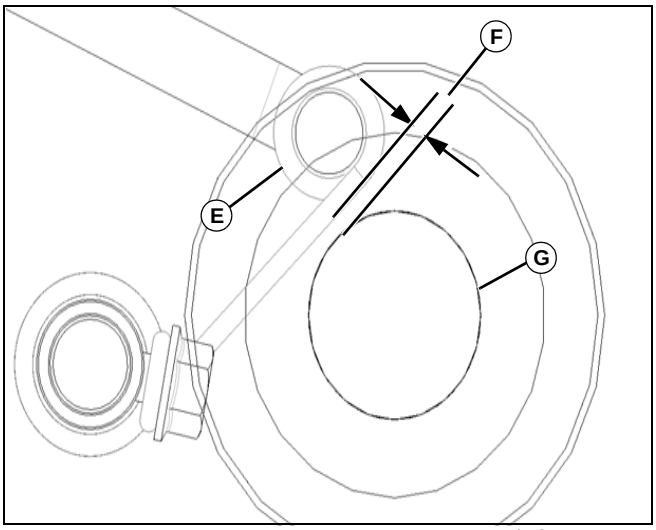
2. Loosen cable clamp (A).

3. Rotate bracket (B) until approximately 1-3 mm (0.040-0.118 in.) clearance (C) is between bracket and pedal bellcrank.

4. Hold bracket (B) in place and tighten cable clamp (A).

5. Move mow/transport lever through its entire range of motion. Clearance (C) must be maintained.

6. If adjustment is needed, adjust clevis (D).



lwfm_om_09

7. Adjust clevis until stop spring (E) has 1-3 mm (0.040-0.118 in.) clearance (F) from cylinder rod (G).

8. Rotate clevis in or out as required for proper adjustment.

9. Cycle cutting units up and down as required.

10. Check wing cutting unit upstop. Repeat procedure as needed.

Results

Wing lift arms should raise and lower fully without damaging the lift arms cylinder or upstop.

Specifications

Distance Between Stop Spring and Cylinder Rod.. 1-3 mm (0.040-0.118 in.)

Test Lift and Steering Pump Flow

Reason

To determine if lift/steering circuit pump is worn by testing hydraulic flow at pump.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to connect flow gage to lift/steering pump.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

1. Disconnect steering supply hose from front section of triple pump.

2. Connect hose from inlet side of flow gage to triple pump.

3. Connect hose from outlet side of flow gage to steering supply hose.

4. Turn tester control knob fully open (counterclockwise).

NOTE: Check engine rpm with electronic tachometer.

5. Apply park brake, start engine, and set throttle to fast idle (3000 ± 50 rpm).

CAUTION: Avoid injury! DO NOT fully close tester control knob while running test.

6. Slowly turn tester control knob clockwise until pressure reading is 6895 kPa (1000 psi).

7. Record flow reading.

Results

Flow must be a minimum of 13.2 L/min (3.5 gpm). If flow is not within specification, repair or replace pump as necessary. (See “Disassemble Triple Pump” on page 366.) (See “Assemble Triple Pump” on page 368.)

Specifications

Engine Speed (Fast Idle) . . . . . 3000 ± 50 rpm

Lift/Steering Pump Flow at 6895 kPa (1000 psi) (Minimum) . . . . . 13.2 L/min (3.5 gpm)

Test Lift System Leakage

Reason

To determine cause of lift arm drift.

Procedure

1. Raise lift arms.

2. Support lift arms and mowers with a block or hoist.

3. Remove hose from rod end of cylinder. Close end of hose and cylinder fitting using caps or plugs.

4. Remove block or hoist from lift arms.

5. 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.

Results

Faulty component identified and replaced. Lift arms no longer drift.

Test Optional Down Pressure Valve

Reason

To adjust the optional down pressure valve to set downward force on lift system and cutting units.

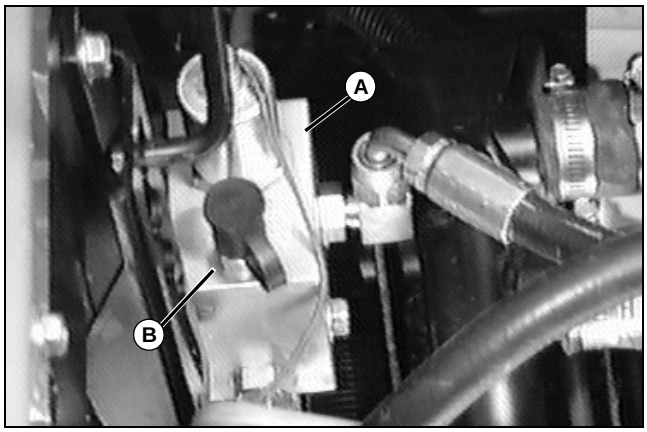
Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit	JDG2033	Read pressure needed to adjust down pressure valve.

Procedure

1. Park machine on level surface, lock park brake, lower cutting units to ground, engine OFF.

2. Test is performed by reading system pressure at down pressure valve. A test connector is located on the top of the valve block.



M58745

3. If machine does not have optional test kit installed, a test fitting (B) will have to be installed into the top of the down pressure valve block (A). A quick-disconnect fitting will allow the test gage to be easily installed and removed for service.

4. Install pressure gage to the test fitting.

IMPORTANT: Avoid damage! DO NOT move steering wheel while test is in progress.

5. Start engine.

6. Unlock park brake.

7. Set mow/transport lever to MOW position.

8. Set raise/lower lever to LOWER position.

9. Move throttle to full forward (full throttle) position.

10. Note reading on gage.

11. Stop engine.

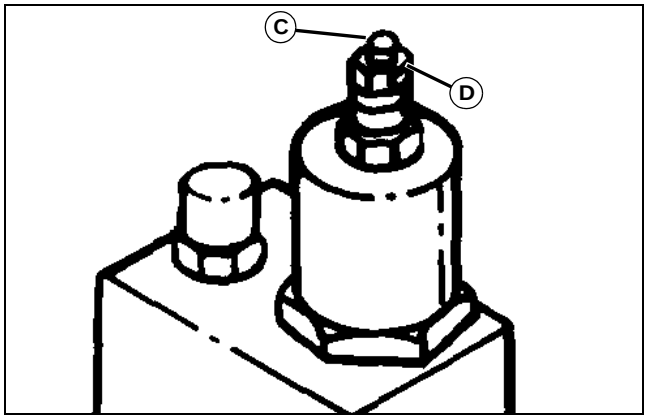
Adjusting Down Pressure Force

Use the chart below to determine pressure setting needed to achieve the required down force.

IMPORTANT: Avoid damage! Adding down force to cutting unit will decrease mower traction. Do not exceed 4826 kPa (700 psi) at the down pressure valve.

Pressure Reading at Down Pressure Valve	Down Force at Cutting Unit
1379 kPa (200 psi)	93 N (21 lb)
2068 kPa (300 psi)	142 N (32 lb)
2758 kPa (400 psi)	187 N (42 lb)
3447 kPa (500 psi)	236 N (53 lb)
4137 kPa (600 psi)	285 N (64 lb)
4826 kPa (700 psi)	334 N (75 lb)

IMPORTANT: Avoid damage! All pressure adjustments must be made with the engine running and the reel drive system at normal operating pressure (mow solenoid energized).



M56671

1. Loosen locknut (D) on top of down pressure solenoid plunger.

2. Follow steps 1-10 from Test Optional Down Pressure Valve section to determine current pressure setting.

3. Turn pressure setscrew (C) while watching pressure gage.

Results

Down pressure valve checked for function and adjusted for optimal downward force on lift system and cutting units.

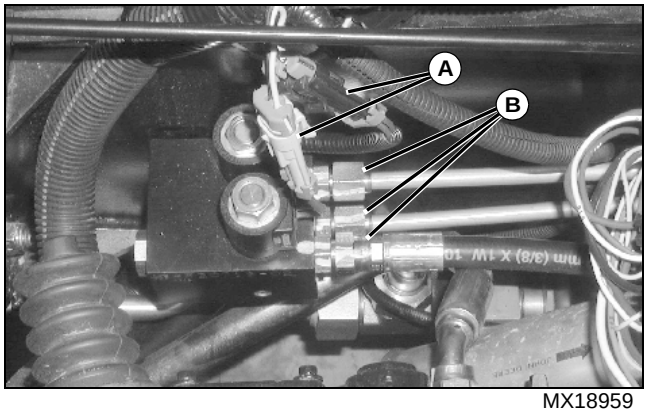
Repair

Remove and Install Lift Valve

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.

Removal



MX18959

1. Disconnect two electrical connectors (A).
2. Disconnect hydraulic lines (B) at lift valve.
3. Remove mounting cap screws and remove valve.

Installation

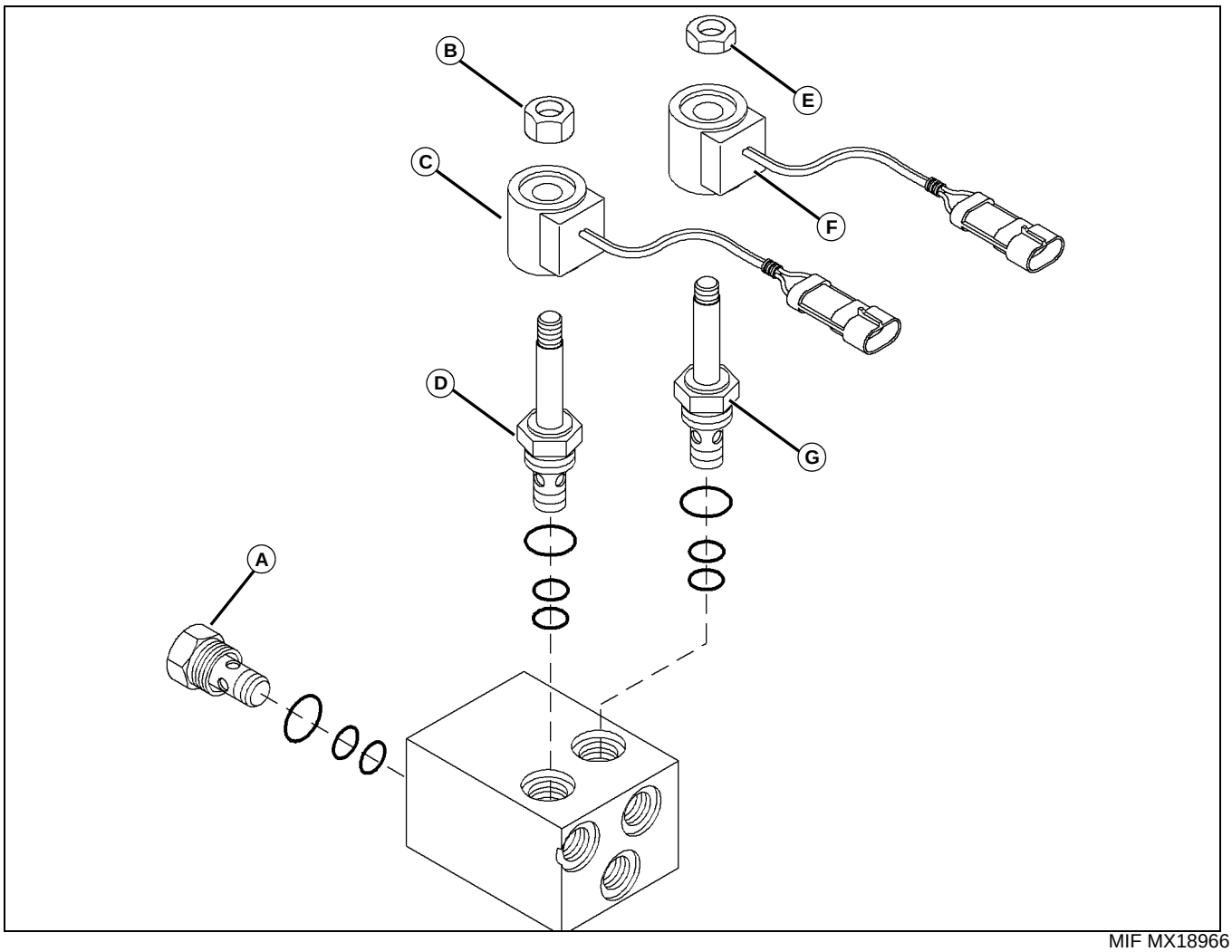
Installation is done in reverse order of removal.

- Tighten mounting cap screws to specification.

Specifications

Mounting Cap Screw Torque . . . . . 43 N•m (32 lb-ft)

Disassemble, Inspect, and Assemble Lift Valve



MIF MX18966

Disassemble

NOTE: Remove fittings, plug all ports, and wash valve assembly with a suitable solvent before disassembly.

1. Remove check valve (A).

NOTE: Mark position of lift and lower spools prior to removal.

2. Remove nut (B) and lift spool solenoid coil (C).
3. Remove lift spool (D).
4. Remove nut (E) and lower spool solenoid coil (F).
5. Remove lower spool (G).

Inspect

1. Clean all parts with a suitable solvent. Clean bores with a brush hone and solvent.
2. Inspect bores in valve housing for scoring.
3. Inspect spools for scoring, fretting, and straightness.
4. Replace all O-rings.

Assemble

IMPORTANT: Avoid damage! Use plenty of fresh hydraulic oil to lubricate parts during assembly.

1. Lubricate and install O-rings onto lower spool (G). Install spool into previously marked location in valve housing. Tighten to specification.
2. Install lower spool solenoid coil over spool shaft. Install nut (E) and tighten to specification.
3. Lubricate and install O-rings onto lift spool (D). Install spool into previously marked location in valve housing. Tighten to specification.
4. Install lift spool solenoid coil over spool shaft. Install nut (B) and tighten to specification.

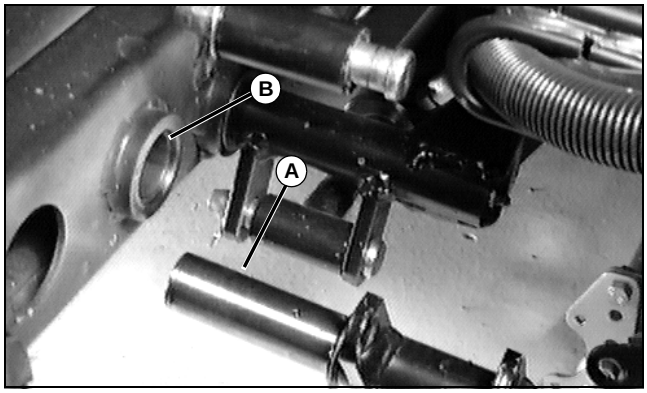
5. Lubricate and install O-rings on check valve. Install check valve and tighten to specification.

Specifications

Check Valve Torque . . . . . 26-28 N•m (19-21 lb-ft)
Spool Torque. . . . . 26-28 N•m (19-21 lb-ft)
Retaining Nut Torque . . . . . 5-7 N•m (48-60 lb-in.)

Remove Lift Arm

1. Remove cutting units from lift arm being serviced.



M57767

2. Remove hydraulic cylinder attachment pin from lift arm yoke. Secure cylinder to frame with wire to keep work area clear.

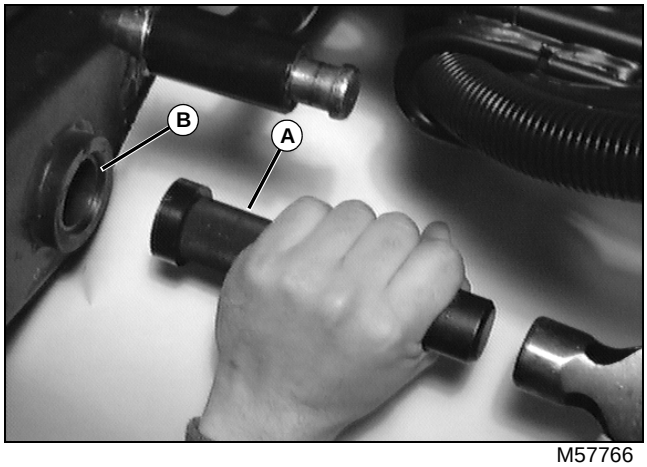
3. Remove lock pin, washers, and O-ring from back side of lift arm pivot.

4. Remove lift arm shaft (A) from lift arm bushing (B).

5. Remove O-ring, washer, and spacer from lift arm shaft.

Remove Lift Arm Bushing

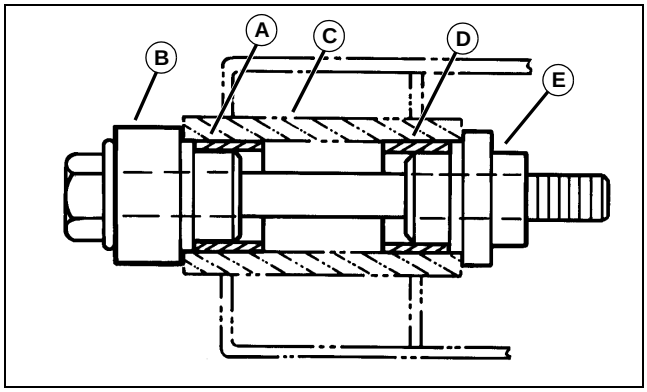
1. Remove lift arm. See “Remove Lift Arm” on page 362.



M57766

2. Using a 1-5/8 in. bearing driver (A), drive front and rear lift arm bushings (B) out back of frame pivot tube.

Install Lift Arm Bushing



M57769

1. Place rear bushing (A) on threaded end of JDG892 Installation Tool (B) and place on back of frame pivot tube (C). Place front bushing (D) on front half of tool (E) and thread bolt from front to rear of tool.

2. Tighten bolt on tool to pull bushings into frame pivot tube. Tool will set correct depth for proper O-ring clearance.

Install Lift Arm

1. Clean old grease from lift arm and frame tube.

2. Inspect bushings for wear. Replace if necessary.

3. Place spacer, washer and O-ring on lift arm pivot shaft.

4. Apply grease to lift arm pivot shaft.

5. Insert lift arm pivot shaft into frame tube.

6. Install O-ring, washers, and lock pin on end of pivot shaft.

7. Grease lift arm pivot using grease fitting.

Remove and Install Lift Cylinder

1. Remove hydraulic hoses.

2. Remove cotter keys and washers at end of hydraulic cylinder mounting pins.

3. Remove mounting pins and cylinders.

4. Install front cylinders on machine with rod end to the right side of machine, and rear cylinder with rod end to the left side of machine. Rear cylinder will require lost motion linkage to be configured during cylinder installation. See “Remove and Install Rear Lift Cylinder Lost Motion Linkage” on page 365.

5. Install mounting pins, washers and cotter keys.

6. On reel mower machines, install flow restrictor in port of rear lift cylinder and front center lift cylinder. See “Remove and Install Rear Lift Cylinder Flow Restrictor” on page 365 or See “Remove and Install Front Center Lift Cylinder Flow Restrictor - 3225C and 3235C” on page 365.

7. Install new O-rings on fittings and install in cylinder ports. Attach hydraulic lines to fittings.

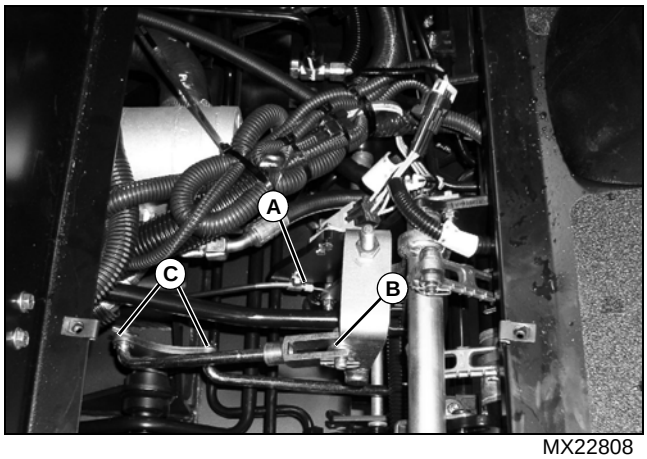
8. Grease mounting pins at grease fittings.

9. Start machine and cycle lift cylinders to purge air from system.

Inspect Wing Lift Arms Upstop and Linkage - 3225C and 3235C

1. Stop engine and lock park brake.

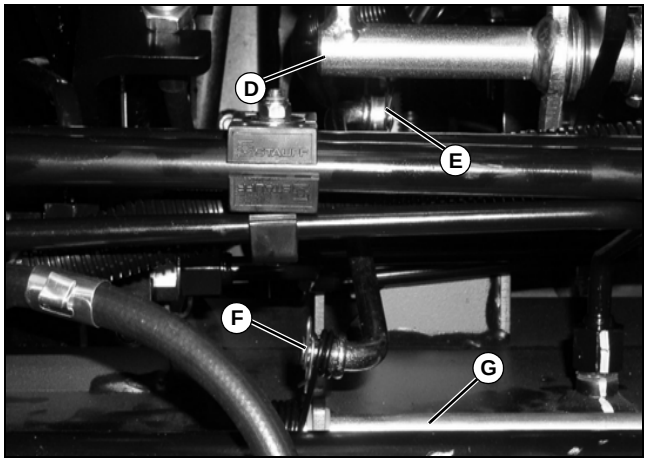
2. Remove operator foot platform.



MX22808

3. Operate mow/transport cable (A) several times, making sure cable is secure and operating freely.

4. Check pivot points (B and C) for wear. Check for missing or bent parts. Check that all pivot points move freely and do not bind.



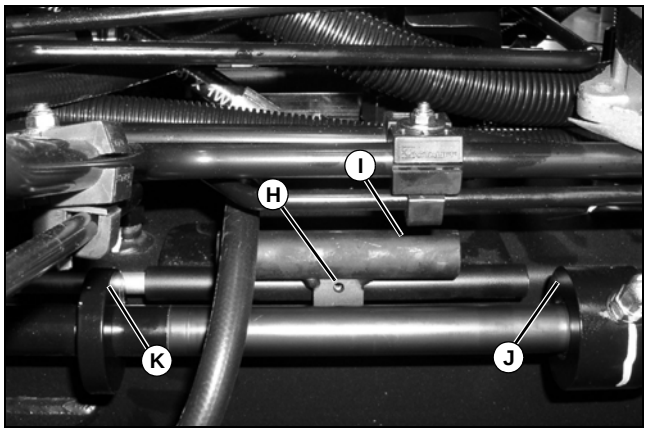
MX22810

5. Check that cross shaft (D) moves freely.

6. Check pivot (E) for wear and proper operation.

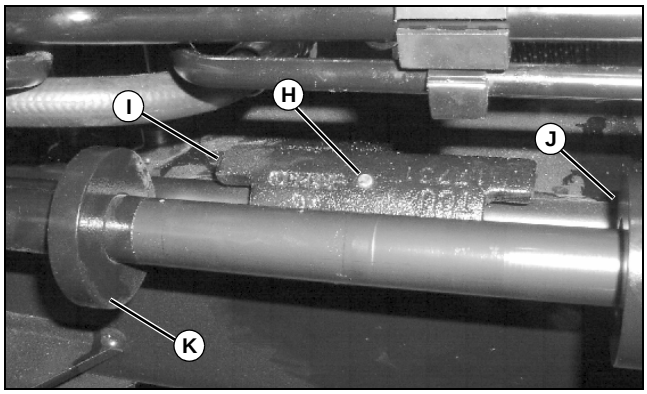
7. Check pivot and spring (F) for wear and proper operation.

8. Check pivot shaft (G) for wear and proper operation.



MX22811

Picture Note: 3225C and 3235C shown



MX20499

Picture Note: 3245C shown

9. Check placement and condition of roll pin (H). Inspect upstop (I) for excessive wear.

10. Inspect cylinder rod washer (K) and cylinder body (J) for damage or wear.

NOTE: If cylinder rod washer has only a small chip missing from the outer edge, rotate cylinder rod so that the damaged area on the washer is 180° opposite the upstop casting.

11. Check for damage on cylinder rod washer (J). If washer is damaged, replace cylinder as an assembly.

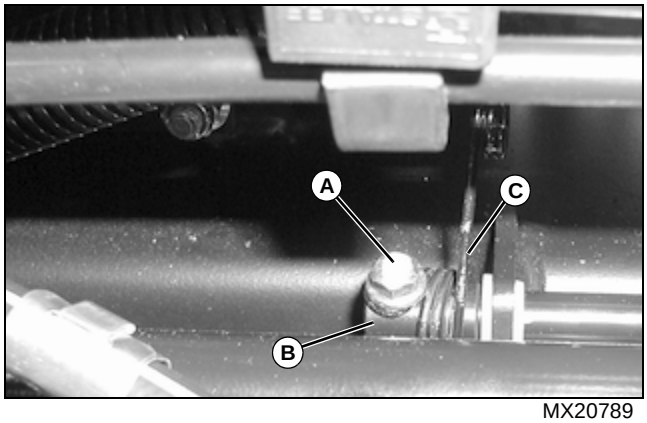
12. Check upstop casting (K) and cylinder barrel (L) for damage. If damage is evident on either component, replace damaged component.

13. Adjust wing cutting units upstop. See “Check and Adjust Wing Cutting Units Upstop” on page 356.

Remove and Install Upstop

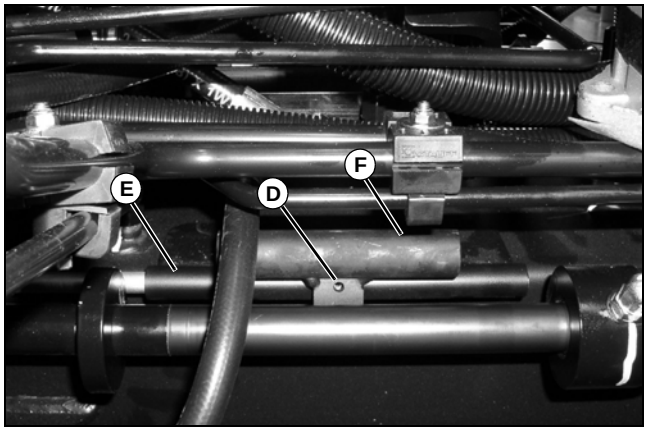
Remove

1. Stop engine and lock park brake.



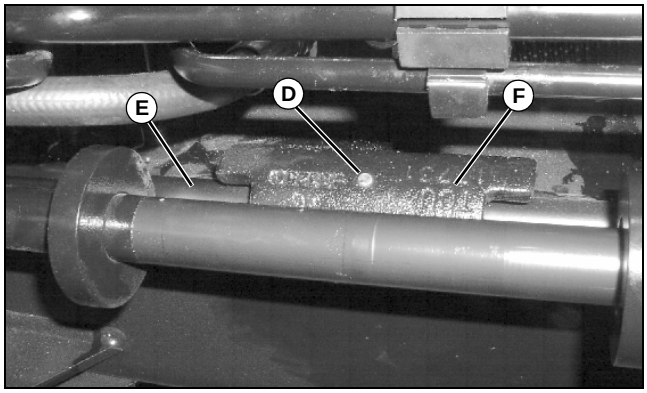
MX20789

2. Remove cap screw (A) and sleeve (B).
3. Pull spring (C) away from upstop shaft.



MX22811

Picture Note: 3225C and 3235C shown



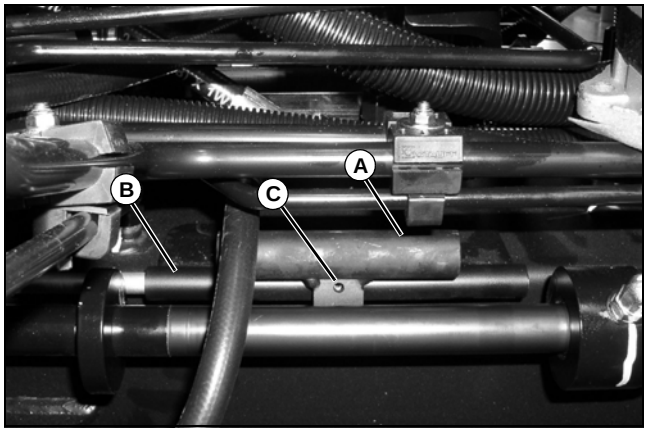
MX20499

Picture Note: 3245C shown

4. Remove rue pin (D). Remove upstop shaft (E) and upstop (F).

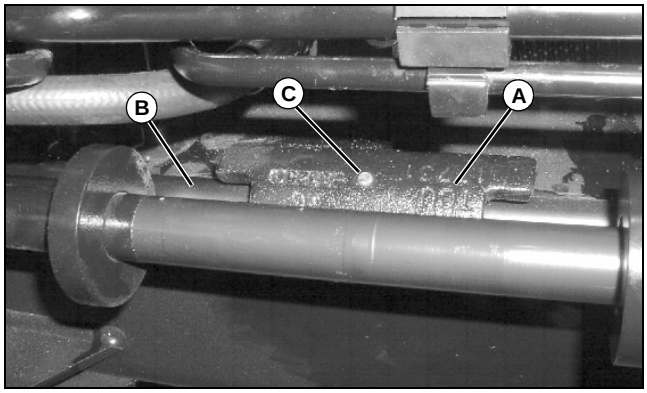
Install

1. Stop engine and lock park brake.



MX22811

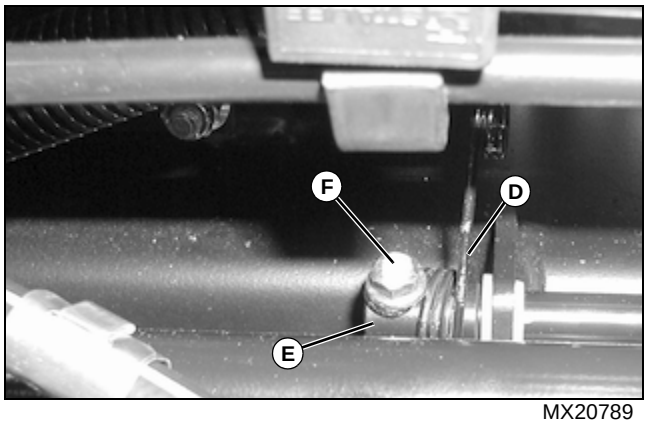
Picture Note: 3225C and 3235C shown



MX20499

Picture Note: 3245C shown

2. Install upstop (A) and upstop shaft (B). Secure with rue pin (C).

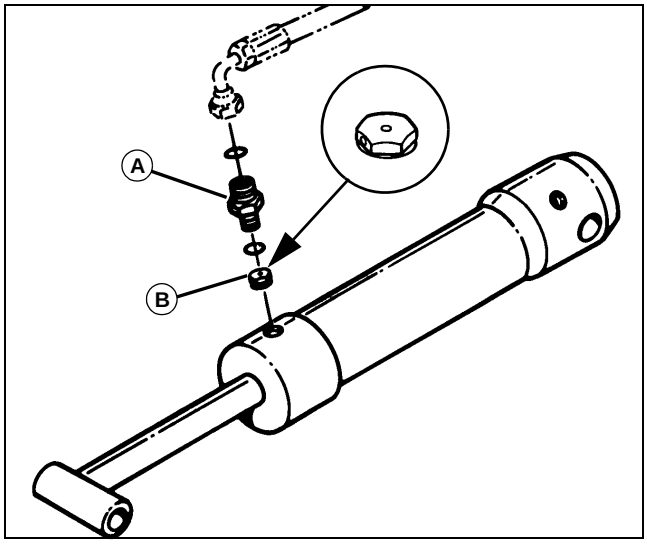


MX20789

3. Install spring (D), sleeve (E), and cap screw (F).

Remove and Install Rear Lift Cylinder Flow Restrictor

1. Remove hydraulic hose to rod end of rear lift cylinder.



M58761B

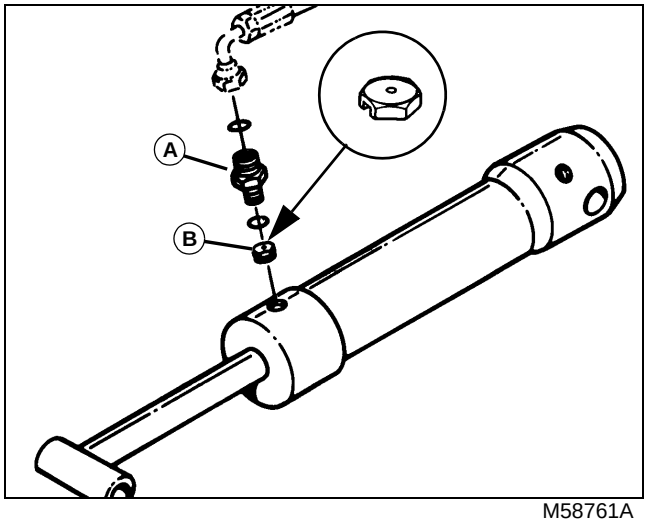
2. Remove fitting (A) from hydraulic cylinder.

3. Remove flow restrictor (B) from under fitting.

4. The flow restrictor is installed with the round end of the body inserted into the cylinder first.

Remove and Install Front Center Lift Cylinder Flow Restrictor - 3225C and 3235C

1. Remove hydraulic hose to rod end of front lift cylinder.



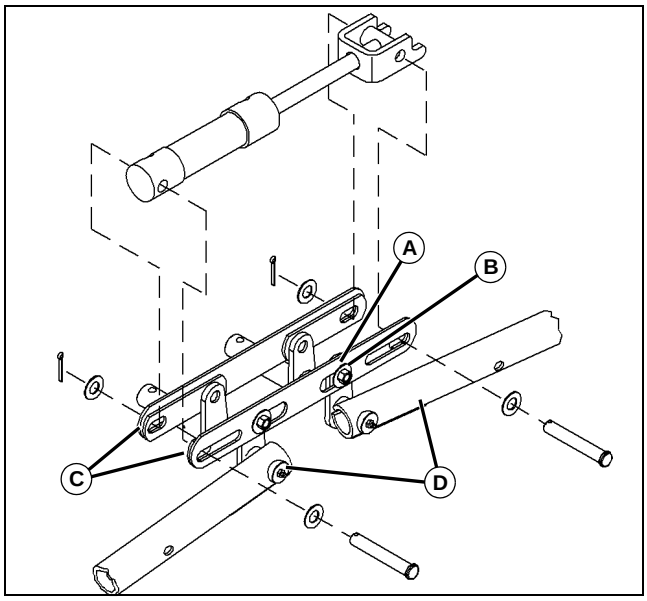
M58761A

2. Remove fitting (A) from hydraulic cylinder.

3. Remove flow restrictor (B) from under fitting.

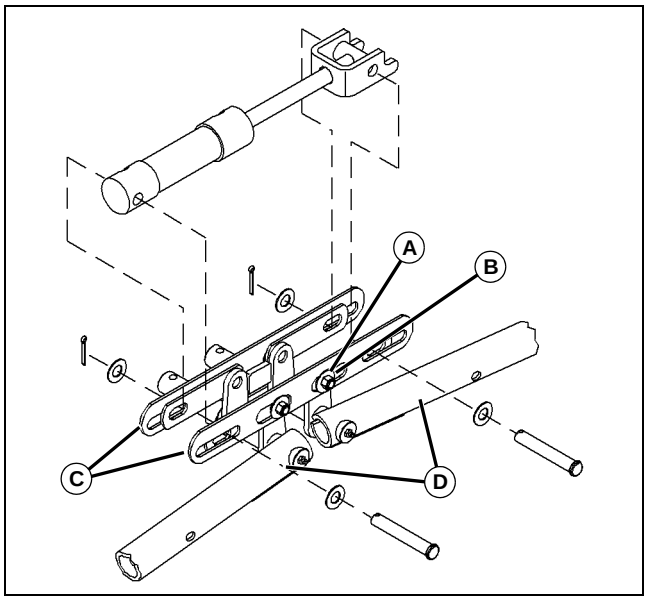
4. The flow restrictor is installed with the slot of the restrictor inserted into the cylinder first.

Remove and Install Rear Lift Cylinder Lost Motion Linkage



MX18511

Picture Note: 3225C and 3235C shown



MX18511

Picture Note: 3245C shown

1. Remove rear lift cylinder and hydraulic hoses. See “Remove and Install Lift Cylinder” on page 362.

2. Remove four nuts (A) and washers (B) holding lost motion linkage (C) to lift arms (D).

3. Inspect linkage and lift arms for wear or bending.

4. Install lost motion linkage and rear lift cylinder.

Remove and Install Triple Pump

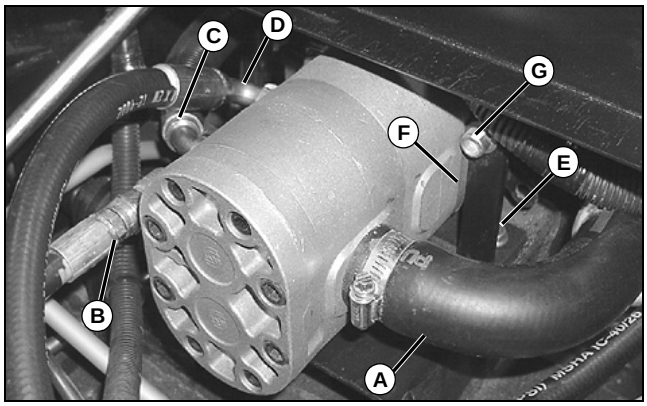
NOTE: Removal and installation of the triple pump is similar for all models; 3235C is shown.

Removal

1. Park vehicle on a level surface, cutting units lowered, park brake locked, engine OFF.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

2. Disconnect battery and remove floor plate.



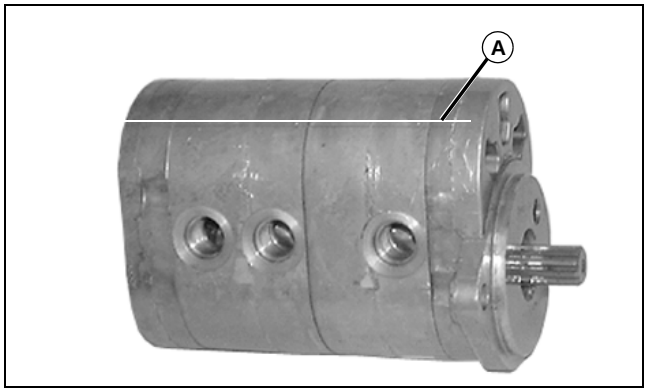
MX20012

3. Disconnect pump inlet hose (A).
4. Mark and disconnect lines (B-D).
5. Remove the two cap screws (E) that secure triple pump mounting bracket (F) to frame.
6. Remove two cap screws (G) and separate triple pump assembly from hydrostatic pump.
7. Remove triple pump from machine.
8. Remove coupler and O-ring from pump.

Installation

1. Apply petroleum jelly to pump flange O-ring and install on pump.
2. Install coupler on pump input shaft.
3. Install triple pump onto hydrostatic pump.
4. Place mounting brackets (F) in position and install cap screws (E and G).
5. Connect lines (B-D) as marked.
6. Connect pump inlet hose (A).
7. Install floor plate and connect battery.

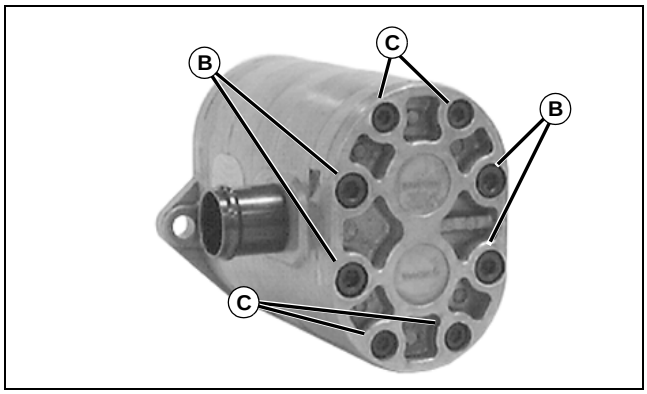
Disassemble Triple Pump



MX2704

1. Place a mark (A) across all sections of the pump housing to ensure proper assembly.

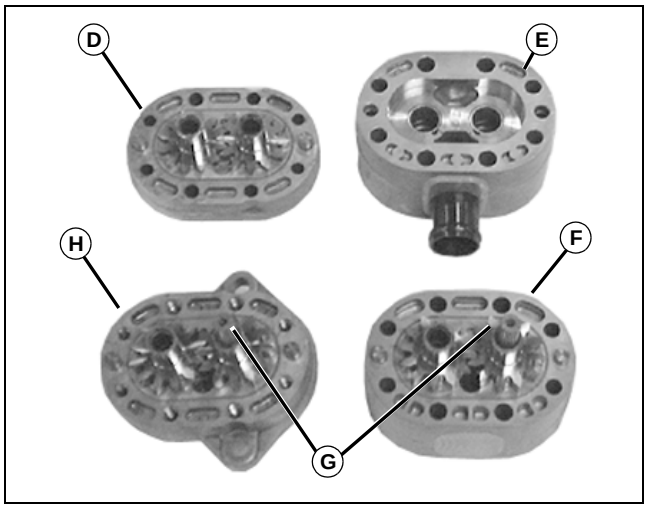
IMPORTANT: Avoid damage! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without damage to pump.



MX2705

2. Remove four 3/8-in. hex head screws (B) and washers and four 5/16-in. hex head screws (C) and washers.

IMPORTANT: Avoid damage! DO NOT intermix parts between pumps. Keep parts for individual pumps separated for reassembly.



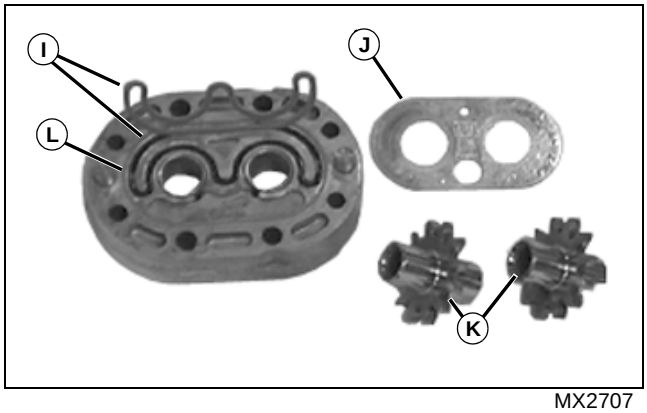
MX2706

3. Carefully separate the rear end plate (D), rear pump body (E), front pump body (F), shaft couplers (G), and front end plate (H) as shown.

4. Remove shaft couplers.

Rear End Plate and Front Pump Body

IMPORTANT: Avoid damage! Note location and orientation of seals and wear plates to aid in installation. Seals and wear plates MUST be installed as removed for proper operation of pump.



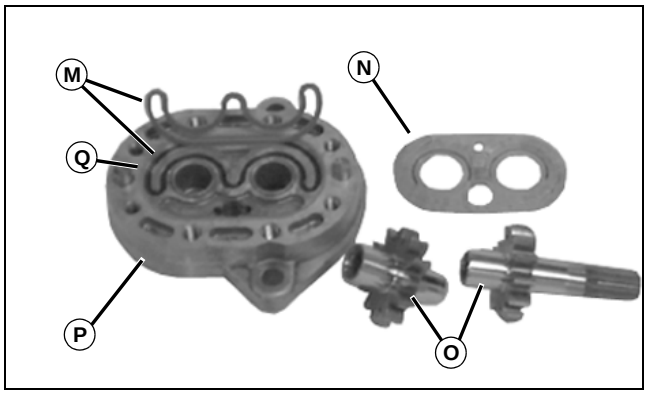
MX2707

Picture Note: Rear end plate is shown. Front pump body is similar.

5. Remove gears (K), wear plate (J) and seals (I and L) from end plate. Repeat procedure for front pump body.

6. Discard wear plate and seals.

Front End Plate

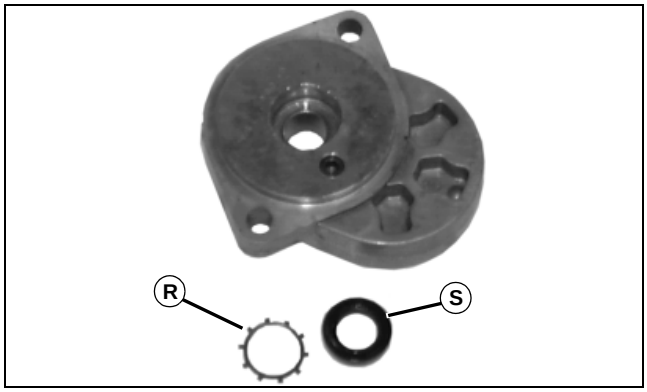


MX2708

7. Remove gears (O), wear plate (N), and seals (M and Q) from front end plate (P).

8. Discard wear plate and seals.

Shaft Seal



MX2709

9. Remove retaining ring (R) from front pump section.

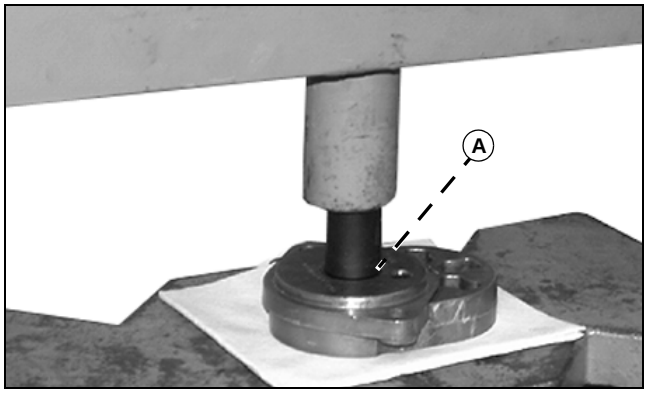
10. Carefully remove the shaft seal (S) using a screwdriver. Discard the shaft seal.

Assemble Triple Pump

IMPORTANT: Avoid damage! Place a cloth or other soft materlal under the end plate to protect the machined surfaces.

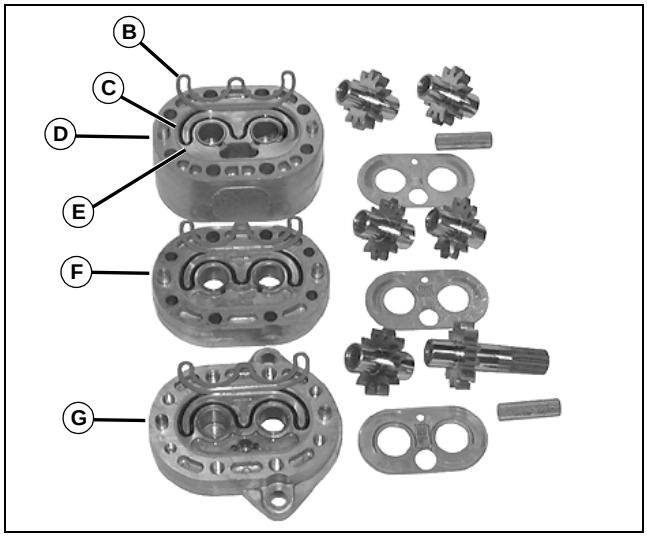
NOTE: Always use new wear plates and seals when rebuilding hydraulic pump.

Clean all components with suitable solvent and blow dry.



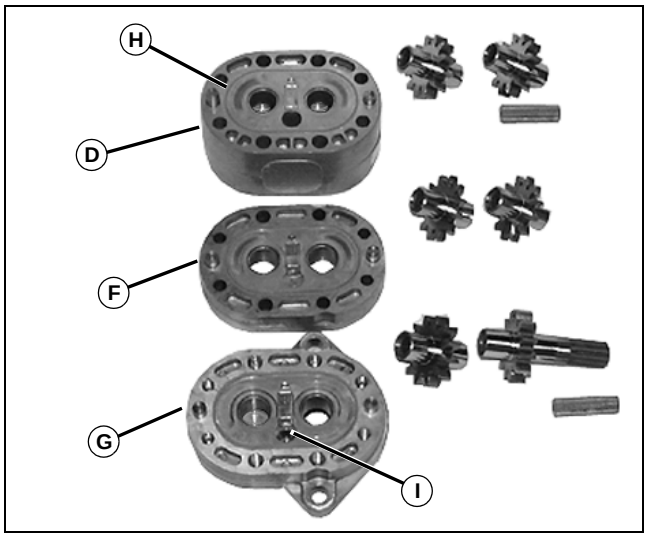
MX2710

1. Install shaft seal (A) with seal lip facing in using a seal driver and press.
2. Lubricate lip of seal with grease.



MX2711

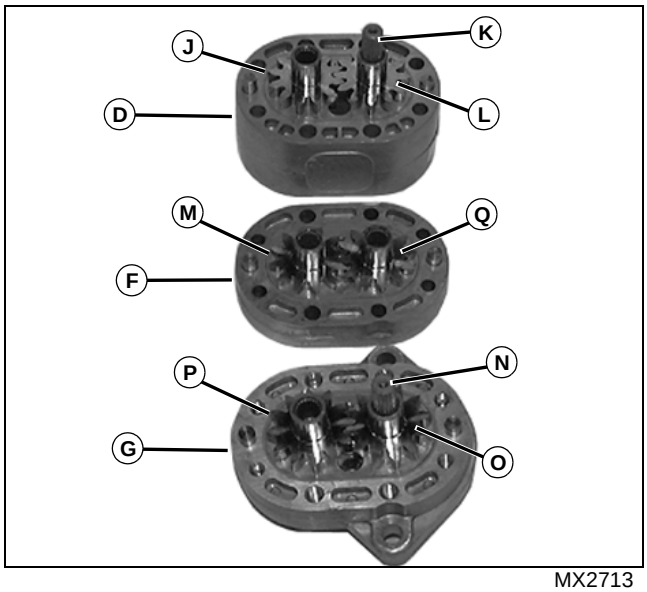
3. Install black seal (C) and then blue seal (B) in front end plate (G), rear end plate (F), and front pump body (D).
4. Install large seal ring (E) in front end plate, rear end plate, and front pump body.



MX2712

5. Install wear plate (H) in front end plate (G), rear end plate (F), and front pump body (D). Ensure bronze side faces up and large hole (I) is over the oil inlet passage.

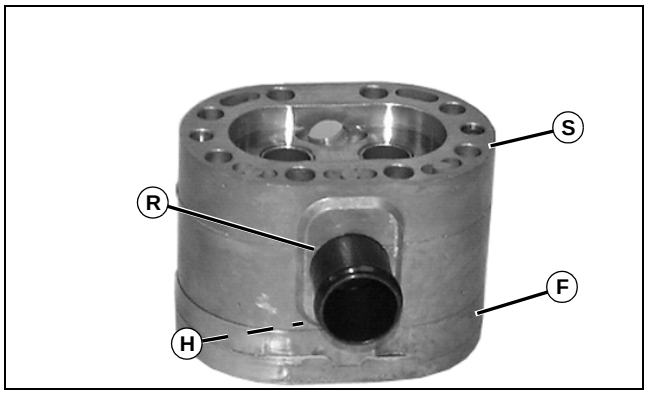
IMPORTANT: Avoid damage! Make sure bronze side of wear plates is facing the gears and large hole is on the inlet side of pump.



MX2713

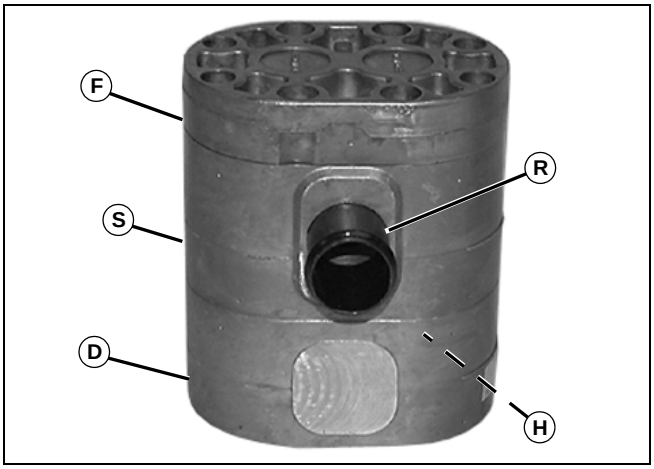
6. Install idler gear (P) and drive gear with input drive shaft (O) in front end plate (G).
7. Install idler gear (M) and drive gear (Q) in rear end plate (F).
8. Install idler gear (J) and drive gear (L) in front pump body (D).
9. Install shaft couplers (K and N) in drive gear of front end plate (G) and front pump body (D).

IMPORTANT: Avoid damage! Use assembly mark placed on side of pump during disassembly to assemble pump sections correctly.



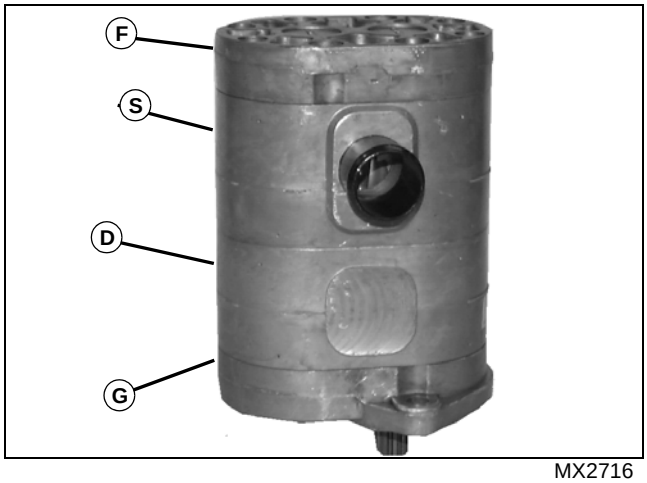
MX2714

10.Install rear pump body (S) on rear end plate (F) using assembly mark as a guide. Oil inlet (R) should be on the same side as the large hole in wear plate (H).



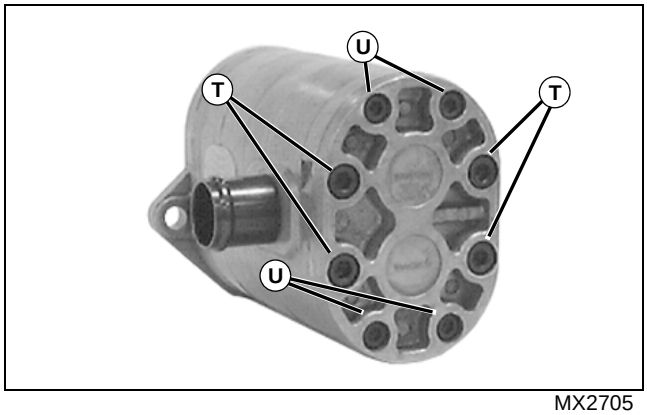
MX2715

11.Install rear pump body (S) and rear end plate (F) on front pump body (D). Oil inlet (R) should be on the same side as the large hole in wear plate (H).



MX2716

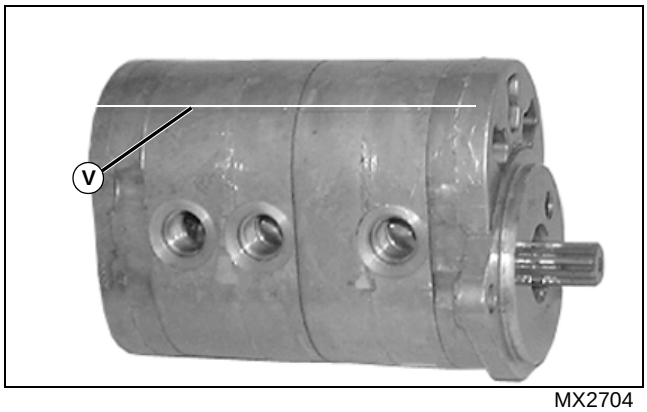
12.Install rear end plate (F), rear pump body (S), and front pump body (D) as an assembly, on front end plate (G).



MX2705

13.Install four 3/8-in. hex head screws (T) and washers, and tighten to specifications.

14.Install four 5/16-in. hex head screws (U) and tighten to specifications.



MX2704

15.Assembly mark (V) placed on side of pump during disassembly must line up across all pump sections if pump sections are assembled correctly.

Specifications

Hex Head Screw (3/8-in.) Torque 40-43 N•m (30-32 lb-ft)

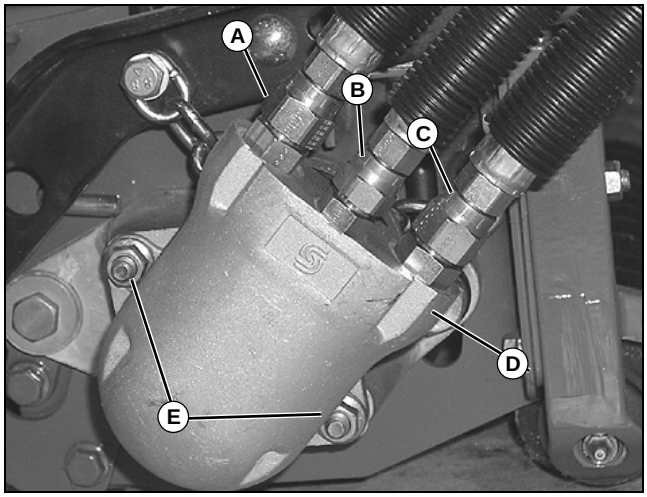
Hex Head Screw (5/16-in.) Torque. . 21-24 N•m (190-210 lb-in.)

Remove and Install Reel Motor

NOTE: Removal and installation of the reel motor is similar for all models; heavy duty reel motor on Model 3235C is shown.

Removal

1. Park vehicle on a level surface, cutting units lowered, park brake locked, engine OFF.



MX20013

2. Mark lines (A-C) and disconnect from reel motor (D).
3. Remove mounting nuts (E).
4. Remove motor from cutting unit.
5. Remove coupler from motor output shaft.

Installation

1. Install output shaft coupler.
2. Install motor onto cutting unit studs, making sure coupler splines line up with cutting unit input shaft.
3. Install mounting nuts.
4. Connect lines (A-C) as marked.

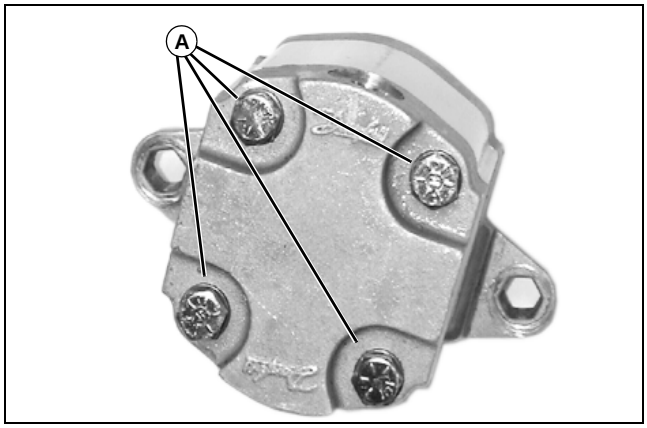
Disassemble and Assemble Reel Motor - Standard Duty 3225C and 3235C

Disassemble

1. Thoroughly clean and dry outside of motor.

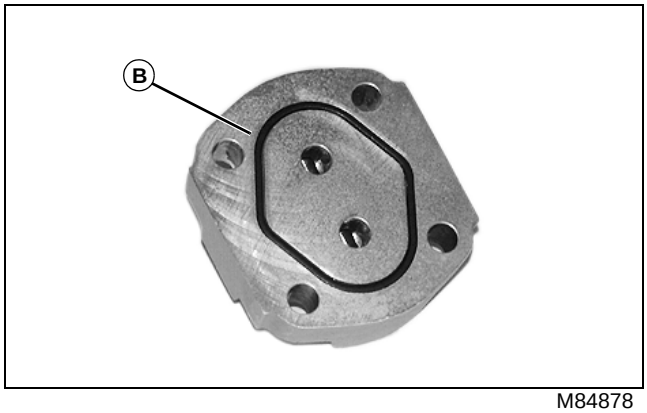
IMPORTANT: Avoid damage! Never pry components apart. Light tapping with a plastic hammer on input shaft will separate components without damage.

Be careful not to drop any parts or disengage gear mesh when separating assemblies.



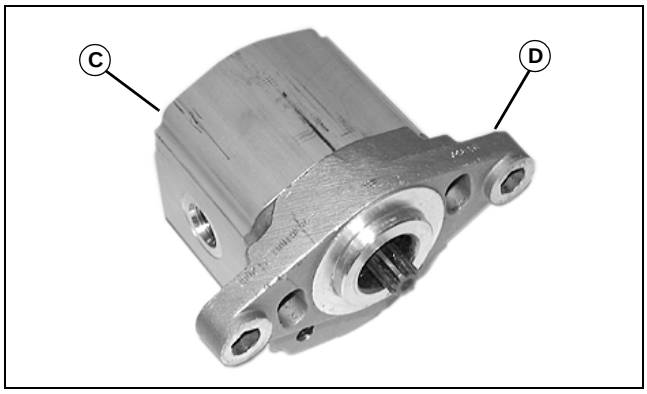
M84877

2. Place motor in a soft-jaw vise using just enough pressure to prevent the motor from turning when removing cap screws.
3. Remove four cap screws (A).
4. Remove end cover.



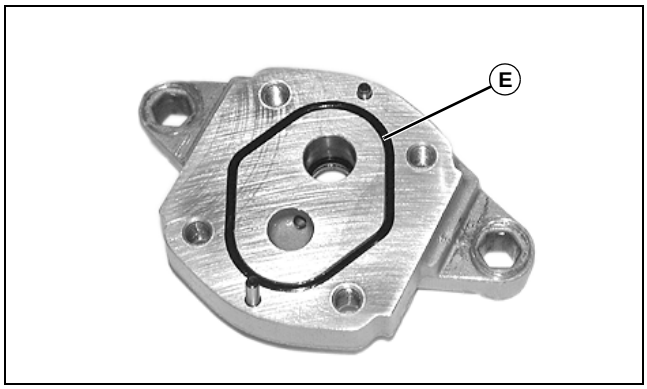
M84878

5. Remove O-ring (B) from end cover.



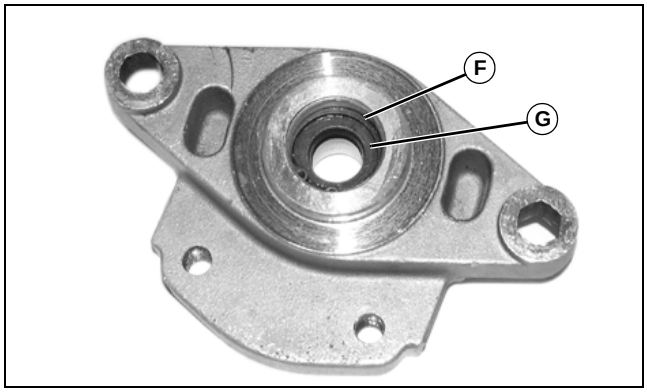
M84879

6. Separate front end cover (D) from main body (C).



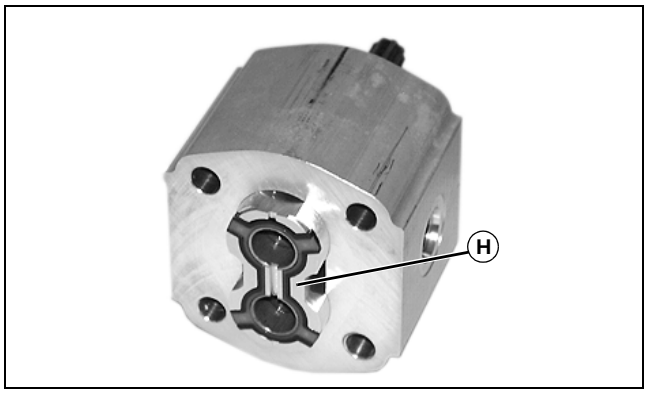
M84880

7. Remove O-ring (E) from front end cover.



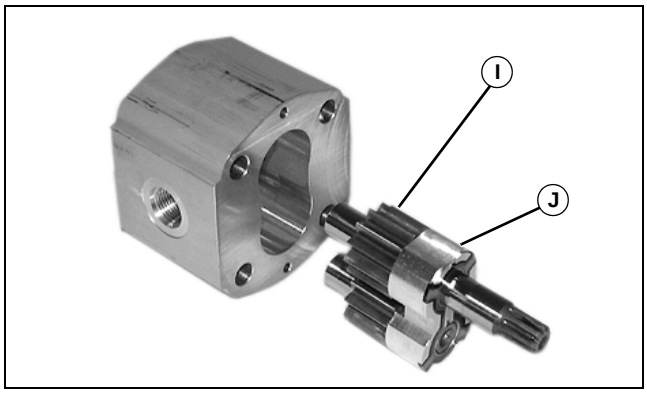
M84881

8. Remove retaining ring (F).
9. Remove seal (G).



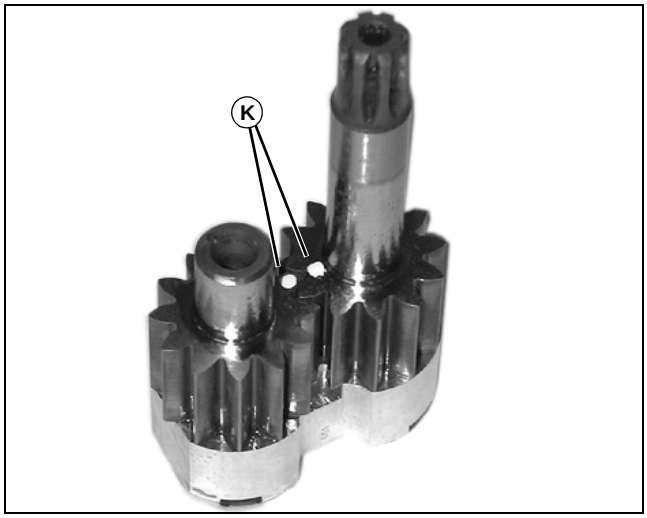
M84882

10. Remove rear wear block assembly (H).



M84883

11. Remove front block assembly (J) and gear set (I).



M84885

12. Place alignment marks (K) on gear mating teeth and remove gears from wear block assembly.

M84886

13.Inspect housing bore (L) for signs of damage.

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.

14.Clean all metal parts with solvent and blow dry with regulated compressed air.

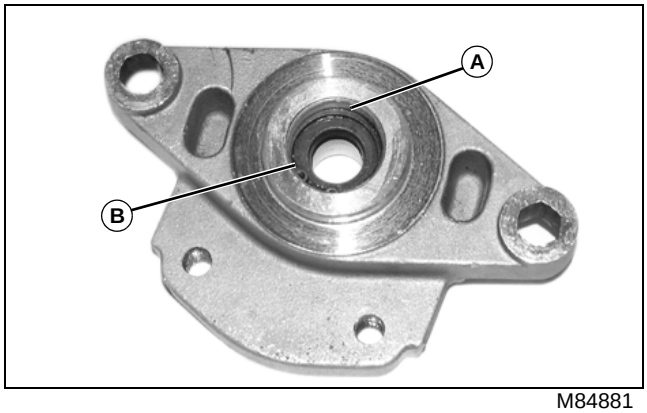
15.Inspect all parts for damage, nicks, or unusual wear. Replace entire reel motor assembly if any parts other than seal rings, seals, or outer bearing are worn or damaged.

Assemble

IMPORTANT: Avoid damage! Always use new O-rings and seals. Used or damaged O-rings and seals will leak.

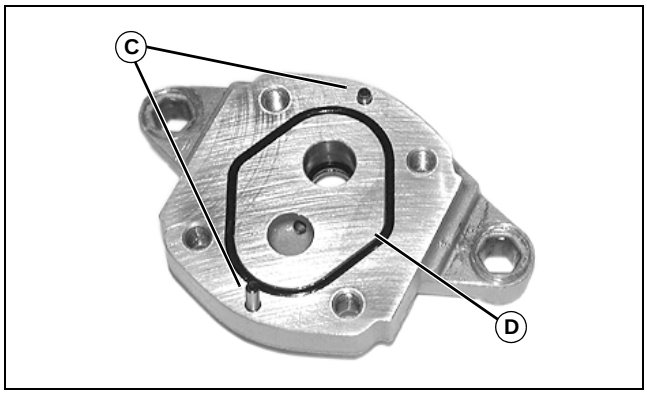
NOTE: Lubricate all seals and O-rings with petroleum jelly during assembly.

Apply a light coat of clean hydraulic oil to all internal parts when assembling the reel motor.



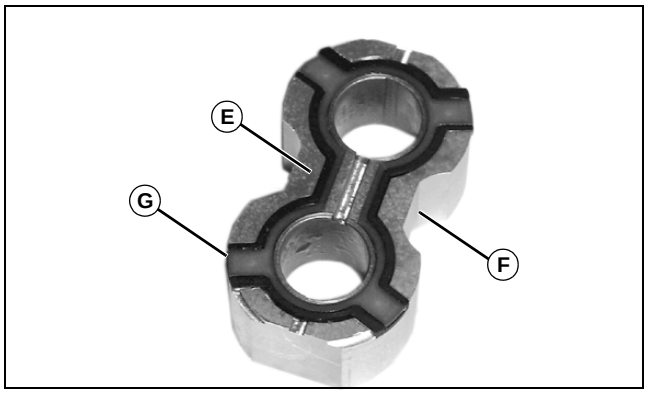
M84881

1. Apply multi-purpose grease to lips of seal (B).
2. Install a new seal parallel to the bore and seat tight against shoulder of bore.
3. Install retaining ring (A).



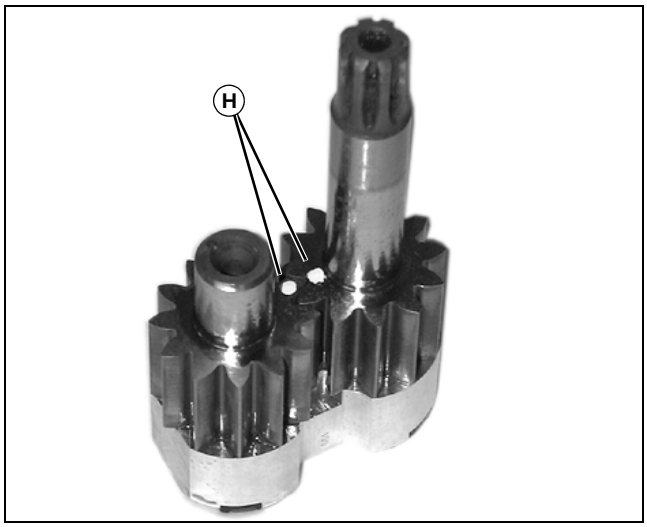
M84880

4. Install new O-ring (D).
5. Install alignment pins (C), if removed.



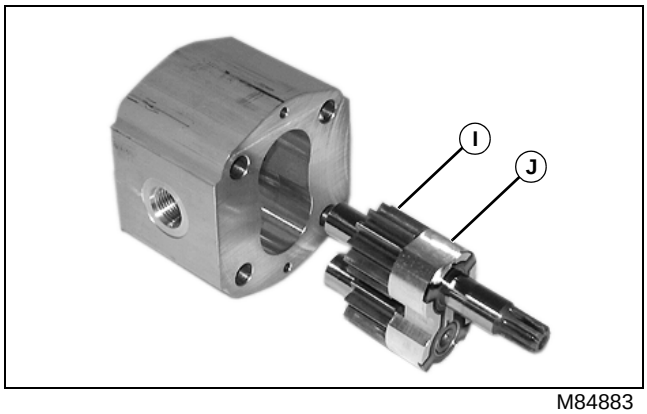
M84884

6. Install new seals (E) and spreaders (G) in wear block (F).



M84885

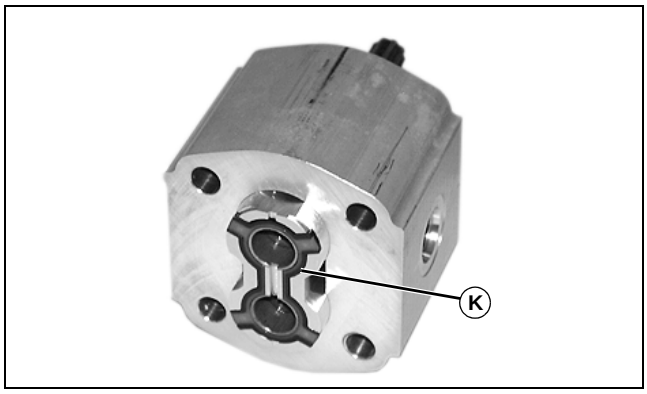
7. Align marks (H) and install gears in wear block.



M84883

8. Apply a light coat of clean hydraulic oil to wear block (J) and gear assembly (I).

9. Install front wear block/gear set assembly in housing.

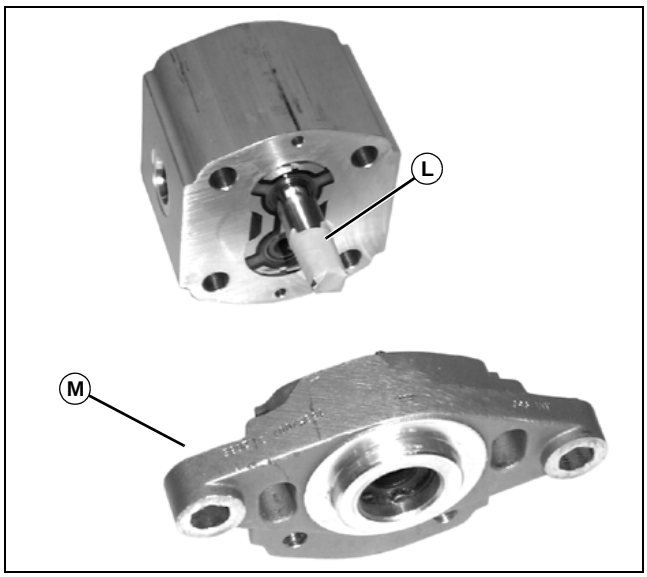


M84882

10. Apply a light coat of clean hydraulic oil to wear block/gear set assembly.

11. Install rear wear block/gear set assembly (K) in housing.

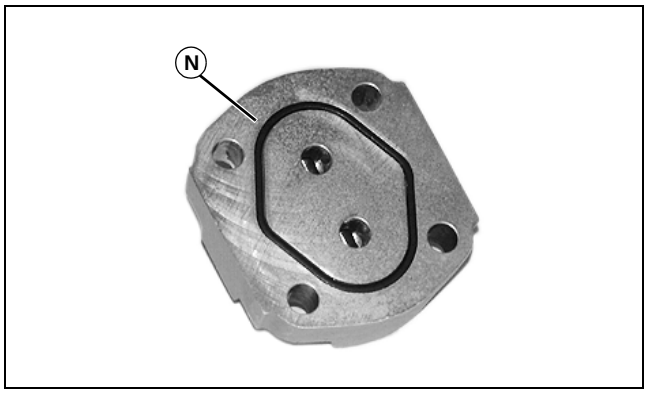
NOTE: The repair kit may include a plastic sleeve to cover the input shaft in order to prevent damage to the seal.



M98191

12. Cover the splines of the input shaft with tape (L) (or sleeve included with the repair kit) to prevent damaging the seal during installation.

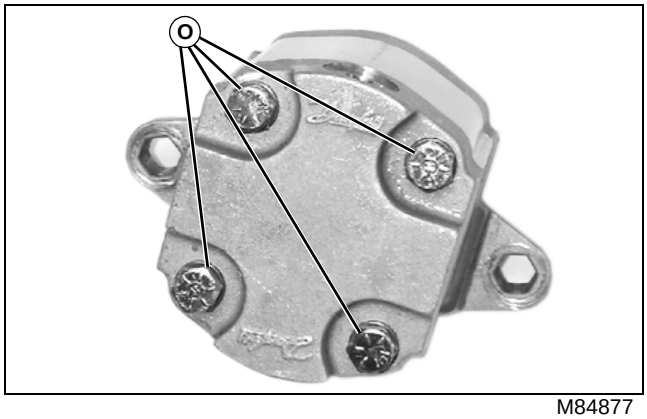
13. Install front cover (M).



M84878

14.Install new O-ring (N) in rear cover.

15.Install rear cover.



M84877

16.Install cap screws (O) (hand tight).

17.Rotate input shaft to verify that all parts are mating smoothly.

18.Tighten cap screws in an alternating pattern to specifications.

Specifications

Standard Duty, Cap Screw Torque . . . 45 N•m (33 lb-ft)

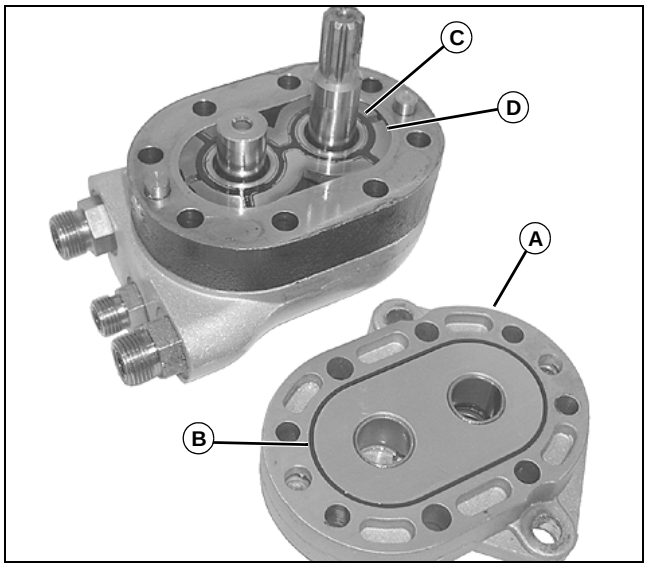
Disassemble and Assemble Reel Motor - Heavy Duty 3225C, 3235C, and Rotary Mower Motor - 3245C

Disassemble

IMPORTANT: Avoid damage! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without damage.

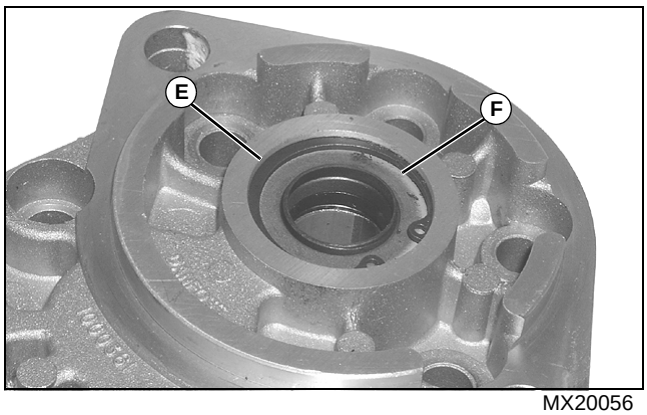
Be careful not to drop any parts or disengage gear mesh when separating assemblies.

NOTE: Disassembly and assembly procedures for the heavy duty reel motor and the rotary mower motor are the same except where noted. Heavy duty reel motor shown throughout.



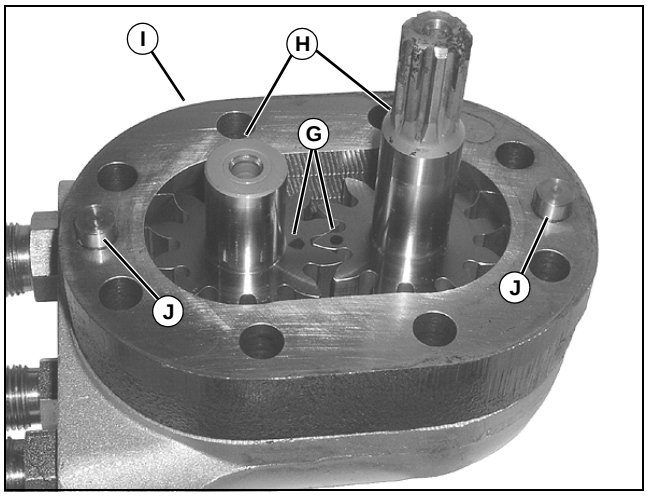
MX20055

1. On rotary mower, remove shaft key.
2. Remove eight hex head screws, washers, and cover (A).
3. Remove seals (B and C) and wear plate (D).



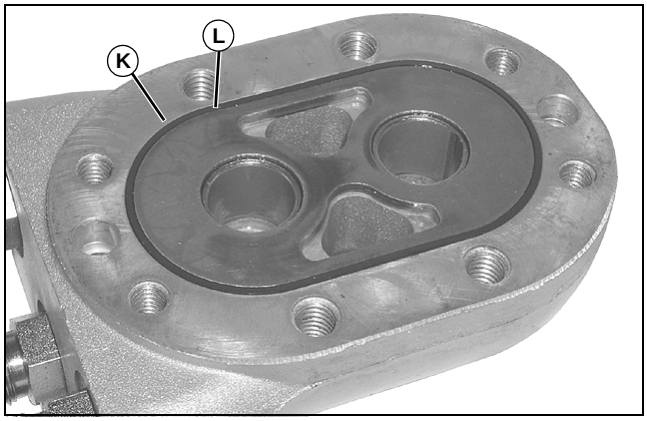
MX20056

4. Remove snap ring (E) and shaft seal (F).



MX20057

5. Apply a mark (G) to both gears (H) to ensure the same gear mesh during assembly. Remove gears and midsection (I) with pins (J).



MX20058

6. Remove seal (K) and wear plate (L).

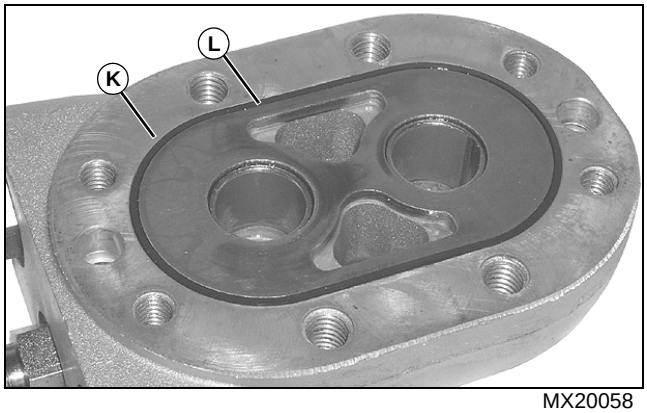
7. Clean and inspect gears, bearings, and midsection for scoring, burrs, fretting, or uneven wear patterns. Replace pump assembly if any of these parts are found worn or damaged.

Assemble

IMPORTANT: Avoid damage! Always install new wear plates, O-rings, and seals when assembling cutting unit motor. Old parts will leak.

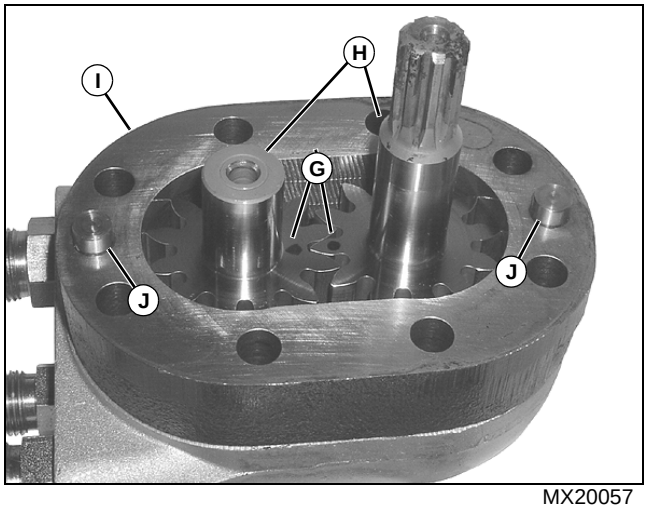
NOTE: Apply clean hydraulic oil to all internal parts before assembling.

Apply petroleum jelly to seals before installation.



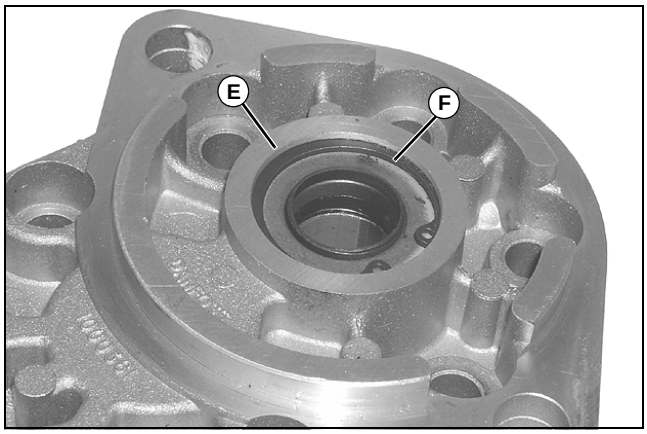
MX20058

1. Install seal (K) and wear plate (L) with bronze side up.



MX20057

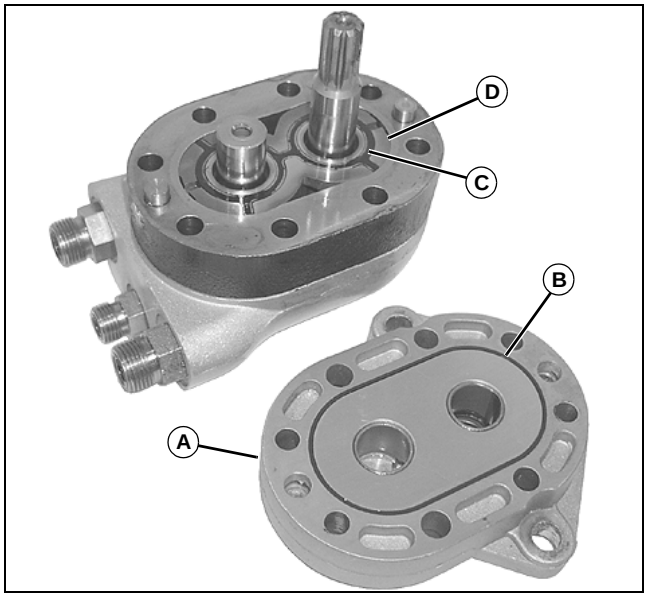
2. Install midsection (I), pins (J), and gears (H), making sure that marks (G) are aligned.



MX20056

3. Install shaft seal (F) with metal face up, using the appropriate seal driver.

4. Install snap ring (E) with sharp edge of ring facing out.

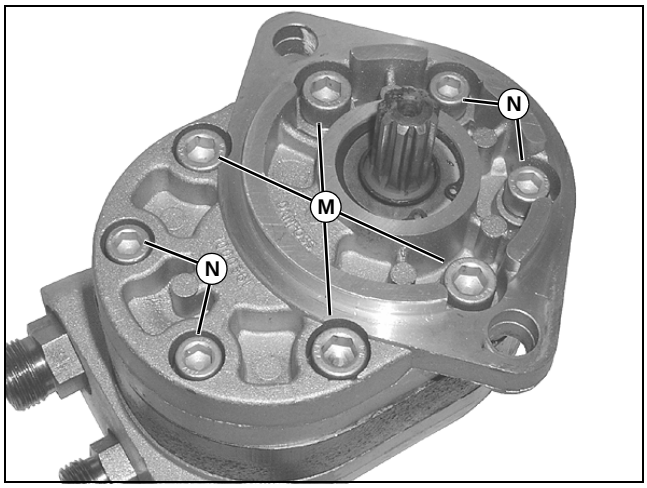


MX20055

5. Install wear plate (D) and seals (B and C).

6. Install cover (A). Make sure shaft seal is not damaged during cover installation.

7. On rotary mower, install shaft key.



MX20059

8. Install hex head screws (M and N) and washers. Tighten to specification.

Specifications

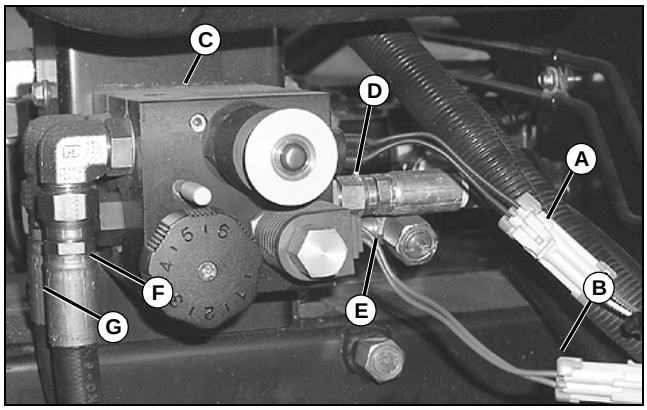
Rotary/Reel Heavy Duty, Hex Head Screw (5/16-in.)
Torque . . . . . 21-24 N•m (190-210 lb-in.)

Rotary/Reel Heavy Duty, Hex Head Screw (3/8-in.)
Torque . . . . . 40-43 N•m (30-32 lb-ft)

Remove and Install Backlapping Valve - 3225C and 3235C

Removal

1. Park vehicle on a level surface, cutting units lowered, park brake locked, engine OFF.
2. Disconnect battery.



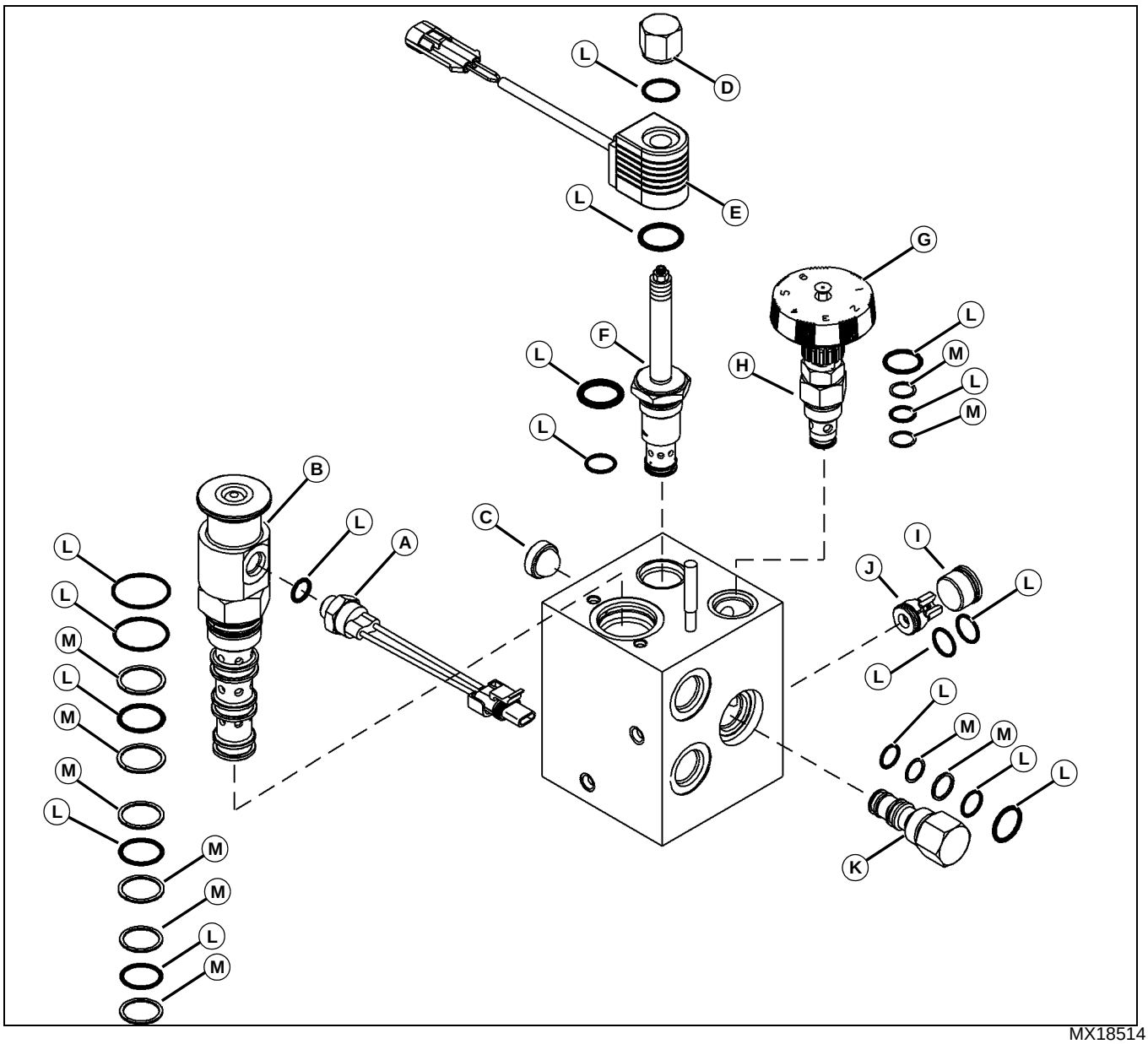
MX20014

3. Disconnect electrical connectors (A and B).
4. Place a suitable container under backlapping valve (C). Mark and disconnect lines (D-G).
5. Remove mounting cap screws and backlapping valve.

Installation

1. Install backlapping valve using four mounting cap screws.
2. Connect lines (D-G) as marked.
3. Connect electrical connectors (A and B).
4. Connect battery.

Disassemble, Inspect, and Assemble Backlapping Valve - 3225C and 3235C



MX18514

Disassemble

1. Remove forward/reverse switch (A) and forward/reverse valve (B).
2. Remove filter screen (C).
3. Remove coil nut (D), coil (E), and solenoid valve (F).
4. Remove flow control knob (G) and flow control valve (H).
5. Remove check valve plug (I) and check valve (J).
6. Remove logic element (K).

Inspect

1. Clean and inspect all components for wear or damage. Replace parts as necessary.

IMPORTANT: Avoid damage! Always use new O-rings and backup rings. Used or damaged O-rings and backup rings will leak.

NOTE: Lubricate all O-rings and backup rings with petroleum jelly during assembly.

Apply clean hydraulic oil to all internal parts when assembling the backlapping valve.

2. Remove all O-rings (L) and backup rings (M) and replace with new. Note location of O-rings and backup rings to aid in assembly.

Assemble

1. Lubricate all O-rings and backup rings before installation. Install all O-rings and backup rings in their proper location as noted during removal.

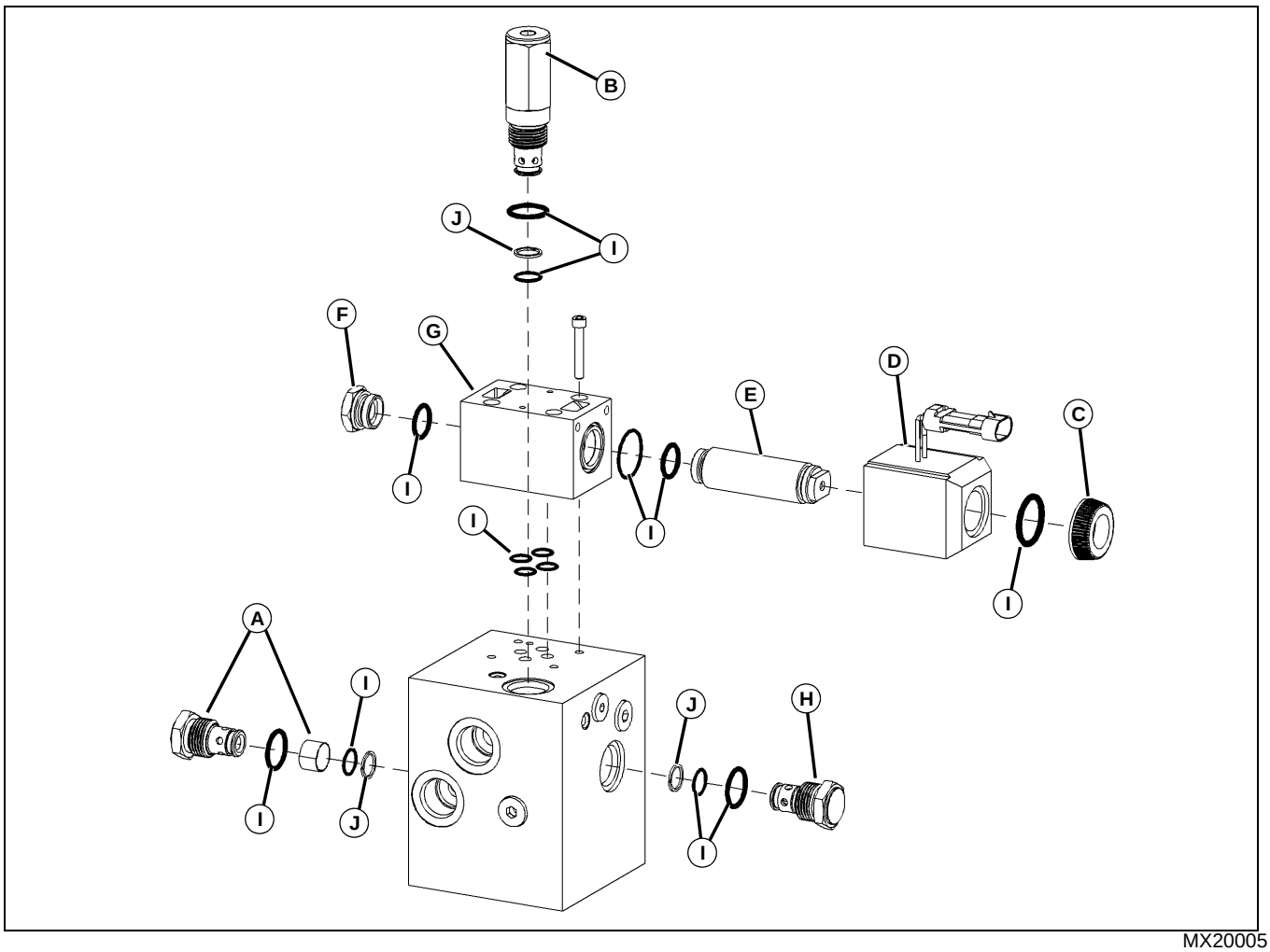
2. Lubricate all internal parts before installation.

3. Install components (A-K) to specification.

Specifications

Forward/Reverse Switch Torque . 4-7 N•m (36-60 lb-in.)
Forward/Reverse Valve Torque 108-136 N•m (80-100 lb-ft)
Filter Screen (Installation Below Spot Face) . 16-17 mm (0.64-0.68 in.)
Solenoid Valve Torque . . . . . 27-34 N•m (20-25 lb-ft)
Coil Nut Torque. . . . . 7-9 N•m (65-75 lb-in.)
Flow Control Knob Screw Torque 2-3 N•m (18-24 lb-in.)
Flow Control Valve Torque. . . . . 34-41 N•m (25-30 lb-ft)
Check Valve Plug Torque. . . . . 47-54 N•m (35-40 lb-ft)
Logic Element Torque . . . . . 41-47 N•m (30-35 lb-ft)

Disassemble, Inspect, and Assemble Mow Valve - 3245C



MX20005

Disassemble

1. Remove strainer/filter (A).
2. Remove relief valve (B).
3. Remove solenoid valve nut (C) and coil (D).
4. Remove mower control solenoid valve (E), mower control valve plug (F), and mower control valve (G).
5. Remove check valve (H).

Inspect

1. Clean and inspect all components for wear or damage. Replace parts as necessary.

IMPORTANT: Avoid damage! Always use new O-rings, seals, and backup rings. Used or damaged O-rings, seals, and backup rings will leak.

NOTE: Lubricate all O-rings, seals, and backup rings with petroleum jelly during assembly.

Apply clean hydraulic oil to all internal parts when assembling the mow valve.

2. Remove all O-rings (I) and backup rings (J) and replace with new. Note location of O-rings and backup rings to aid in assembly.

Assemble

1. Lubricate all O-rings and backup rings before installation. Install all O-rings and backup rings in their proper location as noted during removal.

2. Lubricate all internal parts before installation.

3. Install components (A-H) to specification.

Specifications

Relief Valve Torque. . . . . 47-54 N•m (35-40 lb-ft)
Mower Control Valve Cap Screws Torque . 5-6 N•m (40-53 lb-in.)
Mower Control Valve Plug Torque. 27-34 N•m (20-25 lb-ft)
Mower Control Solenoid Valve Torque 27-34 N•m (20-25 lb-ft)
Solenoid Coil Nut Torque. . . . . 7-9 N•m (65-75 lb-in.)
Check Valve Torque . . . . . 47-54 N•m (35-40 lb-ft)

Table of Contents

STEERING TABLE OF CONTENTS

Specifications

Test and Adjustment Specifications

Steering and Lift System Relief Valve Pressure	**9997 kPa (1450 psi)**
Steering System and Steering Control Unit (SCU) Leakage, Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque	**6 (Maximum)**

Tools and Materials

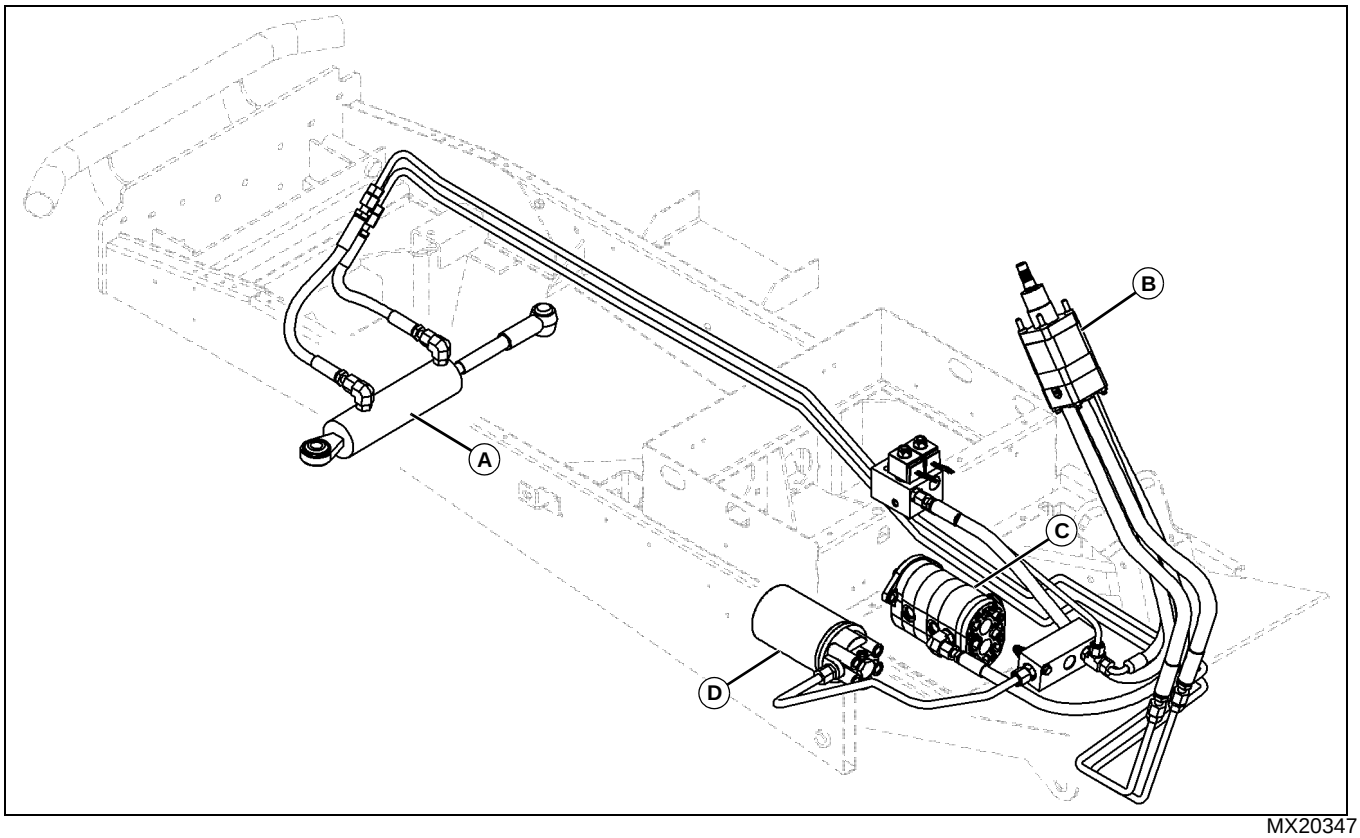
Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit	JDG2033	Connect pressure gage for steering and lift system pressure test.
Pressure Diagnostic Kit	JDG2032	Connect pressure gage for steering and lift system pressure test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.
Hose Removal Tool	JDG1518	Used to remove steering hoses from steering valve.

Component Location

Steering Components

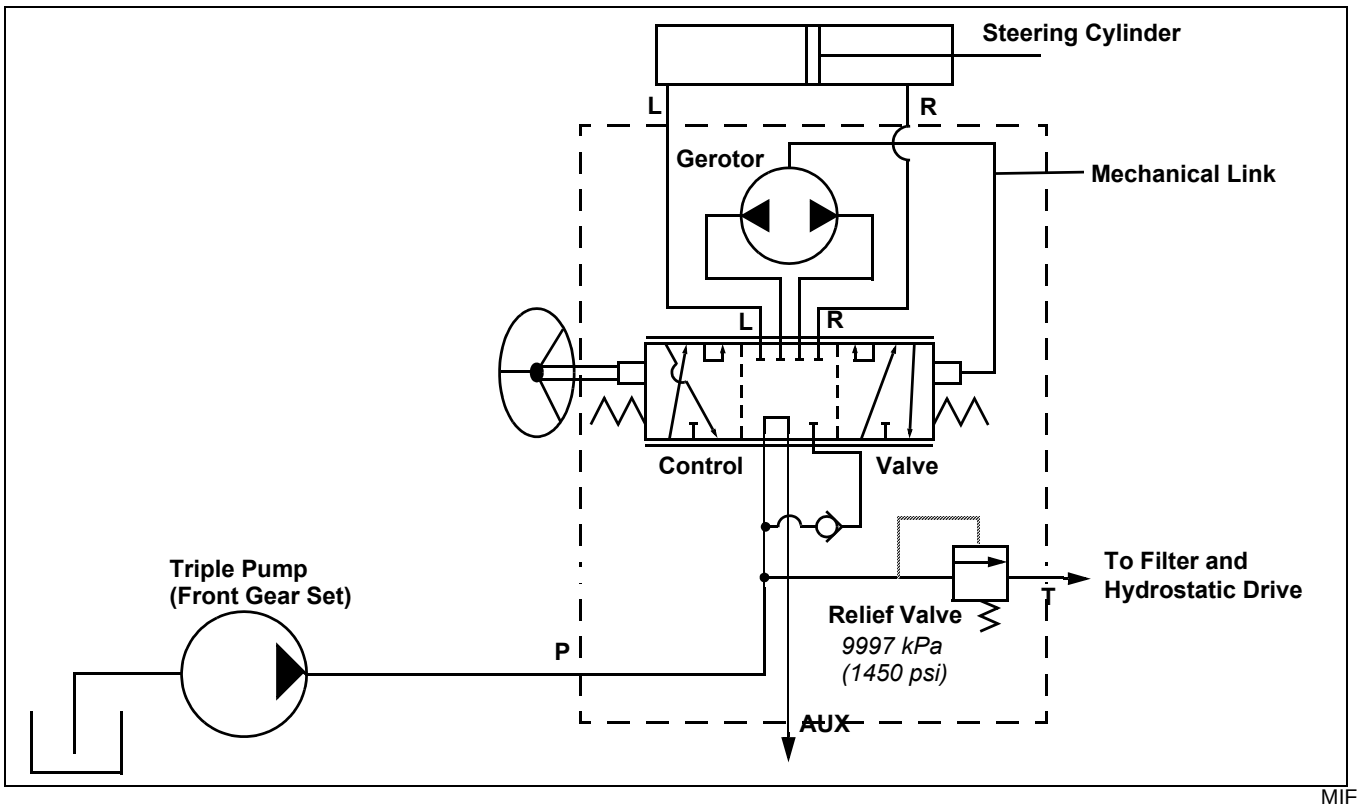


MX20347

A - Steering Cylinder
B - Steering Control Unit (SCU)
C - Triple Pump (Front Gear Set)
D - Hydraulic Oil Filter

Theory of Operation

Steering System



Port Identification

Port P . . . . . Inlet Pressure
Port T . . . . . To Filter and Hydrostatic Drive
Port AUX . . . . . To Lift Valve
Port L . . . . . Left Turn
Port R . . . . . Right Turn

Function

Provides power-assisted steering and manual steering if hydraulic pressure is lost.

Triple Pump (Front Gear Set)

The triple pump (front gear set) is the forward pump of the triple pump assembly. The triple pump (front gear set) provides fluid to the steering mechanism.

Steering Control Unit (SCU)

This unit operates in an “open center series” type hydraulic system which allows hydraulic flow through an open center port when the valve is in the center position. This allows operation of other equipment such as lift, down pressure (if equipped) and hydrostatic drive systems. Each system, except the hydrostatic drive, has a controlling valve with an open center that directs 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.

Theory

Charge pressure flows to a three-position, spring centered control valve inside the steering control unit (SCU). When the control valve is in neutral, oil flows through the open center of the valve and is available for lift operation, for the down pressure system and to charge the hydrostatic drive system. When a turn is initiated, fluid flows to either the left or right side of the steering actuator to position the mechanical steering linkage and wheels for a left or right turn. When the steering wheel is held in any position, except full left or full right, the control valve returns to neutral by centering springs and the fluid is available for use downstream in the circuit. If the steering wheel is held in the full left or full right position, the charge pump pressure will build until the pressure reaches the steering valve internal relief valve setting of 9997 kPa (1450 psi).

Manual steering is available during vehicle towing or in the event charge pressure is lost to the SCU. A mechanical link inside the SCU connects the gerotor to the steering wheel. The gerotor is a manual pump that is driven by the operator when he turns the steering wheel, delivering fluid under pressure to actuate the steering cylinder.

Diagnostics

Steering System Troubleshooting

Symptom: Steering Wanders

(1) Are tires of proper type and inflated to proper pressure?

Yes - Go to step (2).

No - Replace tires with tires of proper type. Inflate tires to proper pressure.

(2) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (3).

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 step (4).

No - Tighten hydraulic fittings.

(4) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (5).

No - Replace parts as needed.

(5) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (6).

No - Repair or replace parts as necessary.

(6) Perform steering system leakage test. (See "Test Steering System Leakage" on page 392.) Is test within specifications?

No - Perform steering valve leakage test. (See "Test Steering Control Unit (SCU) Leakage" on page 392.) Follow results of test.

Symptom: Steering Shimmy

(1) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (2).

No - Replace parts as needed.

(2) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (3).

No - Repair or replace parts as necessary.

Symptom: Steering Shimmy

(3) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (4).

No - Tighten hydraulic fittings.

(4) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (5).

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.

Symptom: Sluggish Steering Response

(1) Is engine rpm within operating range?

Yes - Go to step (2).

No - Adjust slow and/or fast idle speed. (See "Adjust Slow Idle" on page 53.)

(2) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (3).

No - Repair or replace parts as necessary.

(3) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (4).

No - Tighten hydraulic fittings.

(4) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (5).

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 step (6).

No - Remove contaminated fluid, flush system and find source of contamination.

(6) Is hydraulic filter clean and free from restrictions?

Yes - Go to step (7).

No - Replace filter as needed.

Symptom: Sluggish Steering Response

(7) Are hydraulic lines and oil cooler free from any restrictions?

Yes - Go to step (8).

No - Clear lines or cooler of restrictions. Replace parts as needed.

(8) Perform steering system leakage test. (See "Test Steering System Leakage" on page 392.) Is test within specifications?

No - Perform steering valve leakage test. (See "Test Steering Control Unit (SCU) Leakage" on page 392.) Follow results of test.

Symptom: Excessive Steering Wheel Free-Play

(1) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (2).

No - Repair or replace parts as necessary.

(2) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (3).

No - Purge air from system. Check suction line to charge pump for air leaks.

(3) Is steering valve mounted securely?

No - Secure steering valve.

Symptom: High Steering Effort in One Direction

(1) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (2).

No - Replace parts as needed.

(2) Perform steering system leakage test. (See "Test Steering System Leakage" on page 392.) Is test within specifications?

No - Perform steering valve leakage test. (See "Test Steering Control Unit (SCU) Leakage" on page 392.) Follow results of test.

Symptom: High Steering Effort in Both Directions

(1) Are tires of proper type and inflated to proper pressure?

Yes - Go to step (2).

No - Replace tires with tires of proper type. Inflate tires to proper pressure.

(2) Are the steering cylinder ball joints in good condition, not worn?

Yes - Go to step (3).

No - Replace parts as needed.

(3) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (4).

No - Repair or replace parts as necessary.

(4) Is hydraulic filter clean and free from restrictions?

Yes - Go to step (5).

No - Replace filter as needed.

(5) Test triple pump (front gear set). (See "Test Lift and Steering Pump Flow" on page 357.) Is pump flow within specifications?

Yes - Go to step (6).

No - Repair or replace pump as necessary.

(6) Perform steering system leakage test. (See "Test Steering System Leakage" on page 392.) Is test within specifications?

No - Perform steering valve leakage test. (See "Test Steering Control Unit (SCU) Leakage" on page 392.) Follow results of test.

Symptom: Steering Cylinder Will Not Fully Extend or Retract

(1) Is engine rpm within operating range?

Yes - Go to step (2).

No - Adjust slow and/or fast idle speed. (See "Adjust Slow Idle" on page 53.)

(2) Is the steering linkage in good condition, not damaged or worn?

Yes - Go to step (3).

No - Repair or replace parts as necessary.

Symptom: Steering Cylinder Will Not Fully Extend or Retract

(3) Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes - Go to step (4).

No - Purge air from system. Check suction line to charge pump for air leaks.

(4) Are the hydraulic fittings tight, preventing fluid loss?

Yes - Go to step (5).

No - Tighten hydraulic fittings.

(5) Is steering rod free of damage, not bent?

Yes - Go to step (6).

No - Replace steering cylinder.

(6) Test triple pump (front gear set). (See “Test Lift and Steering Pump Flow” on page 357.) Is pump flow within specifications?

Yes - Go to step (7).

No - Repair or replace pump as necessary.

(7) Perform steering system leakage test. (See “Test Steering System Leakage” on page 392.) Is test within specifications?

No - Perform steering valve leakage test. (See “Test Steering Control Unit (SCU) Leakage” on page 392.) Follow results of test.

Tests and Adjustments

Test Steering System Leakage

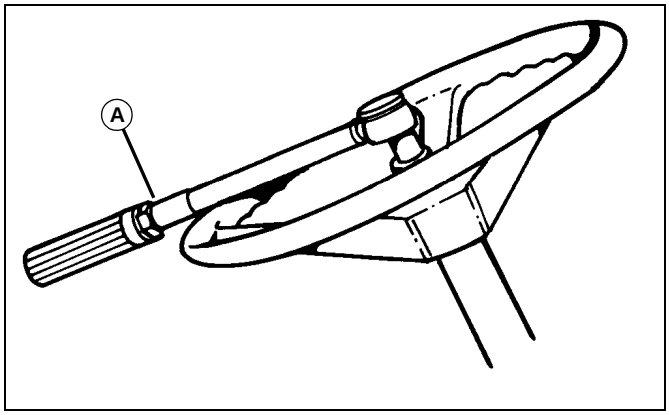
Reason

To check hydraulic steering system for internal leakage.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

2. Start engine and set throttle to slow idle.



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3. With steering wheel at maximum right turn position, use a torque wrench (A) to apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.

4. Repeat step 3 with steering wheel at a maximum left turn position.

Results

If rotations per minute exceed specification, perform the steering control unit (SCU) leakage test to isolate the SCU from the steering cylinder. (See “Test Steering Control Unit (SCU) Leakage” on page 392.)

Specifications

Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque . . . . . 6 (Maximum)

Test Steering Control Unit (SCU) Leakage

Reason

The steering system leakage test should be performed first to verify internal steering system leakage. (See “Test Steering System Leakage” on page 392.)

This procedure isolates steering system leakage between the SCU and the steering cylinder.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

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.

2. Disconnect and cap the lines at the steering cylinder.

3. Start engine and set throttle to slow idle.

4. With steering wheel at a maximum right turn position, apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute. Repeat with steering wheel at maximum left turn position.

Results

If rotations/min exceed specification, replace the SCU.

If rotations/min are less than specification, replace the steering cylinder.

Specifications

Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque. . . . . 6 (Maximum)

Test Steering System Relief Pressure

Reason

To verify triple pump (front gear set) pressure is maintained at correct level for steering and lift systems without causing damage to the system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gage Kit	JDG2033	Connect pressure gage for steering and lift system pressure test.
Pressure Diagnostic Kit	JDG2032	Connect pressure gage for steering and lift system pressure test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

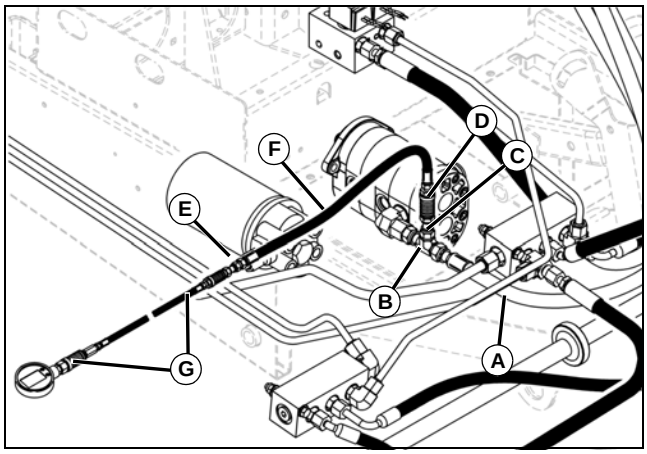
Procedure

1. Operate hydraulic system until fluid is at a minimum temperature of 43°C (110°F).

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.

2. Relieve system pressure by operating the lift system.



MX20040

3. Disconnect steering supply hose (A) from front section of triple pump and install a tee fitting (B) and reconnect hose to fitting.

4.Install a diagnostic fitting (C) on tee fitting.

5. Install quick couplers (D and E).

6. Connect gage and hose (G) to hose (F) and connect hose to diagnostic fitting (C).

NOTE: Check engine rpm with electronic tachometer.

7. Apply park brake, start engine, and run at 3000 ± 50 rpm.

8. Turn steering wheel completely in one direction and hold. Record steady pressure reading.

Results

Pressure should be 9997 kPa (1450 psi). If pressure is not within specification, replace steering valve.

Specifications

Steering System Relief Valve Pressure 9997 kPa (1450 psi)

Repair

Remove and Install Steering Control Unit (SCU)

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1518	Used to remove steering hoses from steering valve.

Remove

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 high-pressure lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

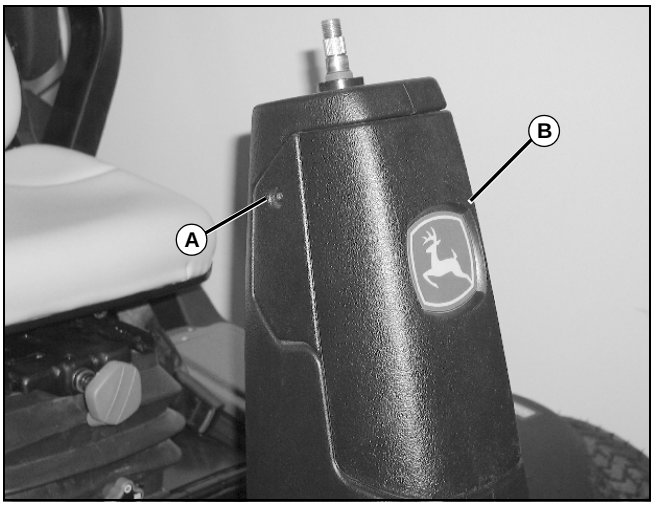
If an accident occurs, see a doctor immediately. Any fluid injected into the skin, must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

IMPORTANT: Avoid damage! Cleanliness is extremely important when repairing the hydraulic SCU. Before disconnecting the hydraulic lines, clean the port area of the SCU to avoid getting contaminants into SCU and hydraulic system.

1. Remove steering wheel center cap.
2. Remove steering wheel retaining nut.

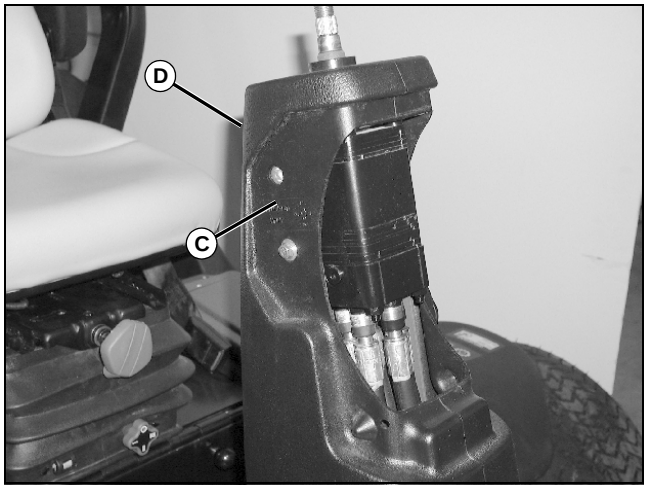
NOTE: Normally, slight upward pressure on the steering wheel combined with light taps on the steering wheel shaft will disengage steering wheel and shaft splines. DO NOT damage steering wheel shaft. If steering wheel does not disengage from shaft with slight taps, use a combination knife-edge puler and 2-jaw puller to remove steering wheel.

3. Remove steering wheel.



MX20191

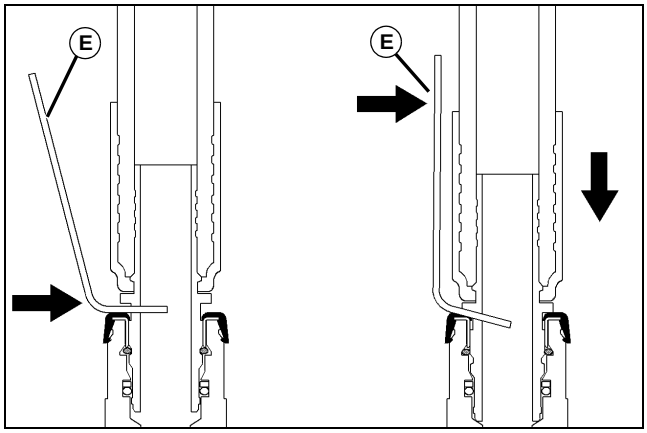
4. Remove screw (A) from each side of access panel (B) and remove panel.



MX20192

5. Remove cap screw (C) from each side of steering column cover (D) and remove cover.

NOTE: Tag or label steering lines to aid during installation.



MX20284

6. Remove steering lines using JDG1518 Hose Removal Tool (E) as follows:

   a. Insert removal tool in gap between hose shell and dust boot.

   b. Push hose into coupler while pushing removal tool handle toward hose until a release snap is felt.

   c. Relieve pressure on removal tool and pull hose out of coupler.

   d. To install, push hose into coupler until dust boot snaps into groove on coupler. Pull hose away from coupler to make sure connection is secure.

7. Remove four retaining nuts and steering valve.

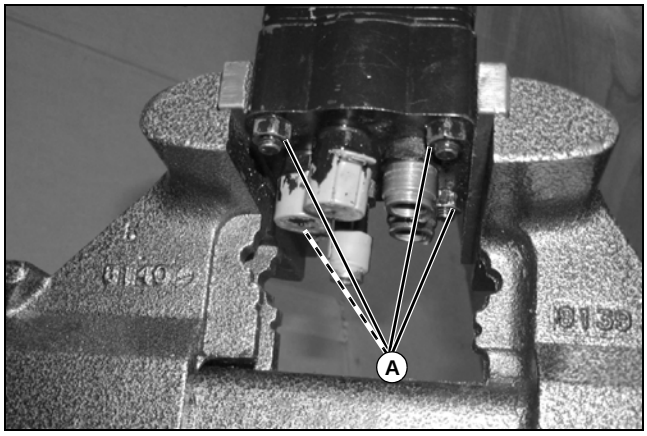
Install

Installation is performed in reverse order of removal.

Remove and Install Steering Valve Bushing

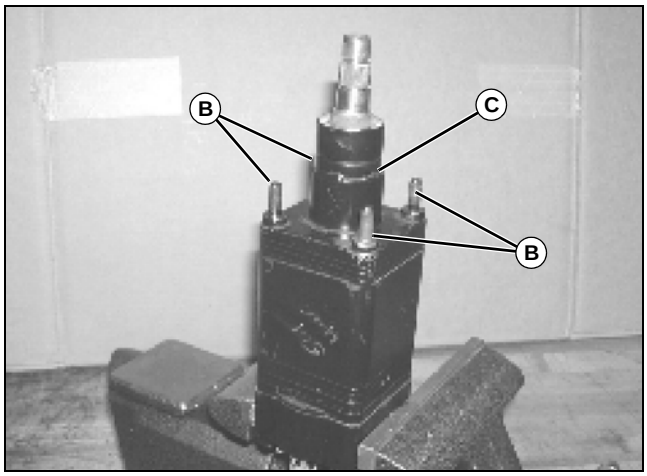
1. Remove steering valve. (See Remove and Install Steering Control Unit on page 386.)

2. Place steering valve in bench vice.



MX22831

3. Remove nuts (A).

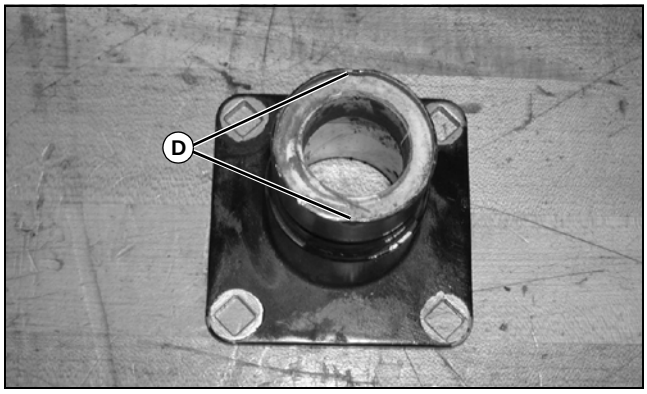


MX22832

4. Remove studs (B).

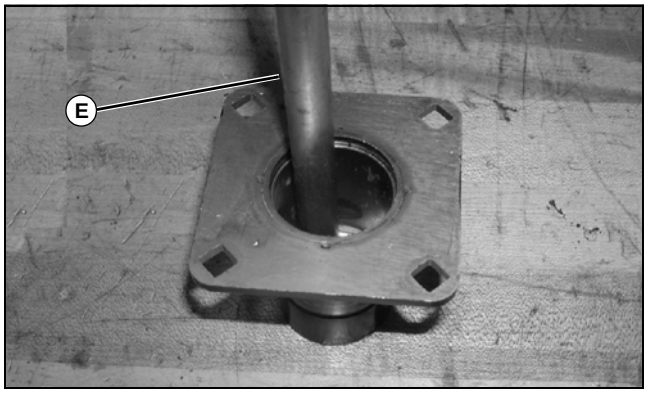
NOTE: To keep valve sections from separating install studs (B) back in valve after bushing housing (C) is removed.

5. Remove top housing (C) holding shaft bushing.



MX22833

6. Bend crimps (D) retaining bushing with pliers.



MX22834

7. Drive bushing out of housing using hammer and punch (E).

Installation

1. Install bushing into housing with appropriately sized bushing driver. Install bushing 2.5 mm (0.100 in.) below top of housing.
2. Crimp housing to retain bushing.
3. Apply multi purpose grease to bushing.
4. Install bushing housing.
5. Install studs and nuts. Tighten to specification.

Specifications

Steering Valve Nut Torque . . . . . 30 N•m (22 lb-ft)

Table of Contents

BRAKES TABLE OF CONTENTS

Specifications

General

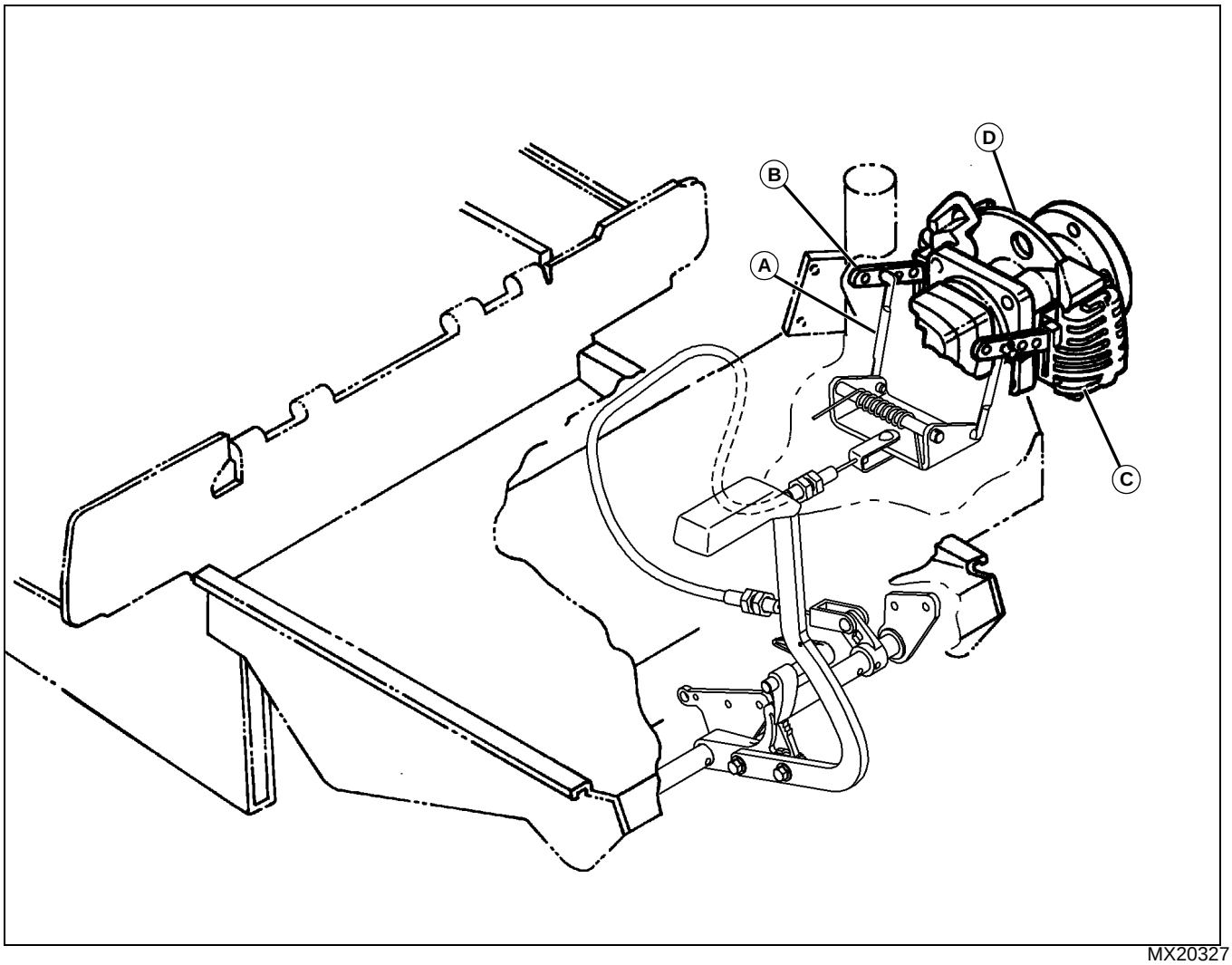
Brake Type	Mechanical
Rotor Diameter (Nominal)	209.54 mm (8.250 in.)
Rotor Thickness (New)	4.78 mm (0.188 in.)
Rotor Minimum Thickness	3.6 mm (0.142 in.)
Rotor Run-Out	0.635 mm (0.025 in.)
Pad Thickness, Usable	3.429 mm (0.135 in.)

Torque Specifications

Rotor Nut Torque	508 N•m (375 lb-ft)

Theory of Operation

Brake System



MX20327

Function

The park brake is used to prevent movement when the mower is not in use and to assist in stopping the mower while on a slope. The brake is not used to stop the mower on level ground. Primary braking is accomplished by the back pressure in the hydrostatic transmission.

The brake interlock switch stops the engine if operator the attempts to move the unit with the brake engaged or leaves the seat without engaging the brake. The switch also prevents the reels from rotating if the brake is engaged.

Theory

When the brake pedal is depressed, the link rod (A) pushes the caliper link (B), which in turn causes the brake caliper (C) to force the brake pads against the rotor (D). This prevents the unit from moving. Operating the brake pedal or park brake lock also operates the brake interlock switch, which will stop the engine and/or the reels under certain circumstances.

The brake is locked on by pulling the park brake lever up and fully depressing the brake pedal. It is unlocked by pushing and holding the pedal down while pushing the park brake lever down. When the park brake lever is engaged, the brakes will remain engaged until the lever is disengaged. Without the lever engaged, the brakes will be engaged only while the pedal is being pushed.

Diagnostics

Brake System Troubleshooting

Symptom: Park Brake Does Not Hold

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 402.

No - Repair or replace linkage as required.

(2) Are pads and rotors clean with no excessive wear or damage?

Yes - Go to step (3).

No - Replace pads.

No - Cut or replace rotors.

(3) Are calipers functioning properly?

No - Repair or replace as required.

Symptom: Excessive Brake Wear

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 402.

No - Repair or replace linkage as required.

(2) Are calipers functioning properly, not binding or damaged?

Yes - Go to step (3).

No - Repair or replace as required.

(3) Are rotor machined surfaces smooth and free of excessive wear or damage?

No - Cut or replace rotors.

Symptom: Brakes Do Not Release

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 402.

No - Repair or replace linkage as required.

Symptom: Brakes Do Not Release

(2) Are calipers functioning properly, not binding or damaged?

No - Repair or replace as required.

Symptom: Brake Pedal Does Not Return

(1) Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes - Go to step (2).

No - Adjust brakes. See “Adjust Brakes” on page 402.

No - Repair or replace linkage as required.

(2) Are calipers functioning properly, not binding or damaged?

Yes - Go to step (3).

No - Repair or replace as required.

(3) Is the brake pedal return spring functioning properly, not broken?

No - Replace brake pedal return spring.

Symptom: Brakes Noisy

(1) Are pads and rotors clean with no excessive wear or damage?

Yes - Go to step (2).

No - Replace pads.

No - Cut or replace rotors.

(2) Are calipers functioning properly, not binding or damaged?

No - Repair or replace as required.

Tests and Adjustments

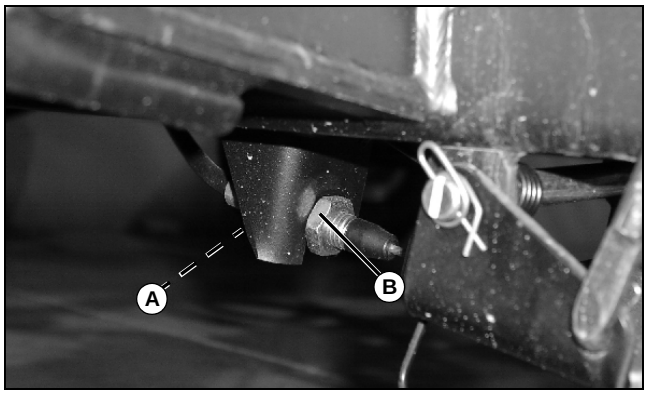
Adjust Brakes

Reason

Allow full activation of the brakes without creating brake drag.

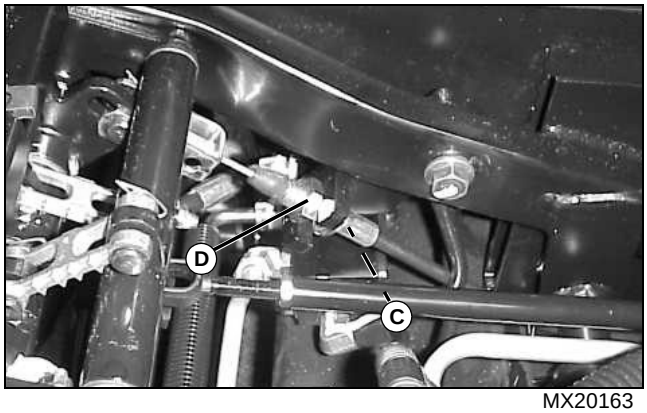
Procedure

1. Park machine on level surface and turn engine off.
2. Block rear wheels and release park brake lock.
3. Use jack stands to support the front wheels off the ground.



MX20329

4. Loosen jam nut (B).
5. Tighten coupler nut (A) while rotating wheel until brake pads begin to contact rotor. Loosen coupler until brake releases. Tighten jam nut.
6. Repeat on other wheel.



MX20163

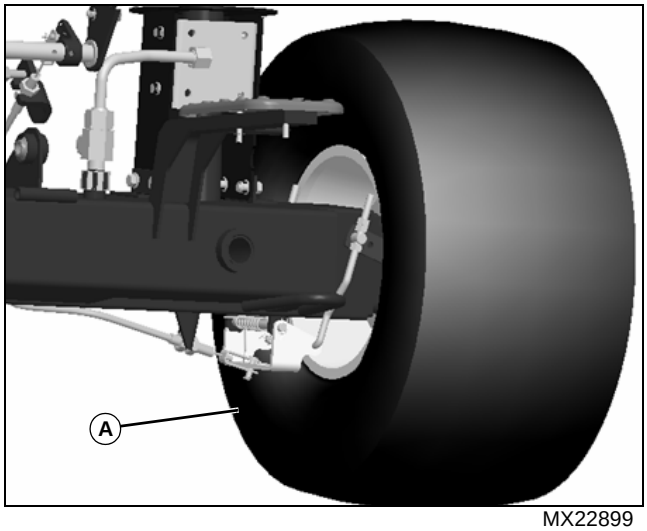
7. Additional adjustment is available at the pedal end of the cable.
8. Loosen jam nut (C) and adjust coupler nut (D).

Results

- Brakes should fully engage with pedal depressed and disengage while the brake pedal is released, preventing the brake pads from dragging on the rotors.

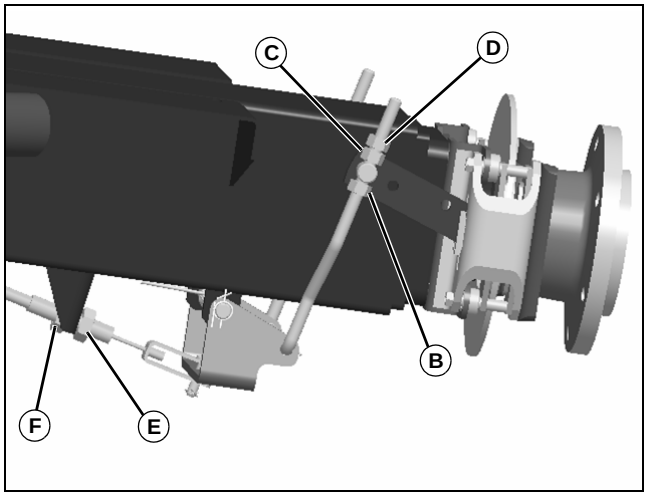
Adjust Park Brake

1. Park machine on level surface and turn off engine.
2. Block rear wheels and unlock park brake.
3. Support the front wheels off the ground safely. Use jack stands.



MX22899

4. Remove wheel (A).



MX22900

5. Loosen bottom nut (B) on the pull rods (both sides).

NOTE: Make sure park brake pedal does not contact floor plate with brakes fully engaged.

6. Tighten coupler nut (C) while rotating wheel until brake pads begin to contact disk. Loosen coupler until brake releases. Tighten bottom nut (B) to (both sides).

7. Tighten top jam nut (D) (both sides)

8. Repeat for left brake.

9. Additional adjustment is available at the brake and pedal end of the brake cable.

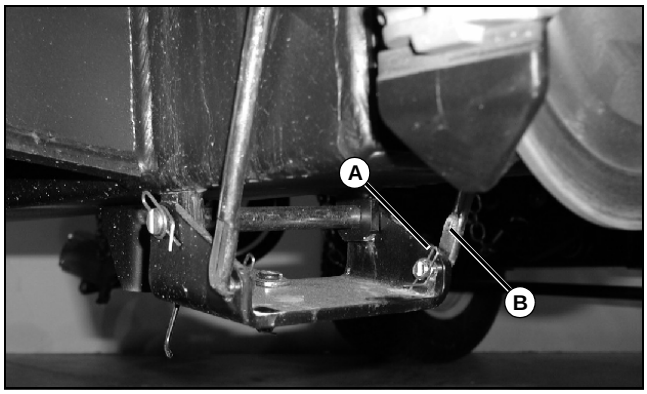
10. Loosen jam nut (E) and adjust coupler nut (F).

11. Repeat for left brake.

Repair

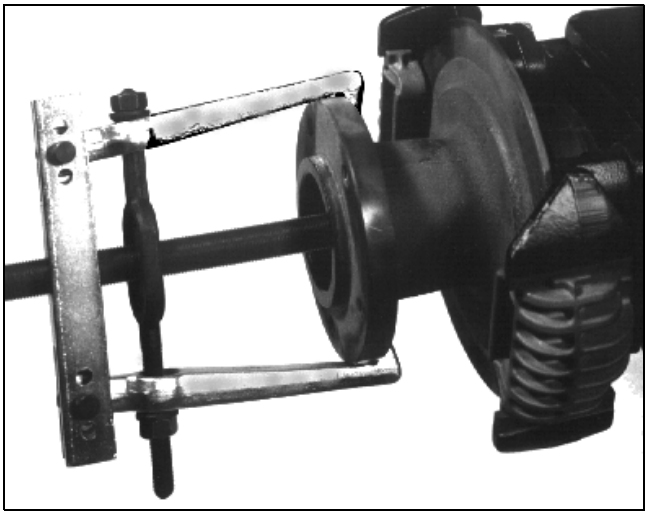
Replace Brake Pads

1. Remove wheel and tire.
2. Release park brake, if applied.



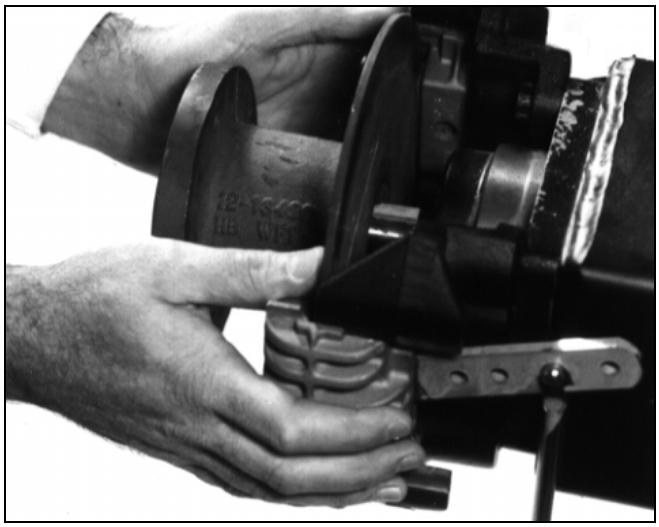
MX20328

3. Remove cotter pin (A) from each linkage rod (B).



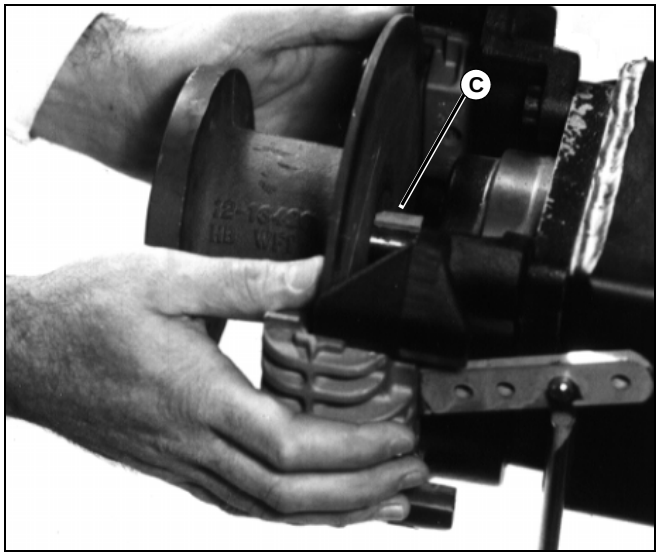
M56621

4. Remove nut securing rotor to wheel motor.
5. Use a puller as shown to remove rotor.



M56632

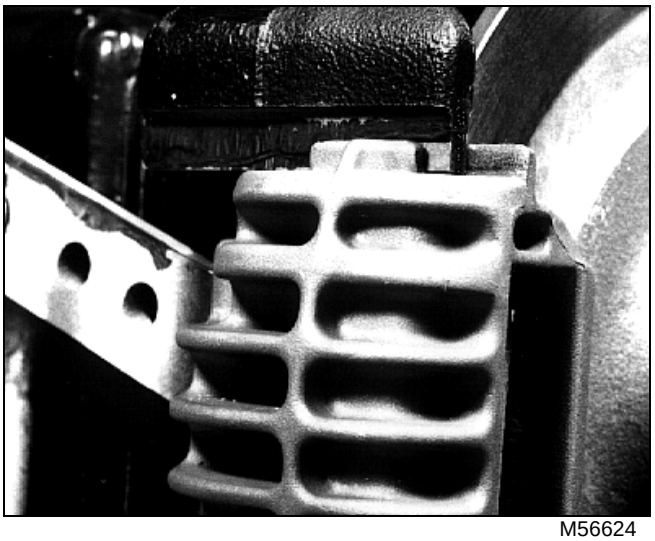
6. Slide rotor and calipers from wheel motor.
7. Replace pads.



M56632

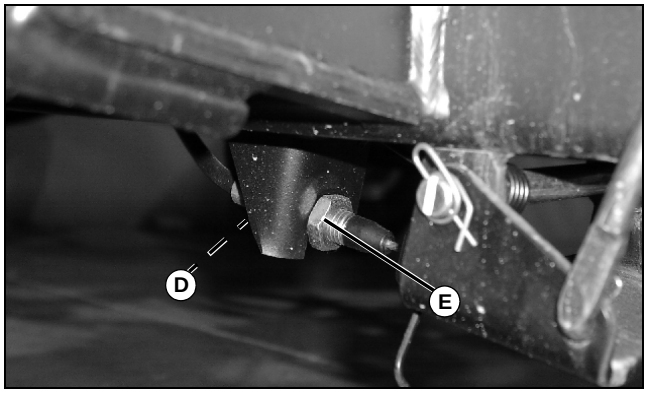
8. Install key (C) into slot of wheel motor shaft. Position the calipers onto the rotor and slide the assembly onto the wheel motor shaft.

IMPORTANT: Avoid damage! Make sure caliper assemblies are positioned on sliders as shown below.

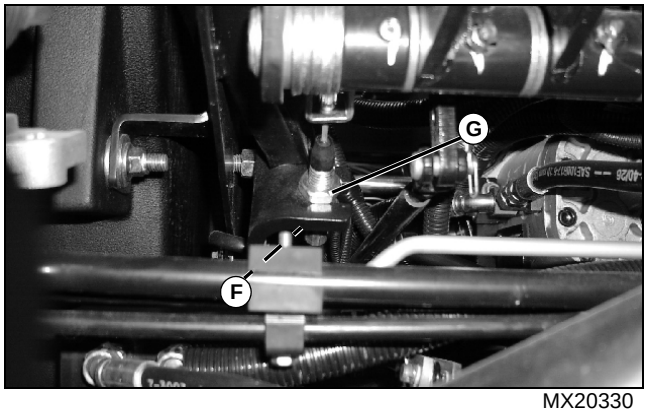


M56624

9. Install nut securing rotor to wheel motor shaft. Torque to specifications.

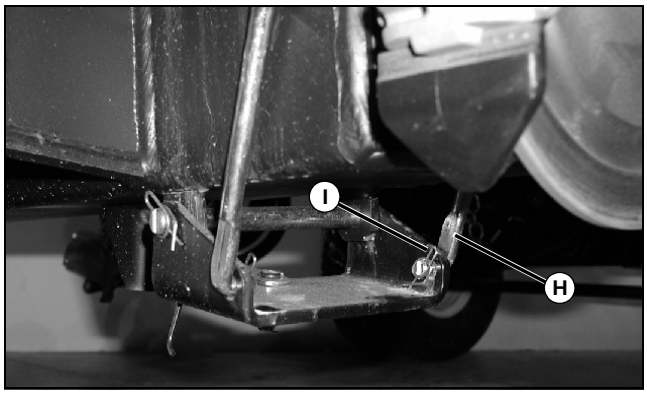


MX20329



MX20330

10.Loosen jam nut (E) and back off coupler nut (D) at wheel assembly, or loosen jam nut (G) and back off coupler nut (F) at brake pedal assembly to loosen brake cable.



MX20328

11.Install linkage rod (H) and secure with cotter pin (I) on each side of assembly.

12.Install wheel and tire assembly.

13.Adjust brakes. See “Adjust Brakes” on page 402.

Specifications

Rotor Nut Torque . . . . . 508 N•m (375 lb-ft)

ATTACHMENTS TABLE OF CONTENTS

Table of Contents

Specifications

Cutting Units

There are three models (22-In. Heavy Duty and 2500M) of cutting units. Refer to the ID tag on the reel cutting units for the model number when servicing.

General Specifications - 22-In. Heavy Duty

Make	**John Deere**
Size	**55.9 cm (22 in.)**
Backlapping	**On machine variable speed**
Clip Ratio	**See Theory of Operation (Performance Variables)**
Front Rollers	**Choice of smooth, grooved or spiral**
Reel Diameter	**12.7 cm (5 in.)**
Bed Knife Adjustment	**Reel-to-bed knife**
Height-of-Cut	**2.4 to 19 mm (3/32 to 3/4 in.)**
Number of Blades (Standard)	**9 (greens)**
Number of Blades (Optional)	**5 (fairways)**
Cutting Unit Drive	**Hydraulic**
Bed Knife Standard	**3 mm (1/8 in.)**
Bed Knife Tournament	**2.38 mm (3/32 in.)**
Bed Knife Fairway	**6.5 mm (1/4 in.)**

Repair Specifications - 22-In. Heavy Duty

Bed Knife Grinding Specification

Bed Knife Top Surface	**5° relief angle**
Front Surface	**5° relief angle**
Reel	**Spin grind with 20° relief angle**

Bed Knife and Support

Bed Knife Mounting Screws (Dry)	**35-45 N•m (26-34 lb-ft)**
Bed Knife Mounting Screws (Lubricated)	**24-36 N•m (18-27 lb-in.)**

Reel Mounting

Reel-to-Pivot Arm	**68 N•m (50 lb-ft)**
Pivot Arm-to-Frame (Forward)	**47 N•m (35 lb-ft)**
Pivot Arm-to-Frame (Rear)	**81 N•m (60 lb-ft)**

Roller

Shaft Lock Nut Torque	**0.34-0.79 N•m (3-7 lb-in.)**

Reel/Bed Knife

Out-of-Round (Smile)	**0.10 mm (0.004 in.) maximum**
Clearance	**0.000-0.051 mm (0.000-0.002 in.)**

Adjustment Specifications - 2500M

Bed Knife-to-Cutting Reel Clearance	0.025 mm (0.001 in.)
Front Roller Out-of-Parallel (Maximum)	0.050 mm (0.005 in.)
Cutting Shield-to-Cutting Reel Clearance (Maximum)	1 mm (0.04 in.)

Repair Specifications - 2500M

Bed Knife Screw Torque	6.5 N•m (58 lb-in.)
Bed Knife Shoulder Screw Torque	55 N•m (40 lb-ft)
FTC Shaft Retaining Nut Torque	47 N•m (35 lb-ft)
Vertical Cutting Unit Shaft Runout (Maximum)	0.50 mm (0.020 in.)

Repair Specifications - Rotary Deck

Rotary Deck Blade Cap Screw Torque	47.5 N•m (35 lb-ft)
Rear Roller Shaft End Play	0.00-0.15 mm (0.00-0.006 in.)
Spindle Housing Cap Screws	24 N•m (18 lb-ft)

Tools and Materials

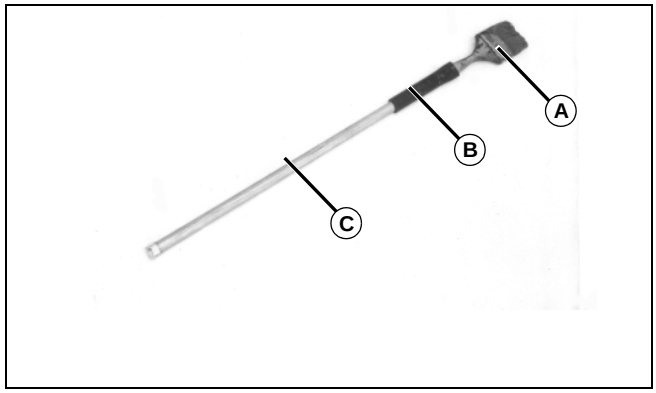
Special or Essential Tools

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
Bearing Installer	JDG243	Used to install bearings.
Bearing Installer	JDG506	Used to install bearings.
Roller Bearing Puller	JDG795	Used to remove bearings from rollers.
Height-of-Cut Gauge Bar	AMT2978	Used to adjust cutting height.
Bench Plate	NA	Used to adjust front roller.

Dealer Fabricated Tools



E32285

•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.

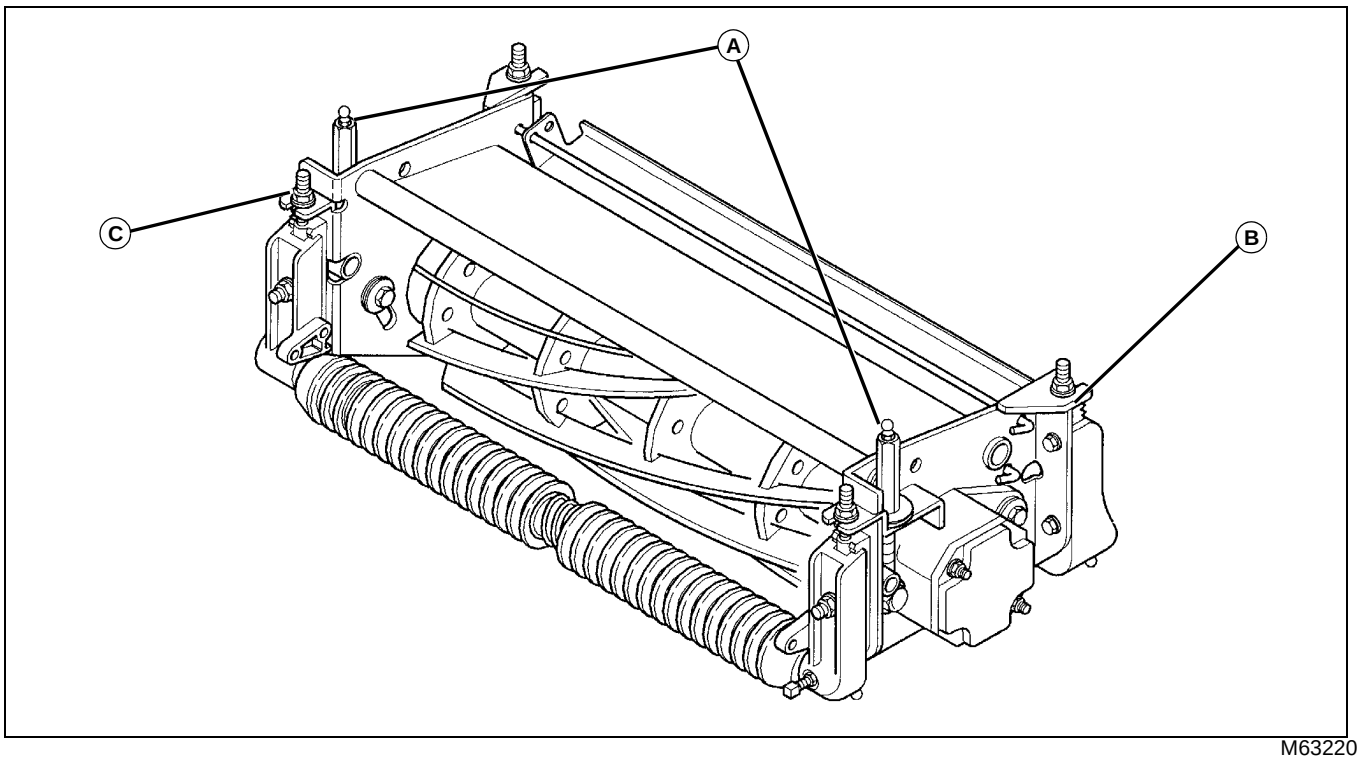
Other Materials

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reels.

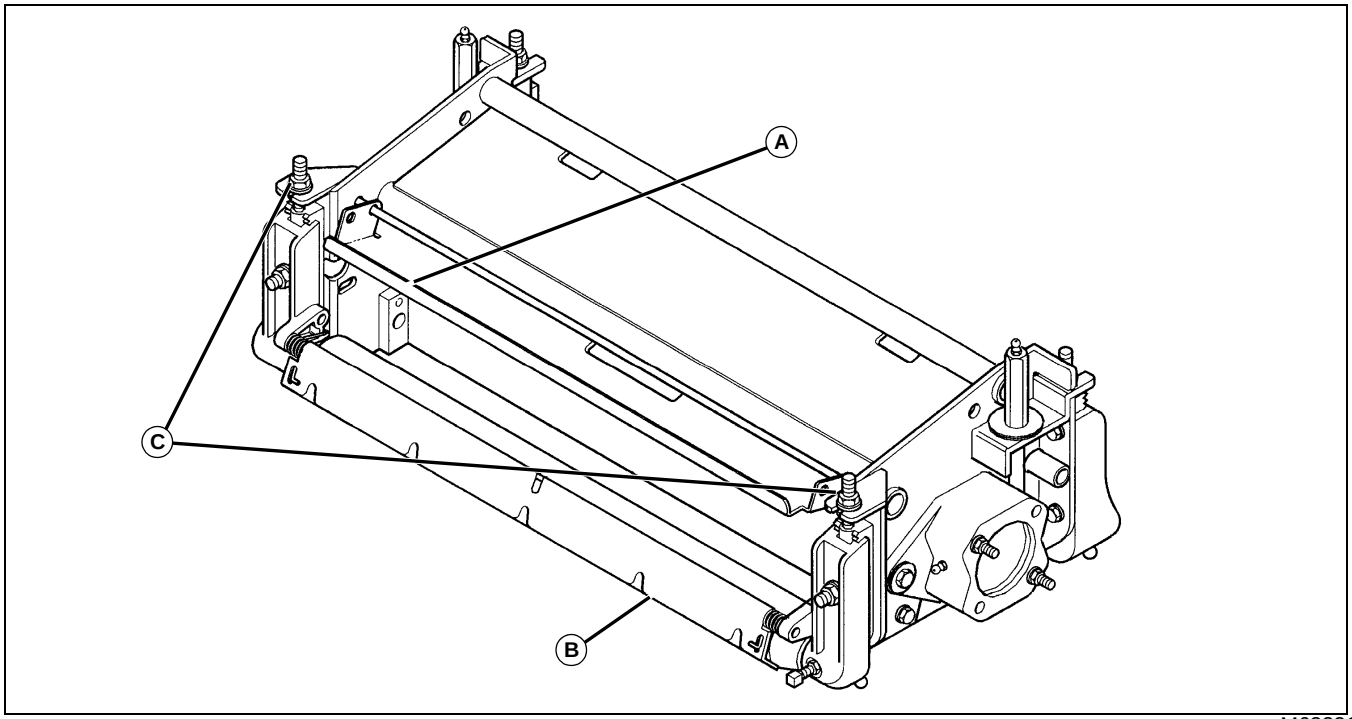
Component Location

22-In. Heavy Duty Cutting Unit



M63220

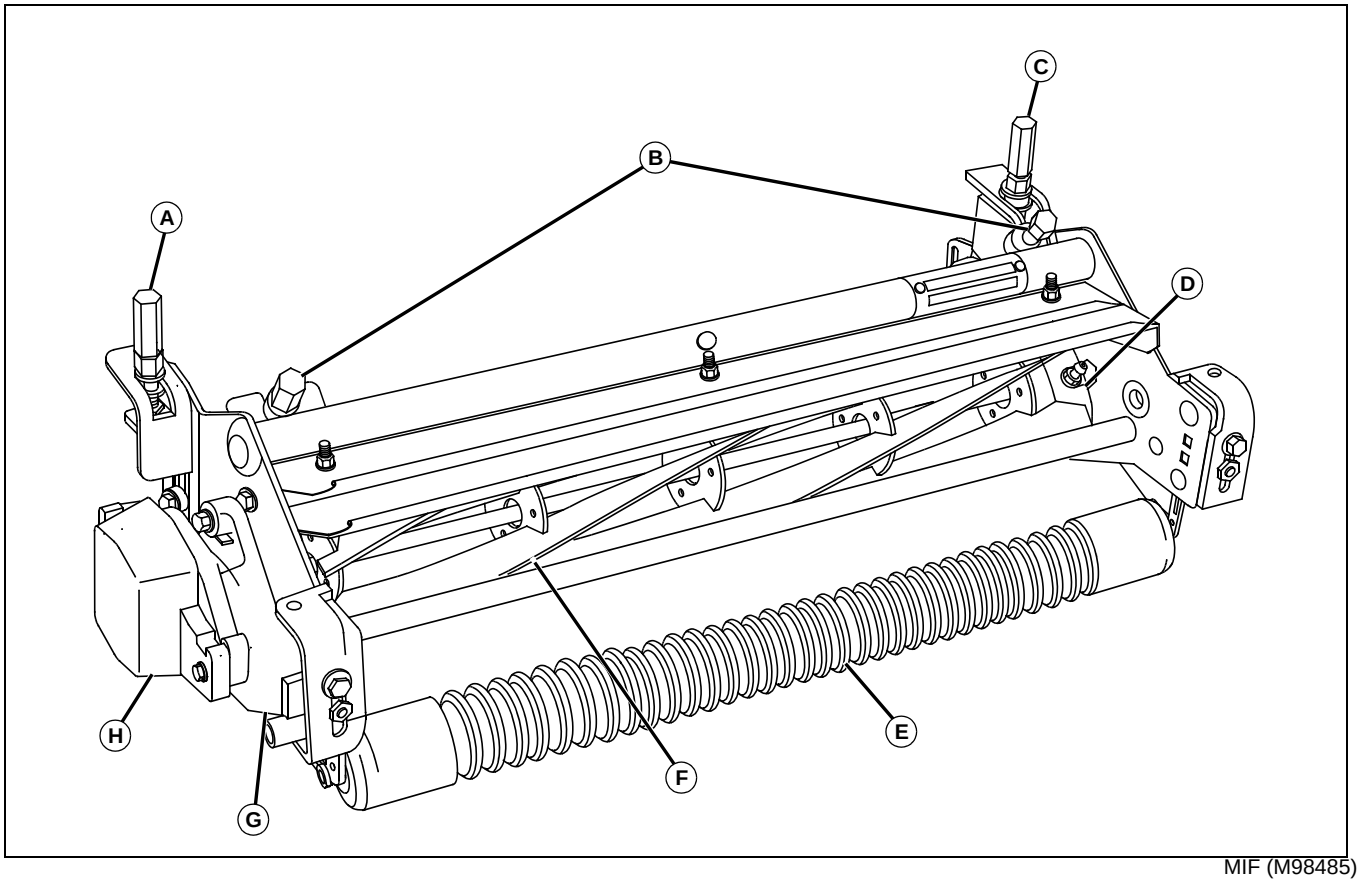
A - Reel-to-Bed Knife Clearance Adjustment
B - Ratchet Teeth
C - Front Roller HOC Adjustment



M63221

A - Rear Deflector
B - Rear Roller Scraper
C - Rear Roller HOC Adjustment

2500M Cutting Unit

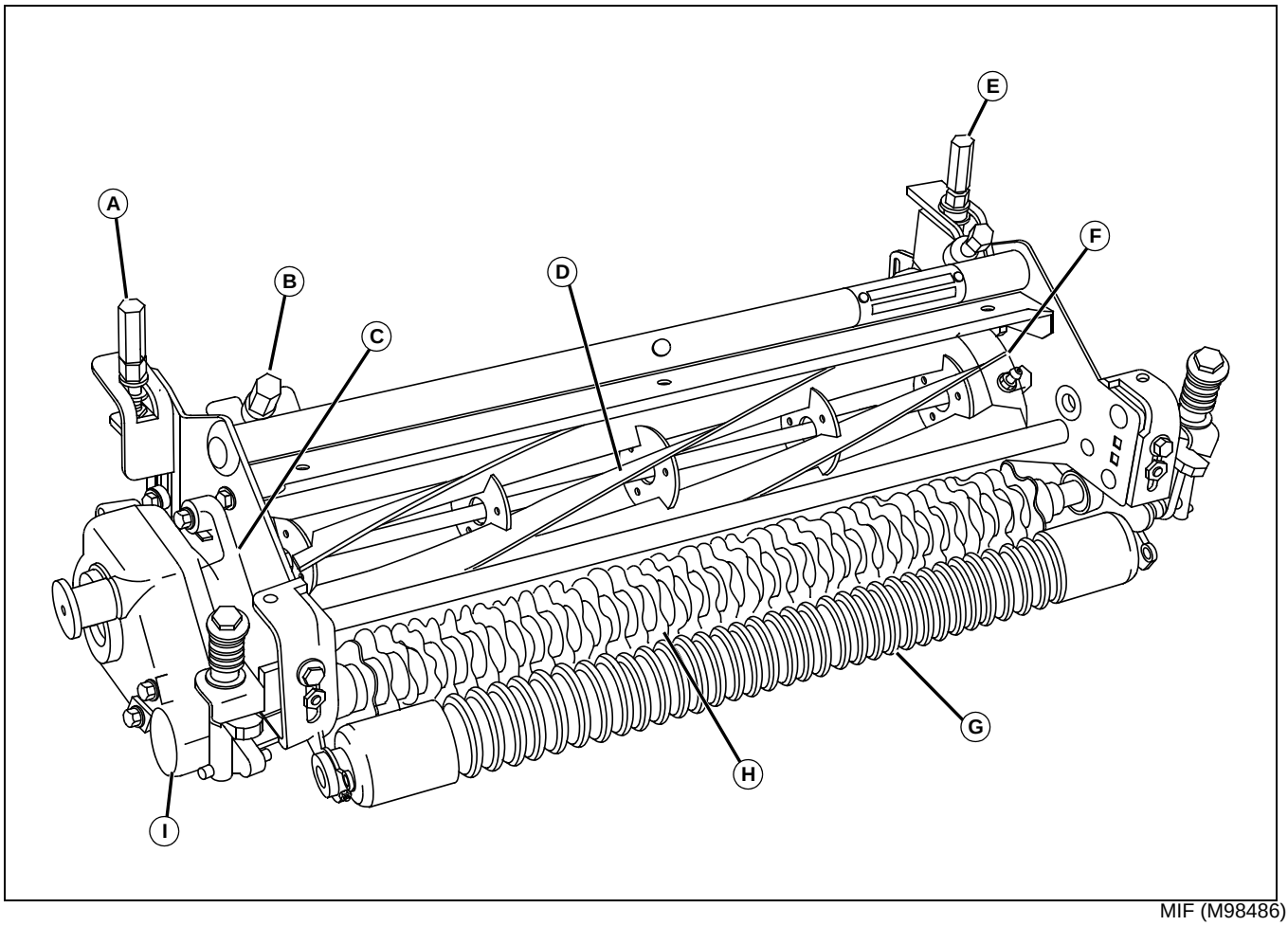


MIF (M98485)

A - Rear Roller Height Adjuster
B - Bed Knife Adjusters
C - Rear Roller Height Adjuster
D - Bearing Housing
E - Front Roller
F - Reel
G - Bearing Housing
H - Counterweight

2500M with Fairway Tender Conditioner (FTC)

NOTE: 2500M cutting unit shown with fairway tender conditioner. 22-in. standard and 22-in. heavy duty cutting units with fairway tender conditioner are similar.

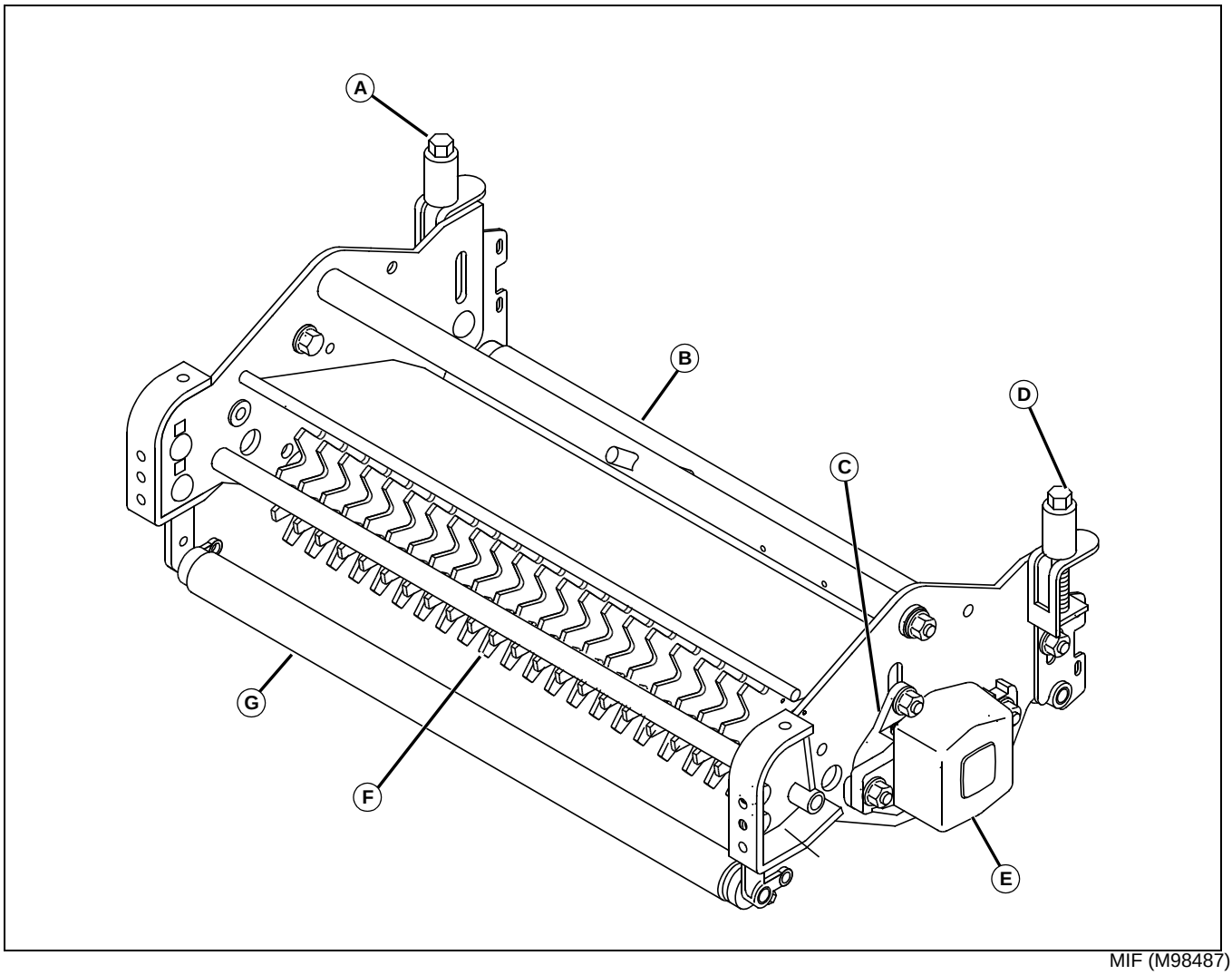


MIF (M98486)

A - Rear Roller Height Adjuster
B - Bed Knife Adjuster
C - Bearing Housing
D - Reel
E - Rear Roller Height Adjuster
F - Bearing Housing
G - Front Roller
H - FTC Shaft Assembly
I - FTC Gear Case

2500M Vertical Cutting Unit

NOTE: 2500M cutting unit shown with vertical cutting unit. 22-in. standard and 22-in. heavy duty vertical cutting units are similar.



MIF (M98487)

A - Rear Roller Height Adjuster
B - Rear Roller
C - Bearing Housing
D - Rear Roller Height Adjuster
E - Counterweight
F - Vertical Blades
G - Front Roller

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, that only a reel mower is capable of achieving, is only possible 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 0.051 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).

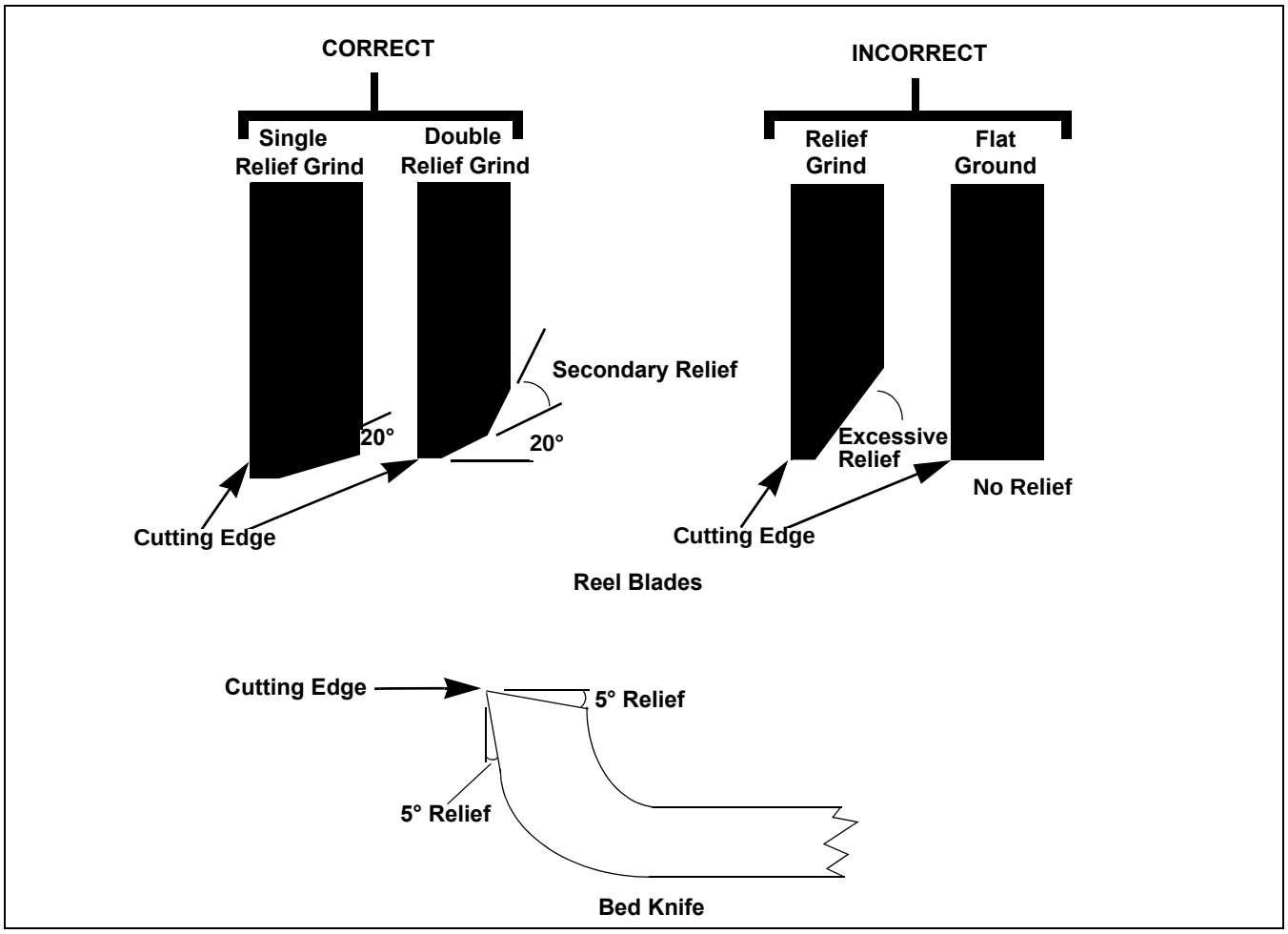
Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass towards the bed knife where it is sheared by the cutting edges as they pass one another.

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 spingrinding machine manufacturers say backlapping is not necessary, John Deere recommends backlapping after spingrinding to remove burrs and rough edges left from the spingrinding 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.

Relief Grinding



MIF

John Deere recommends relief grinding the reels before spingrinding 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

Backlapping is used to sharpen the cutting edges when grinding is not necessary. See Reel/Bed Knife Grinding, in this section, to determine if grinding is necessary.

When compared to grinding, backlapping 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-grit. 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.

Vertical Cutting Unit

The vertical cutting unit is a dedicated cutting unit used to de-thatch fairways, greens and tees prior to topdressing. This tends to promote vertical growth for better consistency of play on the golf course.

The vertical blades are positioned in a helix pattern and are placed 3/4 in. apart as shipped from the factory. Spacing is accomplished by placing three 1/4 in. spacers together between each blade. If a closer spacing is desired, spacers can be removed and blades added.

The helix pattern in the cutters is formed by indexing the center hexagonal cut one additional flat.

Normal rotational direction for the reel is forward; however, for very aggressive cutting, the reel should be operated in the reverse direction. This will prevent the cutting blades from pulling the machine and will provide a more desirable cutting action.

To operate the reel in reverse, the hydraulic hoses must be reversed at the reel motors.

Rollers

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 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 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 (especially in wet conditions), lowering the effective cutting height and possibly scalping the turf. Serious consideration should be given to mowing fairways or greens with a grooved roller attached, especially when the turf is very wet.

Spiral Roller

The 3-in. diameter spiral-grooved front roller with spiral end-caps allows more grass to stand up along the entire width of the cutting unit, providing a better quality of cut. This roller is also self-cleaning, reduces material buildup on the ends, and improves the overall appearance of the finished cut.

Performance Variables

Three performance variables that affect the quality of cut are:

- 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, 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 is 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 20% greater than CH, marcelling (a wavy, rib-like appearance) can occur. CR should be within 20% of CH. Therefore, a CH of 13 mm (0.50 in.) requires a CR of 10-15 mm (0.40-0.60 in.). If CH is 20% 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 on the reel, ground speed and reel speed). In most cases, only two of these performance variables (the number of blades on the reel and/or the vehicle ground speed) are changeable for a given cutting height.

Since the number of blades on the reel, the reel speed, the cutting height and the clip ratio (since CR must equal CH) are known, the formula to calculate optimum vehicle ground speed (mph) is:

mph = (reel rpm) x (CR) x (No. of blades) ÷ 1056

Example:

Using:

- 3215/3235 Lightweight Fairway Mower at a tested reel speed of 2100 rpm
- 9-blade reel on a 22-in. cutting unit
- CH = 0.14 (therefore, CR = 0.14)

Optimum vehicle ground speed (mph) is:

(2100) x (0.14) x (9) ÷ 1056 = 2.5 mph

NOTE: To measure vehicle ground speed (mph):

• Measure off an 88-ft distance and record the length of time (in seconds) it takes to travel that distance.

• Vehicle ground speed equals 60 divided by that time.

Diagnostics

Rotary Cutting Unit Troubleshooting

Symptom: Mower Deck Cuts Unevenly

(1) Are decks adjusted evenly?

Yes - Go to step (2).

No - Adjust mower decks. See “Adjust Rotary Cutting Units (IRS)” on page 438

(2) Are tires inflated to specification?

Yes - Go to step (3).

No - Inflate tires to specification.

(3) Are front and rear rollers clean and free of debris?

Yes - Go to step (4).

No - Clean front and rear rollers.

(4) Are front and rear rollers and bearings in good condition and not damaged or worn?

Yes - Go to step (5).

No - Repair or replace rollers or bearings as required.

(5) Are blades in good condition and not damaged or bent?

Yes - Go to step (6).

No - Replace blades. See “Remove and Install Blades (IRS)” on page 487.

(6) Are blades properly sharpened and balanced?

Yes - Go to step (7).

No - Sharpen and balance blades. See “Sharpen Blades” on page 487.

(7) Are spindle assemblies in good condition?

No - Repair or replace as required.

Symptom: Mower Deck Vibrates Excessively

(1) Are rotary decks properly mounted on the machine?

Yes - Go to step (2).

No - Install decks on machine properly. See “Remove and Install Cutting Units (IRS)” on page 486.

Symptom: Mower Deck Vibrates Excessively

(2) Is rotary deck mounting hardware in good condition and not worn?

Yes - Go to step (3).

No - Repair or replace as necessary.

(3) Are blade cap screws properly torqued?

Yes - Go to step (4).

No - Torque blade cap screws to specification.

(4) Are blades in good condition and not damaged or bent?

Yes - Go to step (5).

No - Replace blades. See “Remove and Install Blades (IRS)” on page 487.

(5) Are blades properly balanced?

Yes - Go to step (6).

No - Sharpen and balance blades. See “Sharpen Blades” on page 487.

(6) Are spindle assemblies clean and free of debris?

Yes - Go to step (7).

No - Remove debris from spindle assemblies.

(7) Are spindle assemblies in good condition?

No - Repair or replace as required.

Symptom: Excessive Noise from Mower Deck

(1) Are blades in good condition and not damaged or bent?

Yes - Go to step (2).

No - Replace blades. See “Remove and Install Blades (IRS)” on page 487.

(2) Are blade cap screws properly torqued?

Yes - Go to step (3).

No - Torque blade cap screws to specification.

(3) Are blades properly balanced?

Yes - Go to step (4).

No - Sharpen and balance blades. See “Sharpen Blades” on page 487.

(4) Are spindle assemblies in good condition?

Yes - Go to step (5).

No - Repair or replace as required.

Symptom: Excessive Noise from Mower Deck

(5) Are mower deck drive motors in good condition?

No - Repair or replace as necessary.

Specifications

Tire Pressure. . . . . 62-83 kPa (09-12 psi)
Rotary Blade Cap Screw Torque . . . . 47.5 N•m (35 lb-ft)

Reel Attachments Troubleshooting

Symptom: Marcelling

(1) Is the ground speed correct?

Yes - Go to step (2).

No - Increase or decrease ground speed as necessary. (See “Performance Variables” on page 418.)

(2) Is engine rpm correct (not too low)?

Yes - Go to step (3).

No - Increase engine speed to specification. (See operator's manual.)

(3) Are the reel and bed knife sharp?

Yes - Go to step (4).

No - Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure - 22-In. Heavy Duty” on page 424, for heavy duty cutting unit.) (See “Backlapping Procedure - 2500M” on page 430, for 2500M cutting unit.)

(4) Is the correct number of reel blades being used for desired clip ratio (CR)?

No - Install reel with correct number of blades. (See “Performance Variables” on page 418.)

Symptom: Streaking

(1) Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes - Go to step (2).

No - Perform reel-to-bed knife adjustment. (See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423, for heavy duty cutting unit.) (See “Adjust Reel-to-Bed Knife - 2500M” on page 429, for 2500M cutting unit.)

Symptom: Streaking

(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 416.)

Symptom: Height-of-Cut (HOC) Changes

(1) Is the grass dry enough for proper cutting (not too wet)?

Yes - Go to step (2).

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 step (3).

No - Install scraper or power brush on roller.

(3) Is the condition of the soil good (not rough or changing)?

Yes - Go to step (4).

No - Use a smooth roller.

(4) Is the cutting unit floating properly?

Yes - Go to step (5).

No - See operator's manual.

(5) Are the roller clamp bolts tight?

Yes - Go to step (6).

No - Perform height-of-cut (HOC) Adjustment. (See “Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty” on page 425, for heavy duty cutting unit.) (See “Adjust Height-of-Cut Range - 2500M” on page 431, for 2500M cutting unit.)

(6) Are the rollers concentric (not out-of-round)?

Yes - Go to step (7).

No - Replace roller. (See procedure in this section.)

(7) Are the roller bearings in good condition (not worn)?

No - Replace roller bearings. (See procedure in this section.)

Symptom: Poor Quality of Cut

(1) Is the grass at an acceptable height (not too high)?

Yes - Go to step (2).

No - Mow grass more frequently.

(2) Are the reel and bed knife sharp?

Yes - Go to step (3).

No - Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure - 22-In. Heavy Duty” on page 424, for heavy duty cutting unit.) (See “Backlapping Procedure - 2500M” on page 430, for 2500M cutting unit.)

(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 - 22-In. Heavy Duty” on page 423, for heavy duty cutting unit.) (See “Adjust Reel-to-Bed Knife - 2500M” on page 429, for 2500M cutting unit.)

Symptom: Reel Does Not Rotate

(1) Is the machine operating properly?

Yes - Go to step (2).

No - See machine operator's manual.

(2) Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes - Go to step (3).

No - Perform reel-to-bed knife adjustment. (See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423, for heavy duty cutting unit.) (See “Adjust Reel-to-Bed Knife - 2500M” on page 429, for 2500M cutting unit.)

(3) Are the roller bearings in good condition (not worn or seized)?

No - Replace roller bearings.

Symptom: Unit Not Cutting

(1) Is the grass dry and height of the grass not too excessive?

Yes - Go to step (2).

No - Allow sufficient time for grass to dry and mow more frequently.

Symptom: Unit Not Cutting

(2) Are the engine and ground speeds correct?

Yes - Go to step (3).

No - Adjust engine speed to specification. (See operator's manual.) Adjust ground speed to conditions. (See “Performance Variables” on page 418.)

(3) Is the correct number of blades used for conditions?

Yes - Go to step (4).

No - Install reel with correct number of blades. (See “Performance Variables” on page 418.)

(4) Are the reel and bed knife sharp?

Yes - Go to step (5).

No - Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure - 22-In. Heavy Duty” on page 424, for heavy duty cutting unit.) (See “Backlapping Procedure - 2500M” on page 430, for 2500M cutting unit.)

(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 - 22-In. Heavy Duty” on page 423, for heavy duty cutting unit.) (See “Adjust Reel-to-Bed Knife - 2500M” on page 429, for 2500M cutting unit.)

Tests and Adjustments

Backlapping and Bed Knife-to-Reel

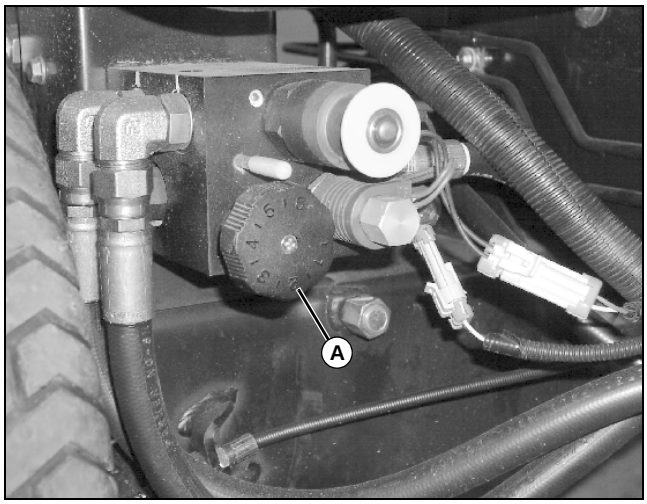
It is best to think of backlapping and bed knife-to-reel adjustments as one procedure. Although backlapping removes only a small amount of metal, the clearance between the reel and bed knife will be increased and must be readjusted.

Another very important point to remember is that adjustments can only be successful if the frame integrity (straightness and strength) is maintained. Attaching bolts must be secure and bearings must be well lubricated and not worn.

Adjust Reel Speed

IMPORTANT: Avoid damage! It is recommended to use the highest speed necessary to avoid marcelling. Reduced reel speed may help reduce bed knife and reel wear.

1. Park fairway mower on a hard, level surface.
2. Stop engine and lock park brake.



MX18585

3. Locate reel speed control knob (A) on the left side of machine.

NOTE: Variances in reel speed may occur when knob settings are equal. Use a reel tachometer to verify that the front and rear reels are turning at the same speed for the same knob settings.

4. Adjust reel speed:

   • Reel speed can be adjusted depending on the type of application for the fairway mower, which type of cutting units are used, and grass height and conditions.

   • It may be appropriate to reduce reel speed when cutting taller grass to prevent grass from being blown over and not being cut. Faster reel speeds with dry grass may cause grass clippings to be thrown over the grass catcher.

   • For mowing fairways, set the speed control knob (A) to the highest setting fully to the left (counterclockwise) for best cutting performance.

   • **For mowing roughs,** reel speed may be reduced by turning the speed control knob to the right (clockwise).

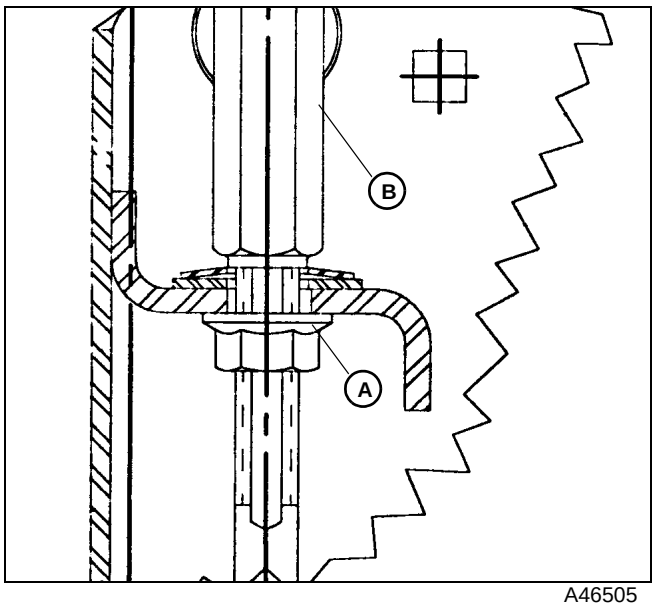
Adjust Reel-to-Bed Knife - 22-In. Heavy Duty

Reason

To maintain reel-to-bed knife clearance for clean, consistent cutting.

Procedure

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.



A46505

1. Turn adjustment nut (A) counterclockwise (as viewed from the top of the cutting unit looking down) to lower the reel and turn the upper adjustment nut (B) clockwise to raise the reel.

2. Rotate adjustment nuts until reel is touching bed knife. Then adjust reel away to achieve a reel-to-bed knife clearance of 0.051 mm (0.002 in.).

3. Now try to insert a 0.1 mm (0.004 in.) feeler gauge along the entire length of the bed knife. It should not go in anywhere. If the clearance exceeds 0.10 mm (0.004 in.) grind the reel and/or bed knife.

IMPORTANT: Avoid damage! Always rotate the reel in the reverse direction to avoid damaging or dulling the cutting edges of the reel or bed knife.

4. Slowly rotate the reel backwards, watching for contact between the reel and bed knife at the center of the bed knife. If contact is made, grind the reel and bed knife to eliminate the "frown" in the bed knife or the out-of-round condition of the reel.

Results

When properly adjusted and sharpened, each reel blade should cut a piece of paper held at 90° to the top surface of the bed knife along the entire length of the bed knife.

Specifications

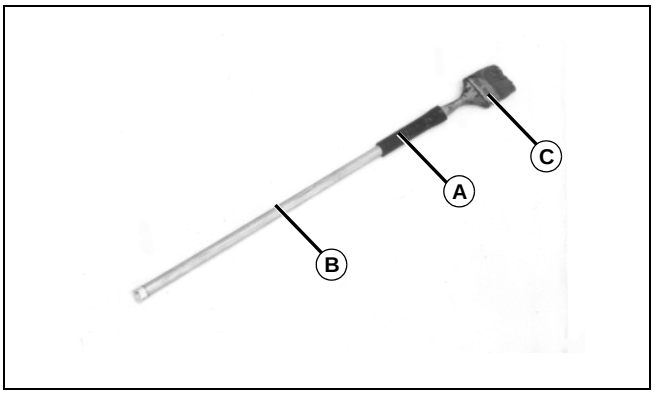
Reel-to-Bed Knife Clearance - 22-In. Heavy Duty 0.051 mm (0.002 in.)

Backlapping Procedure - 22-In. Heavy Duty

Reason

To provide a consistent cutting action and prolong reel life.

Dealer Fabricated Tools



E32285

Attach a piece of rubber hose (A) and additional handle (B) to a paint brush (C) to extend its length. This is used to apply lapping compound.

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reel.

Procedure

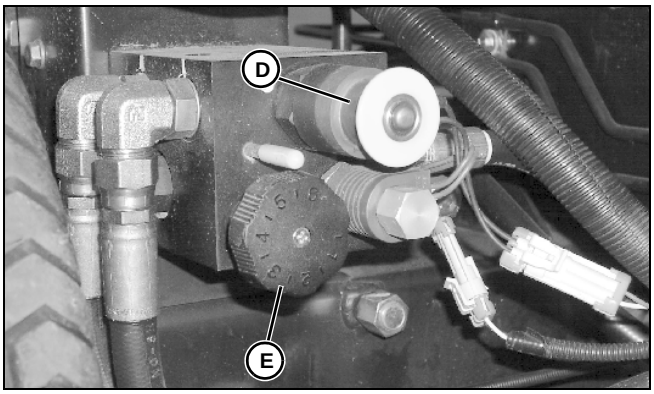
CAUTION: Avoid injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running. Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

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.

Disengage the fairway tender conditioner before backlapping. Severe personal injury may result from rotating blades.

NOTE: Perform reel-to-bed knife adjustment before performing backlapping procedure.

1. Rotate cutting units for service (RFS™). See “Rotating Reel Cutting Units” on page 439. The machine should be running with the park brake locked.



M18585

2. Locate the backlapping valves below the left front fender. The valve facing forward controls the front three cutting units and the valve facing rearward controls the rear two cutting units.

3. Press in on the release button at the center of the forward/reverse knob (D) and pull the knob out until it locks into the reverse position.

4. Engage the PTO. The reels should now be rotating in the reverse direction.

5. Using the flow control knob (E), 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.

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 220-grit compound to achieve a smoother finish.

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 off the cutting unit with water.

9. Disengage PTO switch and shut off the engine. Turn the flow control knob fully counterclockwise.

10. Press in on the release button at the center of the forward/reverse knob and push the knob in until it locks into the forward position.

11. Check reel-to-bed knife clearance. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423.

12. Prepare cutting units for mowing. See “Rotating Reel Cutting Units” on page 439.

13. Adjust reel speed. See “Adjust Reel Speed” on page 423.

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty

Reason

To set desired cutting height.

Special or Required Tools

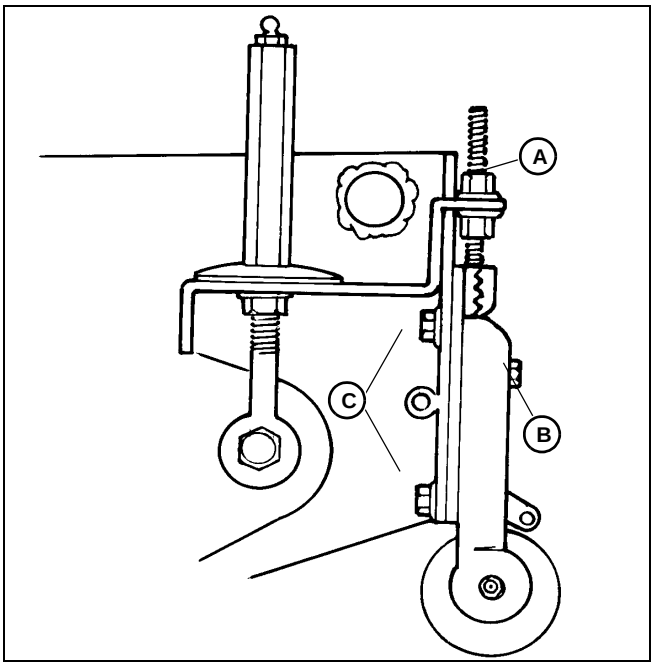
Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	AMT2978	Used to adjust cutting height.

Procedure

CAUTION: Avoid injury! Do not service or adjust cutting units while the engine is running. Disengage PTO and shut off engine prior to making any adjustments. Always wear protective gloves when working on or near the reel or bed knife.

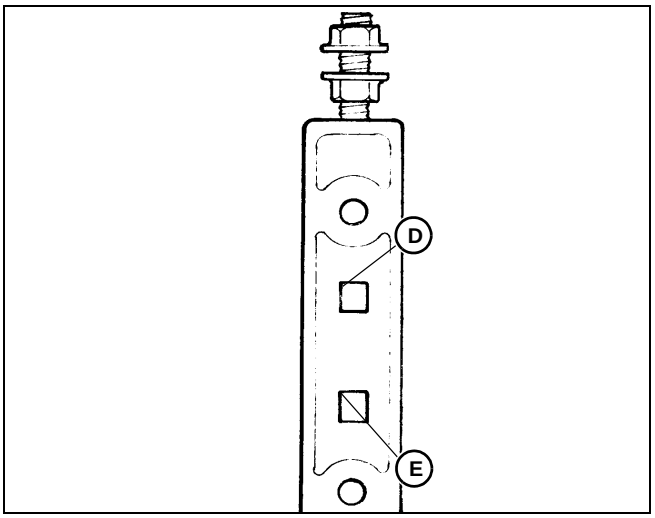
Never allow more than one person at a time to work on any one cutting unit. Never allow adjustments to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

IMPORTANT: Avoid damage! The effective height-of-cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another. When grass length exceeds 38 mm (1-1/2 in.), floating units may not provide a quality cut; operate cutting units in fixed position only.



M46876

1. Loosen nut (A). Remove nut and washer (B) and two bolts (C) (per side) and position the carriage bolt for the cutting height range.



M46861

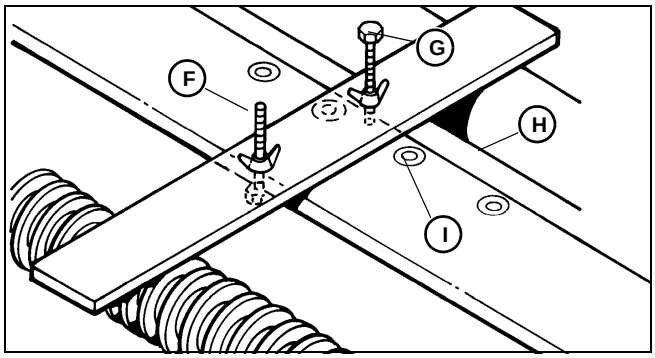
2. For cutting heights of 9.5-41 mm (3/8-1-5/8 in.), position carriage bolt into the upper square opening (D). For cutting heights of 38-90 mm (1-1/2-3-1/2 in.), position carriage bolt into the lower square opening (E).

IMPORTANT: Avoid damage! Ensure the rear bolt (G) on the gauge bar rests on the bed knife support. Ensure it does not rest on a bed knife mounting bolt (I).

NOTE: It may be necessary to raise the rollers to allow for installation of the gauge bar. Forcing the gauge bar into position will bend it and result in an inaccurate height adjustment.

Ensure the rear bolt on the gauge bar rests on the bed knife support, and not on a bed knife mounting bolt.

Gauge bar should be positioned near the end of the solid roller, but not on the end cap.



M56471

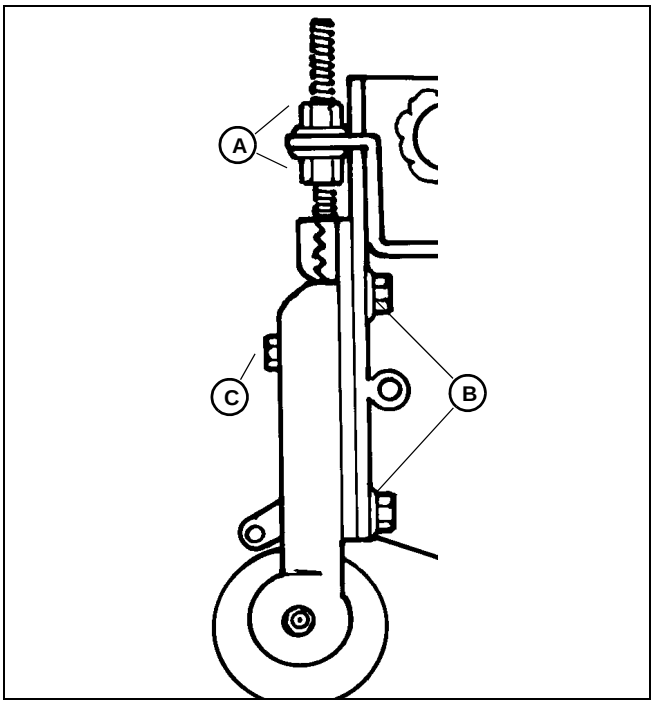
Picture Note: Cutting Unit Shown Upside Down for Clarity.

3. Adjust gauge bar for desired height-of-cut and install on cutting unit (see note above). Ensure the head of the bolt (F) rests on the lip of the bed knife.

4. Adjust rear bolt (G) until the gauge bar is parallel to the bed knife.

Adjust Rear Roller Height

IMPORTANT: Avoid damage! To avoid binding the adjustment mechanisms, make small adjustments on each end of the roller. Each tooth on the adjustment mechanism equals 3.2 mm (1/8 in.).



M56472

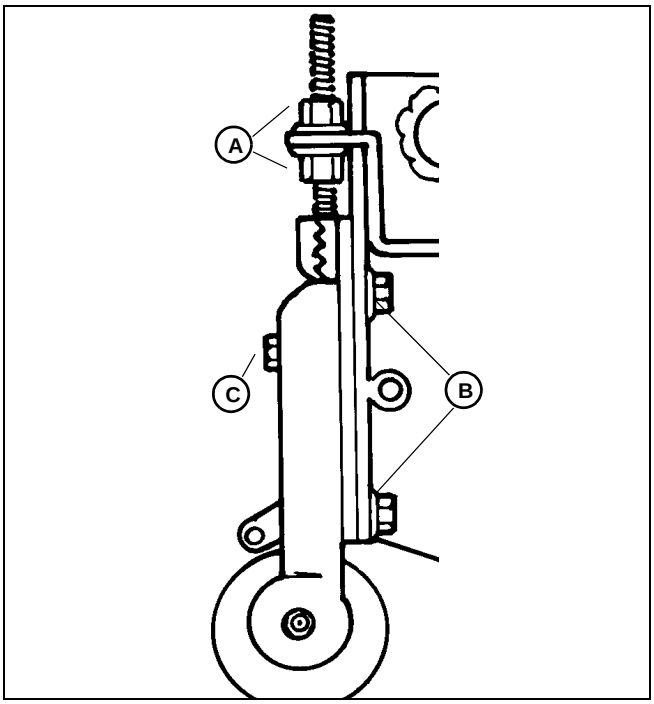
1. Loosen bolts (B) and adjustment nuts (A) (both sides) on the rear roller and slide the roller up or down to center the bolts (B) in the slot. Tighten bolts and adjustment nuts.

2. Loosen nut (C) (both sides) and position the roller as close to the gauge bar as possible without touching it. Tighten nuts (C). Ensure the same number of ratchet teeth are exposed at each end of the roller.

3. Loosen bolts (B) and adjustment nuts (A) and slide the roller down until it just touches the gauge bar. Repeat on opposite end. Recheck the adjustment for the opposite side and readjust if necessary.

Adjust Front Roller Height

NOTE: To avoid binding the adjustment mechanisms, make small adjustments on each end of the roller. Each tooth on the adjustment mechanism equals 3.2 mm (1/8 in.).



M56472

1. Loosen bolts (B) and adjustment nuts (A) (both sides) on the front roller and slide the roller up or down to center the bolts (B) in the slot. Tighten bolts and adjustment nuts.

2. Tighten all hardware and recheck with a HOC gauge to ensure setting did not change.

3. Loosen nut (C) (both sides) and position the roller as close to the gauge bar as possible without touching it. Tighten nuts (C). Ensure the same number of ratchet teeth are exposed at each end of the roller (setting should agree with rear roller).

4. Loosen bolts (B) and adjustment nuts (A) and slide the roller down until it just touches the gauge bar. Repeat on opposite end. Recheck the adjustment for the opposite side and readjust if necessary.

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Adjust Depth-of-Cut - Vertical Cutting Unit (22-In. Heavy Duty)

Reason

To set the desired cutting depth.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	AMT2978	Used to set desired cutting height.

Procedure

CAUTION: Avoid injury! Always wear gloves when handling the reel or cutting blades. Rotating one reel by hand may cause other reels to rotate. If a reel is rotated, be sure no other person is near the other units. Serious personal injury can result from contact with the sharp cutting edges of the blades.

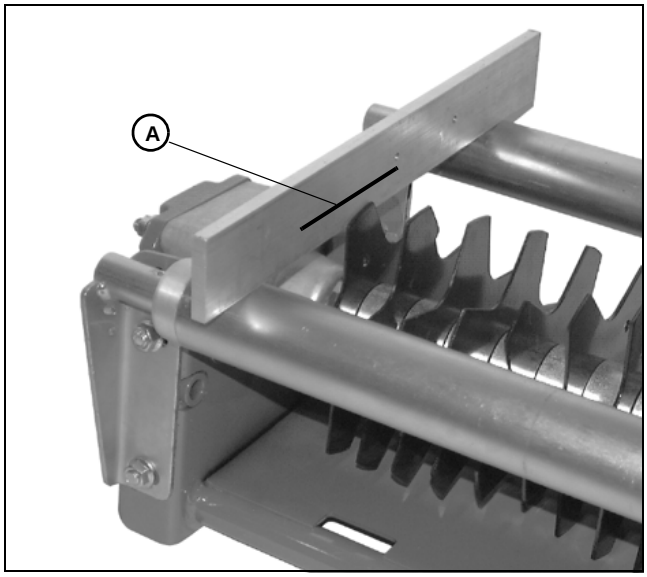
IMPORTANT: Avoid damage! Measure the usable blade length of the cutting blades. If the usable blade length is less than the desired cutting depth, replace the cutting blades before continuing.

1. Mark the desired cutting depth on a gauge bar.
2. Place the gauge bar across the front and rear rollers approximately two inches in from the end of the rollers.

NOTE: When checking cutting depth of blade against mark on gauge bar, rotate reel back and forth to ensure blade travel does not extend beyond mark on gauge bar.

If desired depth cannot be achieved with roller adjustment, adjust pivot arms to raise or lower the cutting blades.

If blade wear is beyond adjustment, move rear roller adjuster bolts to top holes.



MX18308

3. Adjust front roller height to bring leading edge of cutting blade even with mark (A) on gauge bar.

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Specifications

Vertical Cutting Unit Flap Adjustment . . 13 mm (1/2 in.)

Adjust Reel-to-Bed Knife - 2500M

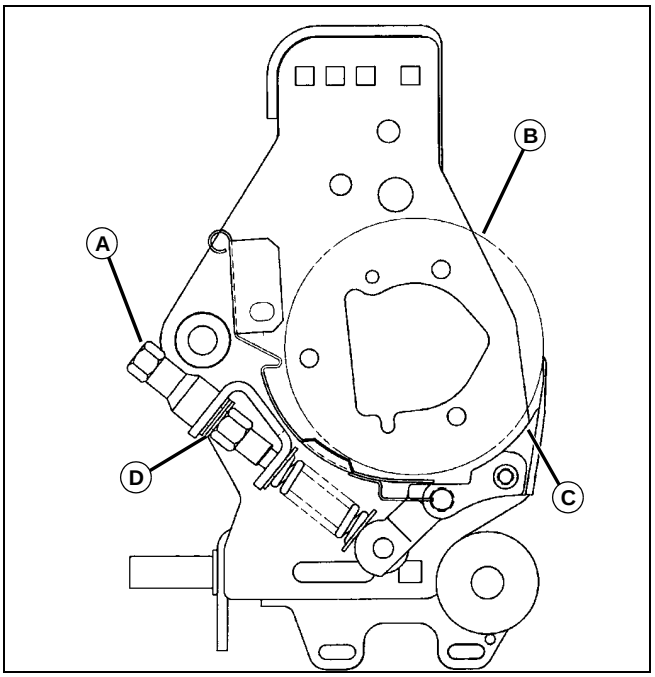
Reason

To maintain reel-to-bed knife clearance for clean, consistent cutting.

Procedure

CAUTION: Avoid injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.



M84842

2. Place cutting unit on a stable working surface with the front roller facing up.

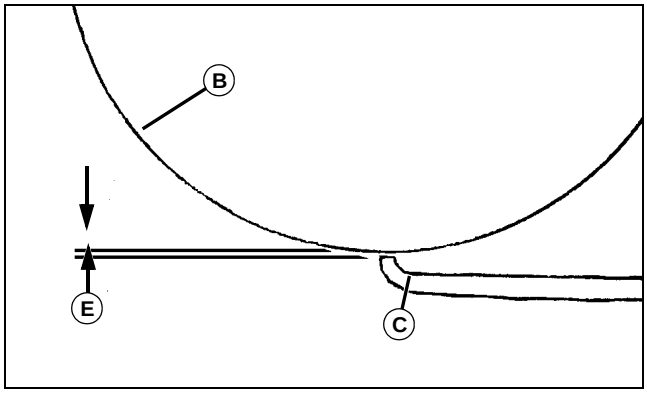
3. Loosen jam nut (D) on both sides of the cutting unit.

IMPORTANT: Avoid damage! Both sides of the bed knife must be adjusted evenly in small increments. DO NOT turn each bed knife adjuster more than one flat at a time.

4. Turn both bed knife adjusters (A) counterclockwise (alternating from one side to the other) until the bed knife (C) is tight against the cutting reel (B).

5. Slowly turn both bed knife adjusters clockwise (alternating from one side to the other) until the bed knife begins to pull away from the cutting reel. At this time the cutting reel should rotate freely.

NOTE: Make sure that when making the final adjustment, the bed knife is moving away from cutting reel.



E35559

6. Using a feeler gauge, turn both bed knife adjusters clockwise (alternating from one side to the other) until bed knife-to-cutting reel clearance (E) is set to specifications.

7. Tighten jam nuts.

IMPORTANT: Avoid damage! Always rotate the cutting wheel backwards to prevent damaging or dulling the cutting edges of the reel and/or bed knife.

8. Slowly rotate the cutting reel backwards and check the gap at several points along the entire length of the bed knife using a 0.050 mm (0.002 in.) feeler gauge. The feeler gauge should not pass between the bed knife and cutting reel at any point.

Results

- **If the gap is 0.050 mm (0.002 in.) or greater at the center of the bed knife:** Grind the reel and/or bed knife to eliminate the “smile” in the bed knife or the out-of-round condition of the reel.
- **If there is contact at the center of the bed knife:** Grind the reel and/or bed knife to eliminate the “frown” in the bed knife or the out-of-round condition of the reel.

Specifications

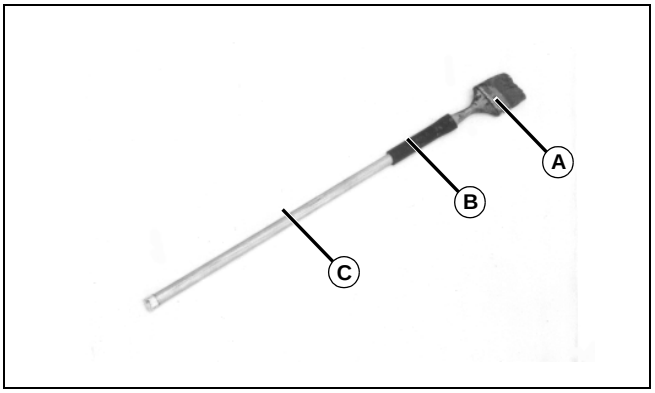
Reel-to-Bed Knife Clearance - 2500M 0.025 mm (0.001 in.)

Backlapping Procedure - 2500M

Reason

To provide a consistent cutting action and prolong reel life.

Dealer Fabricated Tools



E32285

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.

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used to backlap bed knife/cutting reel.

Procedure

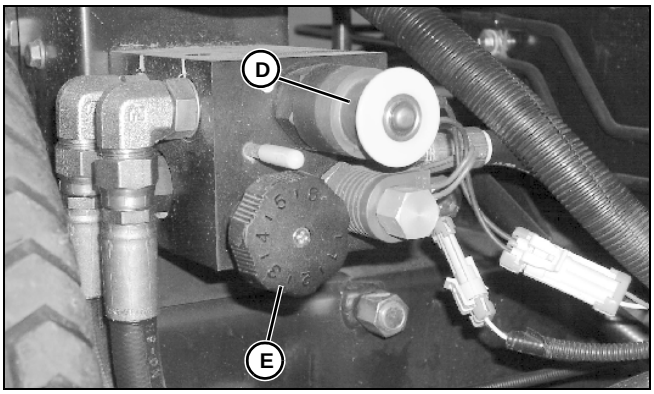
CAUTION: Avoid injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running. Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

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.

Disengage the fairway tender conditioner before backlapping. Severe personal injury may result from rotating blades.

NOTE: Perform reel-to-bed knife adjustment before performing backlapping procedure.

1. Park machine on a level surface.
2. Lower cutting units to the ground.
3. Move mow/transport lever to TRANSPORT position.
4. Turn key switch to STOP position.
5. Engage park brake.
6. Start engine.
7. Move throttle lever to a position between slow idle and half-throttle position.



M18585

8. Locate the backlapping valves below the left front fender. The valve facing forward controls the front three cutting units and the valve facing rearward controls the rear two cutting units.
9. Press in on the release button at the center of the forward/reverse knob (D) and pull the knob out until it locks into the reverse position.
10. Engage the PTO.
11. Move lift/lower lever forward to LOWER position. Release lever when cutting reels begin to rotate backward.
12. Using the flow control knob (E), 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.

13. Apply lapping compound to the rotating reel evenly from one side to the other and back again using a long-handled brush.
14. Allow the reel to spin until quiet. If desired, follow with a 220-grit compound to achieve a smoother finish.

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.

15. Rinse the lapping compound off the cutting unit with water.

16.Disengage PTO switch and shut off the engine. Turn the flow control knob fully counterclockwise.

17.Press in on the release button at the center of the forward/reverse knob and push the knob in until it locks into the forward position.

18.Check reel-to-bed knife clearance. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423.

19.Adjust reel speed. See “Adjust Reel Speed” on page 423.

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut Range - 2500M

Reason

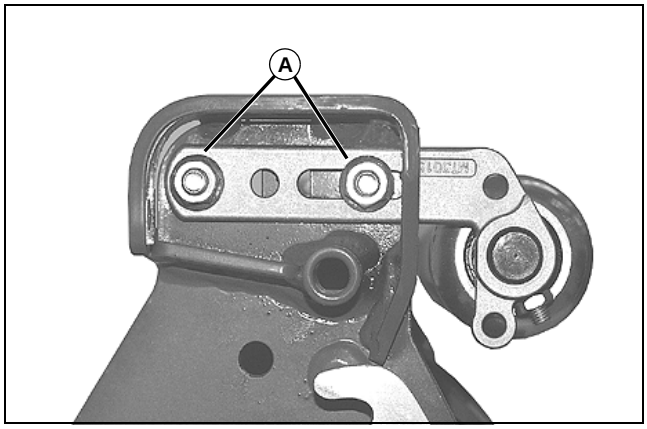
To set front roller range for proper height-of-cut position.

Procedure

1. Remove cutting units from mower.

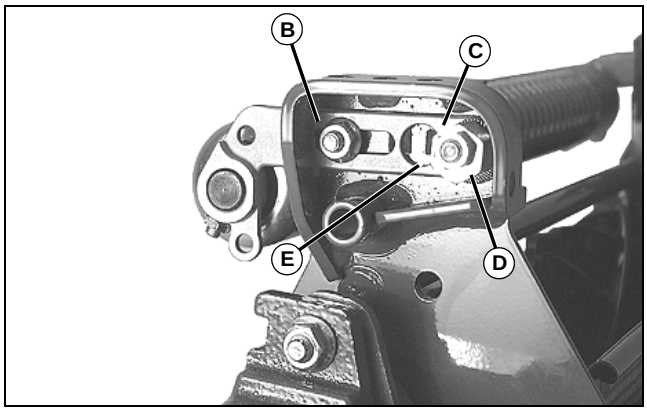
2. Place cutting unit on a stable working surface with the front roller facing up.

NOTE: The effective height-of-cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another.



M84841

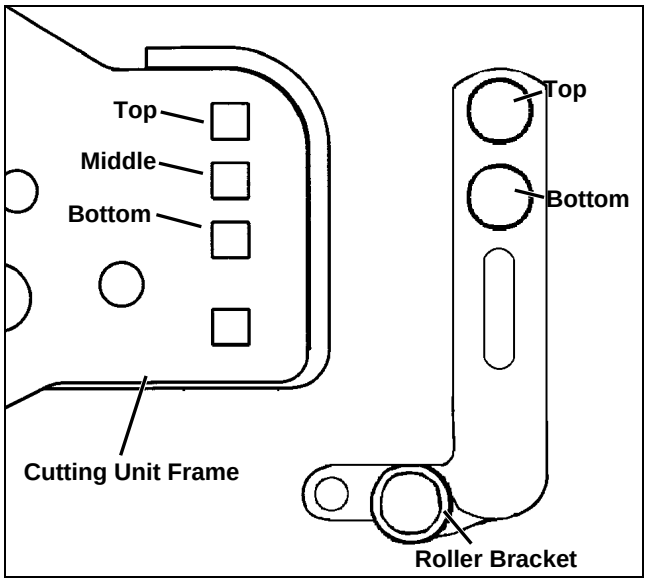
3. Remove two flanged nuts and carriage bolts (A).



M84828

4. Remove lower flanged nut and carriage bolt (B).

5. Remove eccentric lock nut (C), eccentric adjuster (E), serrated washer (D) and carriage bolt.

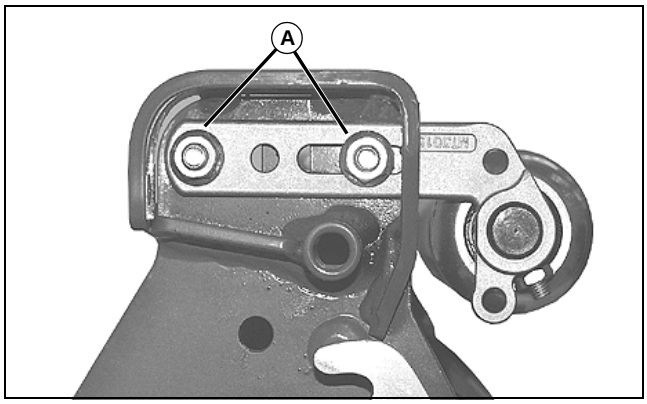


M84845

6. Reposition roller bracket to holes in cutting unit frame to the desire cutting height range (see chart).

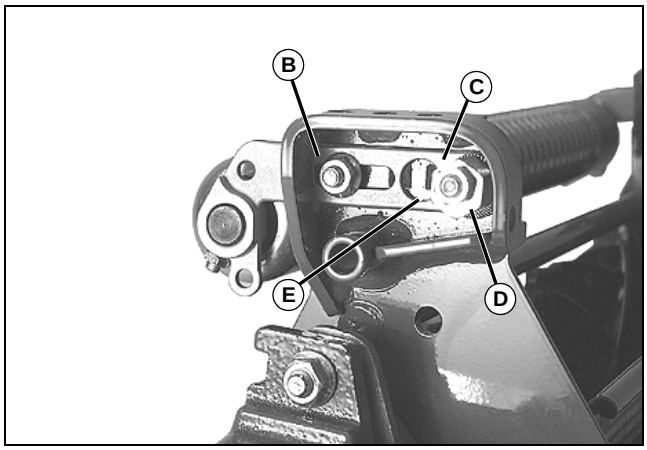
Height of Cut	Roller Bracket Hole	Cutting Unit Frame Hole
0-9.53 mm (0-3/8 in.)	Top	Top
6.35-15.88 mm (1/4-5/8 in.)	Bottom	Bottom
12.70-22.23 mm (1/2-7/8 in.)	Top	Middle
0-6.53 mm[1] (0-1/4 in.)	Bottom	Middle

1. This setting is used when the diameter of the cutting reel has worn down to 120 mm (4.7 in.) or less.



M84841

7. Install two flanged nuts and carriage bolts (A).
8. Tighten nuts.



M84828

9. Install lower flanged nut and carriage bolt (B).
10. Install eccentric lock nut (C), eccentric adjuster (E), serrated washer (D) and carriage bolt.
11. Adjust front roller. (See “Adjust Front Roller - 2500M” on page 432.

Results

Front roller range positioned for proper height-of-cut adjustment.

Adjust Front Roller - 2500M

Reason

To ensure that the front roller is parallel with the bed knife.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Bench Plate	NA	Used to adjust front roller.
Height-of-Cut Gauge Bar	AMT2978	Used to adjust front roller.

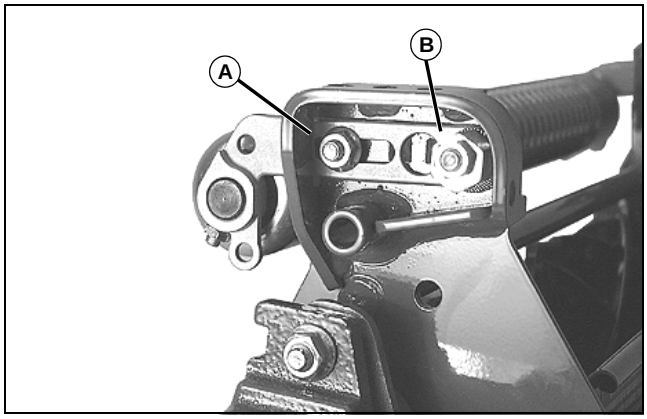
Procedure

CAUTION: Avoid injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

NOTE: The bed knife-to reel clearance should be adjusted before performing the following procedure.

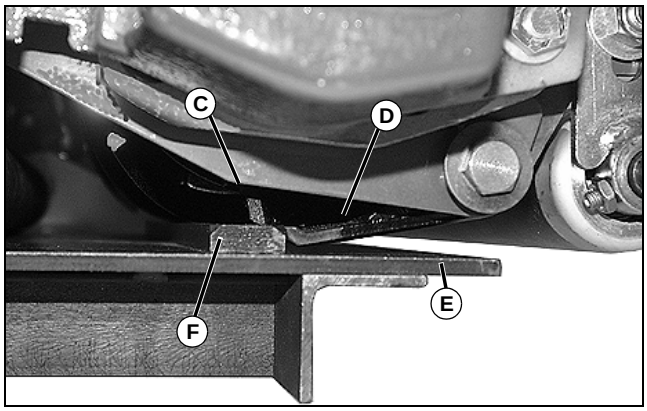
Bench Plate Procedure

1. Place cutting unit on a stable working surface with the front roller facing up.



M84828

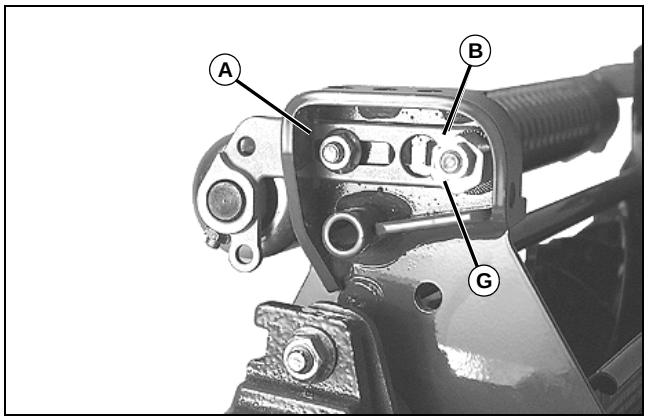
2. Loosen flanged nut (A) on left roller bracket.
3. Loosen eccentric lock nut (B).



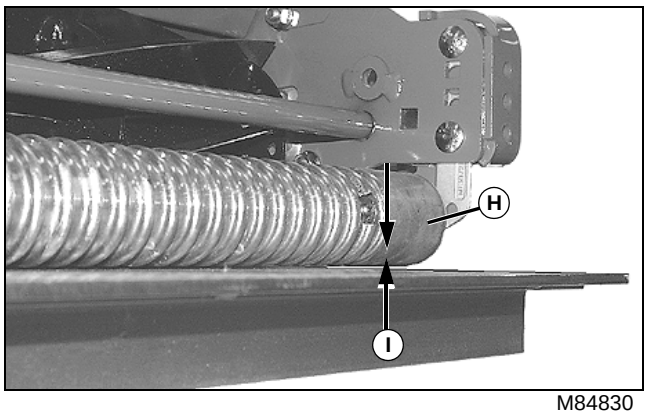
M84829

4. Set bench plate (E) on a level surface.

5. Set cutting unit on top of bench plate. The bed knife (D) must rest firmly against the plate stop (F), with the cutting reel blade (C) on top of plate stop.



M84828



M84830

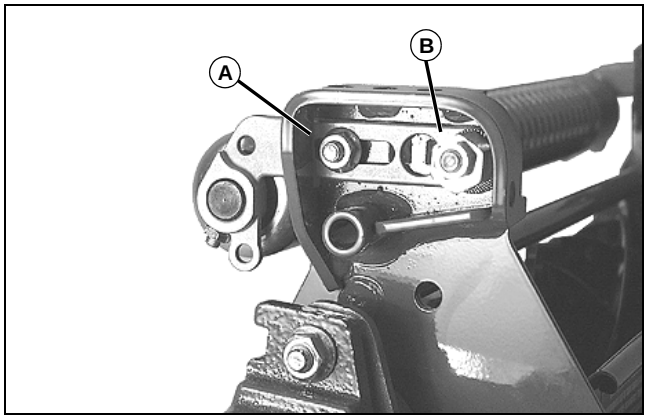
6. Rotate eccentric adjuster (G) until the front roller (H) sits flat and parallel with the bench plate. The gap (I) should not exceed 0.050 mm (0.005 in.).

7. Tighten left roller lower flanged nut (A).

8. Tighten eccentric lock nut (B).

Height-of-Cut Gauge Bar Procedure

1. Place cutting unit on a stable working surface with the front roller facing up.

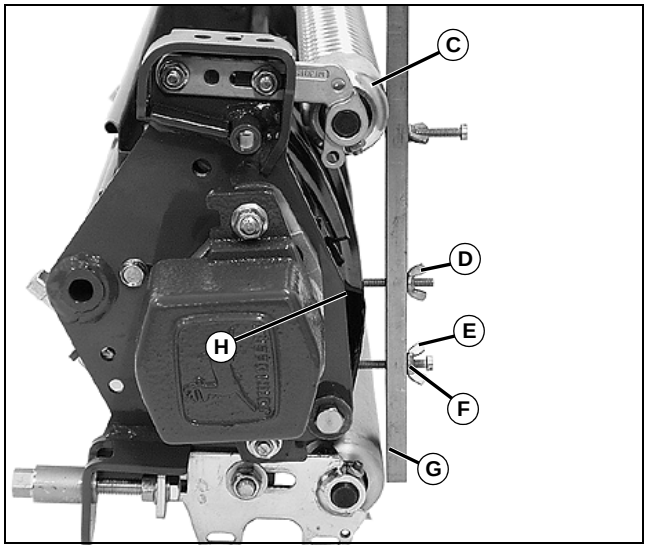


M84828

2. Loosen lower flanged nut (A) on left roller bracket.

3. Loosen eccentric lock nut (B).

NOTE: The height-of-cut gauge bar should not contact the bottom of the rear roller.



M84831

4. Rest the height-of-cut gauge bar (G) approximately 51 mm (2.0 in.) from the right end of bed knife (H).

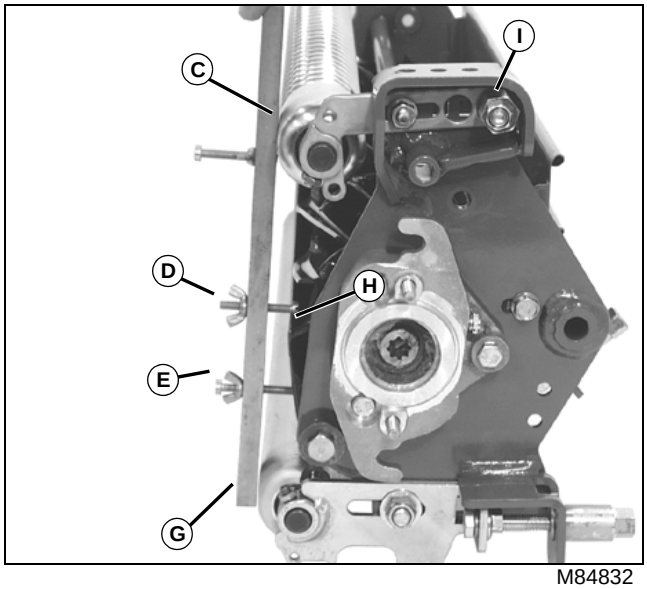
5. Hook the center gauge screw head (D) on the edge of the bed knife. Hold end of gauge bar against the bottom of the front roller (C).

6. Loosen wing nut (F).

7. Turn lower gauge screw (E) clockwise until the top of screw makes contact with the flat edge of bed knife.

8. Tighten wing nut (F).

NOTE: The height-of-cut bar should not contact the bottom of the rear roller.

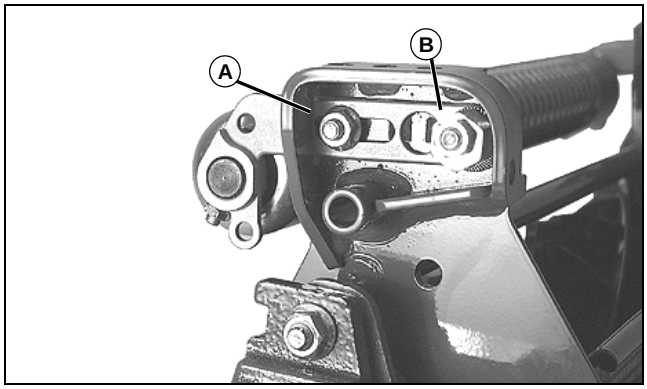


M84832

9. Rest the height-of-cut gauge bar (G) approximately 51 mm (2.0 in.) from the left end of the bed knife (H).

10.Hook the center gauge screw head (D) on the edge of the bed knife. Hold end of gauge bar against the bottom of the front roller (C).

11.Rotate eccentric adjuster (I) until the top of lower gauge screw (E) makes contact with the bed knife.



M84828

12.Tighten left roller lower flanged nut (A).

13.Tighten eccentric lock nut (B).

14.Check adjustment using height-of-cut bar.

15.Adjust cutting height. (See “Adjust Height-of-Cut (HOC) - 2500M” on page 434.)

Results

Front roller positioned for proper height-of-cut adjustment.

Adjust Height-of-Cut (HOC) - 2500M

Reason

To set desired cutting height.

Special or Required Tools

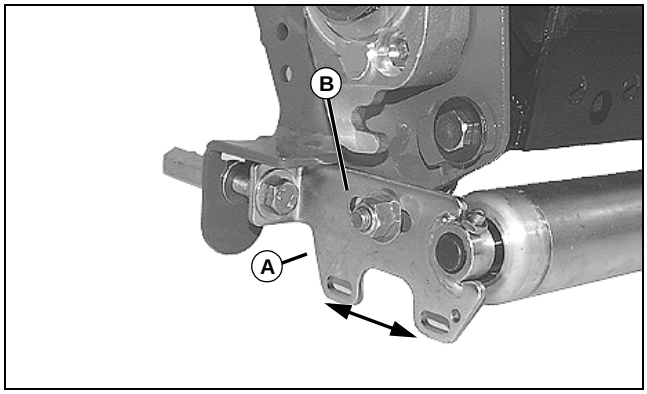
Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	AMT2978	Used to set desired cutting height.

Procedure

CAUTION: Avoid injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

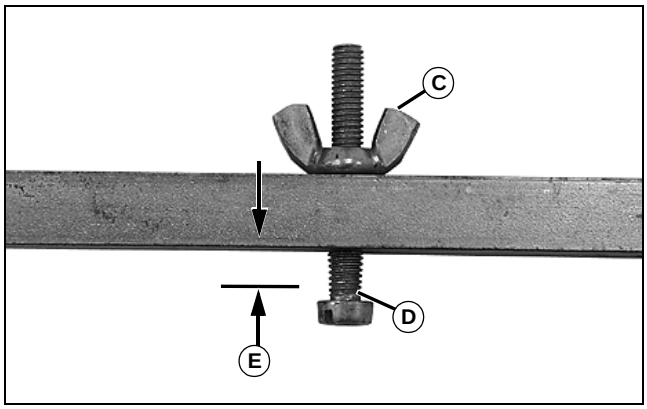
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M98489

3. Loosen lock nut (B) on each side of the cutting unit, just enough to allow the height-of-cut bracket (A) to slide.

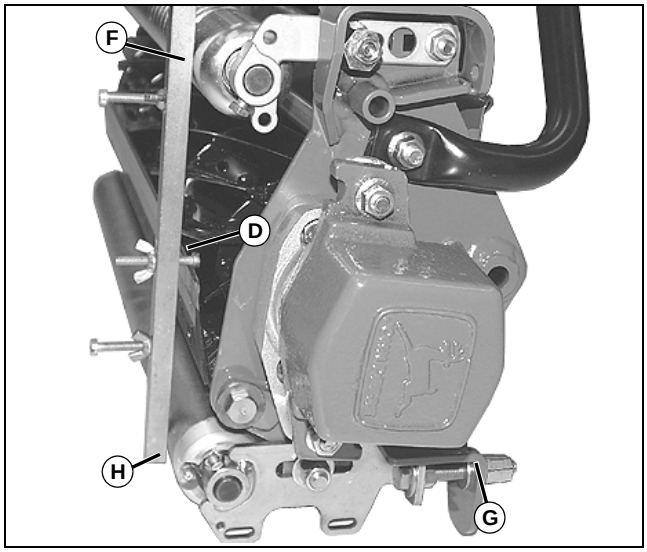


M84833

4. Adjust the center adjustment bolt head (D) on the height-of-cut gauge bar to the desired cutting height (E).

NOTE: DO NOT allow the adjustment bolt to turn while turning the wing nut.

5. Hold the adjustment bolt and turn the wing nut (C) until it sets firmly against the bar.

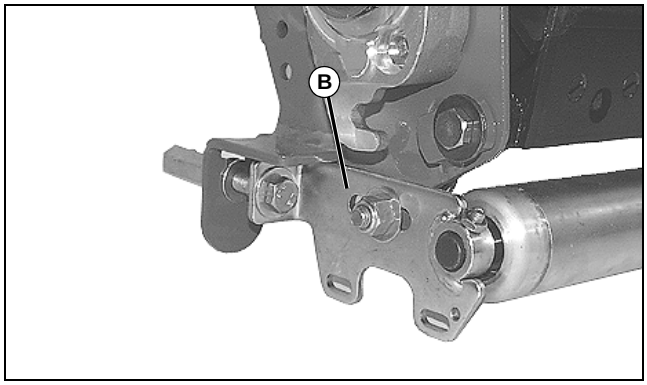


M84834

6. Rest height-of-cut gauge bar against the front roller (F), approximately 51 mm (2.0 in.) from the end of the bed knife. Rest the inside of the bolt head (D) against the edge of the bed knife.

7. Turn tower adjuster (G) until the rear roller (H) makes contact with the height-of-cut gauge bar. Repeat for other side.

8. Check adjustment on both sides of cutting unit using height-of-cut gauge bar. Repeat adjustment as needed.



M98489

9. Tighten lock nut (B) on each side of the cutting unit.

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Adjust Fairway Tender Conditioner (FTC) - 2500M

Reason

To set the desired cutting height.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	AMT2978	Used to set desired cutting height.

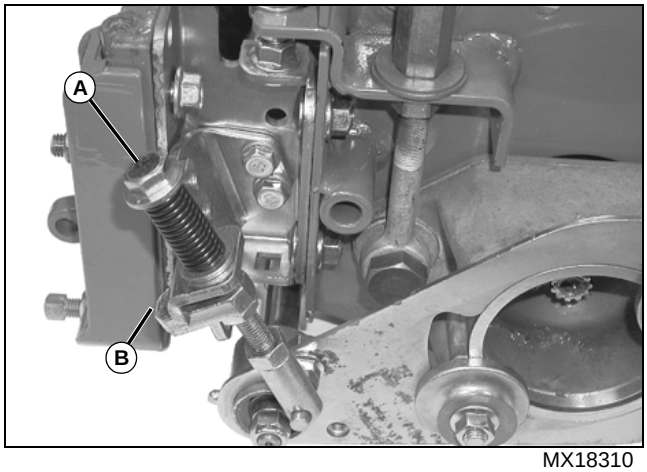
Procedure

NOTE: Height-of-cut must be adjusted before adjusting the fairway tender conditioner.

CAUTION: Avoid injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface.

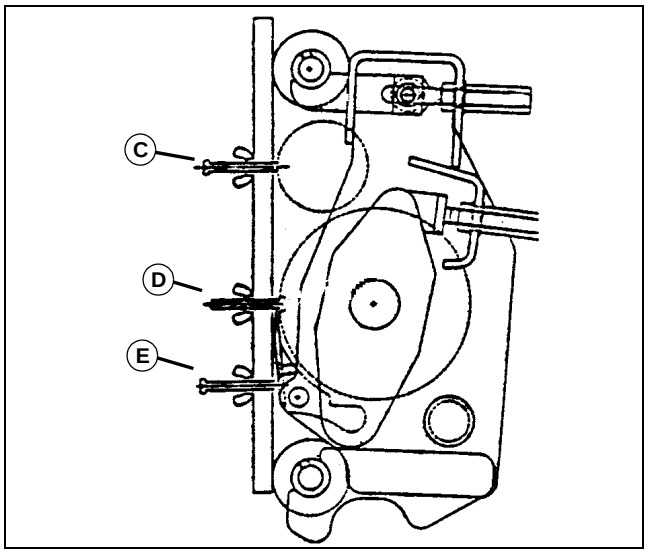


MX18310

Picture Note: Operating Position Shown

3. Press down on FTC adjuster bolts (A) and swing adjuster stops (B) toward the front of the cutting unit on both ends of the cutting unit (engaged position).

NOTE: Measure the usable blade length of the cutting blades. If the usable blade length is less than the desired cutting depth, replace the cutting blades before continuing.

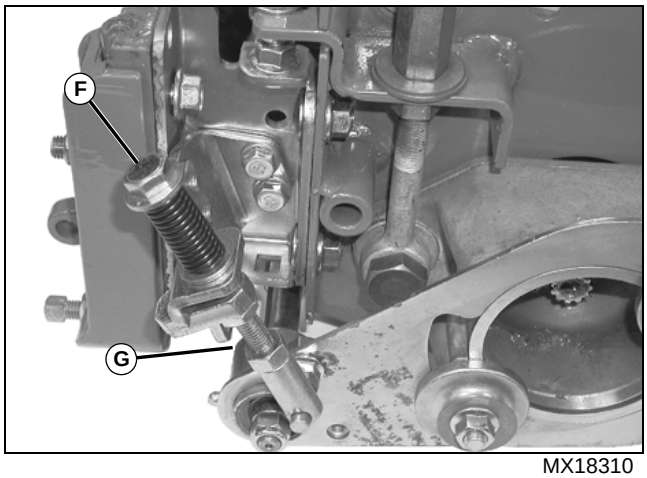


M44324

4. Set FTC adjustment screw (C) on the gauge bar to desired height.

5. Loosen adjustment screw (E), if needed, to allow the gauge bar to rest against the rollers.

6. Place the depth gauge on cutting unit. Hook the underside of height-of-cut screw head (D) on bed knife. The ends should rest firmly on the front and rear rollers.



MX18310

Picture Note: Operating Position Shown

7. Loosen adjuster lock nut (G) on both ends of the cutting unit.

8. Turn adjuster bolt (F) to raise or lower FTC roller. Alternate from end to end until the teeth touch the screw on the gauge bar.

9. Tighten adjuster lock nuts.

10.Remove gauge bar.

Results

FTC cutting height should be set to desired level, consistently across cutting unit.

Adjust Cutting Shield - 2500M

Reason

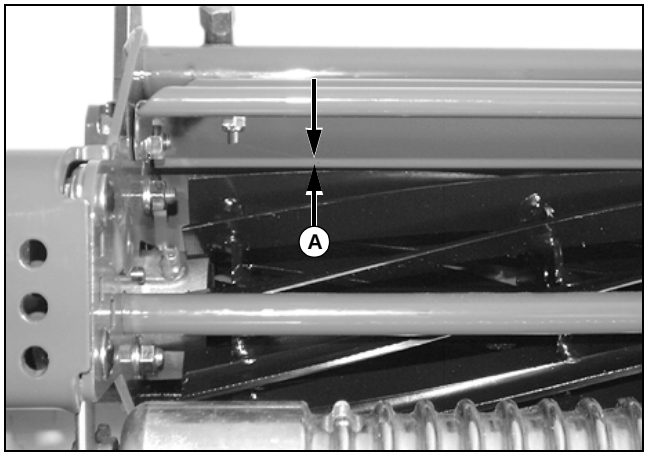
Correct adjustment of the cutting shield improves the performance of the grass catcher.

Procedure

CAUTION: Avoid injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

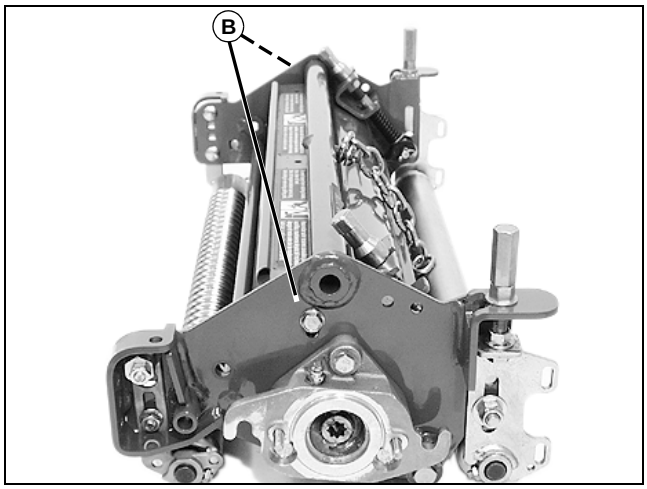
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface.



M84844

3. Check the clearance (A) between the bottom of the cutting shield and the cutting blades. Gap should be at specifications. If the clearance is not correct, adjust as follows.



M84848

4. Loosen cap screws and lock nuts (B) on both sides of cutting unit.

5. Raise or lower shield until correct clearance is obtained.

6. Tighten bolts and lock nuts.

Results

Proper clearance between shield and cutting blades will result in greater grass catching performance.

Specifications

Cutting Unit Shield Clearance - 2500M. 1 mm (0.04 in.)

Adjust Depth-of-Cut - Vertical Cutting Units (2500M)

Reason

To set the desired cutting depth.

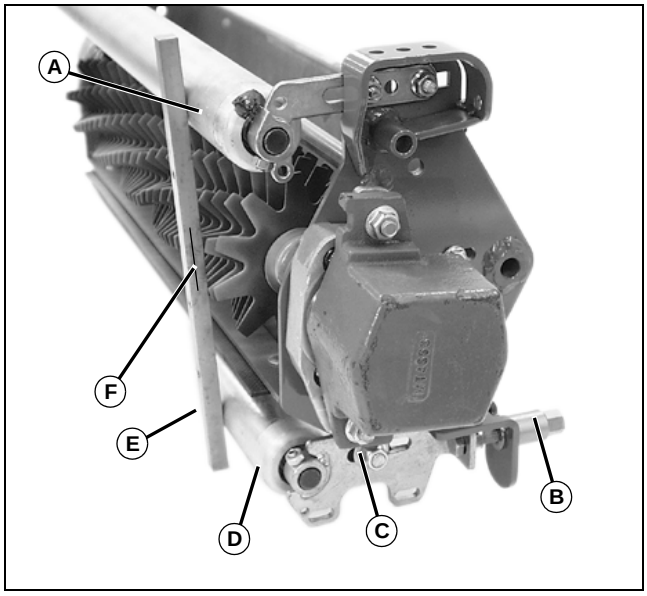
Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	AMT2978	Used to set desired cutting height.

Procedure

1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M98504

3. Mark the desired cutting depth (F) on the gauge bar (E).

4. Place gauge bar across the front and rear rollers (A and D) approximately 50 mm (2 in.) in from the end of the rollers.

5. Loosen the lock nut (C) on each side of the cutting unit.

6. Turn each tower adjuster (B) until the leading edge of the vertical cutting unit blade aligns with the cutting depth on the gauge bar.

7. Rotate the cutting reel back and forth to ensure the tips of the cutting blade do not extend past the mark on the gauge bar.

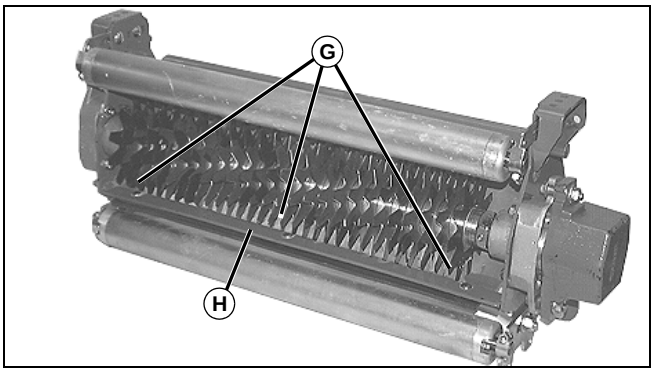
8. Repeat steps 4-7 on the other side of the cutting reel.

9. Tighten lock nuts.

NOTE: Adjustment of flap height will depend on turf conditions.

On short turf, lower flap to prevent material from flying out the rear of the cutting unit.

On turf with a lot of thatch, raise flap to allow the removed thatch to exit out the rear of the cutting unit.



M98561

10.Loosen three carriage bolts and hex nuts (G).

11.Adjust flap (H) from the bottom of the rollers to specifications.

12.Tighten hardware.

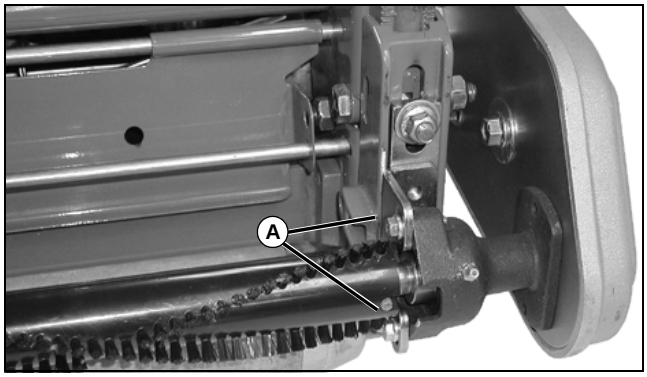
Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Specifications

Vertical Cutting Unit Flap Adjustment . . 13 mm (1/2 in.)

Adjust Power Brush



MX18343

Picture Note: Heavy Duty Shown

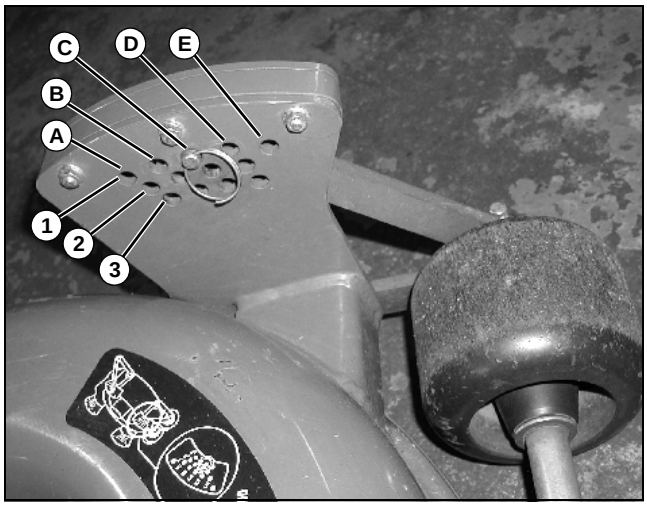
1. Loosen cap screws (A) on both sides of cutting unit.
2. Move brush up or down to achieve specification.
3. Tighten cap screws (A) on both sides of cutting unit.

Specification

Brush-to-Roller Clearance . . . . . 0-1 mm (0-0.031 in.)

Adjust Rotary Cutting Units (IRS)

1. Stop machine on level surface.
2. Lower cutting units to ground.
3. Push PTO switch down into TRANSPORT position, lock park brake and shut down engine.



MX17971

4. Remove ring from pin and remove pin from adjustment hole.

	A	B	C	D	E
1	25.4 mm (1.00 in.)	44.5 mm (1.75 in.)	63.5 mm (2.50 in.)	82.6 mm (3.25 in.)	101.6 mm (4.00 in.)
2	31.8 mm (1.25 in.)	50.8 mm (2.00 in.)	69.9 mm (2.75 in.)	88.9 mm (3.50 in.)	- - -
3	38.1 mm (1.50 in.)	57.2 mm (2.25 in.)	76.2 mm (3.00 in.)	95.3 mm (3.75 in.)	- - -

5. Insert pin into desired adjustment hole and retain with ring. Repeat for other 3 adjusters.

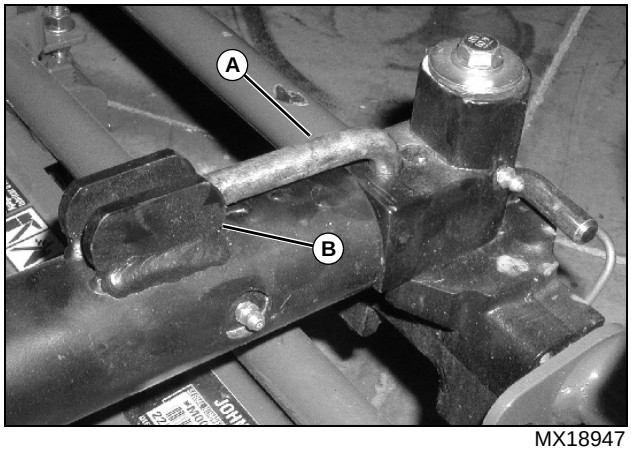
Repair

Rotating Reel Cutting Units

Rotate for Service™ (RFS)

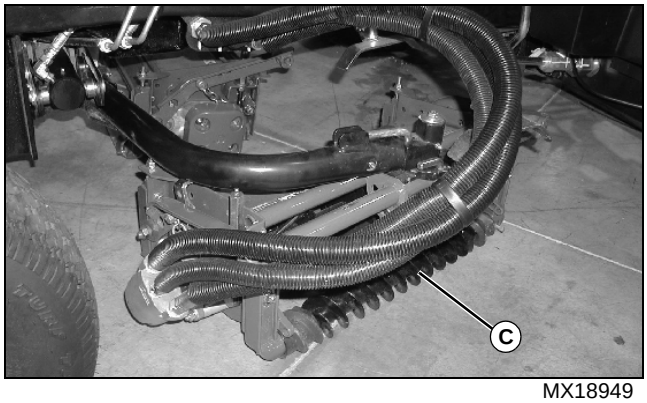
CAUTION: Avoid injury! Always use the mower's hydraulic system to rotate the units. DO NOT attempt to rotate units manually. Keep others away from mower during RFS operation to prevent injury.

1. Lock park brake.
2. Lower units to the ground and stop engine.



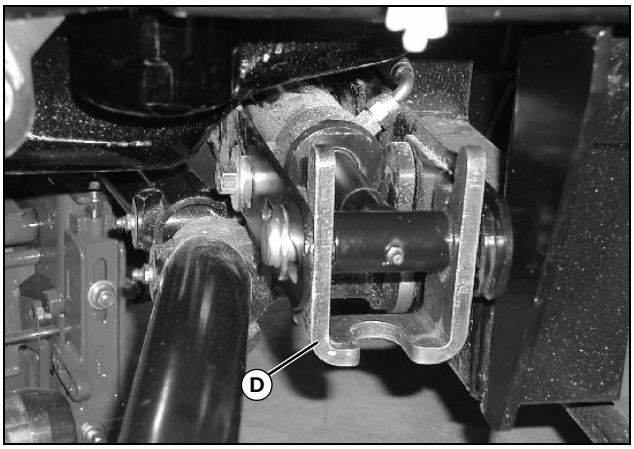
MX18947

3. Pull out pin (A) of rear cutting unit and insert the pin with the short leg in the hole and the long leg in the channel (B).



MX18949

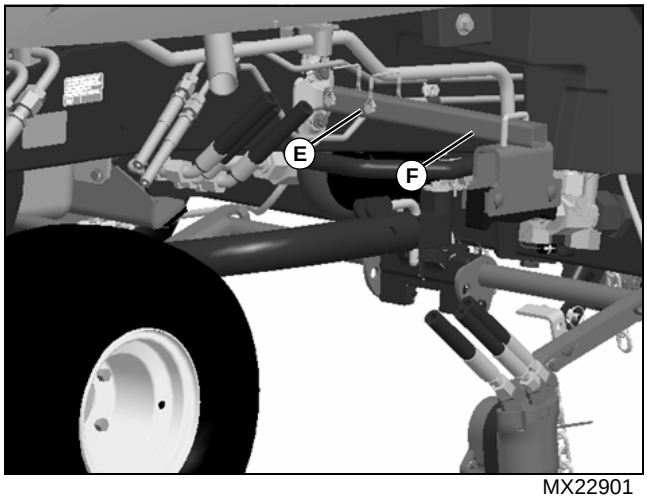
4. Turn the cutting unit (C) outward.
5. Repeat for second rear cutting unit.



MX18950

Picture Note: U-shaped rear lift arm stop shown rotated away from rear lift arm cylinder.

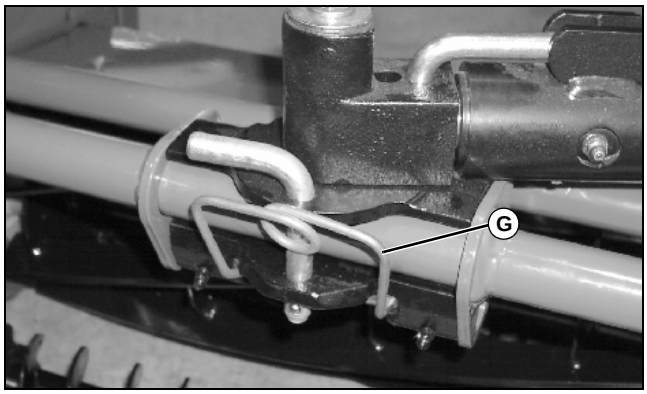
6. **S.N. (030000-) Only:** Rotate the U-shaped rear lift arm stop (D) away from the rear lift arm cylinder.



MX22901

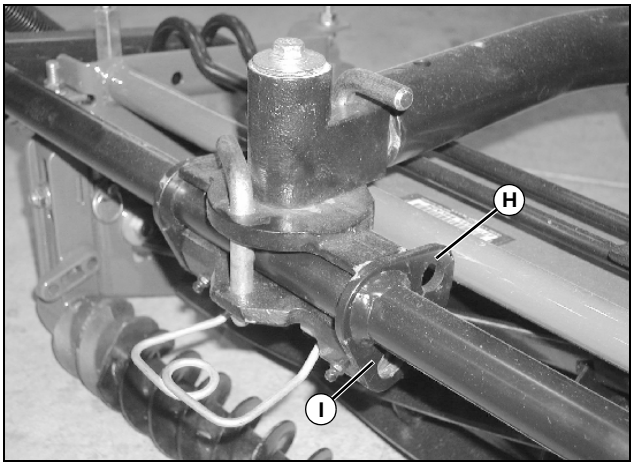
7. **S.N. (-030001) Only:** Remove pins (E) from rear reel stabilizers (F) and slide stabilizers off the machine

CAUTION: Avoid injury! Units must be on the ground when releasing the spring levers. DO NOT release spring levers with units raised, to prevent injury.



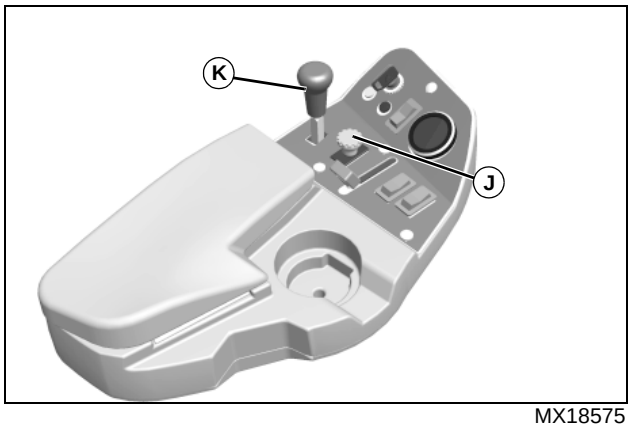
MX10837

8. Push down spring (G) on each cutting unit until spring holds in down position.



MX18951

9. The unique spring design has two settings: The bottom hole (H) locks the cutting units in the normal operating position. The top hole (I) locks the cutting unit in forward position to present the blades.



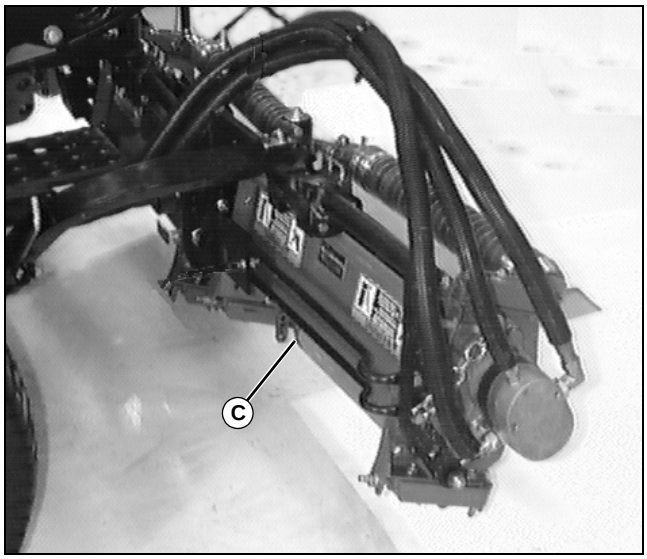
MX18575

10.With the PTO switch (J) pushed down into the TRANSPORT position, start the engine while in the seat.

11.Pull up on PTO switch (J) into the MOW position and pull back the lift lever (K) to raise the cutting units.

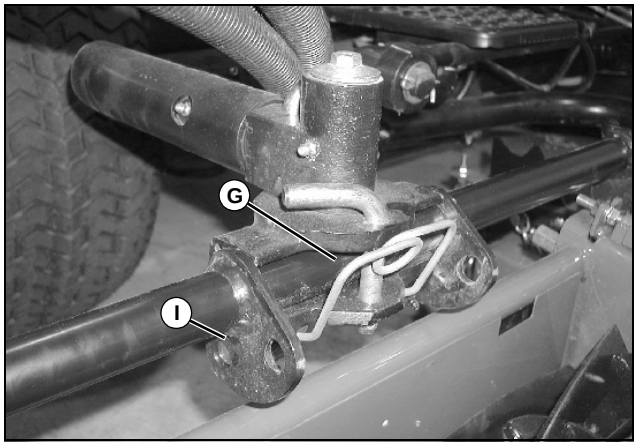
12.Push the PTO switch (J) down into the TRANSPORT position.

13.Lock the park brake and shut off the engine.



MX18946

14.The cutting units (C) are pointing up because the retaining pins are not in place.

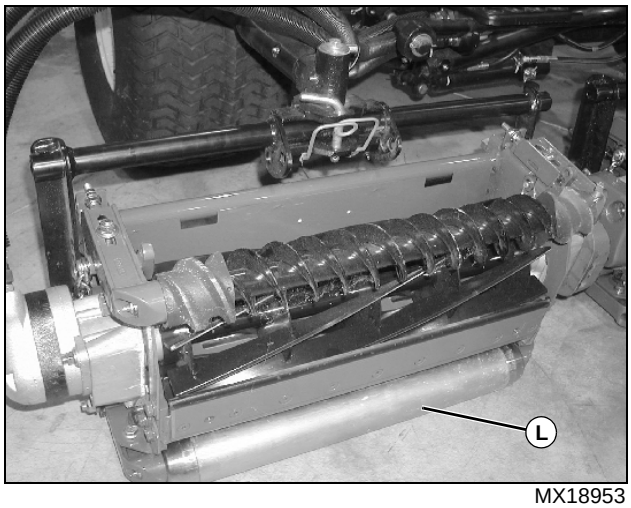


MX18952

15.Pull the spring lever (G) back up to the normal position. Then, pull the cutting unit up by the front roller so the pins align with the top hole (I) and lock the cutting unit in place.

NOTE: Lock the rear cutting units in place facing the side.

16.Restart the machine.

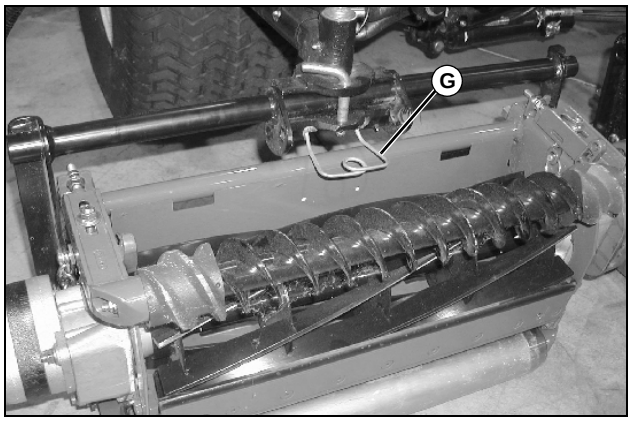


MX18953

17.Lower the cutting units so the back roller (L) is on the floor. This stabilizes the cutting units and takes the load off the lock pins. The cutting units are now ready for servicing.

Preparing Cutting Units for Mowing

CAUTION: Avoid injury! Rear rollers must be on the ground when releasing spring levers. DO NOT release spring levers with the units lifted.

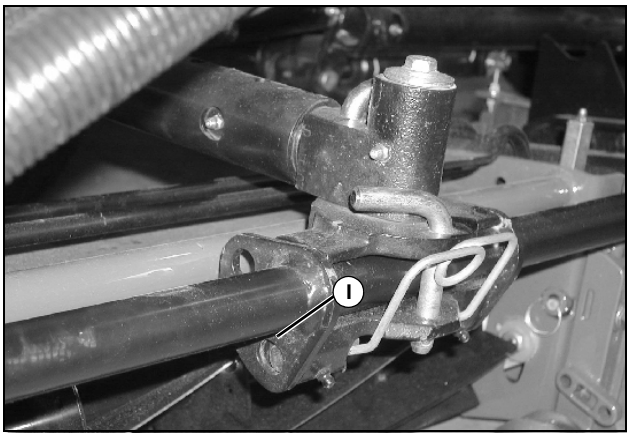


MX18954

1. When finished servicing the cutting units, release the spring levers (G) on all five units.

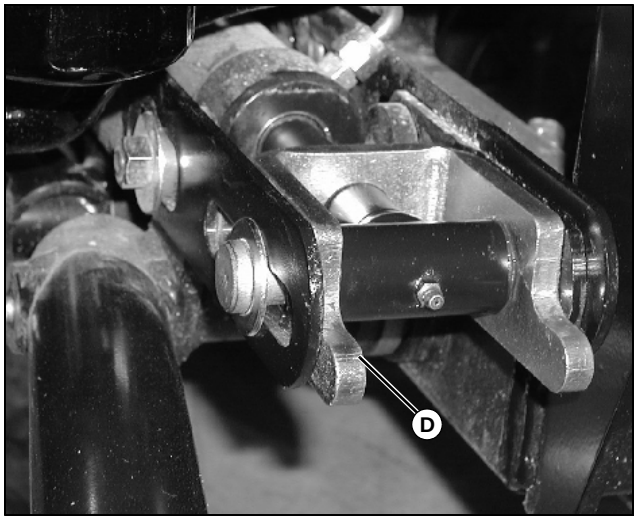
2. Start the machine and pull the lift lever back to raise the cutting units, causing them to hang in their normal free positions.

3. Push the lift lever forward to lower them back down.



MX18955

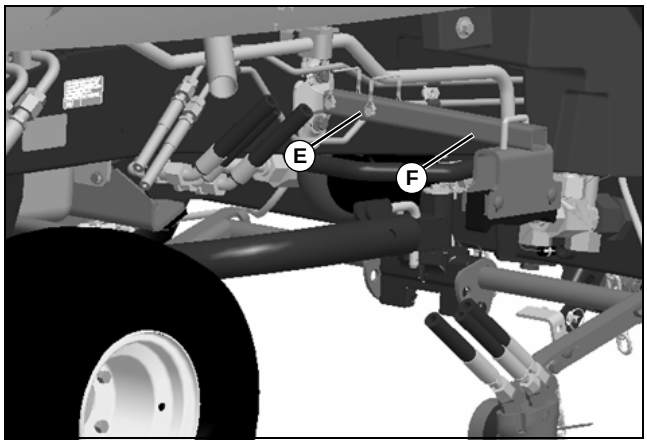
4. Shut off the engine and put the spring levers back up on each cutting unit. Jiggle them to make sure the pins lock in place (I).



MX18956

5. **S.N. (-030000) Only:** Turn the rear cutting units to face forward again. Replace their retaining pins with the long leg in one of the holes. Place the U-shaped rear lift arm stop (D) back into place.

The RFS system allows a choice of fixed steer and normal steer cutting unit mowing options, as well as a transport position.

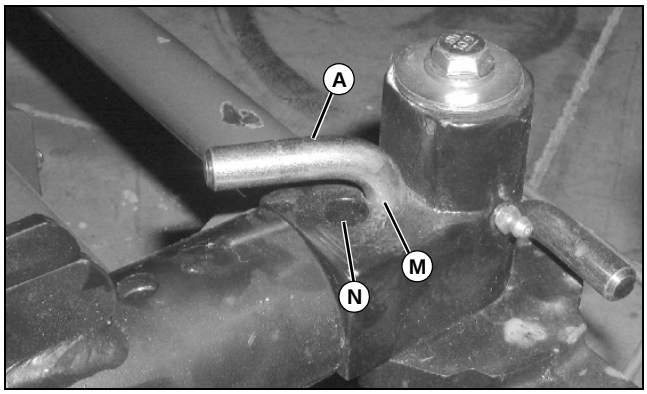


MX22901

6. **S.N. (-030001) Only:** Install rear reel stabilizers (F) and pins (E).

Fixed Steering

IMPORTANT: Avoid damage! DO NOT install pin in channel except for servicing the rear units.

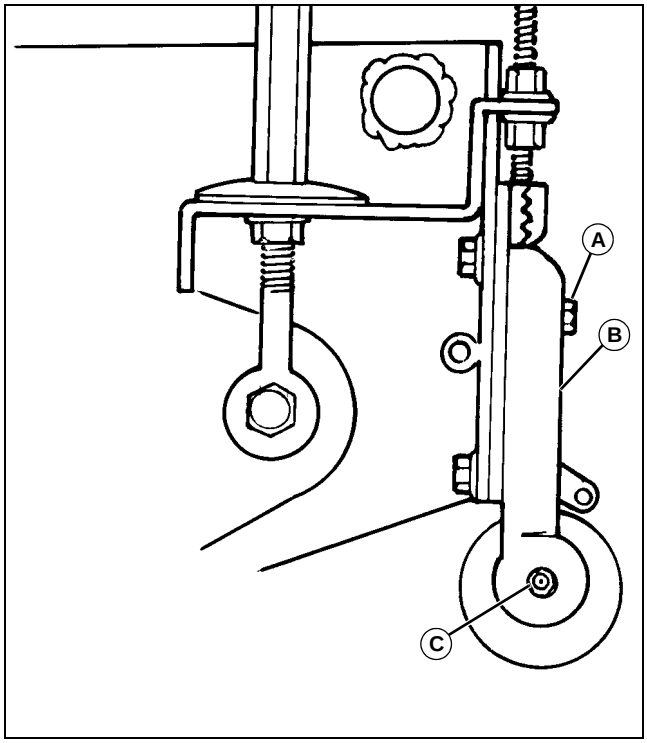


MX18959

Fixed steer cutting unit position is where the linger leg of pin (A) is inserted into the front hole (M).

Normal steer is where pin (A) is inserted into rear hole (N).

Remove Front Roller - 22-In. Heavy Duty



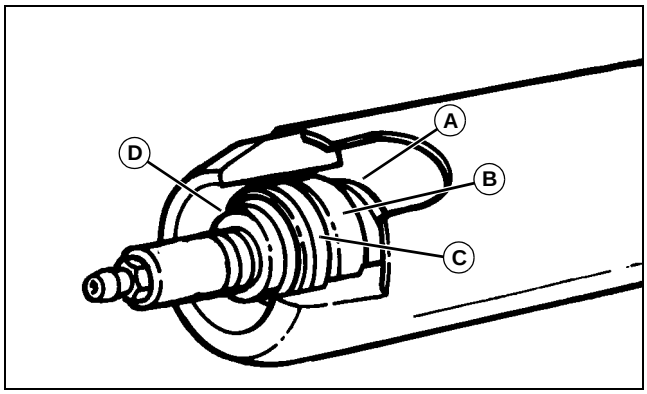
M46876

1. Remove the two cap screws (A) securing the roller adjustment brackets to the cutter frame. Remove roller with brackets from cutting unit.

2. Loosen lock nut and set screw (left side only). Slide the roller adjustment brackets (B) off the roller.

3. Remove grease fittings (C).

Disassemble and Inspect Roller - 22-In. Heavy Duty

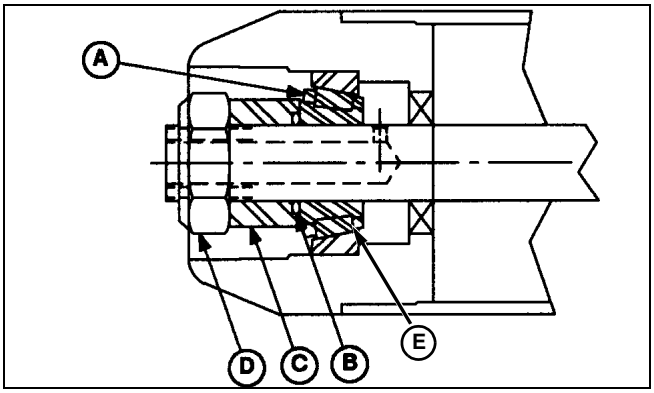


M46888

1. Remove lock nuts from each end of the roller.
2. Press roller shaft out of roller.
3. Remove seals (C) (A, smooth roller only), spacer (D) and bearings (B). Clean bearings and end caps with a suitable solvent.
4. Inspect bearings and bearing cups for pitting, scoring and bluing from overheating. Replace bearings and bearing cups as necessary.

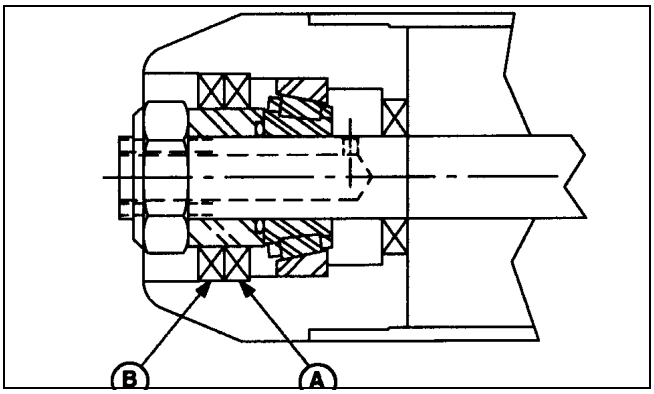
Assemble Roller - 22-In. Heavy Duty

1. Install bearing cup.



E35821

2. Pack bearing (A) with grease and install into bearing cup.
3. Apply grease to seal lip and install seal (E) with lip of seal facing out.
4. Lubricate O-ring (B) and install next to bearing.
5. Slide spacer (C) over shaft with O-ring groove facing bearing and install shaft.



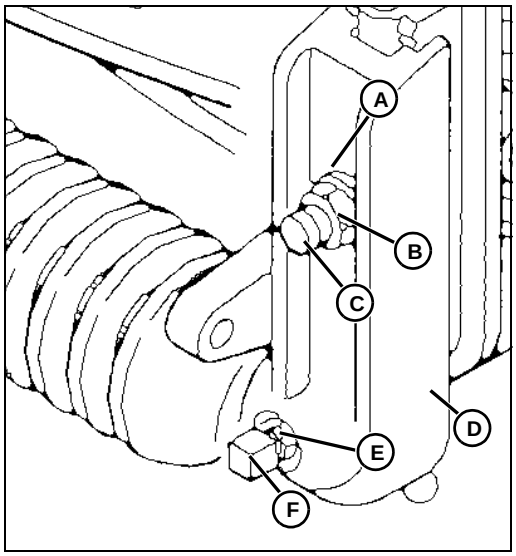
E35823

6. Apply grease to lips of seals (A and B) and install with seal lips facing away from bearing.
7. Repeat steps 1 through 5 on opposite end.
8. Install self-locking nut (D) on each end and tighten until snug. Back off slightly and retighten to specifications.
9. Install grease fittings and lubricate.

Specifications

Self-Locking Nut Torque . . . . 0.34-0.79 N•m (3-7 lb-in.)

Install Roller - 22-In. Heavy Duty



M56473

1. Slide adjustment brackets (D) onto roller shaft (bracket with set screw on left side).
2. Secure each bracket to frame with cap screw (C), nut (B) and washer (A).
3. Center the roller between the brackets and tighten set screw (F). Tighten jam nut (E).
4. See “Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty” on page 425.

Remove Bed Knife and Support - 22-In. Heavy Duty

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.

1. Raise reel away from bed knife approx. 10 mm (3/8 in.).

2. Remove six cap screws (3 each side) securing bed knife support to cutter frame.

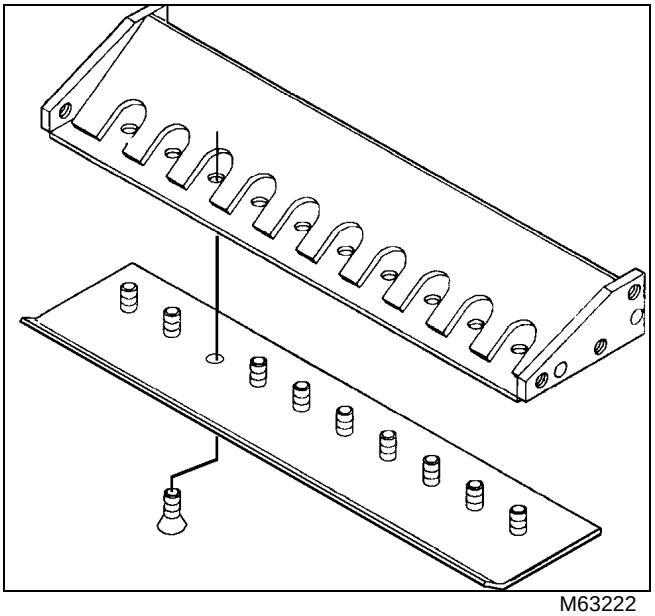
3. Carefully remove bed knife support from cutter frame.

4. Remove ten hex head cap screws and nuts securing bed knife to support.

5. Remove dirt and corrosion from bed knife mounting surface.

6. Inspect support for straightness. Repair or replace if necessary.

Install Bed Knife and Support - 22-In. Heavy Duty



M63222

1. Position the bed knife on the bed knife support and secure with new mounting hardware (install the outer screws first to position the bed knife). Starting with the center hex screw and working your way toward the ends of the bed knife, alternating from side to side, torque the bolts in two steps to specifications.

2. Grind bed knife after securing it to the support and before installing in cutting unit frame.

3. Clean the bed knife support mounting bolt threads. and clean the bolt shoulders with crocus cloth. Apply NEVER-SEEZ® to the threads and shoulders.

4. Position the bed knife and bed knife support in the cutting unit frame and secure with six mounting bolts. Tighten bolts to specifications.

5. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423.

6. See “Backlapping Procedure - 22-In. Heavy Duty” on page 424.

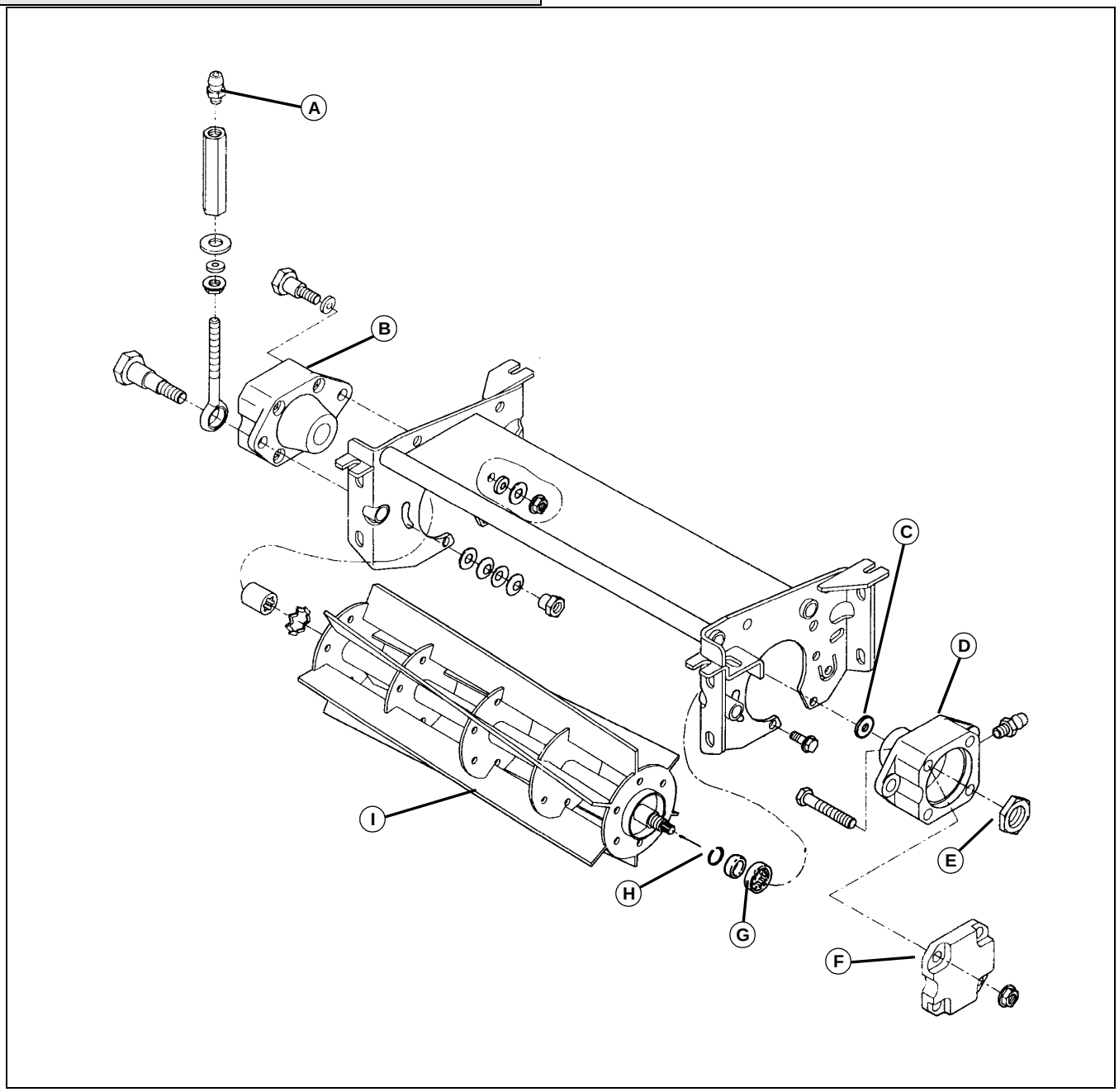
7. See “Adjust Height-of-Cut (HOC) - 22-In. Heavy Duty” on page 425.

Specifications

Hex Screw Torque (Dry). . . . . 35-45 N•m (26-34 lb-ft)
Hex Screw Torque (Lubricated) 24-36 N•m (18-27 lb-ft)
Bed Knife/ Support Mounting Bolt Torque. . 63 N•m (46 lb-ft)

Remove Reel - 22-In. Heavy Duty

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.



M56517

1. See “Remove Bed Knife and Support - 22-In. Heavy Duty” on page 444 prior to performing this procedure.
2. Loosen reel-to-bed knife adjustment nut (A) on each side of reel.
3. Remove end cover (F).
4. Remove one retaining nut (E), washer (C) and tapered roller bearing (G) from each end of the reel.
5. Remove one snap ring (H) from the right end of the reel.
6. Remove nuts, washers and shoulder bolts securing the pivot arms (B and D) to the cutter frame.
7. Remove the pivot arms. Remove reel (I).

Disassemble and Inspect Pivot Arm - 22-In. Heavy Duty

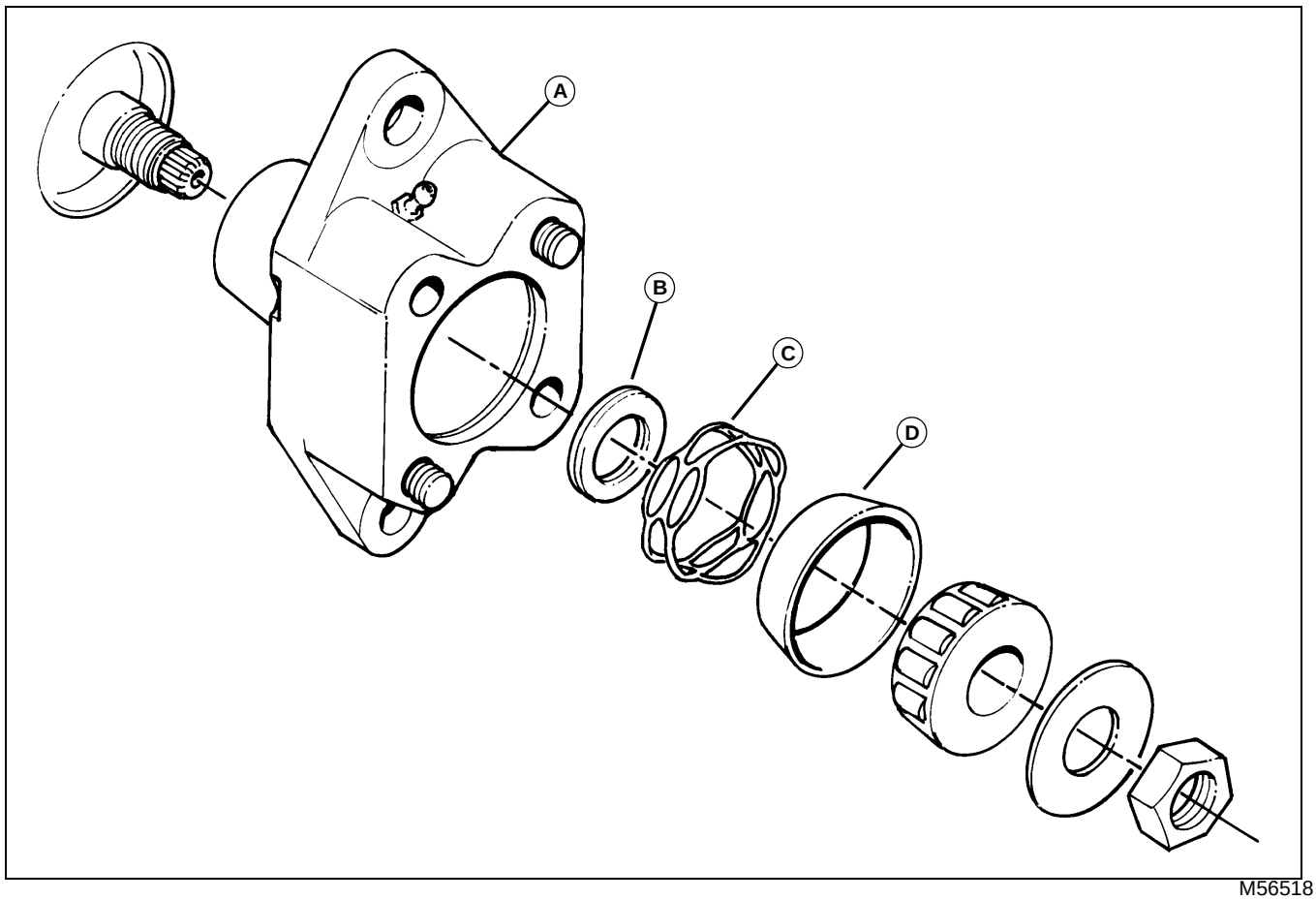
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove bearing cup, wave spring and seal from the right side.
2. Clean parts in a suitable solvent.

IMPORTANT: Avoid damage! Always replace bearing cone and bearing cup as a set.

3. Inspect bearings and bearing cups for wear, scoring and bluing from overheating. Replace if necessary.
4. Inspect wave spring for distortion or wear. Replace if worn.

Assemble Pivot Arm - 22-In. Heavy Duty



M56518

1. Install seal (B) flush with pivot arm housing (A).

NOTE: Left side housing uses an internal snap ring instead of a wave spring.

2. Install wave spring (C) on right side only.
3. Install bearing cup (D).

Install Reel - 22-In. Heavy Duty

1. Position reel in frame. Apply grease to lip of seal and slide pivot arm over reel shaft.

2. Install shoulder bolts through adjustment link, pivot arm and cutter frame. Install spring washers and shoulder nuts. DO NOT tighten. Repeat on opposite side.

3. Position shoulder bolt through pivot arm and cutter frame. Secure with washer and nut. DO NOT tighten. Repeat on opposite side.

4. Pack bearings with grease and slide over shaft and into bearing cup (one each side). Install washers and nuts. DO NOT tighten.

5. After bed knife is installed, tighten reel attachment nuts to specifications.

6. See “Adjust Reel-to-Bed Knife - 22-In. Heavy Duty” on page 423.

Specifications

Reel Attachment Nut Torque . . . . 68 N•m (50 lb-ft) min.

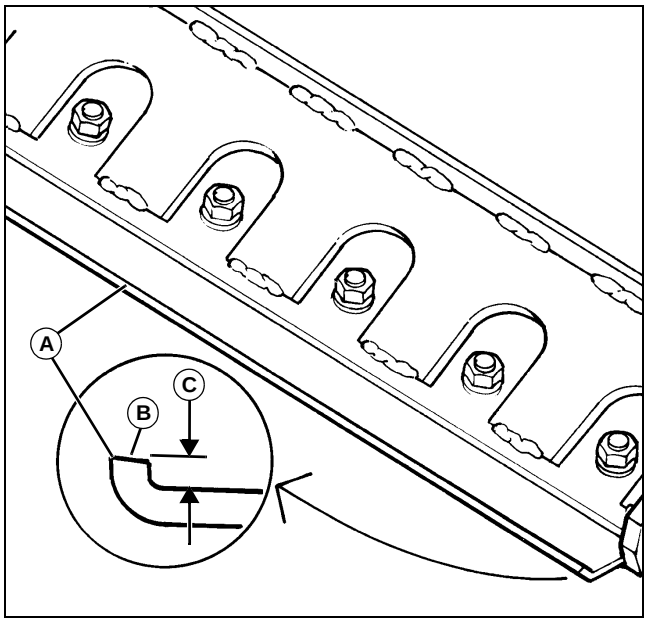
Inspect Reel and Bed Knife - 22-In. Heavy Duty

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.

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 the cutting edge land does not exceed more than 3/4 of the blade thickness. See “Reel and Bed Knife Grinding” on page 416 to restore the relief angle and cutting edge before continuing with this procedure.



M56519

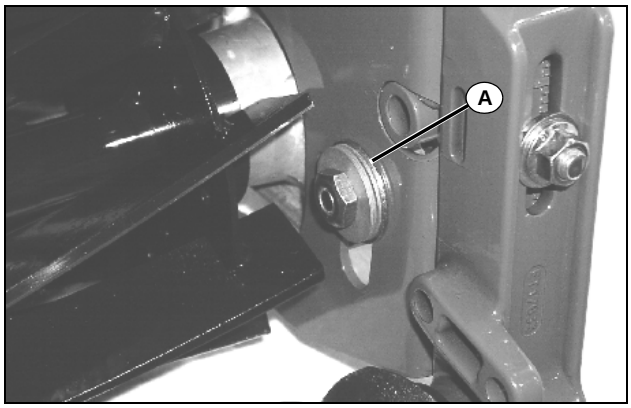
4. Inspect the bed knife cutting edge (A) for nicks, gouges or distortion.

5. Inspect the bed knife for uneven wear (indicated by uneven land (B) 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-to-mounting surface distance (C) is less than specification.

Specifications

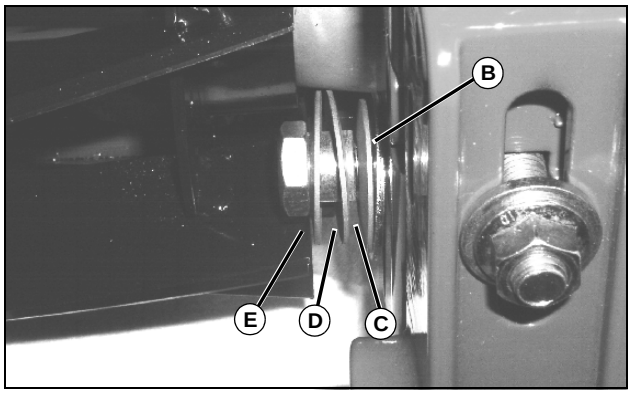
Bed knife Cutting Edge-to-Mounting Surface Distance . 1.45 mm (0.057 in.)

Install Reel Adjustment Washers - 22-In. Heavy Duty



MX18019

NOTE: It is NOT necessary to remove reel adjustment hardware (A) to adjust reel-to-bed knife clearance.

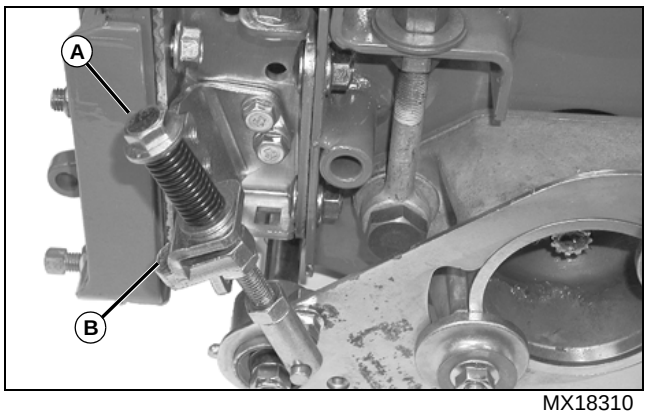


MX18018

1. Install flat washer (B) onto bolt.
2. Install one spring washer (C) onto bolt with cupped side toward flat washer.
3. Install one spring washer (D) with cupped side out and install last spring washer (E) with cupped side in. The cupped sides of (D) and (E) should face each other.
4. Install adjuster nut and tighten. DO NOT overtighten.

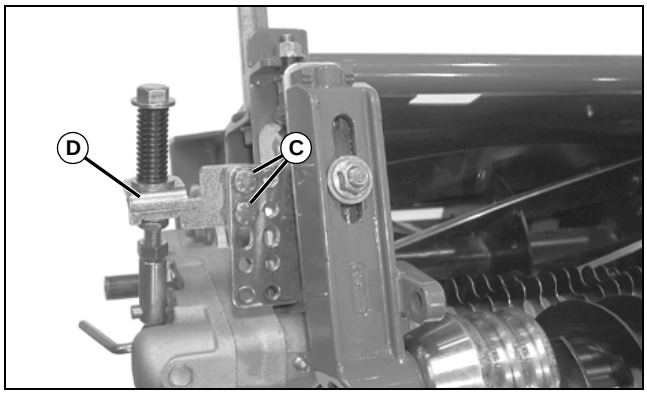
Remove Fairway Tender Conditioner - 22-In. Heavy Duty

1. Remove brush if equipped. (See “Remove Power Brush - 22-In. Heavy Duty” on page 453.)



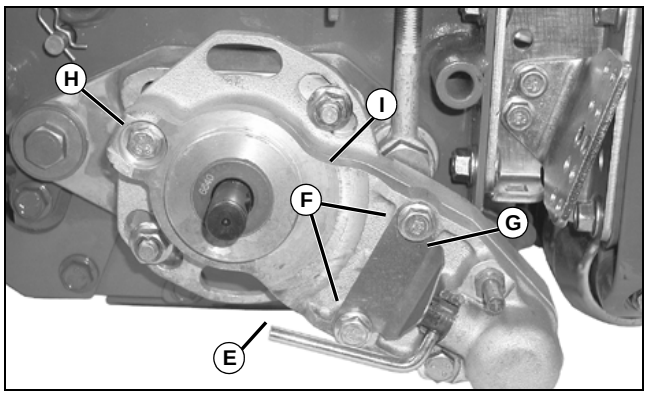
MX18310

2. Press down on FTC adjuster bolt (A) and swing adjuster stop (B) toward the rear of the cutting unit (disengaged position). Repeat on other end of cutting unit.



MX18320

3. Remove cap screws (C) from both sides of cutting unit.
4. Remove adjuster bracket assembly (D) from both sides of cutting unit.



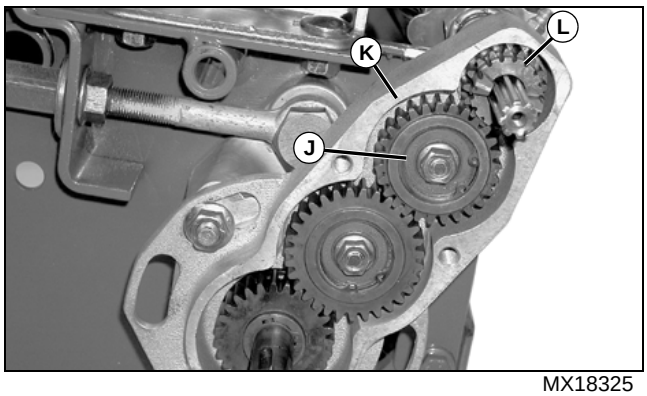
MX18323

5. Turn lever (E) to OFF position.

6. Remove two M8 hex flange bolts (F) and engagement spring (G).

7. Remove one M8 hex bolt (H).

8. Remove FTC gearcase cover (I).

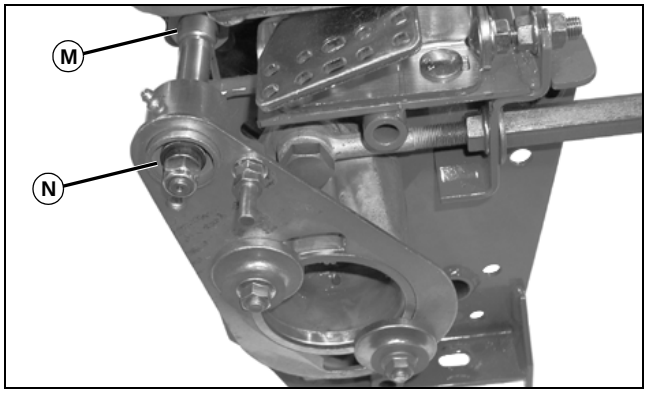


MX18325

9. Remove nut and shoulder bolt (J).

10.Remove idler gear (K) from gear case housing.

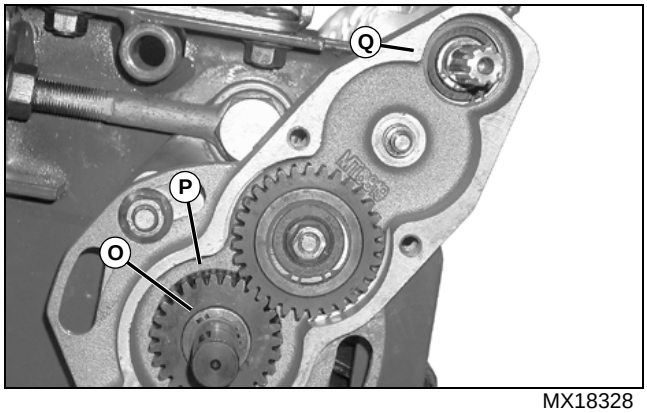
11.Remove gear assembly (L) from splined shaft.



MX18326

12.Hold shaft, using wrench on flats (M).

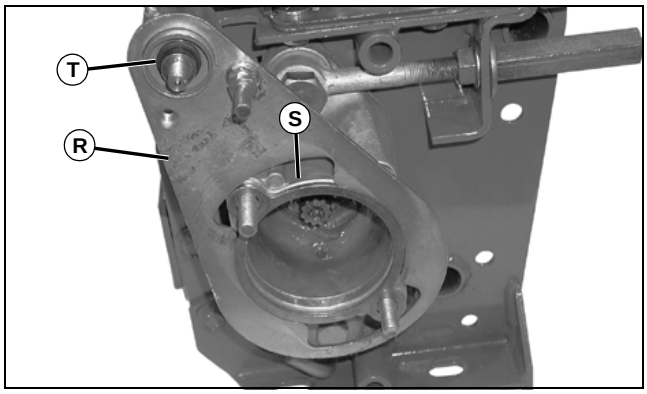
13.Remove nut (N) from conditioner shaft.



MX18328

14.Remove snap ring (O) and gear (P).

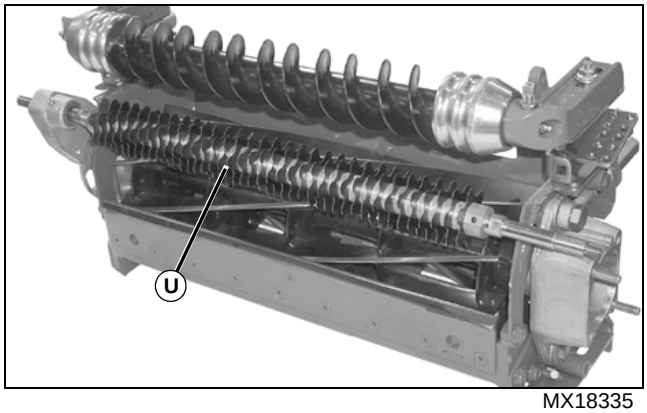
15.Remove snap ring (Q) from conditioner shaft.



MX18327

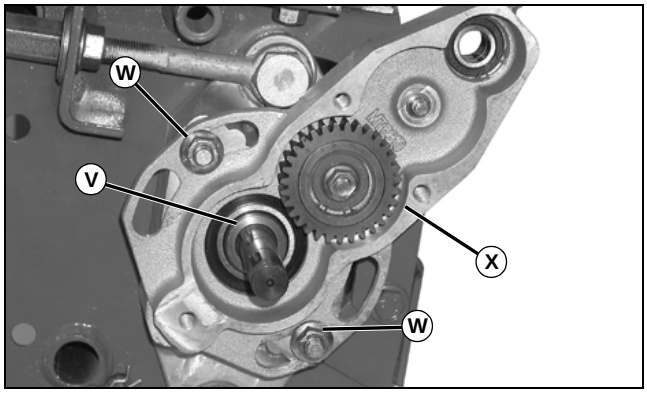
16.Remove bracket (R) and ring (S).

17.Remove spacer (T).



MX18335

18.Remove roll conditioner assembly (U).



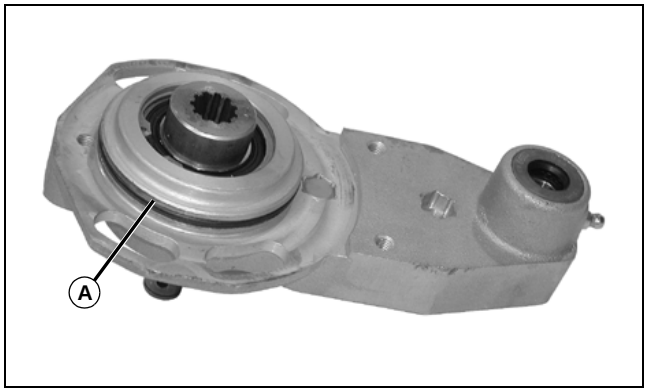
MX18329

19.Remove key (V) from shaft.

20.Remove flange nuts (W) and gear housing (X).

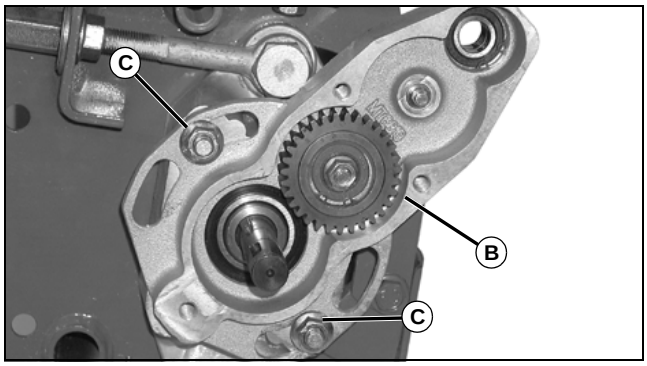
Install Fairway Tender Conditioner - 22-In. Heavy Duty

NOTE: The following procedure shows FTC unit mounted on right-hand side of cutting unit. The procedure for units mounted on the left side is the same.



MX18340

1. Lightly grease and install O-ring (A) on the back of the gearcase.

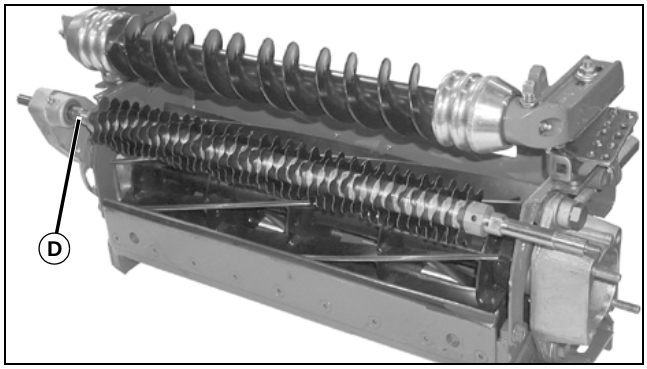


MX18329

2. Install gearcase (B) onto the reel bearing housing.

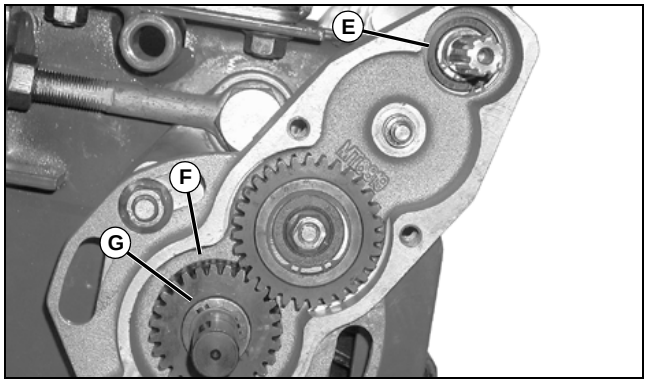
3. Install lock nuts (C). Do not overtighten nuts; be sure gearcase will pivot freely.

NOTE: There are two bearings and one washer at the front of each housing. If the washer is not centered in the housing, the shaft will not fit through both bearings. To hold washers in position, lubricate each housing grease fitting with a shot of JD Special Purpose HD water resistant grease, then center the washer.



MX18335

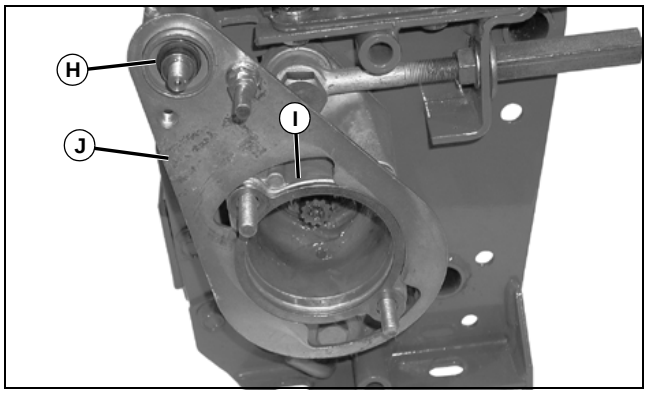
4. Slide the splined end of the roll conditioner shaft (D) into the bearing of the gearcase assembly.



MX18328

5. Install snap ring (E) to secure shaft.

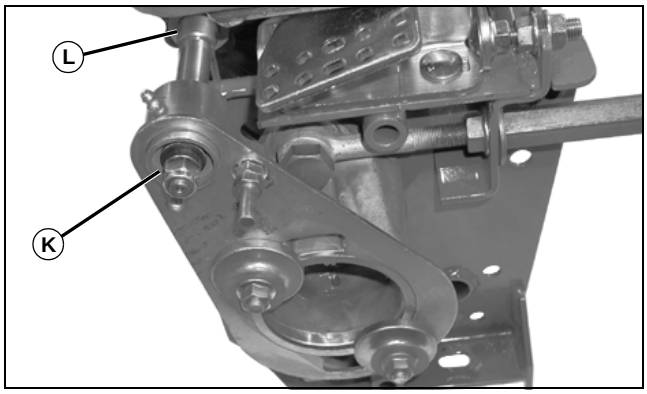
6. Install drive gear (F) with higher raised pad toward bearing and snap ring (G).



MX18327

7. Install spacer (H).

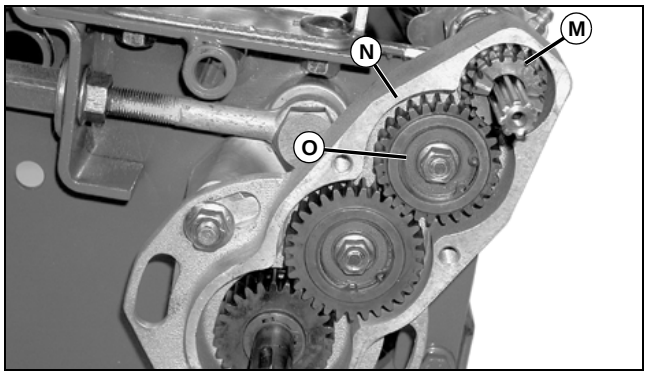
8. Install ring (I) and side bracket (J).



MX18326

9. Install M10 lock nut (K) onto threaded shaft. Hold shaft using a wrench on flats (L).

10.Tighten lock nut (K) so the conditioner shaft has no play in the reel bearing housing. The shoulder of the shaft should be tight against the bearings.

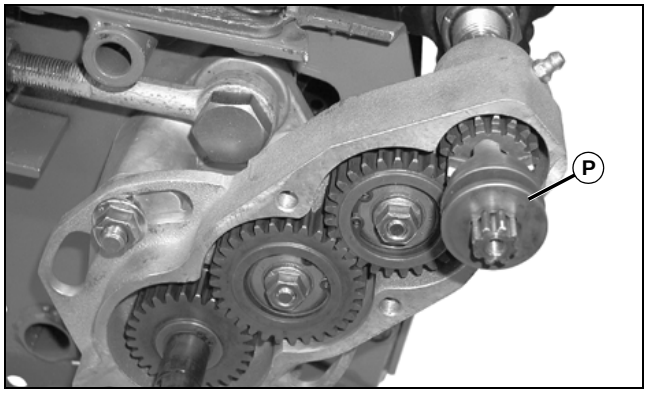


MX18325

11.Install gear assembly (M) onto splined shaft.

12.Install shoulder bolt with O-ring into gearcase.

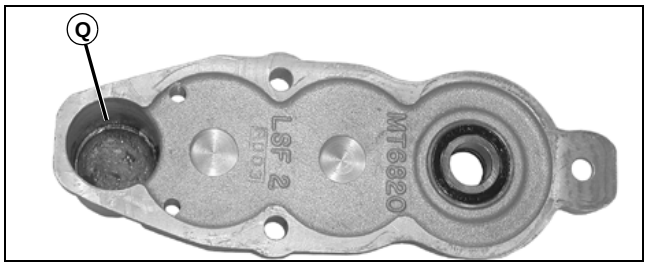
13.Install idler gear (N) and secure with M8 lock nut (O).



MX18341

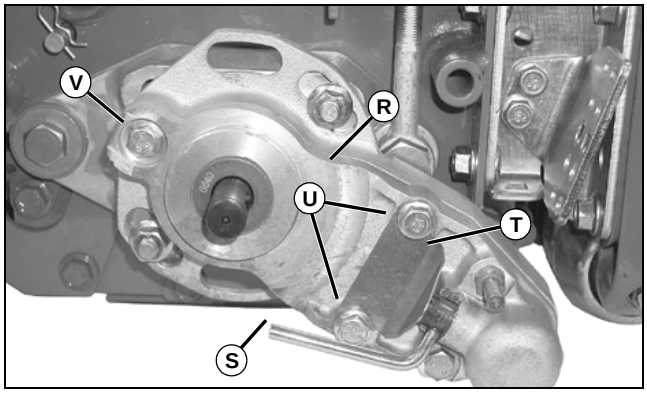
14.Install the engagement shift collar (P).

15.Grease the drive shaft end and fill openings around gears with cornhead grease.



MX18342

16.Apply cornhead grease into cover area between the seal and bearing, and into the engagement hole. Apply cornhead grease into the cast boss (Q) on the cover.



MX18323

17.Install gasket and gearcase cover (R).

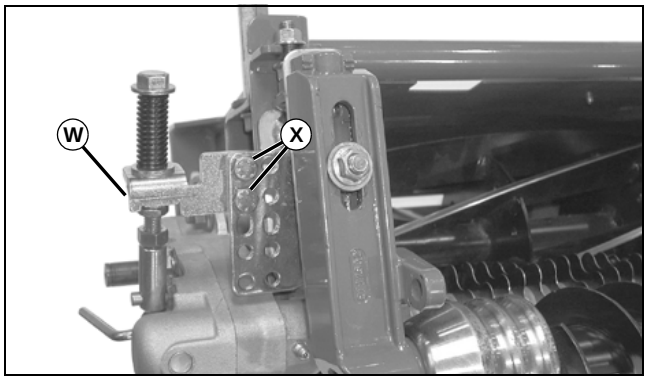
NOTE: Coat O-ring with grease to assist in installation.

18.Install engagement handle (S) with O-ring into gearcase cover. Eccentric on handle must fit into groove in shift collar.

19.Install engagement spring (T) using two M8 x 35 cap screws (U).

20.Install one M8 x 25 cap screw (V).

21.Be sure engagement handle turns freely.



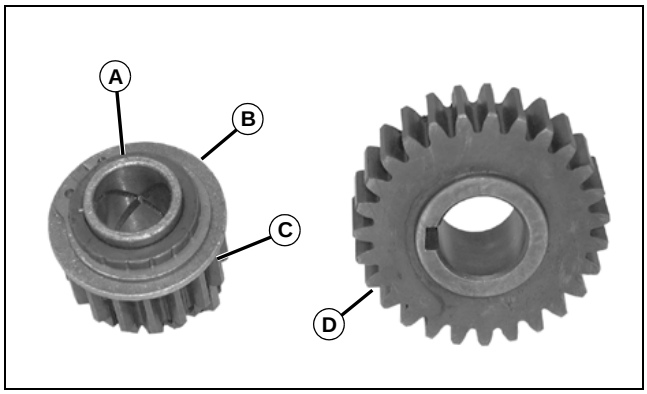
MX18320

22.Install adjuster bracket assembly (W) and cap screws and nuts (X) to both sides of cutting unit.

23.Install brush if equipped. (See “Install Power Brush - 22-In. Heavy Duty” on page 455.)

Disassemble and Inspect FTC - 22-In. Heavy Duty

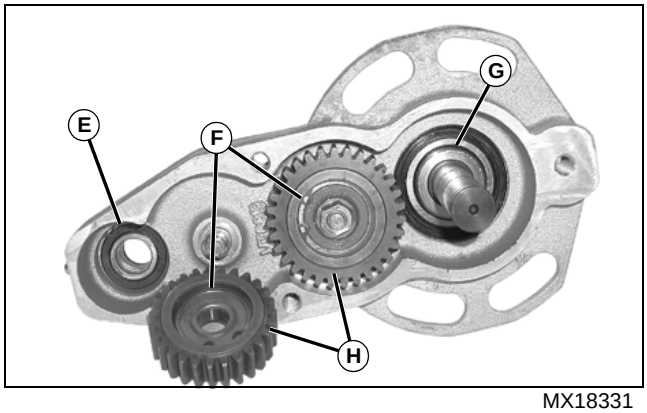
FTC Housing



MX18337

1. Inspect bushing (A) and washer (B) for signs of wear or damage. Replace as needed.

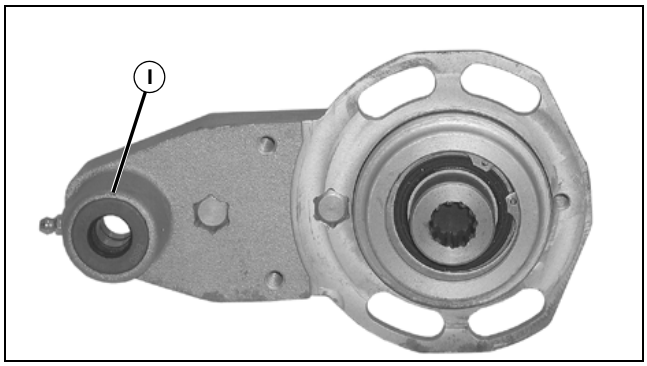
2. Inspect reel gear (C) and drive gear (D) for signs of wear or damage. Replace as needed.



MX18331

3. Inspect reel shaft bearing (E), idler gear bearings (F), and driveshaft bearing (G) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

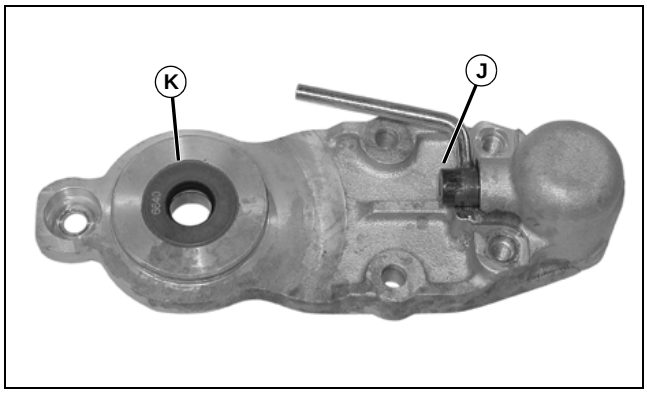
4. Inspect gears (H) for signs of wear or damage. Replace as needed.



MX18330

5. Inspect reel shaft seal (I) for signs of wear or damage. Replace as needed.

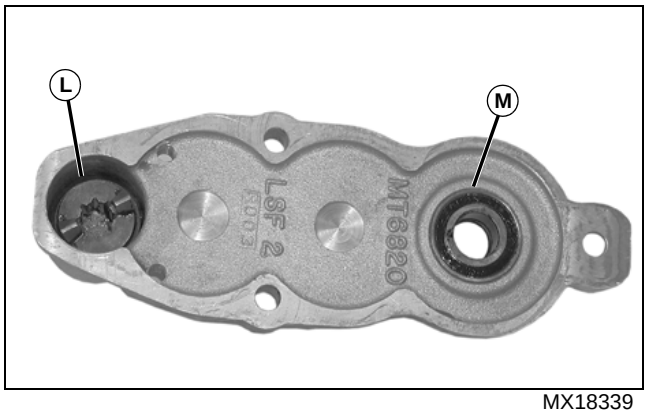
NOTE: Removing engagement pawl will cause engagement cog to fall out of housing.



MX18338

6. Remove engagement pawl by pulling shaft (J) straight out of housing.

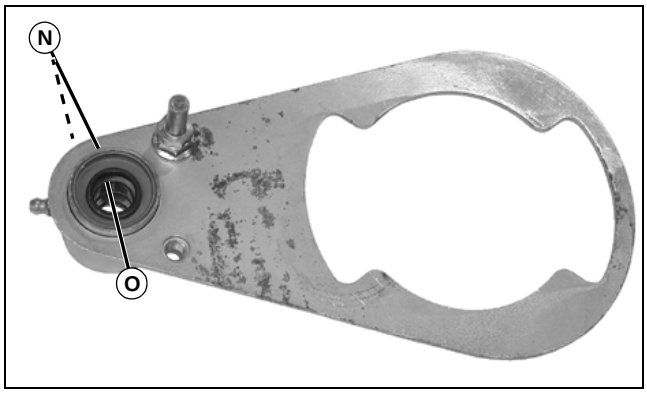
7. Inspect seal (K) for wear or damage. Replace as needed.



MX18339

8. Remove engagement cog (L) from housing. Inspect cog for wear or damage. Replace as needed.

9. Inspect bearing (M) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

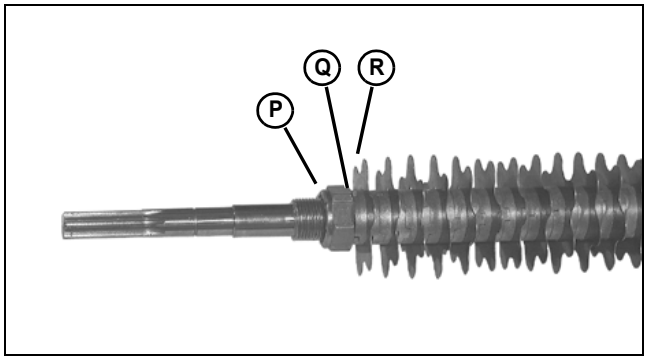


MX18334

10.Inspect seals (N) on both sides of bearing for wear or damage. Replace as needed.

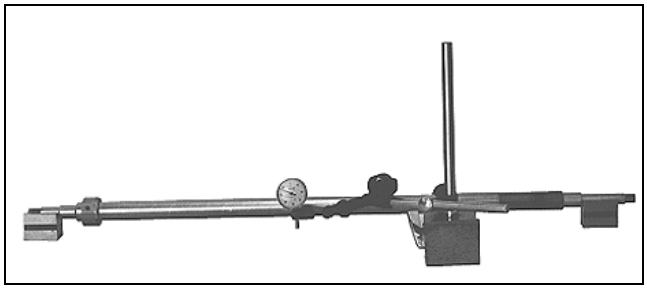
11.Inspect bearing (O) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

FTC Shaft Assembly

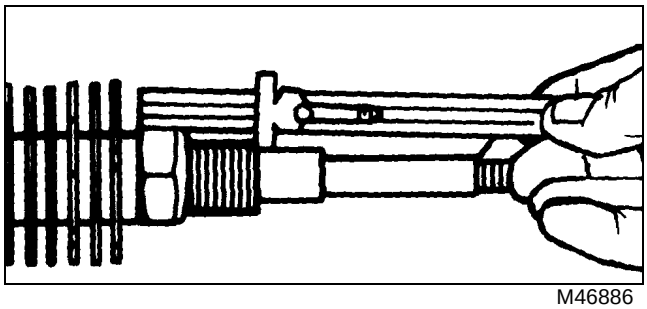


MX18332

1. Remove lock nut (P).
2. Remove index rings (Q) and blades (R).
3. Inspect blades for excessive wear and broken, cracked, or distorted cutting teeth. Replace parts as needed.


M46725

4. Remove debris and/or corrosion from shaft and place on V-blocks. Check runout at center of the shaft. Runout should not exceed 1.4 mm (0.0625 in.). Straighten or replace shaft as necessary.

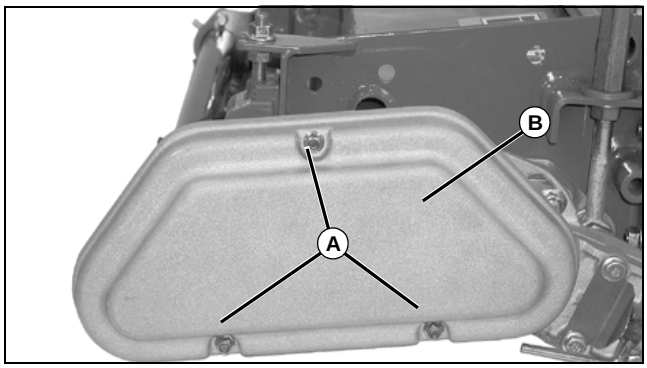

M46886

5. Install index rings and blades on shaft, rotating occasionally to align blades and index rings. Install all spacers and blades until approximately 38 mm (1.50 in.) of exposed shaft is left.
6. Stand shaft on end and shake it slightly to ensure blades and index rings are aligned.
7. Install locking nut and tighten to specification.

Specifications

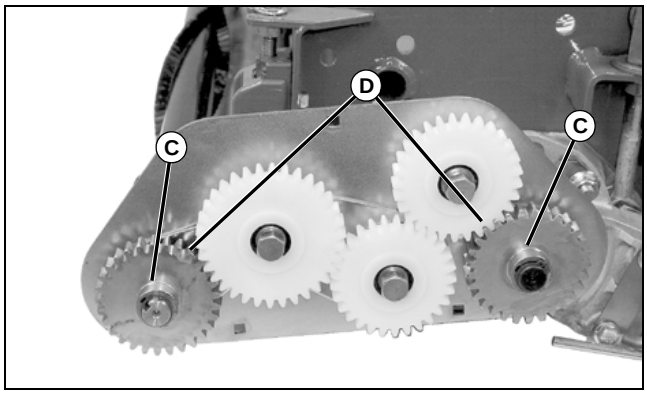
Locking Nut Torque . . . . . 47 N•m (35 lb-ft)

Remove Power Brush - 22-In. Heavy Duty



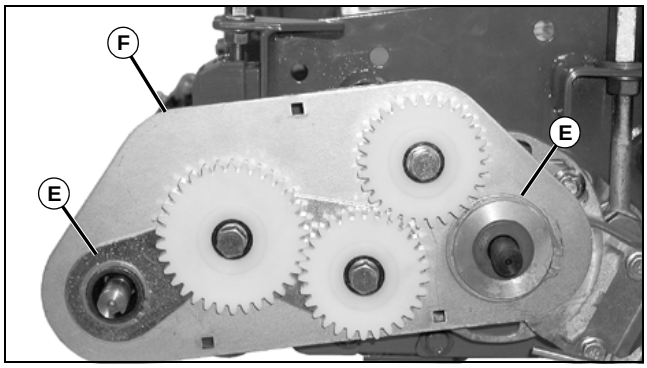
MX18311

1. Remove three nuts and carriage bolts (A).
2. Remove cover (B) and gasket.



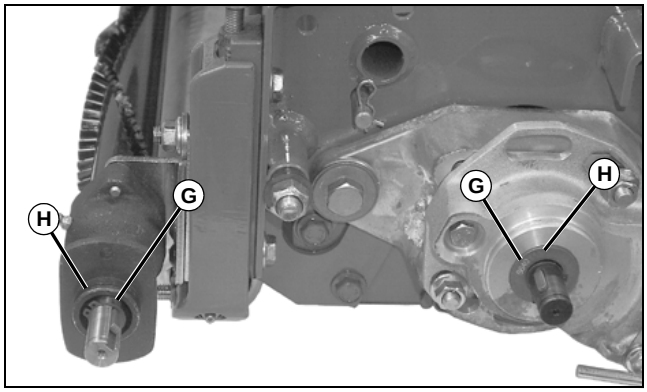
MX18312

3. Remove snap rings (C).
4. Remove gears (D).



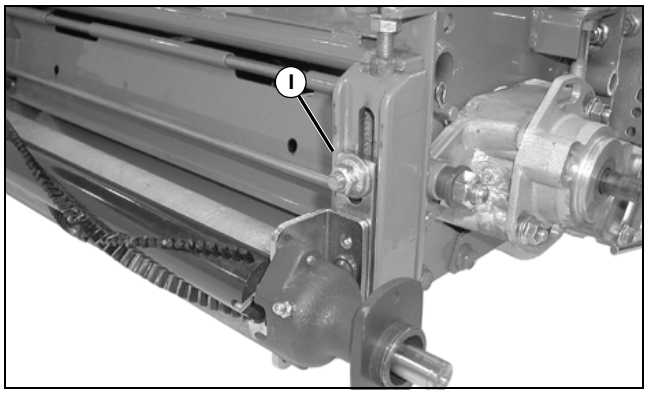
MX18314

5. Remove snap rings (E) and gear plate (F).



MX18313

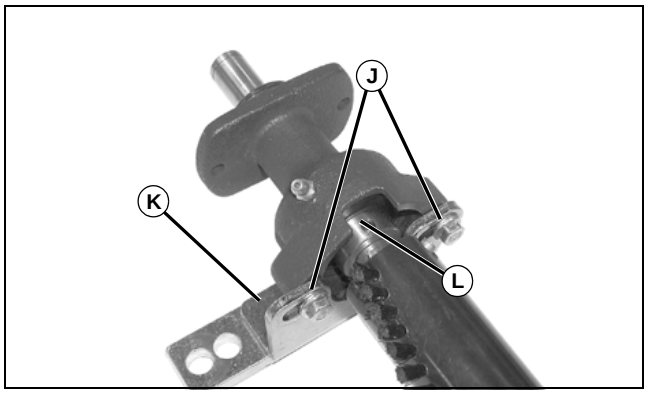
6. Remove keys (G) from shafts. Remove snap rings (H).



MX18315

7. Remove nut and washer (I) from bracket on both sides of cutting unit.

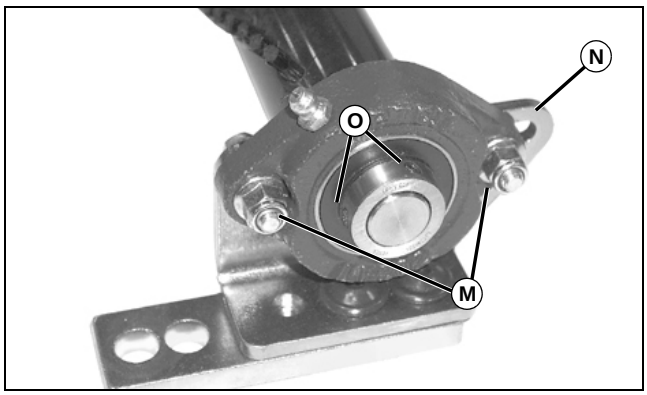
8. Remove brush assembly.



MX18316

9. Remove cap screws (J) and mount bracket (K).

10. Loosen two set screws (L) and slide drive housing off shaft.

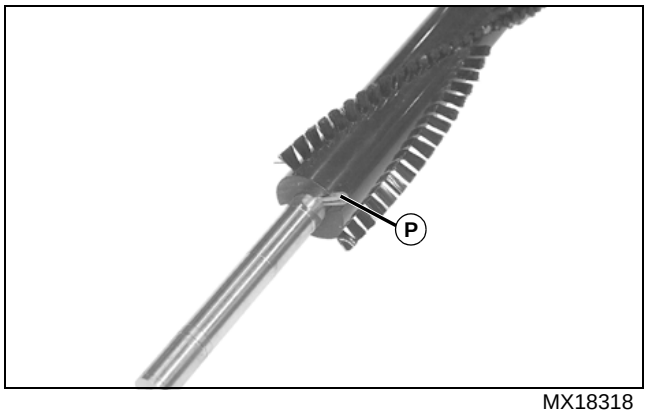


MX18317

11. Remove cap screws and nuts (M).

12. Remove mount bracket (N).

13. Loosen two set screws (O) and remove ball bearing with flange from shaft.

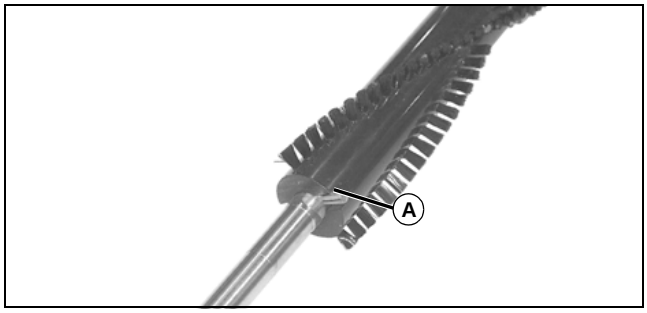


MX18318

14. Drive spring pin (P) from shaft using a punch.

15. Remove brush from shaft.

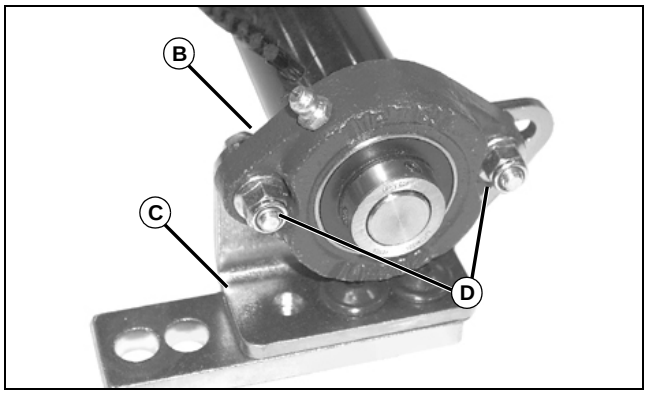
Install Power Brush - 22-In. Heavy Duty



MX18318

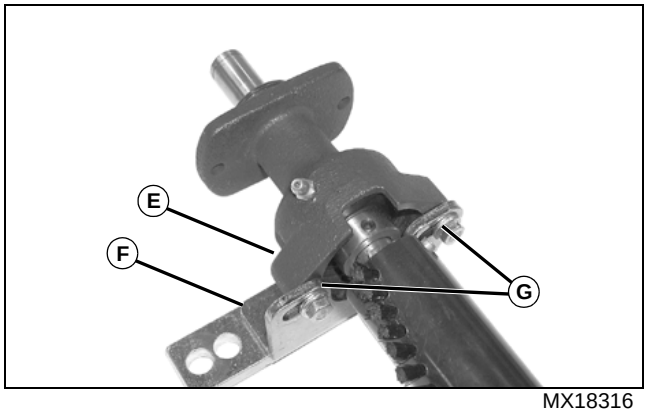
1. Install brush on shaft.
2. Install spring pin (A) to secure brush.

NOTE: The grease fittings will be more accessible for service it the housing and bearing are installed with the fittings to the rear of the unit.



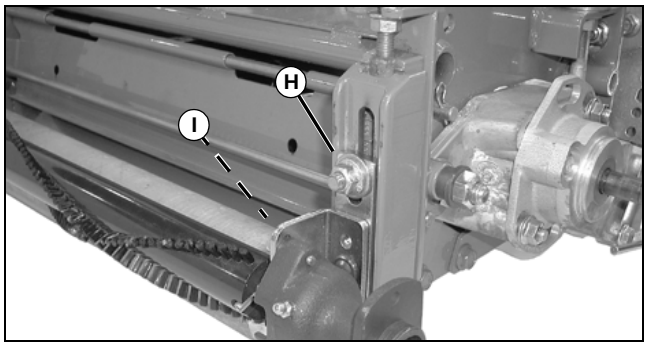
MX18317

3. Install ball bearing with flange (B) to short shaft end of brush. Do not tighten set screws at this time.
4. Loosely fasten the ball bearing with flange (B) to mount bracket (C) using two M6 x 25 bolts and two lock nuts (D).



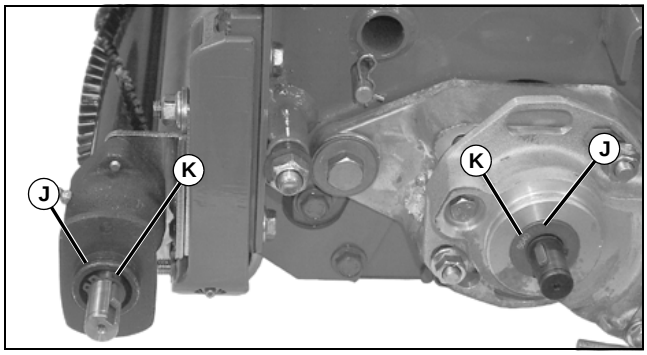
MX18316

5. Install brush drive housing (E) on long end of brush. Do not tighten set screws at this time.
6. Loosely fasten the brush drive housing (E) to mount bracket (F) using two M6 x 25 flange bolts (G).



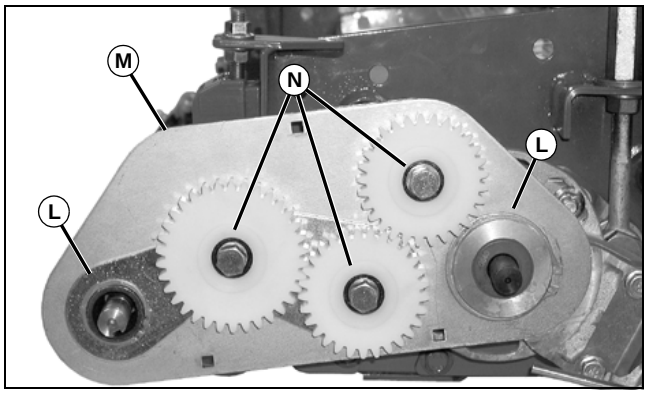
MX18315

7. Install brush assembly to cutting unit.
8. Install nut and washer (H) on bracket on both sides of cutting unit.
9. Adjust the brush to the roller with a clearance of 0-1 mm (0-0.031 in.) by raising or lowering brush and tighten cap screws and nuts (I) on both sides of cutting unit.
10. Position the brush between the housings so that the short end of the shaft is flush with the cast bearing. Apply thread locking compound and tighten the set screws in both bearings.



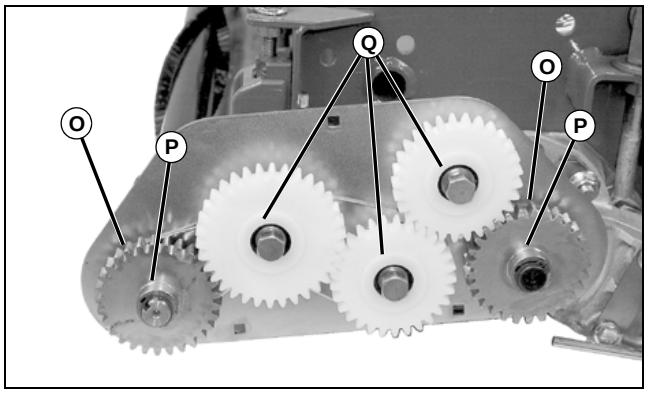
MX18313

11. Install snap rings (J) and keys (K) on shafts.



MX18314

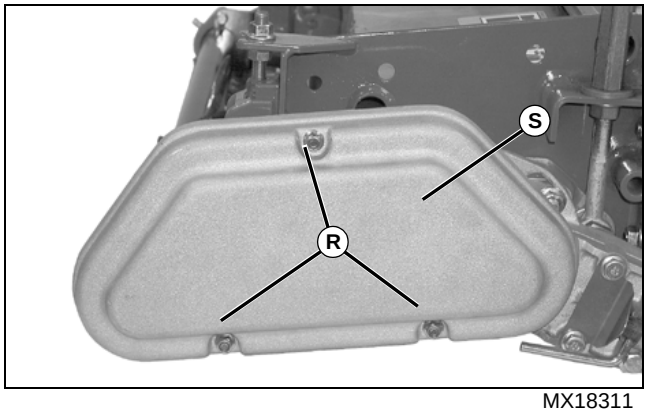
12. Loosen gear shaft bolts (N) before installing plate.
13. Install gear plate (M) and snap rings (L).



MX18312

14.Install gears (O) and snap rings (P).

15.Tighten gear shaft bolts (Q).

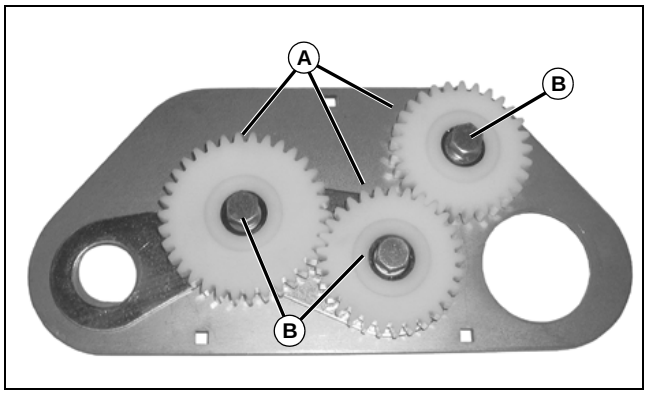


MX18311

16.Install gasket and cover (S).

17.Install three carriage bolts and lock nuts (R).

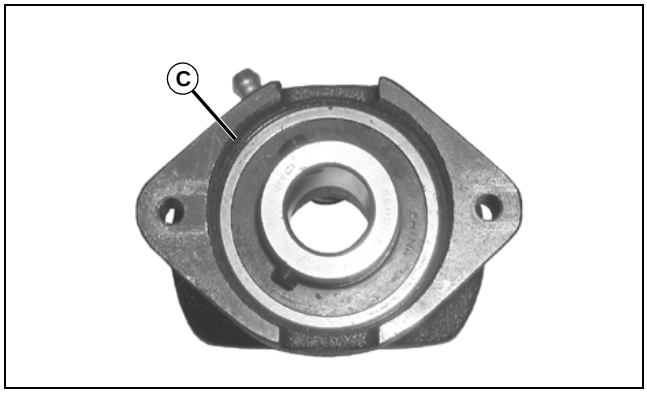
Disassemble and Inspect Power Brush - 22-In. Heavy Duty



MX18319

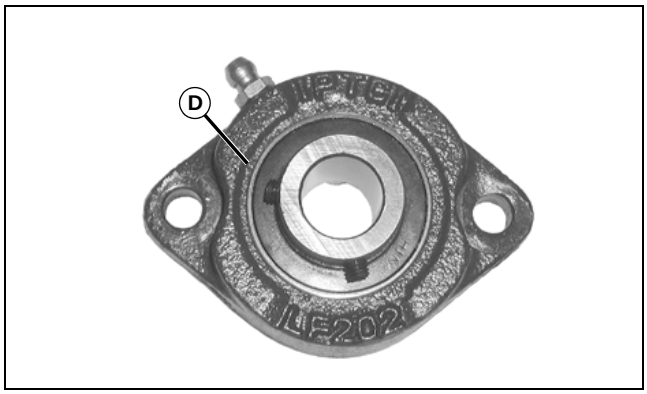
1. Inspect gears (A) for signs of wear or damage. Replace if needed.

2. Inspect bearings (B) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



MX18321

3. Inspect bearing (C) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



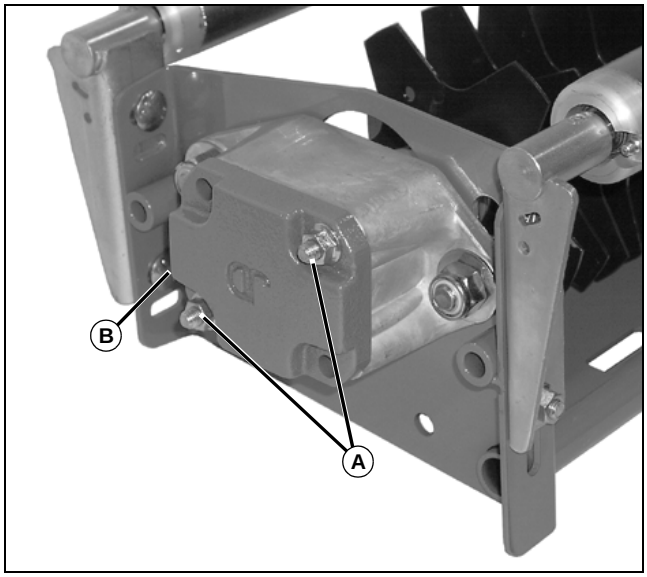
MX18322

4. Inspect bearings (D) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

Remove Reel Assembly - Vertical Cutting Unit (22-In. Heavy Duty)

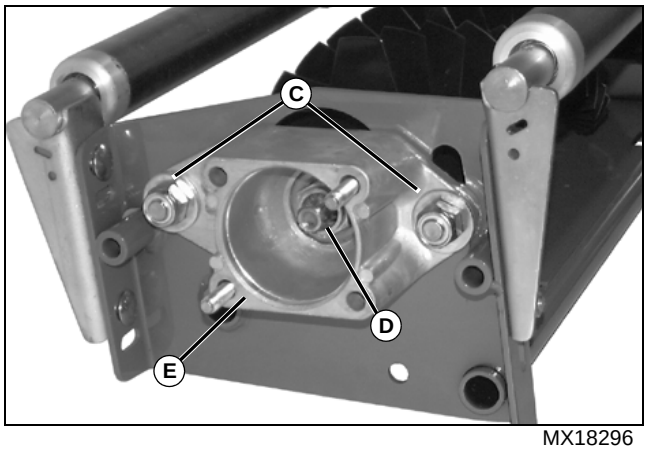
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



MX18301

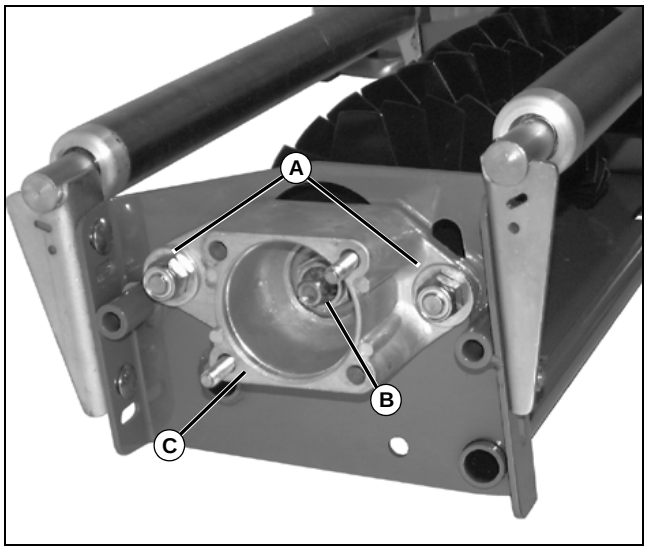
3. Loosen flange nuts (A).
4. Remove weight (B).



MX18296

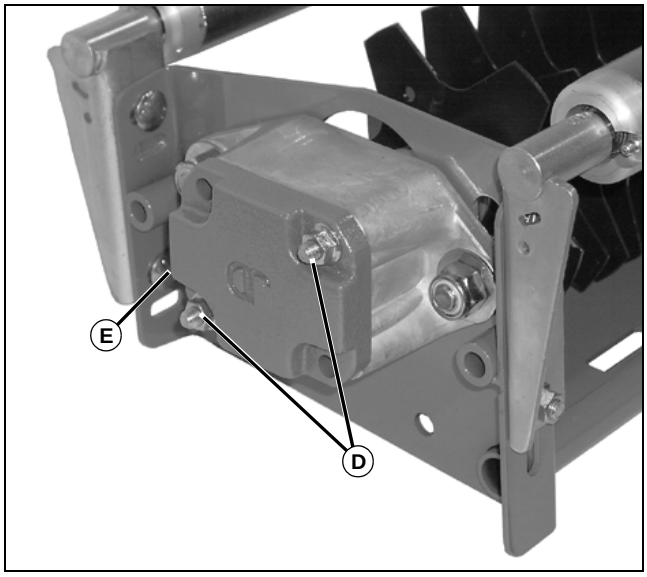
5. Remove nut (D), two nuts and cap screws (C) and pivot arm (E) from both sides of cutting unit.
6. Remove reel assembly.

Install Reel Assembly - Vertical Cutting Unit (22-In. Heavy Duty)



MX18296

1. Place cutting unit into housing.
2. Install pivot arm assembly (C), nut (B) and cap screws and nuts (C) on each side of cutting unit. (See “Assemble Pivot Arm - 22-In. Heavy Duty” on page 446.)
3. Grease both pivot arms with proper grease. (See “Grease - North America” on page 23.)(See “Grease - Europe” on page 24.)

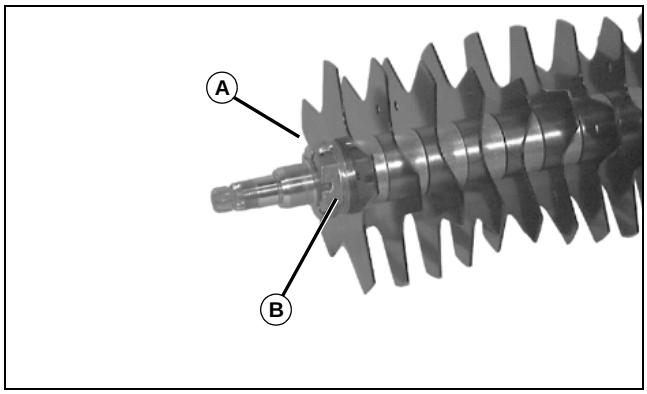


MX18301

4. Install weight (E).
5. Tighten flange nuts (D).
6. See “Adjust Depth-of-Cut - Vertical Cutting Unit (22-In. Heavy Duty)” on page 428.

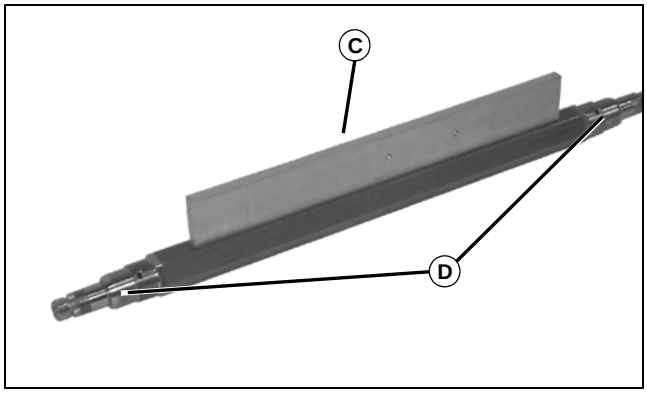
Disassemble and Inspect Reel Assembly - Vertical Cutting Unit (22-In. Heavy Duty)

CAUTION: Avoid injury! Always wear gloves when handling reel or cutting blades. Serious personal injury can result from contact with sharp cutting edges.



MX18299

1. Remove cotter pin and nut (A), washers (B) and cutting blades and spacers from reel shaft.



MX18298

2. Using a straightedge (C), check several sides of hex shaft for straightness. Shaft runout should not exceed 0.50 mm (0.020 in.).

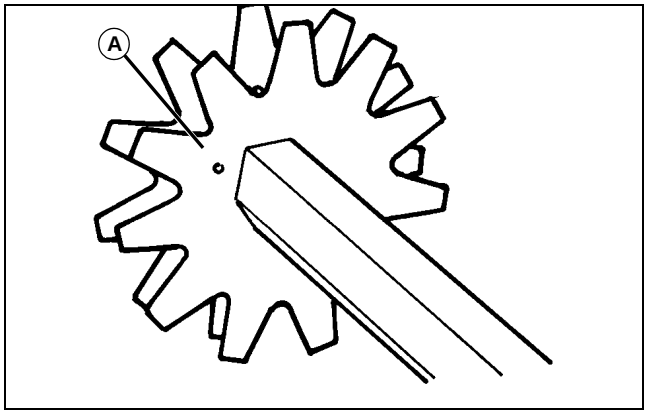
3. Inspect machined surfaces (D) of shaft for wear or damage. Replace shaft if needed.

Assemble Reel - Vertical Cutting Unit (22-In. Heavy Duty)

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.

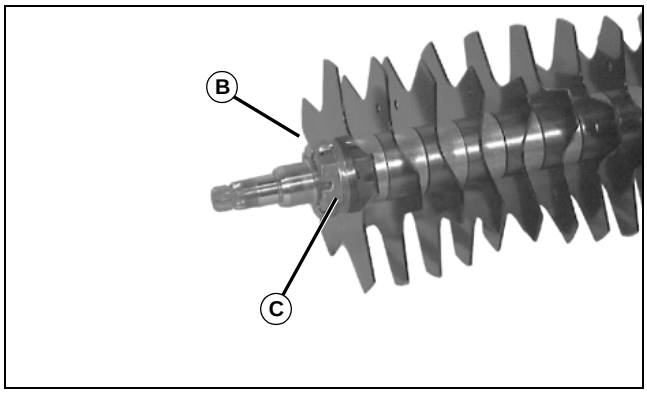
1. Install nut and cotter pin and washers on one end.

NOTE: Fewer spacers and more blades can be used if desired.



M46882

2. Assemble blades and spacers starting with a blade against the washers. Ensure that the index hole (A) of the next blade is placed on the next flat counterclockwise on the shaft as shown. This will establish the proper helix pattern.

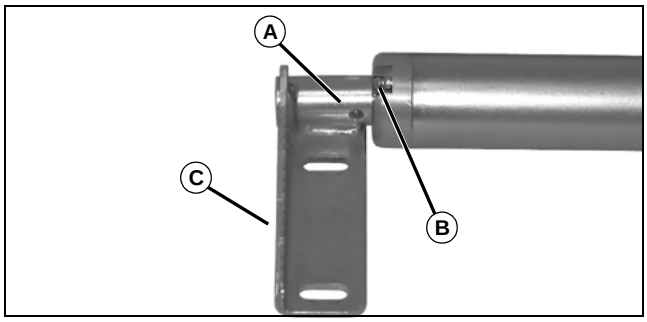


MX18299

3. After the last cutting blade is installed, install washers (C) and nut (B). Tighten nut until a slight deflection of cutting blade on opposite side of shaft is observed, then tighten nut until cotter pin can be installed.

Replace Roller Bearing - Vertical Cutting Unit (22-In. Heavy Duty)

NOTE: This procedure applies to both smooth and grooved rollers.



MX18324

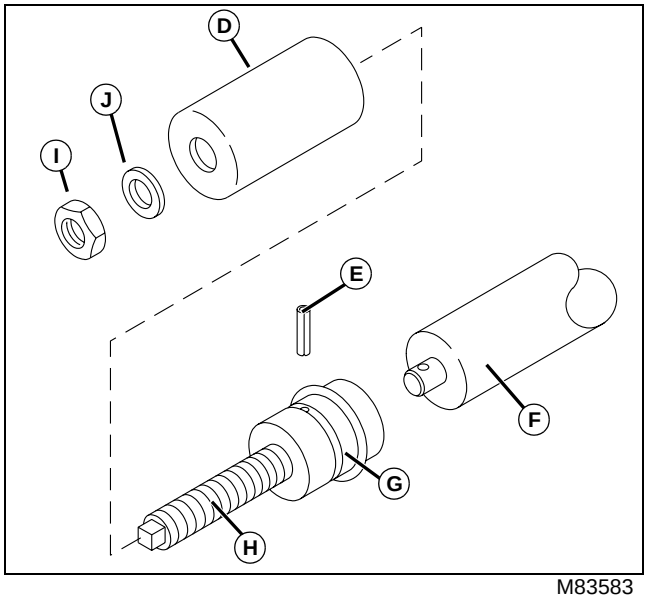
Picture Note: Smooth Roller Shown

1. Remove spring pin (A).

NOTE: It may be necessary to press the bearing shaft from the bracket.

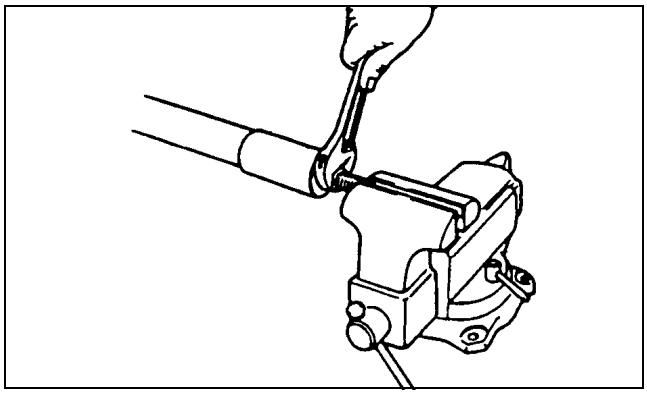
2. Remove bracket (C) from bearing shaft.
3. Remove grease fitting (B) (smooth rollers only).

CAUTION: Avoid injury! Wear approved eye protection when using JDG795 Roller Bearing Puller.



M83583

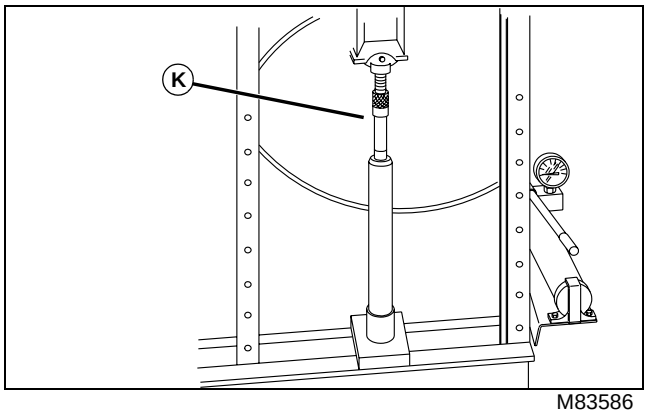
4. Attach threaded puller (H) to the bearing by inserting the pin (E) through the hole in the bearing shaft and puller. Slide the O-ring (G) over the pin to keep it in position.
5. Slide roller sleeve (D) over the threaded puller with the concave end of the roller sleeve against the end of the roller (F). Install flat washer (J) and nut (I) on threaded puller.



M83584

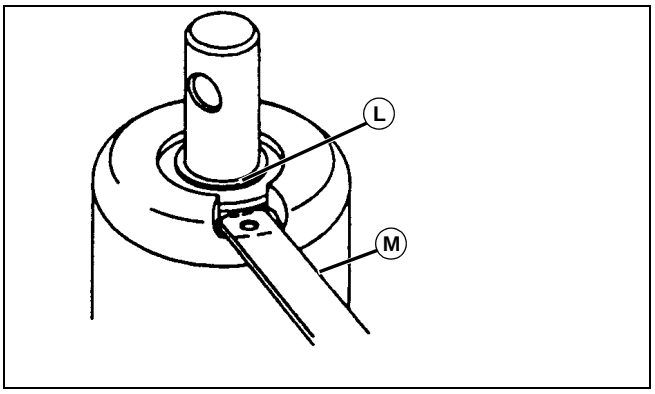
6. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn nut counterclockwise until the bearing is removed from the roller.

IMPORTANT: Avoid damage! DO NOT press on center shaft of bearing when installing bearing. Bearings will set and become tight. Bearings must only be installed by pressing on the outisde of bearing race.



M83586

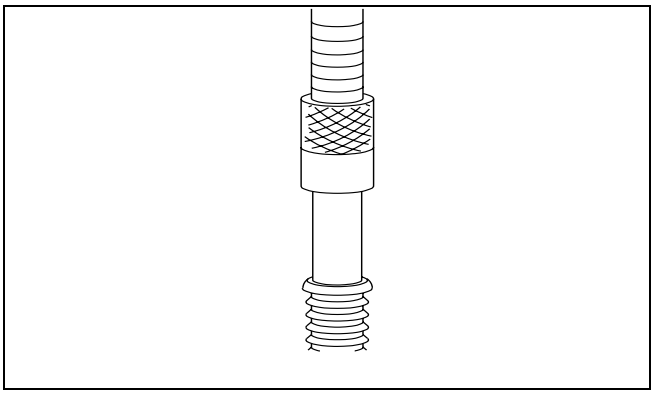
7. Position roller in a press using the roller sleeve to hold the roller while installing the bearing in the other end.
8. Position JD243 or JD506 Bearing Installer (K) over the new bearing in the top end of the roller.



M83585

9. Smooth Rollers: Place a 0.89 mm (0.035 in.) feeler gauge (M) in the slot where the grease fitting was located. Press the bearing into the roller until the top of the outside bearing race (L) is flush with the top of the feeler gauge.

10.Install the grease fitting.



M83587

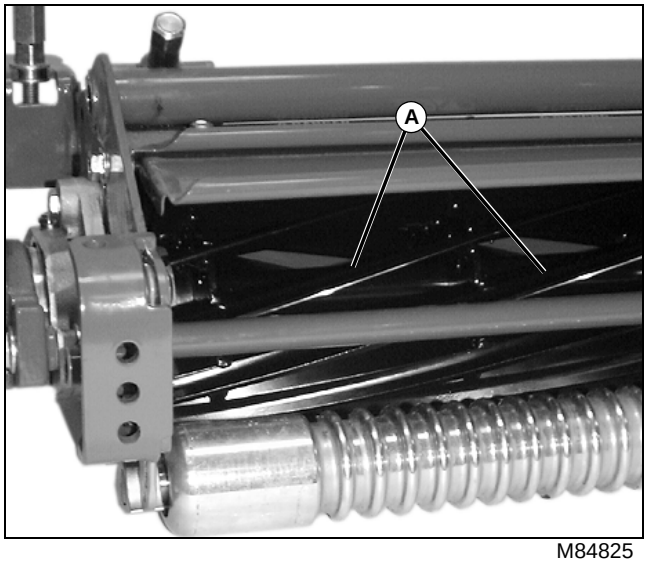
11.Grooved Rollers: Press bearing into roller until the top of the outside bearing is flush with the end of the roller.

Inspect Reel and Bed Knife - 2500M

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.

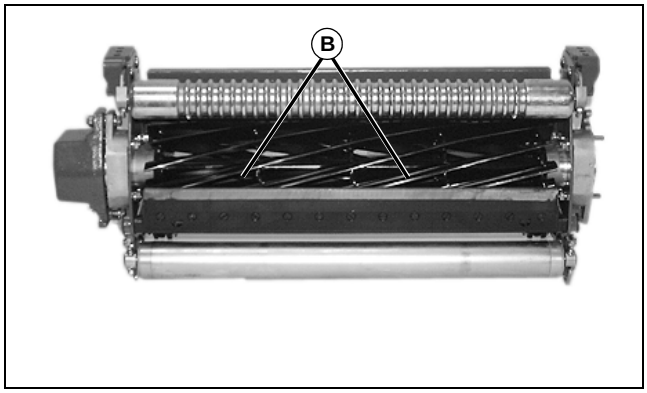
1. Visually inspect cutting unit for damage. Chipped paint, dents or gouges may indicate the need for a closer look at the frame for distortion, broken weldments or other damage that could prevent proper adjustment. Repair or replace parts as necessary.

2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.



M84825

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. See “Reel and Bed Knife Grinding” on page 416 to restore the relief angle and cutting edge before continuing with this procedure.



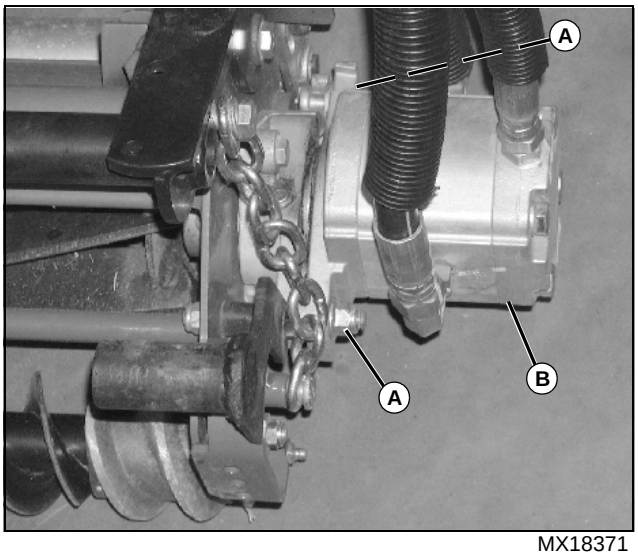
M84823

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.

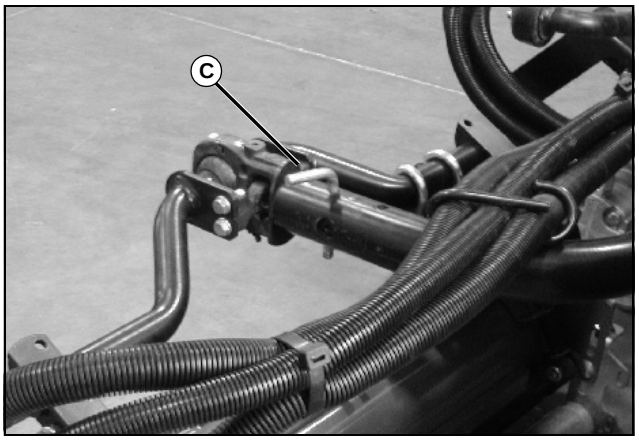
Remove and Install Cutting Unit - 2500M

1. Park machine on a level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Engage park brake.



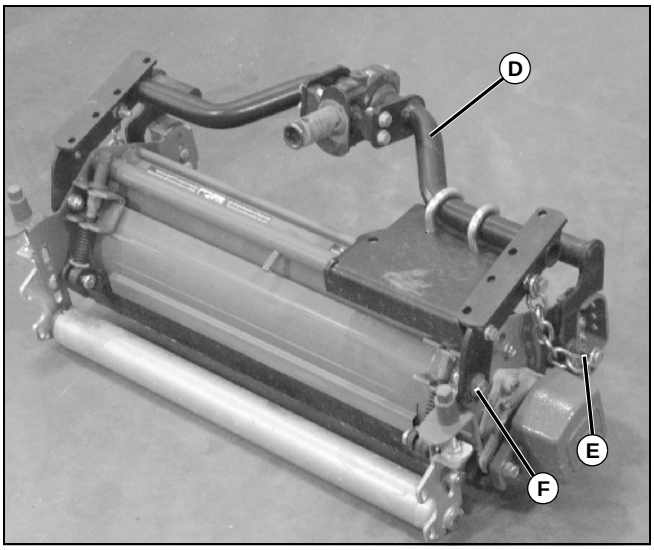
MX18371

5. Loosen reel motor mounting cap screws (A).
6. Remove the reel motor (B).



M84610

7. Remove retaining pin (C) and remove cutting unit from machine.



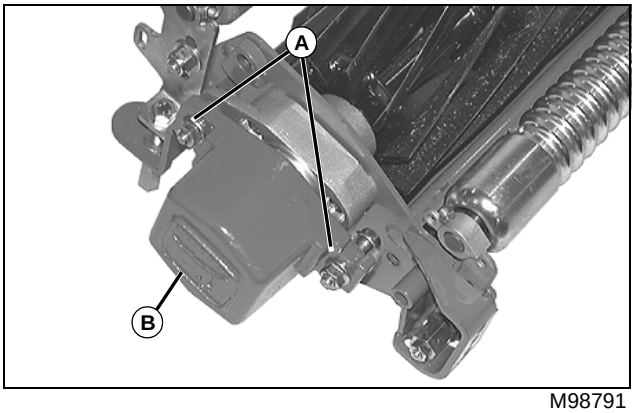
M84822

8. If cutting unit is to be repaired, remove ring and pin (E) and cap screw and nut (F) from both sides of cutting unit.
9. Remove yoke (D).

Installation is done in reverse order of removal.

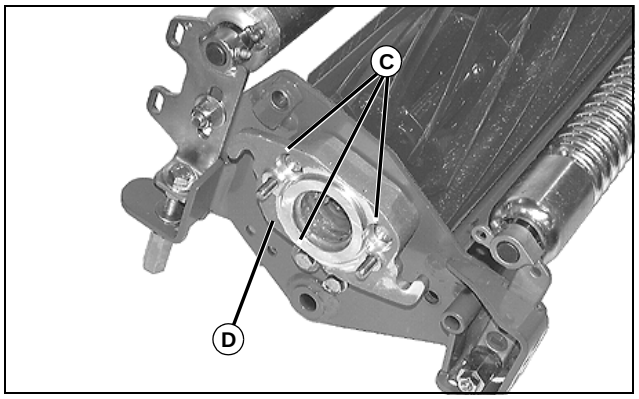
Remove Reel - 2500M

1. Remove cutting units from mower.
2. Remove fairway tender conditioner (if equipped). (See “Remove Fairway Tender Conditioner - 2500M” on page 469.)
3. Remove bed knife. (See “Remove Bed Knife - 2500M” on page 464.)
4. Place cutting unit upside-down on a stable working surface (rollers facing up).



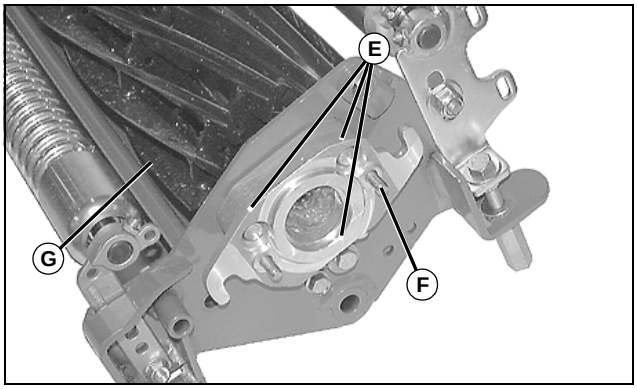
M98791

5. Loosen flange nuts (A).
6. Remove weight assembly (B).



M98798

7. Remove three cap screws and flange nuts (C).
8. Remove bearing housing (D).

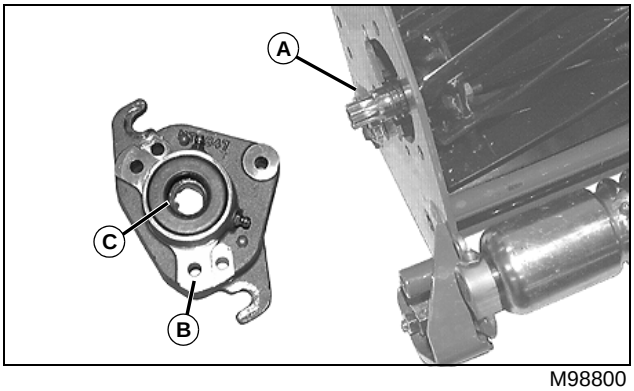


M98799

9. Remove three cap screws and nuts (E).
10. Remove bearing housing (F).
11. Remove reel (G).

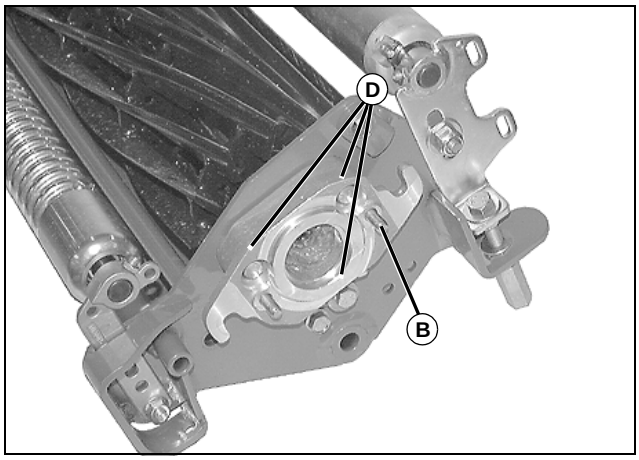
Install Reel - 2500M

1. Install reel assembly in housing with the shaft end with the keyway on the left side of the frame.



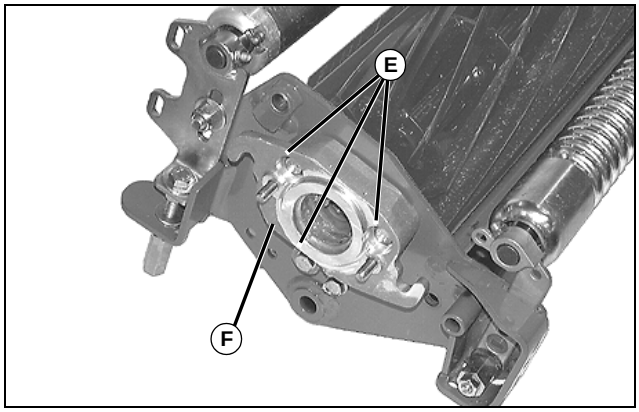
M98800

2. Align the tab (C) on the keyed washer with the keyway (A) on the reel shaft.
3. Install the bearing housing (B).



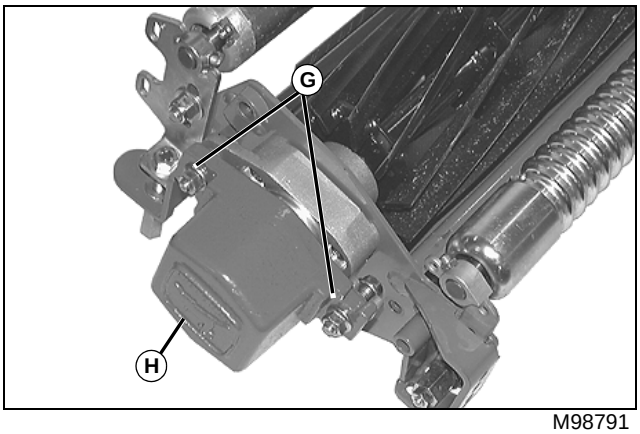
M98799

4. Install three cap screws and nuts (D) retaining bearing housing (B).



M98798

5. Install bearing housing (F).
6. Install three cap screws and nuts (E).

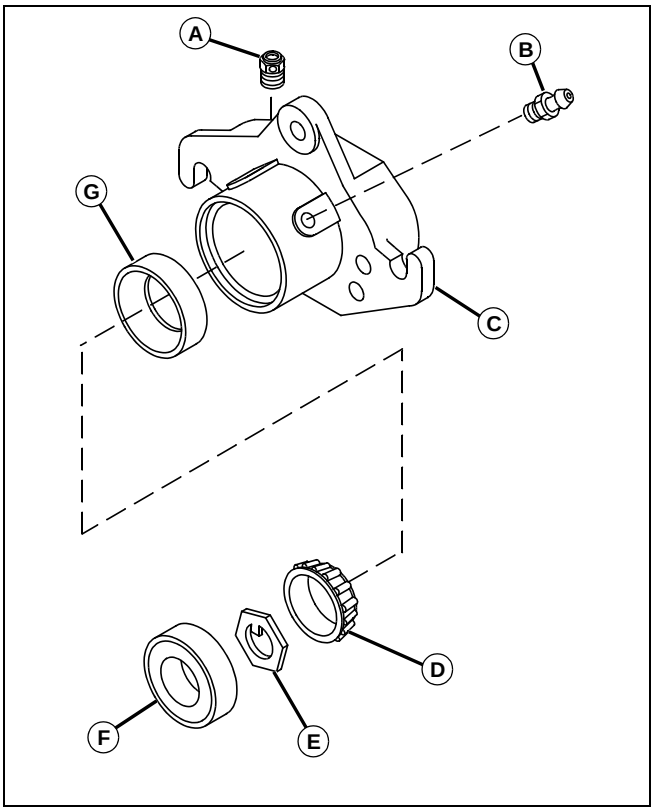


M98791

7. Install weight assembly (H) with flange nuts (G).
8. Adjust bed knife-to-reel clearance. (See “Adjust Reel-to-Bed Knife - 2500M” on page 429.)

Disassemble and Inspect Bearing Housing - 2500M

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Remove seal (F), keyed washer (E) (left side only), tapered roller bearing (D), bearing cup (G), breather (A) and grease fitting (B) from each housing (C).

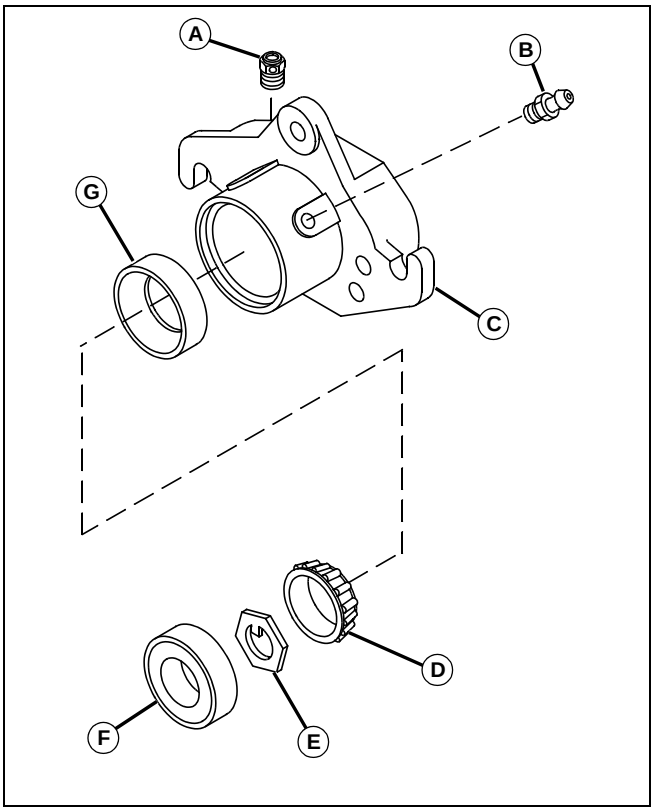
2. Clean bearings and housing with solvent.

IMPORTANT: Avoid damage! Always replace bearings and bearing cups as a set.

3. Inspect bearings and bearing cups for scoring, pitting or bluing from overheating. Replace as needed.

Assemble Bearing Housing - 2500M

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Install bearing cups (G) into housing (C) using a suitable driver or a press (tapered end facing the outside of the housing).

2. Pack tapered roller bearings (D) with John Deere special purpose golf and turf cutting unit grease and position in the bearing cups.

3. Install keyed washer (E) (left side only).

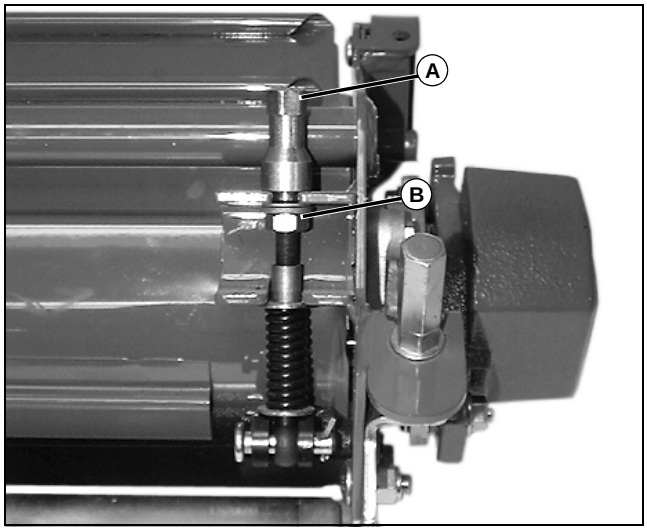
4. Install seal (F) flush with the face of the housing. Apply John Deere special purpose golf and turf cutting unit grease to the seal lips.

5. Install breather (A) and grease fitting (B).

Remove Bed Knife - 2500M

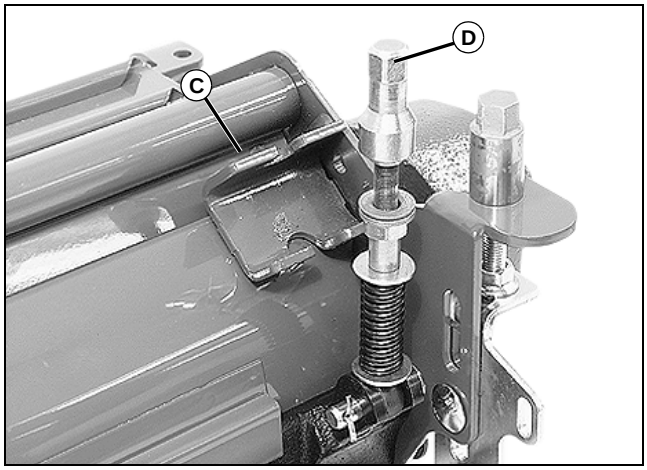
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower.
2. Place cutting unit on a stable working surface.



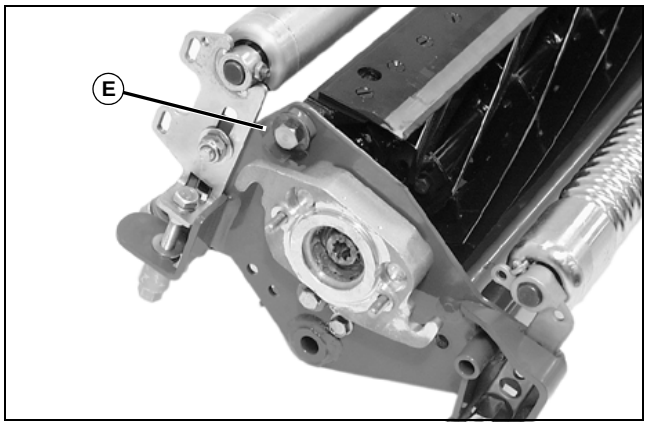
M84843

3. Rotate jam nut ((B) on each adjuster assembly counterclockwise until springs are completely compressed.
4. Loosen each adjuster (A).



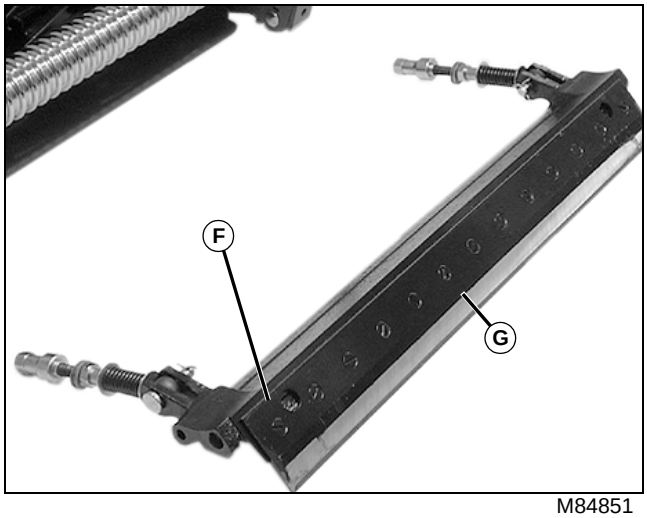
M84853

5. Rotate both adjuster assemblies (D) away from reel housing brackets (C).



M84852

6. Turn the cutting unit over (bed knife facing up).
7. Remove shoulder bolt (E) from both sides of cutting unit.



M84851

8. Slide bed knife (G) out of the cutting unit housing.
9. Remove debris and corrosion from bottom surface of bed knife support.

IMPORTANT: Avoid damage! DO NOT reuse bed knife screws if bed knife is removed.

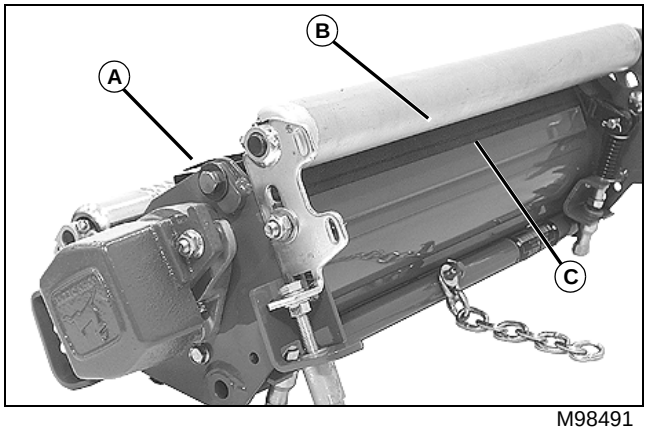
10. Remove and discard thirteen bed knife mounting screws (F).
11. Remove and discard bed knife.
12. Install bed knife using new screws. Starting at the center screw, alternately tighten the bed knife screws working toward both ends of the bed knife. Tighten screws to specifications.
13. Place shoe/bed knife in a suitable grinder. Grind until nicks are removed from the entire top surface of the bed knife lip. (See “Reel and Bed Knife Grinding” on page 416.)

Specifications

Bed Knife Mounting Screw Torque . . . 7 N•m (62 lb-in.)

Install Bed Knife - 2500M

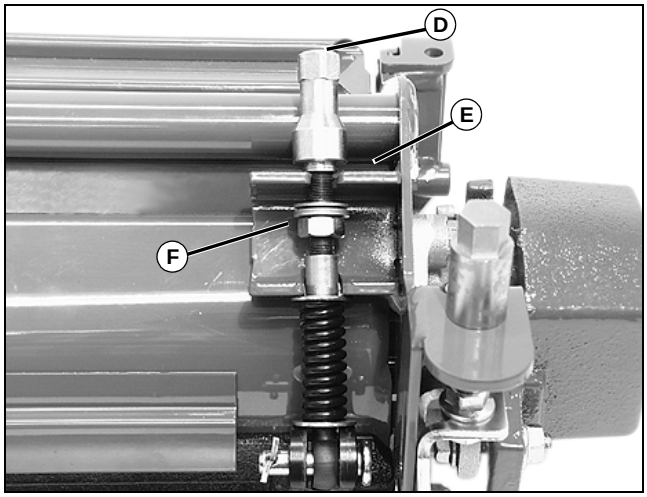
1. Place cutting unit on a stable working surface with the bottom of the cutting unit facing up.



M98491

2. Slide bed knife/shoe assembly (B) into position inside locator shoe (C).

3. Install both shoulder bolts (A) and tighten to specification.



M84854

4. Turn the cutting unit over.

5. Install adjuster assembly (D) in housing bracket (E) on both sides of cutting unit.

6. Turn adjuster jam nut (F) on each adjuster assembly clockwise until the jam nut is midway up the exposed threads.

7. Adjust bed knife-to-reel clearance. (See “Adjust Reel-to-Bed Knife - 2500M” on page 429.)

8. Adjust cutting height. (See “Adjust Height-of-Cut (HOC) - 2500M” on page 434.)

9. Backlap reel. (See Backlapping Procedure.)

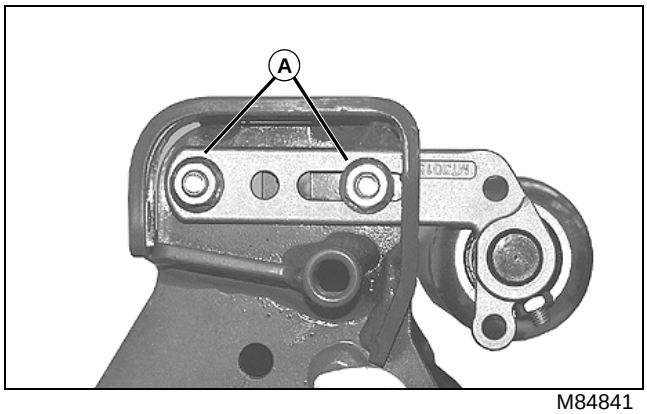
Specifications

Shoulder Bolt Torque . . . . . 5 N•m (40 lb-ft)

Remove and Install Front Roller - 2500M

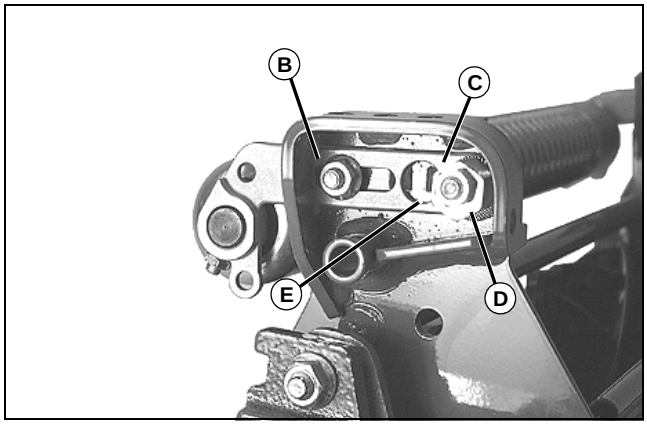
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M84841

3. Remove two flanged nuts and carriage bolts (A).



M84828

4. Remove lower flanged nut and carriage bolt (B).

5. Remove eccentric lock nut (C), eccentric adjuster (E), serrated washer (D) and carriage bolt.

6. Remove roller and bracket assembly.

Installation is done in the reverse order of removal.

NOTE: Roller brackets are offset. For standard use, the bracket should be installed on the roller with the offset to the rear of the cutting unit.

If Fairway Tender Conditioner (FTC) is installed, the bracket should be installed on the roller with the offset to the front of the cutting unit.

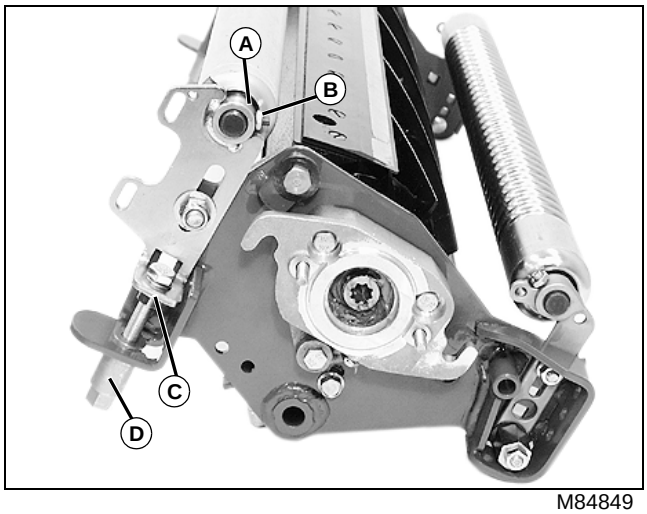
Install roller bracket with the larger holes and adjustment slot on the left side of the cutting unit, in the direction of travel.

•Adjust roller height. (See “Adjust Front Roller - 2500M” on page 432.)

Remove Rear Roller - 2500M

1. Remove cutting units from mower.

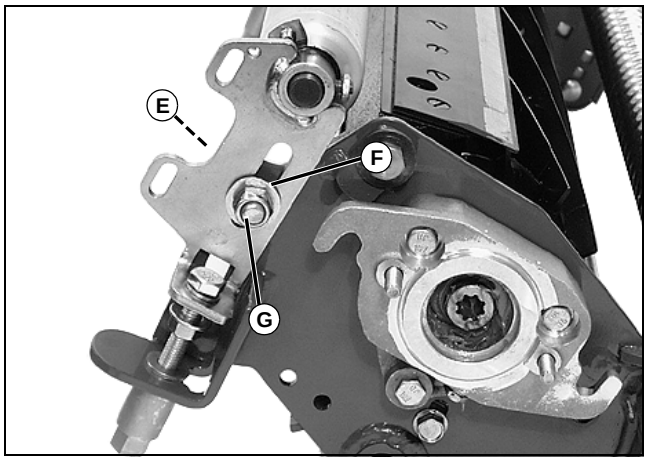
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



M84849

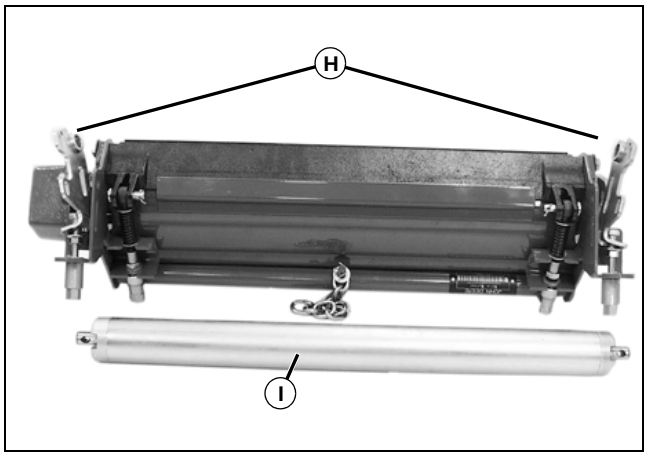
3. Loosen jam nut (A) and set screw (B) on both sides of cutting unit.

4. Loosen jam nut (C) on adjuster tower (D) from both sides of cutting unit.



M98490

5. Remove carriage bolt (E), flat washer (F) and lock nut (G) from both sides of cutting unit.

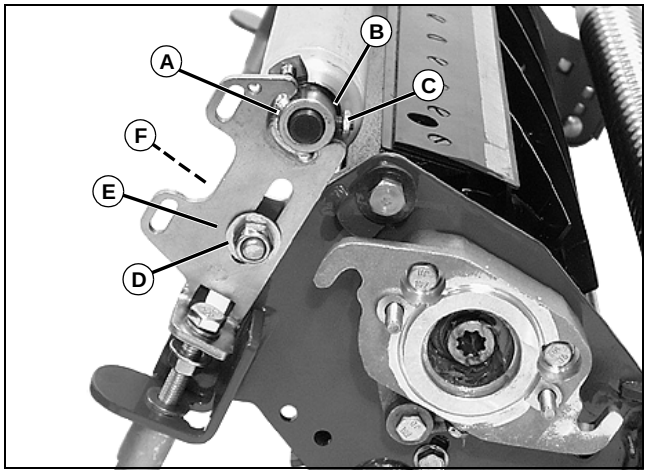


M84850

6. Move height-of-cut brackets (H) away from bearing spindle shaft ends.

7. Remove rear roller (I).

Install Rear Roller - 2500M



M98490

NOTE: DO NOT tighten roller shaft set screws and jam nuts at this time.

1. Install roller bearing spindle shaft (A) into height-of-cut bracket on both sides of cutting unit.

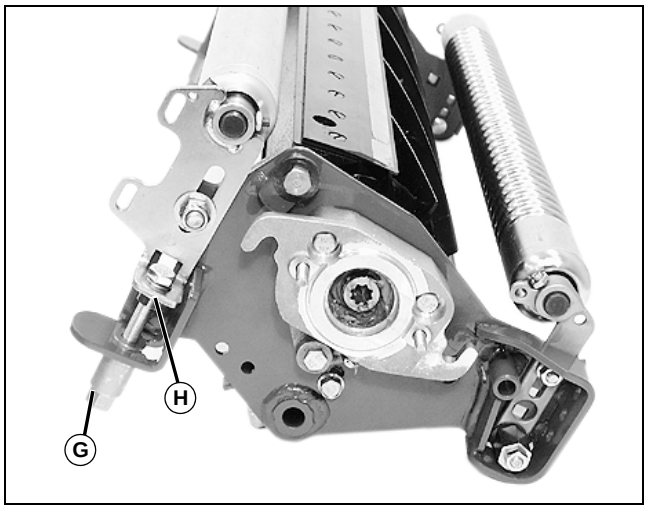
NOTE: Install carriage bolts with the flat washer and nut on the outside of the cutting unit.

2. Attach height-of-cut brackets to cutting unit frame using carriage bolt (F), flat washer (E) and lock nut (D) on both sides of cutting unit.

NOTE: DO NOT install set screws into holes in roller spindle shafts.

3. Center rear roller between height-of-cut brackets.

4. Tighten set screws (C) and jam nuts (B) on both sides of cutting unit.



M84849

5. Loosen bracket lock nuts approximately 1/4 turn (on both sides of cutting unit.

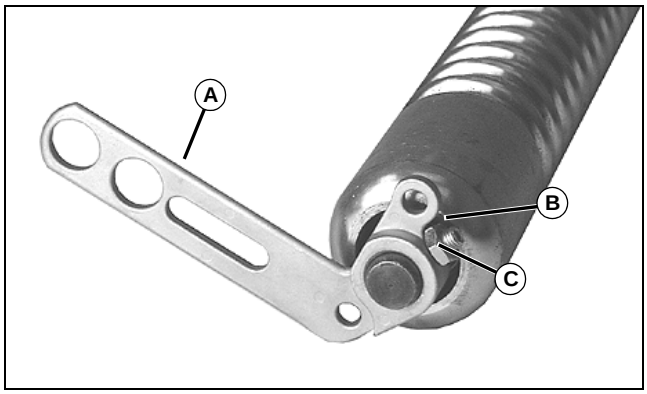
6. Tighten jam nut (H) on adjuster tower (G) on both sides of cutting unit.

7. Tighten bracket lock nuts (both sides of cutting unit).

8. Adjust height-of-cut. (See “Adjust Height-of-Cut (HOC) - 2500M” on page 434.)

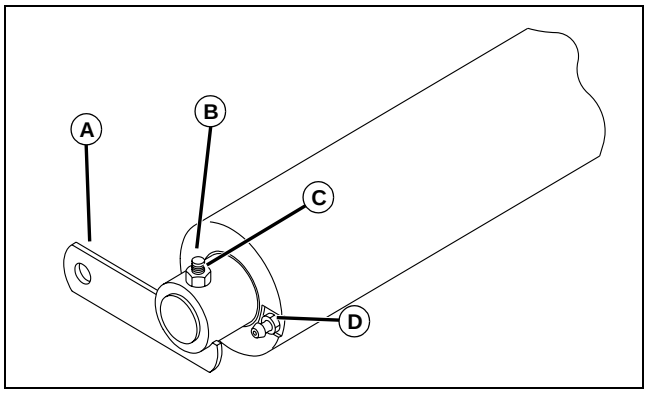
Disassemble and Assembly Roller - 2500M

NOTE: This procedure applies to both smooth and grooved rollers.



M84840

Picture Note: Grooved Roller Shown



M83582

Picture Note: Smooth Roller

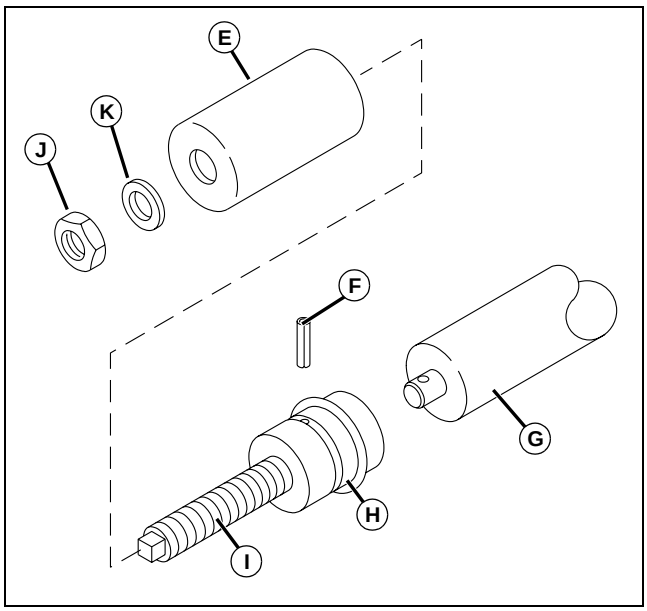
1. Loosen jam nut (C) and remove set screw (B).

NOTE: It may be necessary to press the bearing shaft from the bracket.

2. Remove brackets (A) from bearing shafts.

3. Remove grease fitting (D) (smooth rollers only).

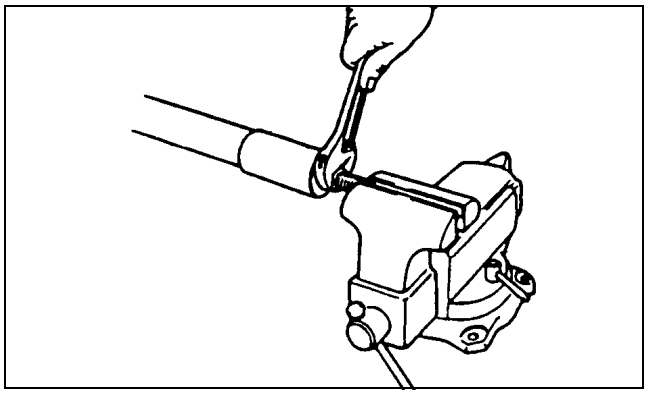
CAUTION: Avoid injury! Wear approved eye protection when using JDG795 Roller Bearing Puller.



M83583

4. Attach threaded puller (I) to the bearing by inserting the pin (F) through the hole in the bearing shaft and puller. Slide the O-ring (H) over the pin to keep it in position.

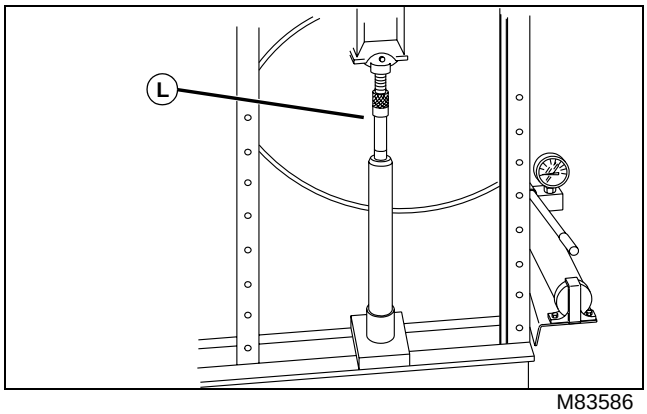
5. Slide roller sleeve (E) over the threaded puller with the concave end of the roller sleeve against the end of the roller (G). Install flat washer (K) and nut (J) on threaded puller.



M83584

6. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn nut counterclockwise until the bearing is removed from the roller.

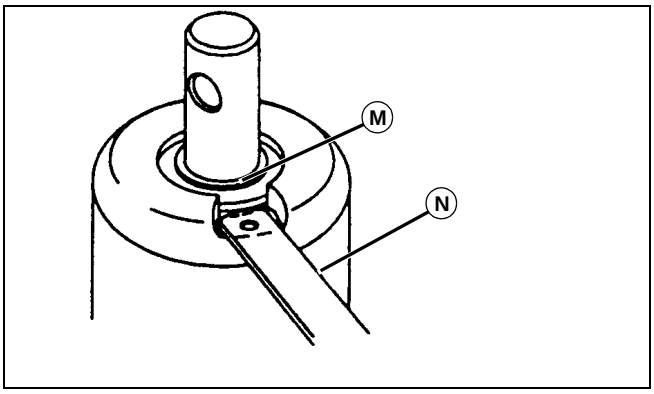
IMPORTANT: Avoid damage! DO NOT press on center shaft of bearing when installing bearing. Bearings will set and become tight. Bearings must only be installed by pressing on the outside of the bearing race.



M83586

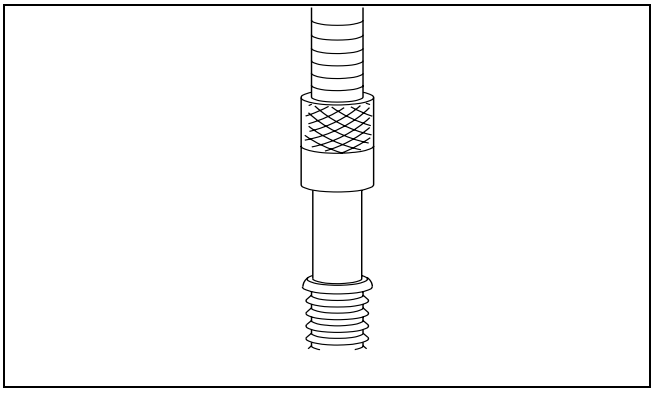
7. Position roller in a press using the roller sleeve to hold the roller while installing the bearing in the other end.

8. Position JD243 or JD506 Bearing Installer (L) over the new bearing in the top end of the roller.



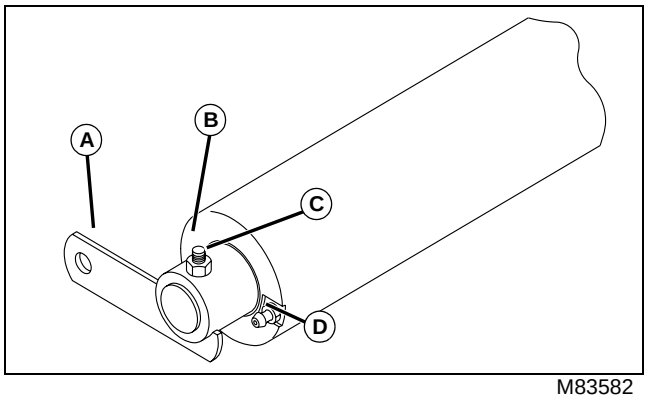
M83585

9. Smooth Rollers Only: Place an 0.89 mm (0.035 in.) feeler gauge (N) in the slot where the grease fitting was located. Press the bearing into the roller until the top of the outside bearing race (M) is flush with the top of the feeler gauge.



M83587

10.Grooved Rollers: Press bearing into roller until the top of the outside bearing is flush with the end of the roller.



M83582

Picture Note: Smooth Roller Shown

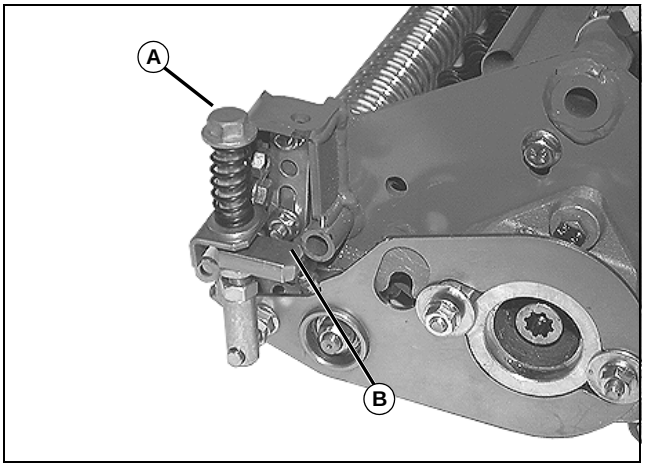
11.Install bracket (A) on both sides of roller.

12.Install set screw (B) and jam nut (C) on both sides of roller.

13.Install grease fitting (D) (smooth rollers only) on both sides of roller.

Remove Fairway Tender Conditioner - 2500M

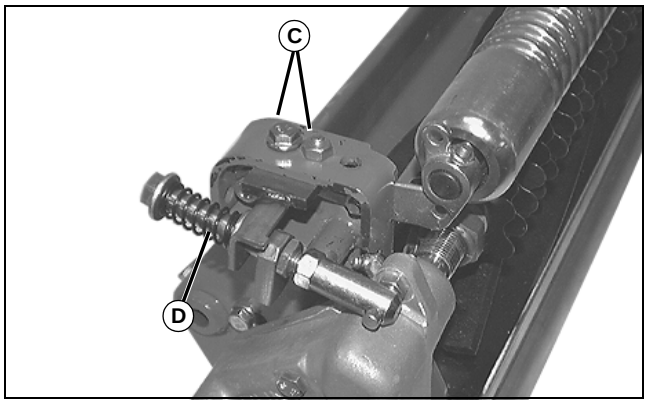
NOTE: The following procedures show FTC unit mounted on right-hand side of the cutting unit. The procedure for units mounted on the left side are the same.



M98560

Picture Note: FTC - Disengaged Position

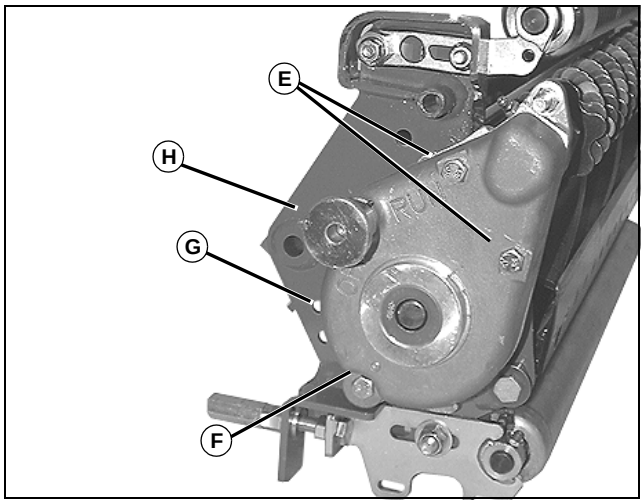
1. Press down on FTC adjuster bolt (A) and swing adjuster stop (B) toward the rear of the cutting unit (disengaged position). Repeat on other end of cutting unit.



M98565

2. Remove cap screws and nuts (C) from both sides of cutting unit.

3. Remove adjustment bracket assembly (D) from both sides of cutting unit.



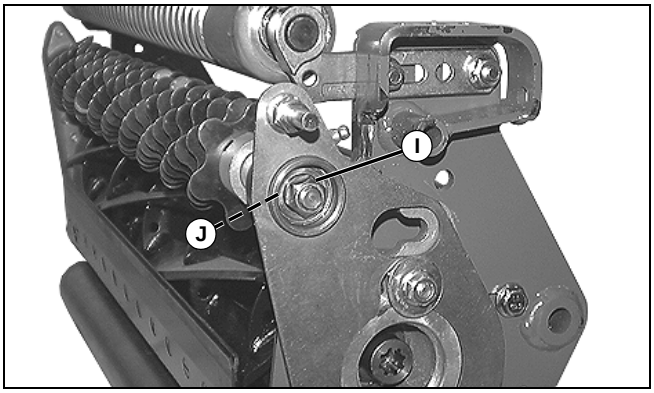
M98562

4. Move knob (H) to OFF position.

5. Remove two M8 x 50 hex-flange bolts (E) and one M8 x 30 hex bolt (F).

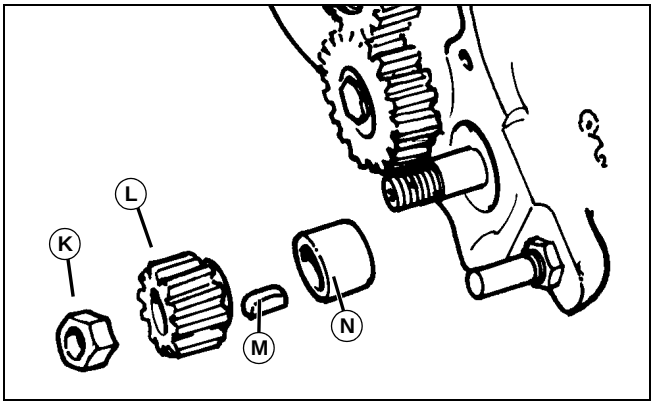
6. Remove FTC cover (G) and gasket.

NOTE: Hold gears on opposite side of cutting unit while loosening nut.



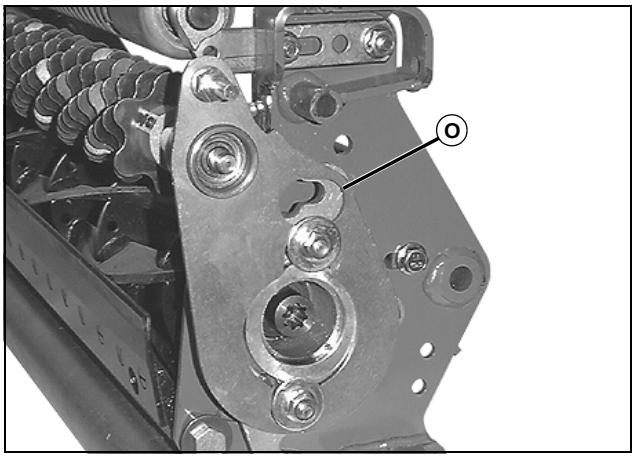
M98564

7. Remove nut (I) and spacer (J).



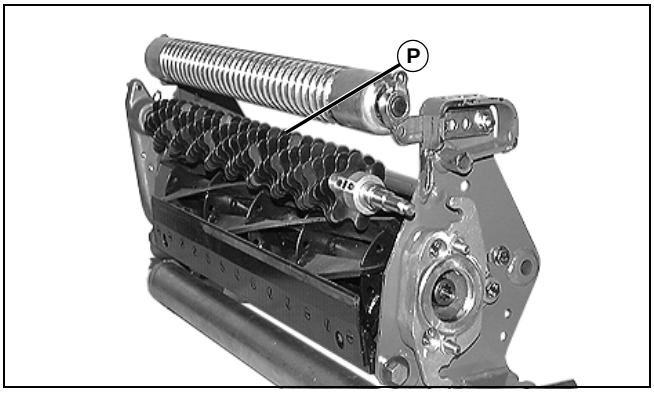
M46877

8. Remove nut (K), gear (L), key (M) and spacer (N).



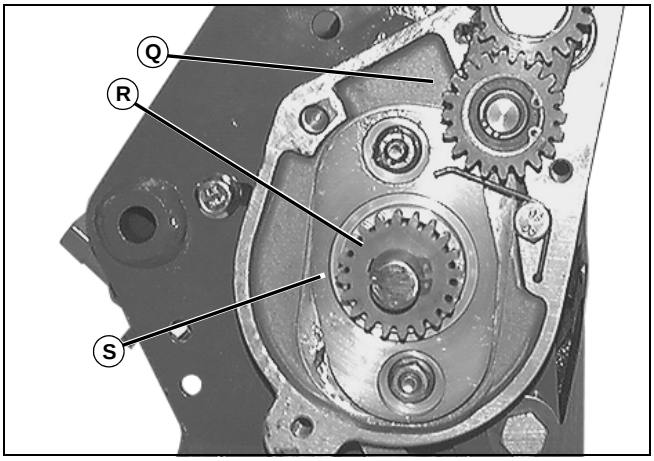
M98567

9. Remove bracket (O).



M98568

10.Remove FTC assembly (P).

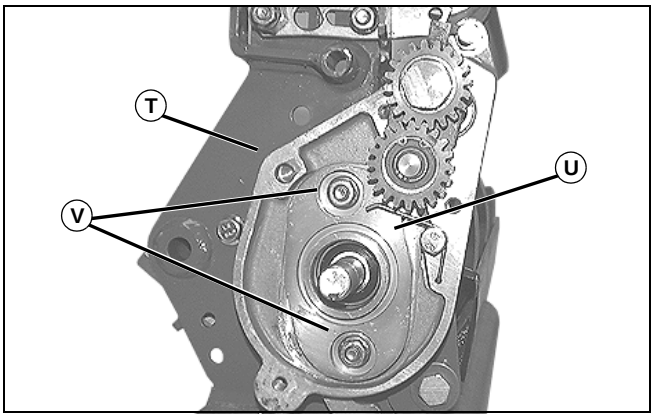


M98569

11.Swing idler gear bracket (Q) away from main drive gear.

12.Remove retaining ring (R).

13.Remove gear (S).



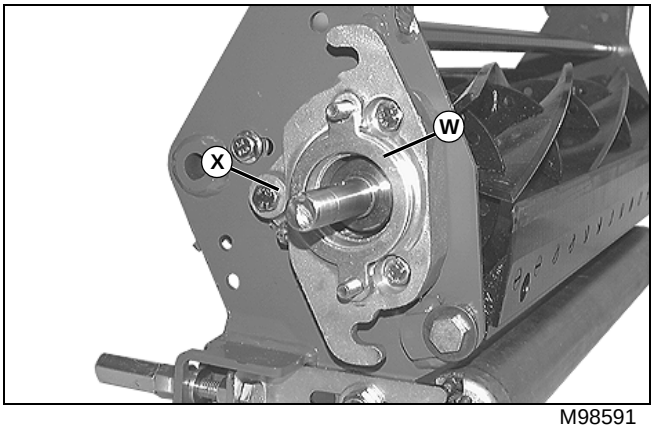
M98570

14.Remove two nuts (V).

NOTE: Spacer ring and shaft may come off with housings.

15.Remove bearing housing assembly (U).

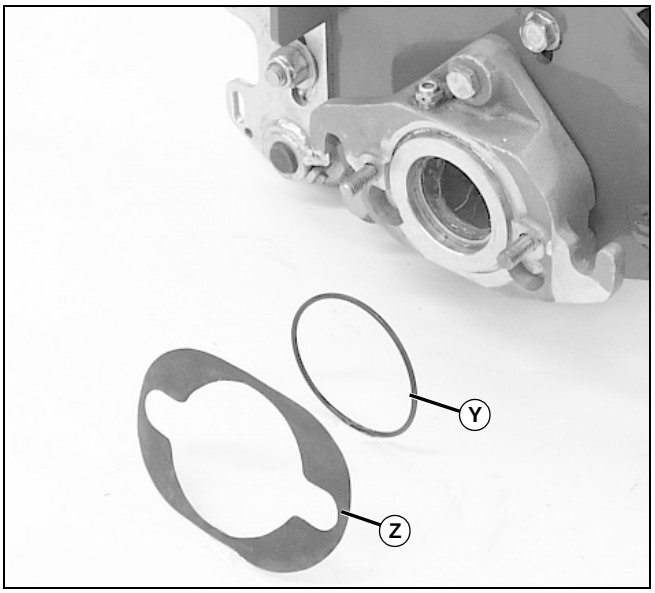
16.Remove FTC housing (T).



M98591

17.Remove spacer ring (W).

18.Remove shaft (X).

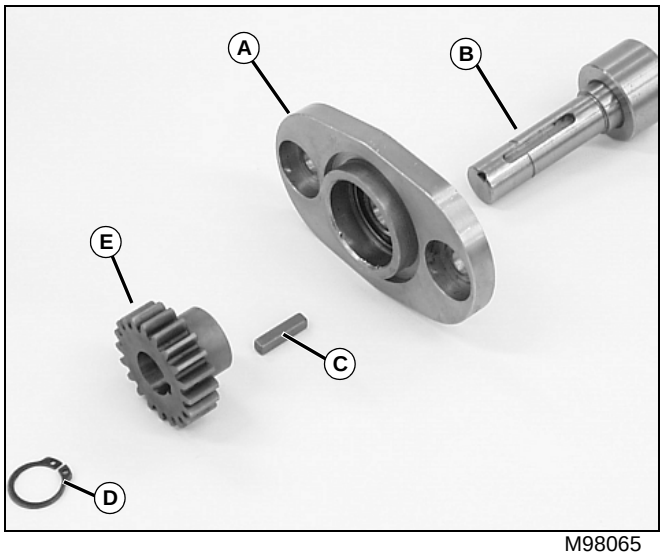


M98066

19.Remove gasket (Z) and O-ring (Y).

Install Fairway Tender Conditioner - 2500M

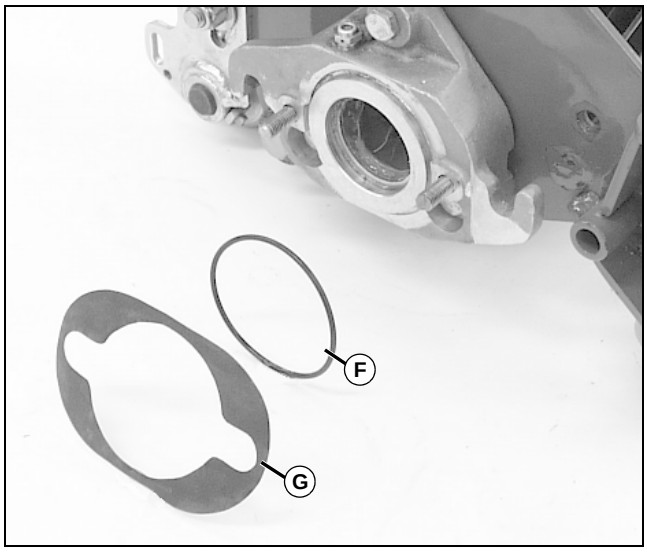
The following procedures show FTC unit mounted on right-hand side of the cutting unit. The procedure for units mounted on the left side is the same.



M98065

NOTE: If a rear roller brush kit is installed with the FTC, use the long, double key-slot drive shaft supplied with the brush kit.

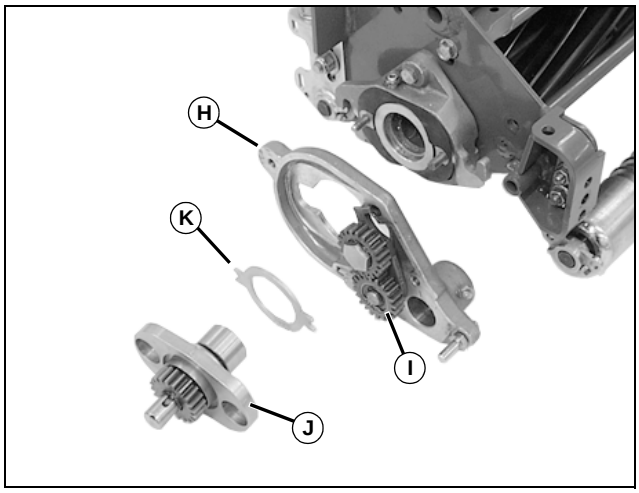
1. Install the drive shaft (B) into bearing housing (A).
2. Install square key (C) into drive shaft key slot.
3. Install main drive gear (E) on drive shaft.
4. Install snap ring (D).



M98066

5. Install O-ring (F) into groove in reel bearing housing.
6. Install gasket (G) over the bolts and O-ring.

NOTE: Slots in spacer ring must align with bolts projecting from reel bearing housing. If not assembled correctly, the FTC height cannot be adjusted.



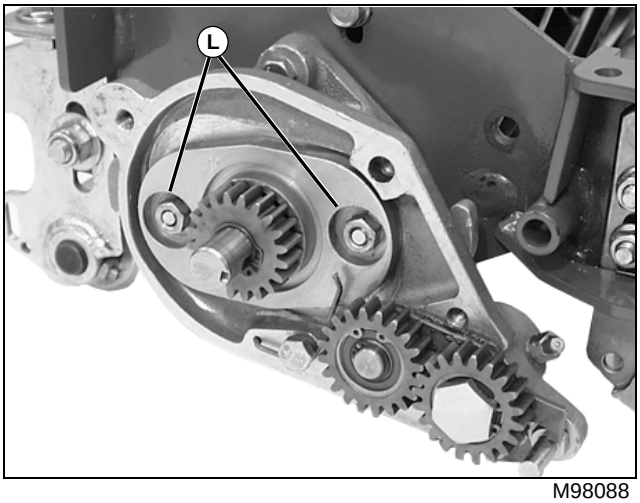
M99034

7. Position spacer ring (K) onto gear drive assembly (J).

NOTE: Apply John Deere Corn Head Grease to the drive shaft end before installing the shaft onto the reel drive housing. (See Specifications and Information section.)

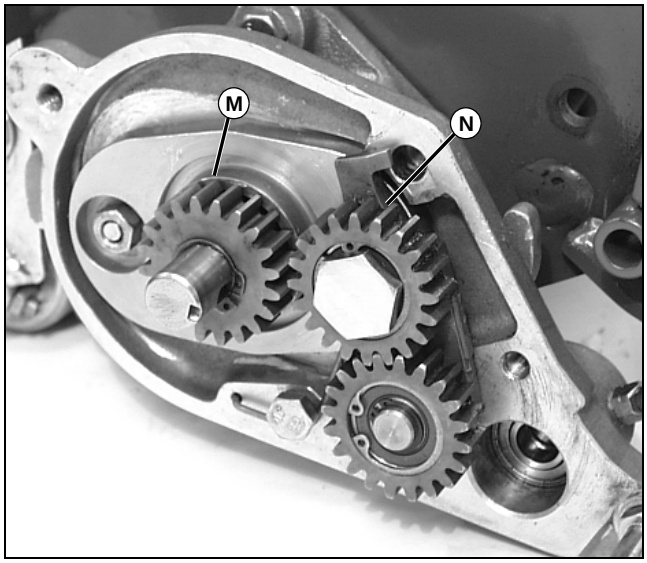
8. Rotate the idler gear bracket (I) away from the opening to gain clearance for installing the gear drive assembly (H).
9. Install drive gear assembly with spacer ring into gear case assembly.

NOTE: Make sure that the torsion spring is positioned in front of the gear drive assembly bearing end cap.



M98088

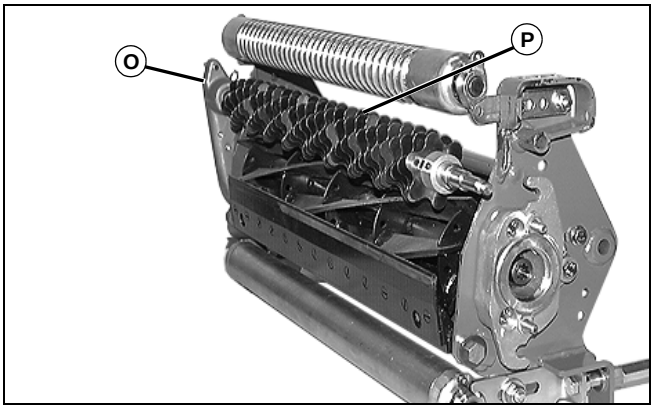
10.Secure the drive gear assembly using two hex lock nuts (L).



M98089

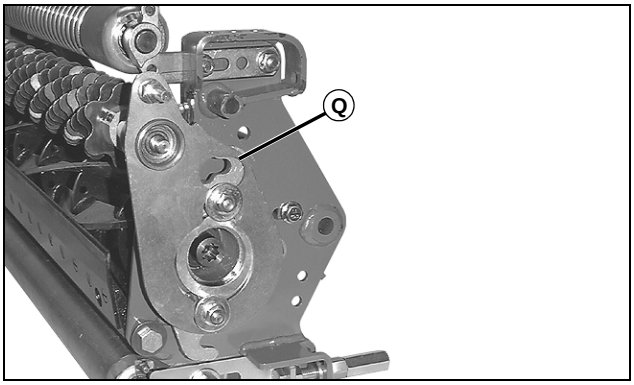
11.Rotate idler gear bracket (N) down to engage the main drive gear (M).

NOTE: There are two bearings and one washer in each arm bearing housing. If the washer is not centered in the housing, the shaft will not fit through both bearings. To hold the washers in position, lubricate each housing lubrication fitting using John Deere Special Purpose HD Water Resistant Grease, then center the washers. (See Specifications and Information section.)



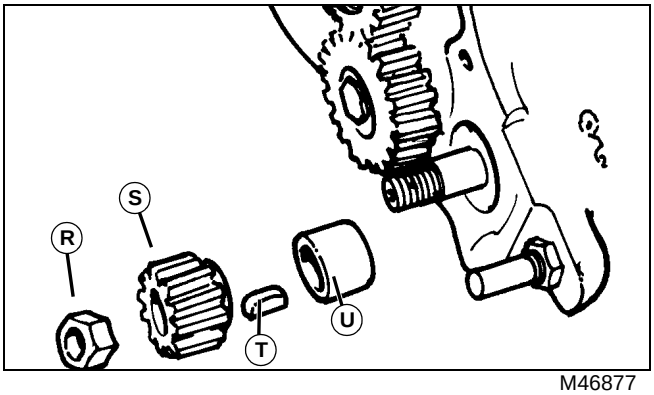
M98568

12.Slide the keyway end of the reel assembly (P) into the bearings in the FTC housing (O).



M98567

13.Install the bracket (Q).



M46877

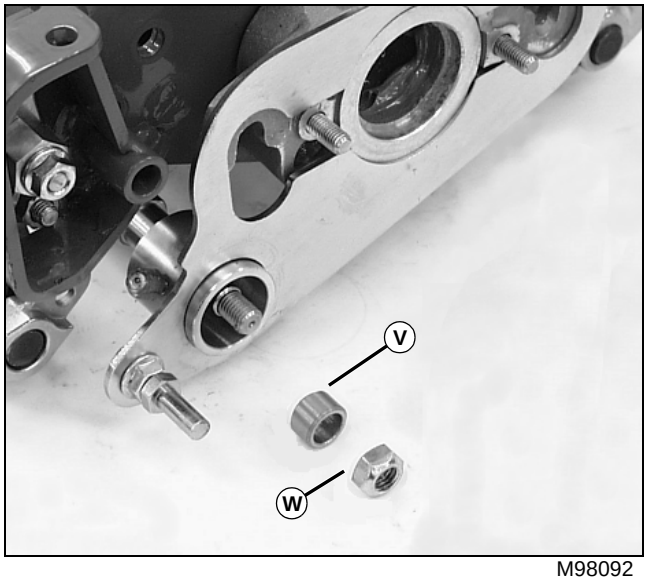
14.Slide large spacer (U) onto the FTC shaft (gear case assembly side).

15.Install key (T) in keyway slot.

16.Install gear (S) onto shaft.

NOTE: Tighten lock nut until there is no play of the conditioner shaft in the reel bearing housing. The shoulder of the shaft should be tight against the bearing.

17.Install and tighten the lock nut (R).

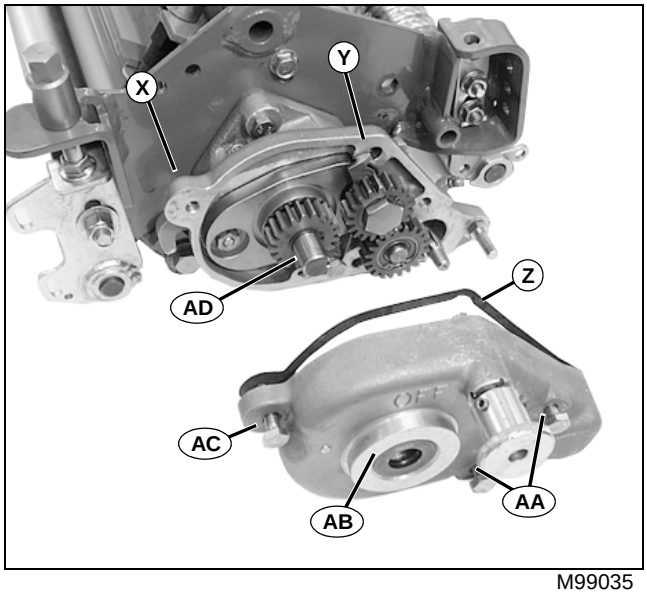


M98092

18.Install spacer (V) on conditioner shaft (bracket side).

NOTE: When properly tightened, the shoulder of the shaft and spacer should be against the bearings.

19.Install and tighten lock nut (W) against spacer.



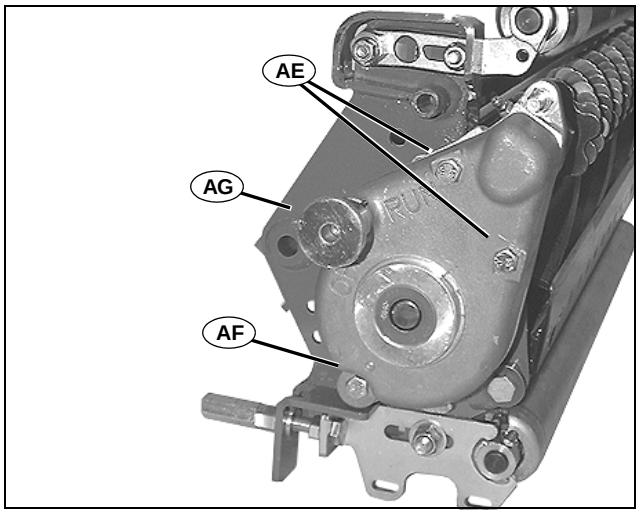
M99035

20.Fill gear case cover with approximately 240 mL (8 oz) of John Deere Corn Head Grease. (See Specifications and Information section.)

21.Apply a light coat of John Deere Corn Head Grease to the end of the drive shaft (AD).

22.Apply a light coat of John Deere Corn Head Grease to the area between the seal (AB) and bearing and to the engagement hole (Y).

23.Install a new gasket (Z) and gear case cover on the gear case assembly (X). Secure the cover using two M8 x 50 hex-flange bolts (AA) and one M8 x 30 hex bolt (AC). DO NOT tighten bolts at this time.

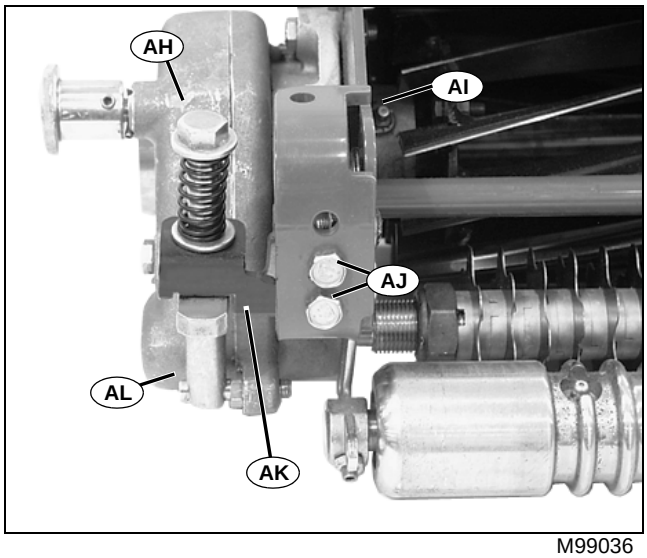


M98562

24.Turn engagement knob (AG) past the OFF position.

25.Tighten the M8 x 30 hex bolt (AF) first, then tighten the two M8 x 50 hex-flange bolts (AE).

26.Check engagement knob for free movement. If the knob does not move freely, remove and reinstall the cover.



M99036

27.Install adjuster assembly (AH) on the mounting bracket stud (AL).

NOTE: The alignment of the stop bracket and mounting holes used will determine the height of cut.

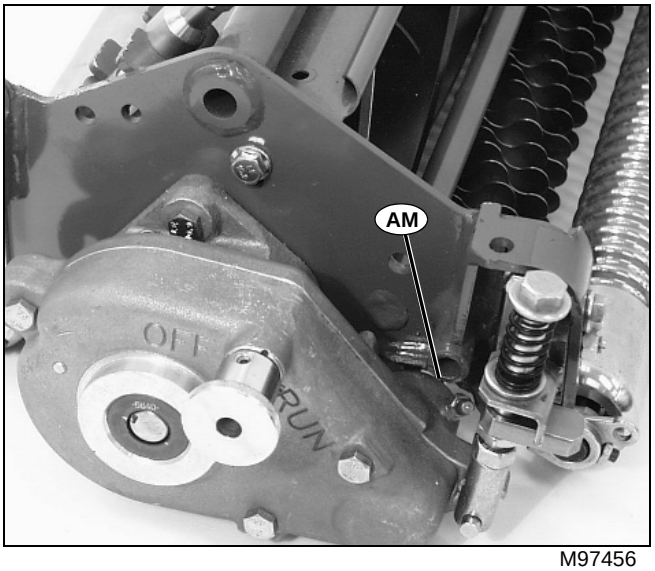
28.Secure the stop bracket (AK) to the cutting unit frame using two cap screws (AJ).

Height of Cut	Cutting Unit Frame Hole
0-12.70 mm (0-1/2 in.)	Top two holes
9.53-15.88 mm (3/8-5/8 in.)	Bottom two holes

29.Apply John Deere Corn Head Grease to the lubrication fittings (AJ) until grease begins to escape from the roller bearing vent plug.

30.Repeat steps 28 and 30 for adjuster assembly on the other side of the cutting unit.

31.Press down on the adjuster assembly bolt and swing the adjuster stop toward the front of the cutting unit on both sides of the cutting unit (engaged position).

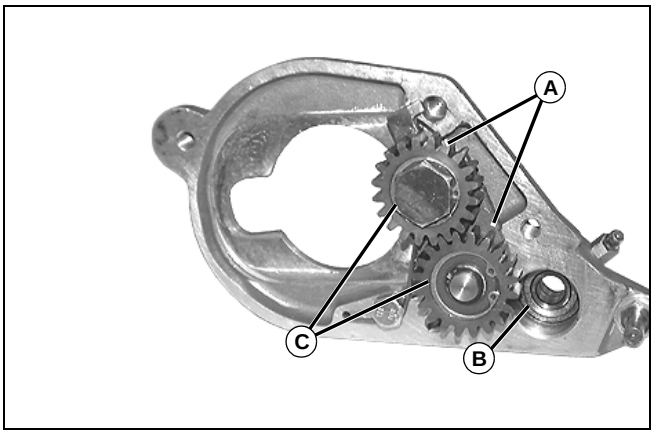


M97456

32.Apply John Deere Special Purpose HD Water Resistance Grease to the lubrication fittings (AM).

Disassemble and Inspect Fairway Tender Conditioner - 2500M

FTC Housing

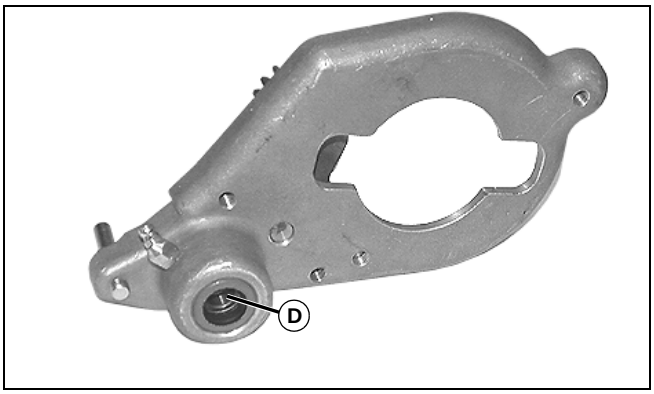


M98593

1. Inspect gears (A) for signs of wear or damage. Replace as needed.

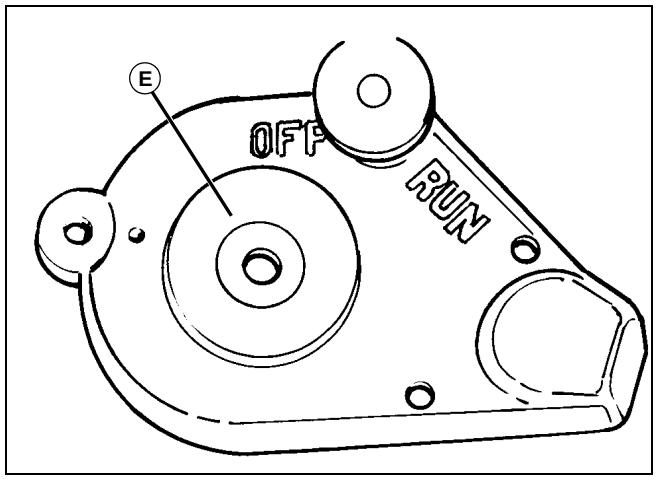
2. Inspect gear bearings (C) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.

3. Inspect reel shaft bearing (B) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.



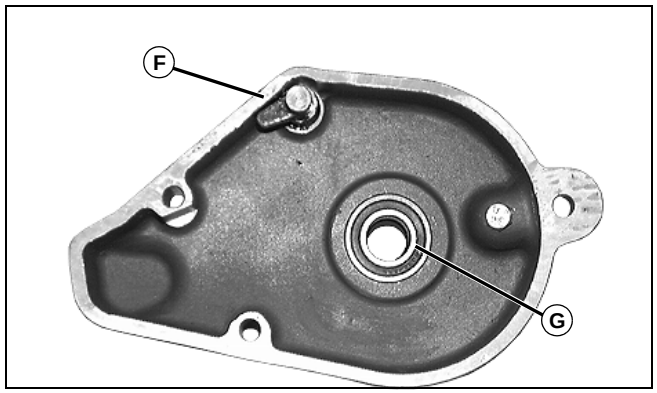
M98594

4. Inspect seal (D) for wear or damage. Replace bearing if it has excessive play or if it is noisy.



M46903

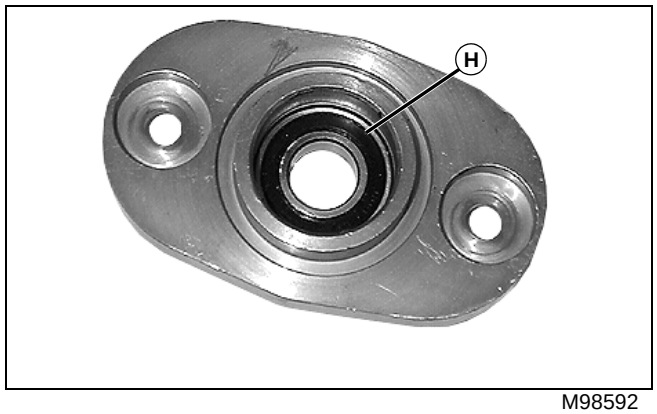
5. Inspect seal (E) in cover for wear or distortion. Replace seal as needed.



M98563

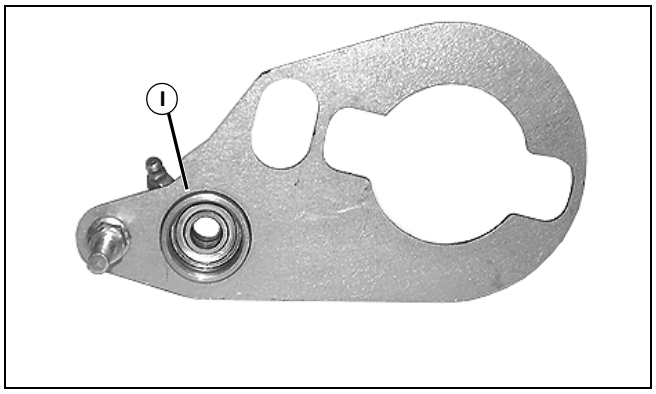
6. Inspect bearing (G) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.

7. Inspect engagement pawl and spring (F) for wear or damage. Replace as needed.



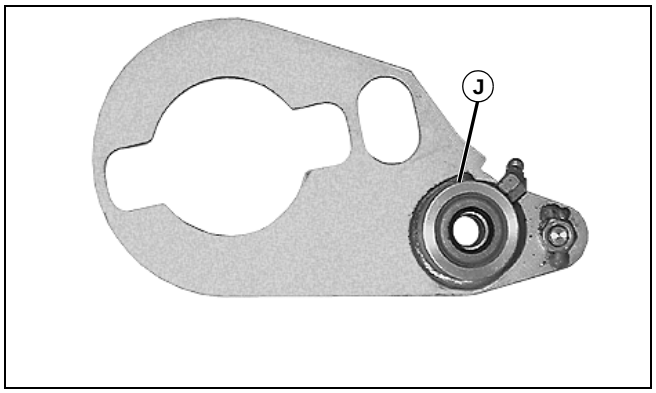
M98592

8. Inspect bearing (H) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.



M98599

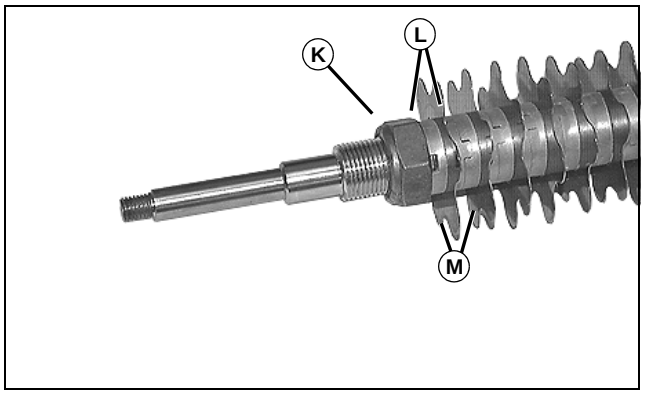
9. Inspect bearing (I) for free movement and excessive play. Replace bearing if it has excessive play or if it is noisy.



M98600

10.Inspect seal (J) in plate for wear or damage. Replace seal as needed.

FTC Shaft Assembly

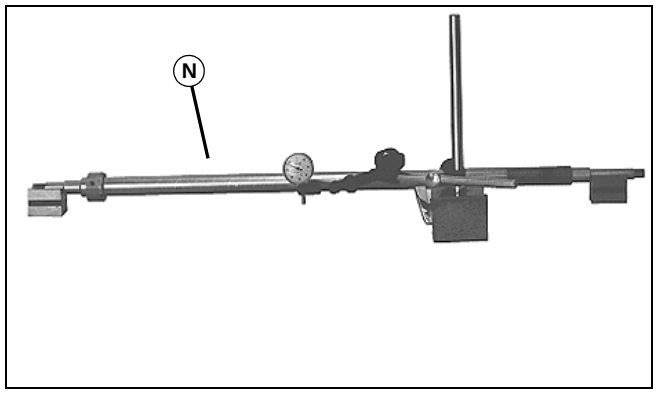


M98566

1. Remove lock nut (K).

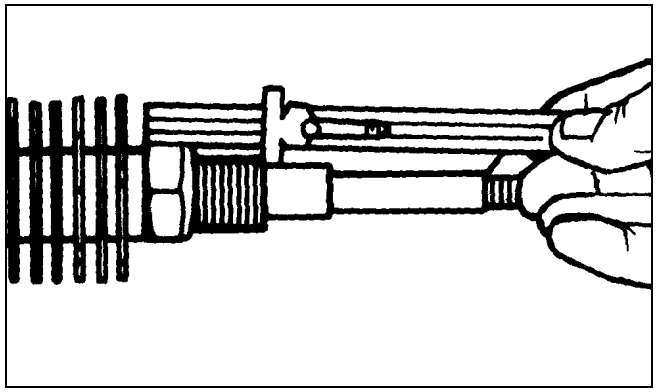
2. Remove blades (M) and index rings (L).

3. Inspect blades for excessive wear and broken, cracked or distorted cutting teeth. Replace parts as needed.



M46725

4. Remove debris and/or corrosion from shaft (N) and place on V-blocks. Check runout at the center of the shaft. Runout should not exceed 1.4 mm (0.0625 in.). Straighten or replace shaft as needed.



M46886

5. Install index rings and blades on shaft, rotating occasionally to align blades and index rings. Install all spacers and blades until approximately 38 mm (1.50 in.) of exposed thread is left.

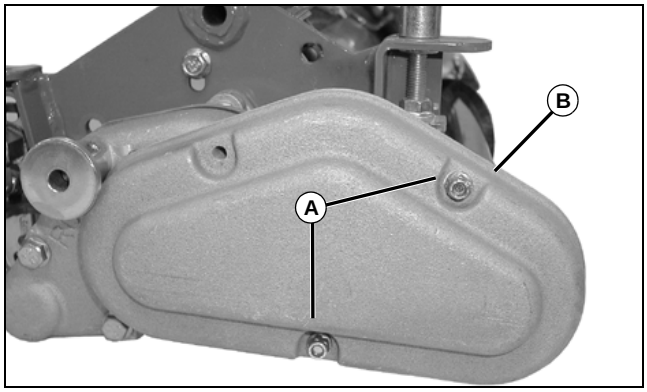
6. Stand the shaft on end and shake it slightly to ensure the blades and index rings are aligned.

7. Install locking nut and tighten to specifications.

Specifications

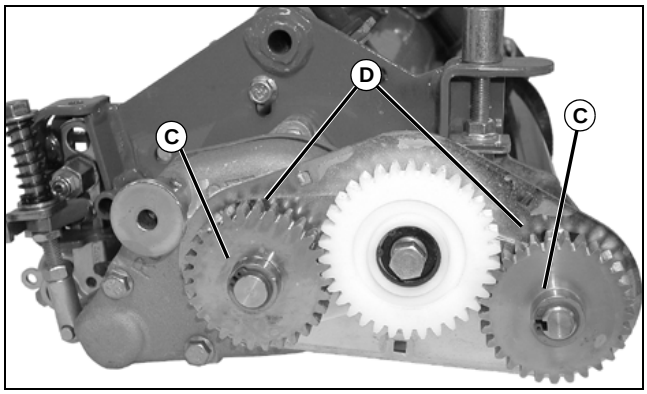
Locking Nut Torque . . . . . 47 N•m (35 lb-ft)

Remove Power Brush - 2500M



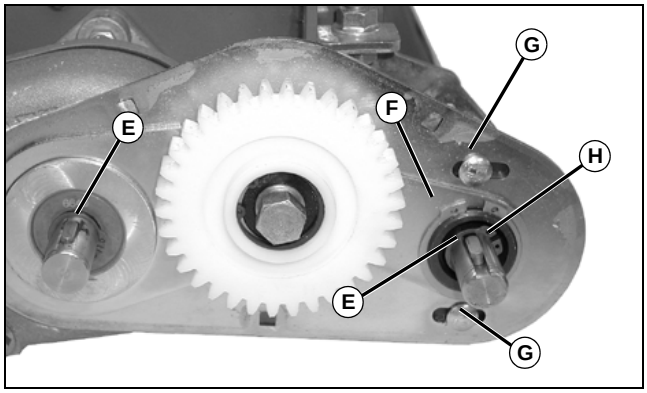
MX18345

1. Remove two carriage bolts and lock nuts (A).
2. Remove cover (B) and gasket.



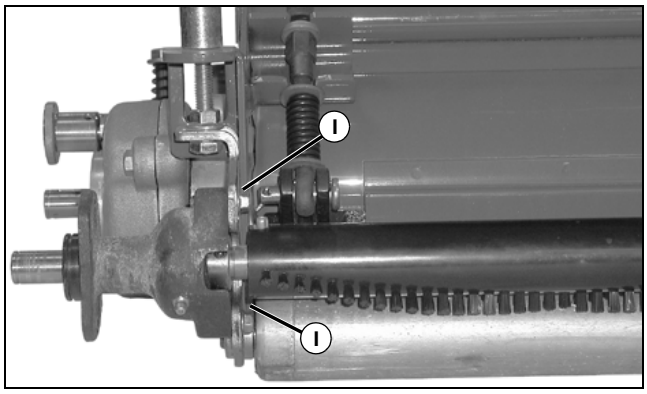
MX18346

3. Remove snap rings (C).
4. Remove gears (D).



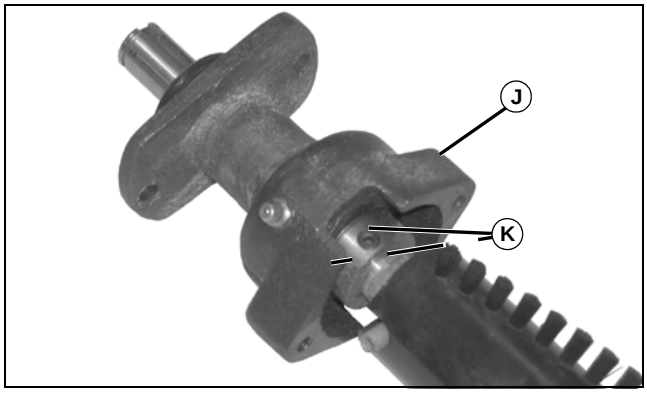
MX18347

5. Remove keys (E) and snap ring (H).
6. Remove two carriage bolts (G) and nuts.
7. Remove snap ring (F).
8. Remove gear plate from cutting unit with attached idler gear.



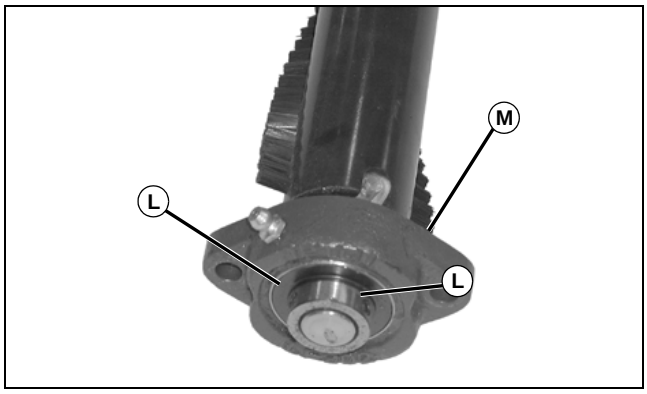
MX18348

9. Remove both cap screws (I) and remove two cap screws and nuts from opposite side of brush. Remove assembly from cutting unit.



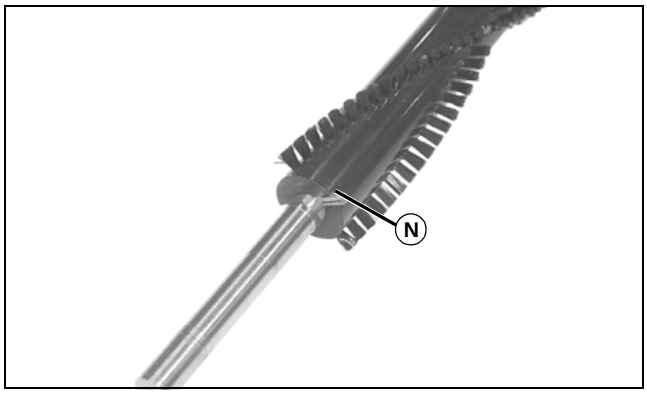
MX18349

10.Remove two set screws (K) and slide off drive housing (J).



MX18350

11.Loosen two set screws (L) and slide off bearing flange (M).

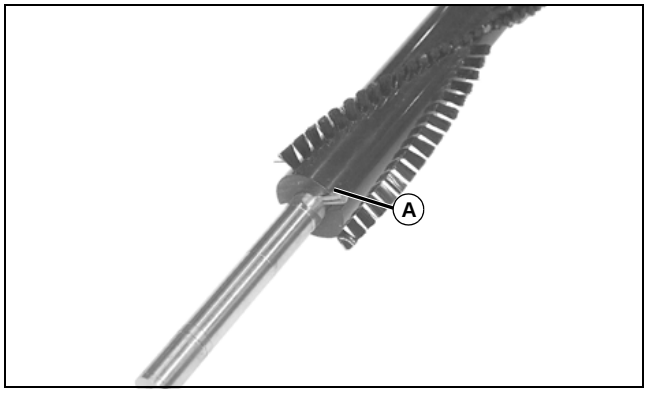


MX18318

12.Drive spring pin (N) from shaft using a punch.

13.Remove brush from shaft.

Install Power Brush - 2500M

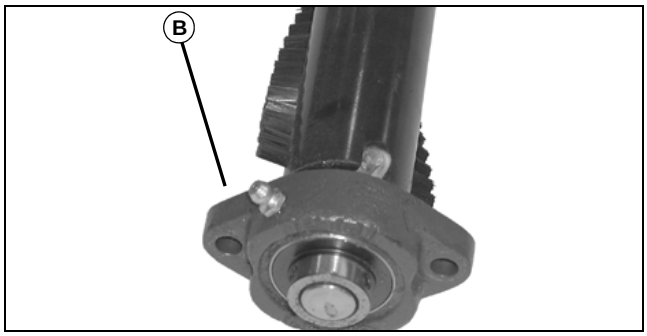


MX18318

1. Install brush on shaft.

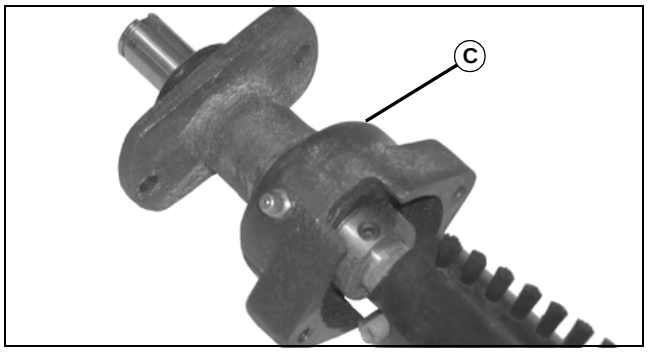
2. Install spring pin (A) to secure brush.

NOTE: The grease fittings will be more accessible for service if the drive housing and bearing flange are installed with the fittings to the rear of the unit.



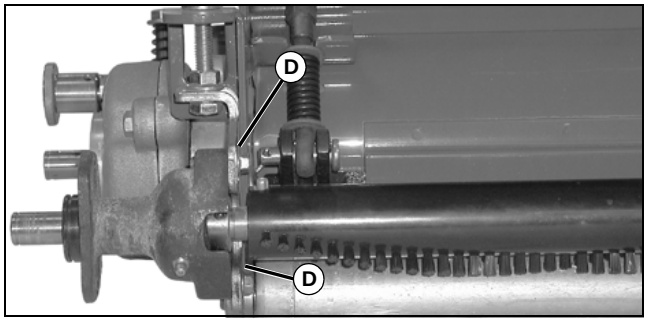
MX18350

3. Install bearing flange (B) to short shaft end of brush. Do not tighten set screws at this time.



MX18349

4. Install brush drive housing (C) on long end of brush. Do not tighten set screws at this time.



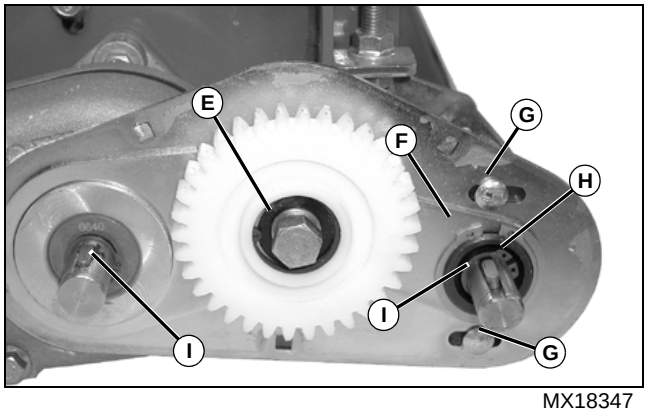
MX18348

5. Install brush assembly to cutting unit.

6. Install both cap screws (D) and two cap screws and nuts on opposite side of cutting unit, securing each bracket on cutting unit.

7. Adjust the brush to the roller with a clearance of 0-1 mm (0-0.031 in.) by raising or lowering brush. Tighten cap screws on both sides of cutting unit.

8. Position the brush between the housings so that the short end of the shaft is flush with the cast bearing. Apply thread locking compound and tighten the set screws in both bearings.



MX18347

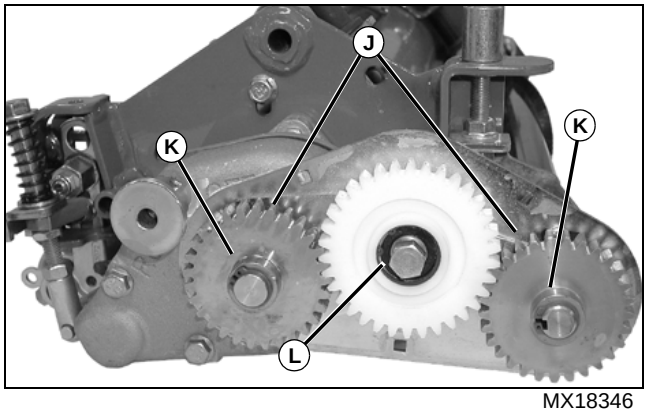
9. Loosen gear shaft bolt (E) before installing plate.

10.Install gear plate and snap ring (F).

11.Install two carriage bolts and nuts (G).

12.Install snap ring (H) on brush shaft.

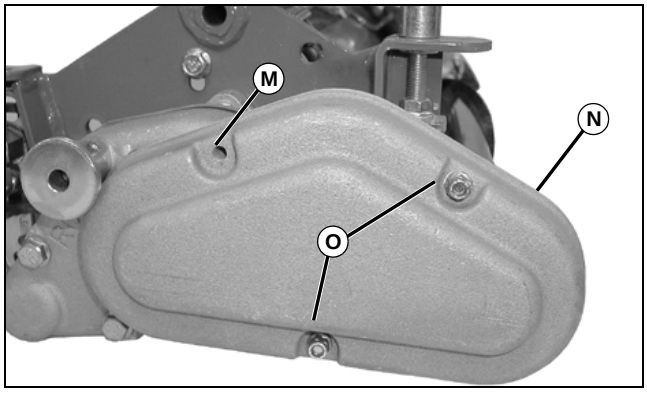
13.Install keys (I).



MX18346

14.Install gears (J) and snap rings (K).

15.Tighten gear shaft bolt (L).

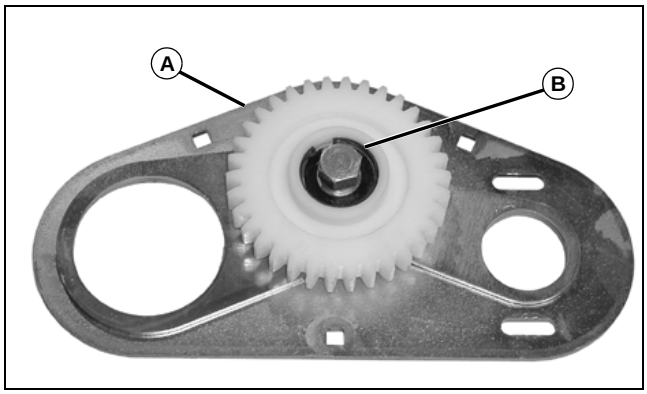


MX18345

16.Install gasket and cover (N).

17.Install two carriage bolts and lock nuts (O). Hole (M) is not used.

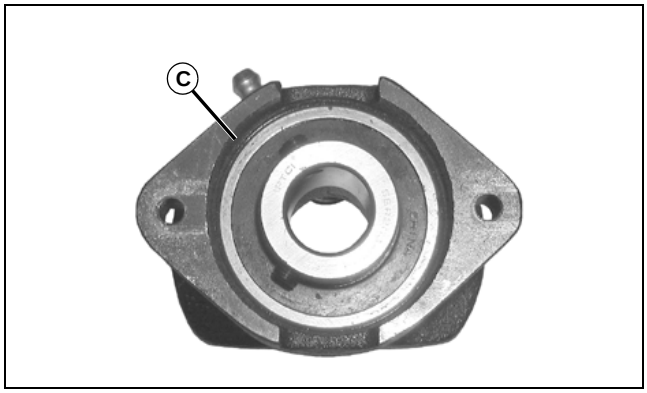
Disassemble and Inspect Power Brush - 2500M



MX18351

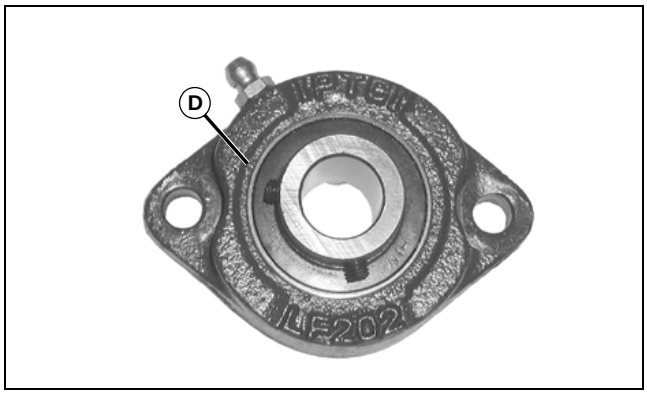
1. Inspect gear (A) for signs of wear or damage. Replace if needed.

2. Inspect bearing (B) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



MX18321

3. Inspect bearing (C) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.



MX18322

4. Inspect bearings (D) for free movement and excessive play. Replace bearing if it has excessive play or is noisy.

Remove and Install Vertical Cutting Unit - 2500M

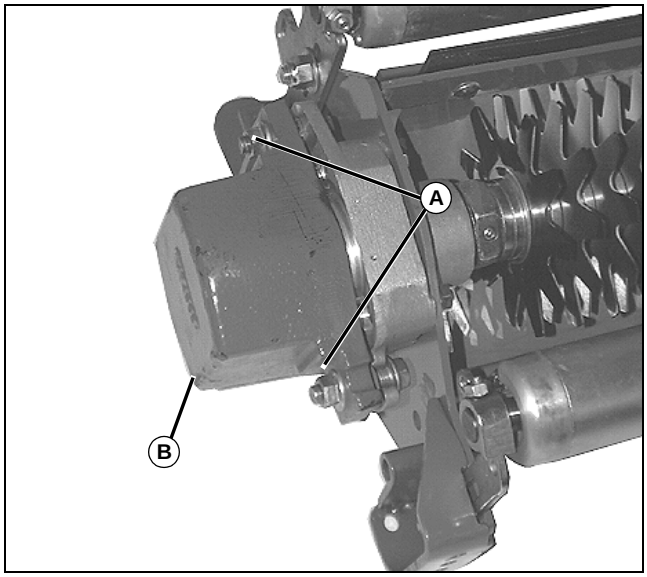
NOTE: Vertical cutting units are removed and installed in the same manner as reel mowers. (See "Remove and Install Cutting Unit - 2500M" on page 461.)

Remove Reel Assembly - Vertical Cutting Unit (2500M)

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.

1. Remove cutting units from mower.

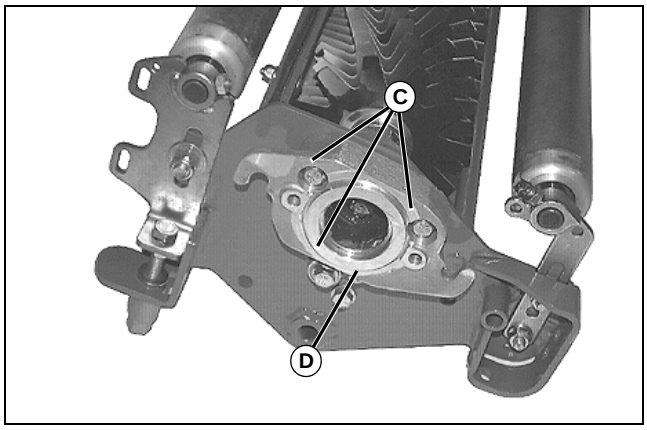
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



M98492

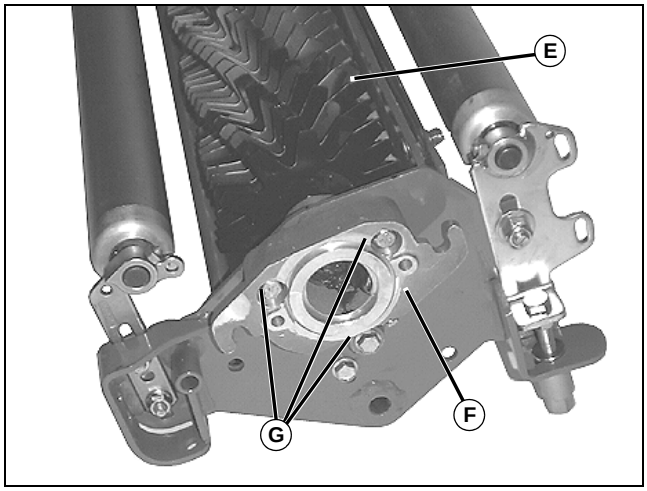
3. Loosen flange nuts (A).

4. Remove weight assembly (B).



M98493

5. Remove three cap screws and nuts (C).
6. Remove bearing housing (D).



M98494

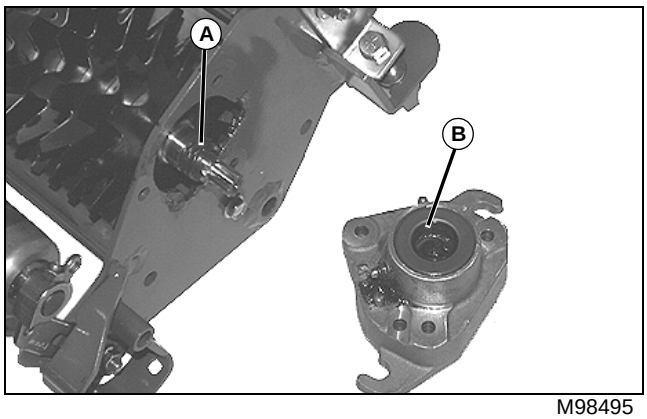
7. Remove three cap screws and nuts (G).
8. Remove reel assembly (E).

NOTE: Remove bearing housing only if repair is required.

9. Remove bearing housing (F).

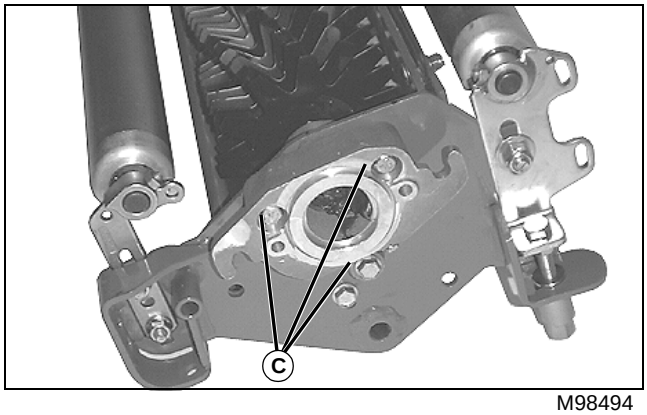
Install Reel Assembly - Vertical Cutting Unit (2500M)

1. Install reel assembly in housing with the shaft end with the keyway on the left side of the frame.



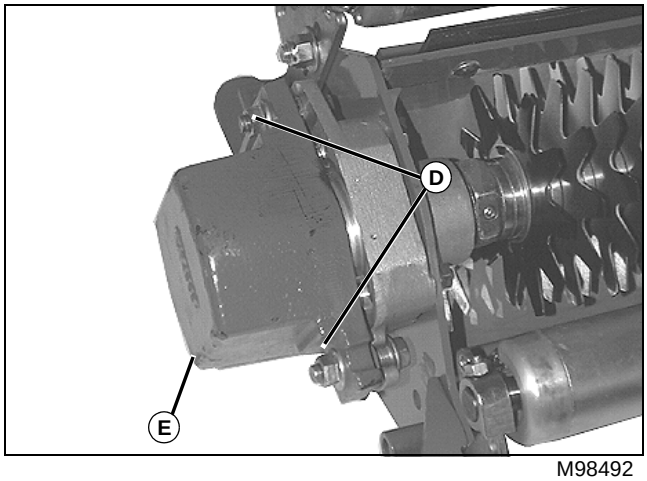
M98495

2. Align the tab (B) on the keyed washer with the keyway (A) on the reel shaft.
3. Install the bearing housing.



M98494

4. Install three cap screws and nuts (C).

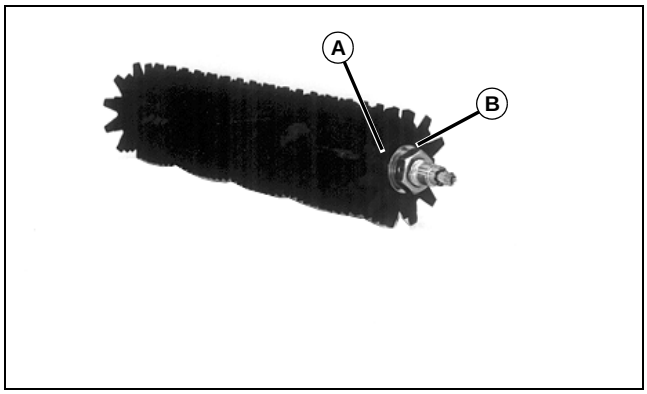


M98492

5. Install weight assembly (E).
6. Tighten flange nuts (D).

Disassemble and Inspect Reel Assembly - Vertical Cutting Unit (2500M)

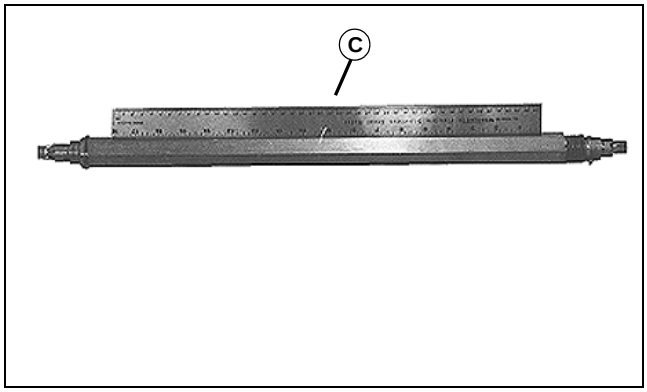
CAUTION: Avoid injury! Always wear gloves when handling reel or cutting blades. Serious personal injury can result from contact with sharp cutting edges.



M46740

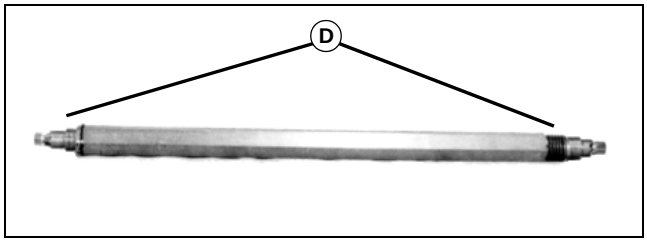
1. Remove set screw (A).

2. Remove nut (B) and remove cutting blades and spacers from reel shaft.



M46741

3. Using a straightedge (C), check shaft for straightness. Shaft runout should not exceed 0.50 mm (0.020 in.).

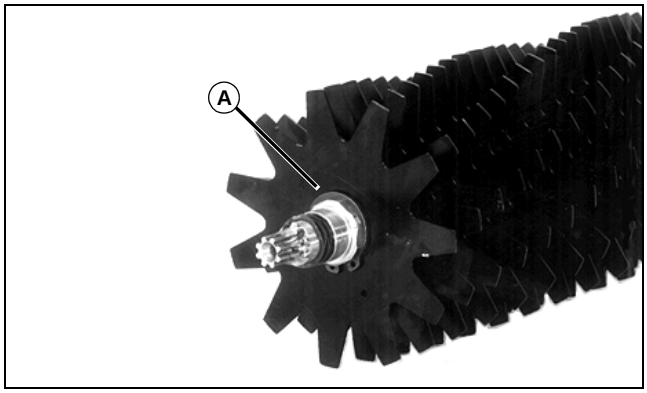


M46742

4. Inspect machined surfaces (D) of shaft for wear or damage. Replace shaft if needed.

Assemble Reel - Vertical Cutting Unit (2500M)

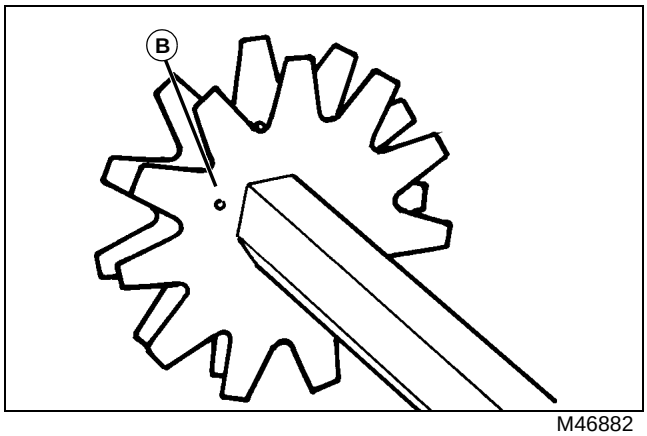
CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.



M46743

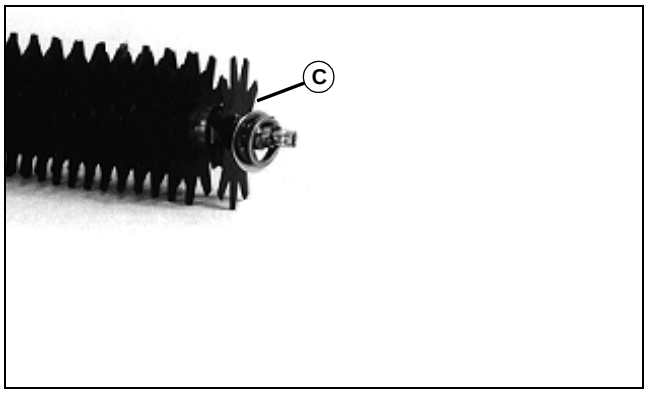
1. Install snap ring (A) in groove on shaft. (Sharp edge of snap ring facing away from the blades.)

NOTE: The cutting unit is shipped with three 6 mm (0.25 in.) spacers between each cutting blade. Fewer spacers and more blades can be used if desired.



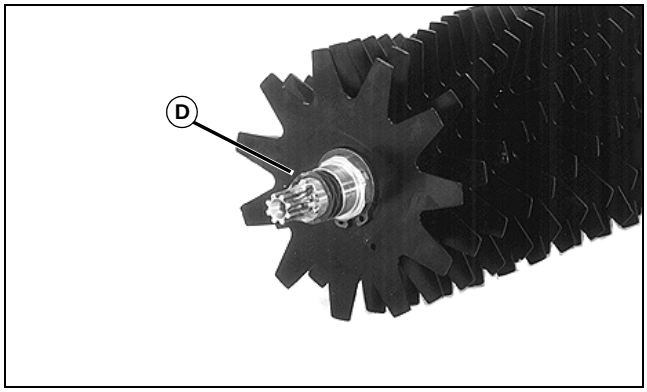
M46882

2. Assemble blades and spacers starting with a blade against the snap ring. Ensure that the index hole (B) of the next blade is placed on the next flat counterclockwise on the shaft as shown. This will establish the proper helix pattern.



M46745

3. After the last cutting blade is installed, install a washer, spacer (C) and nut. Tighten nut until a slight deflection of the cutting blade, next to the snap ring, is observed.

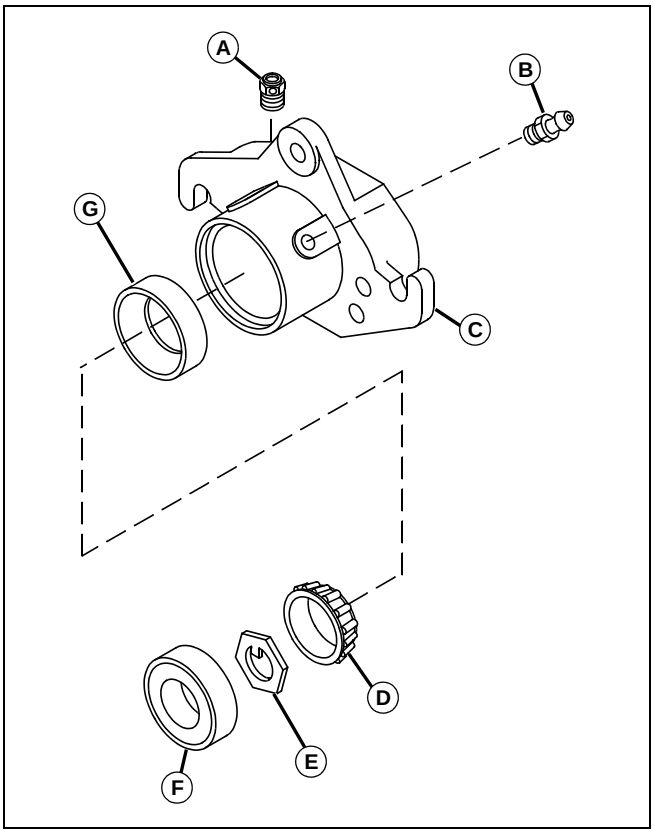


M46746

4. Install set screw (D).

Disassemble and Inspect Bearing Housing - Vertical Cutting Unit (2500M)

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

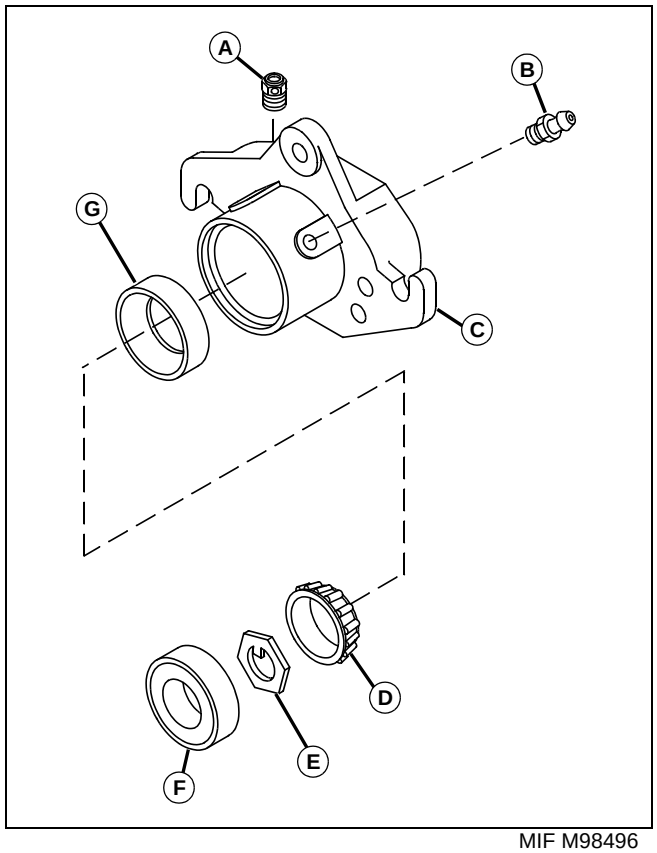
1. Remove seal (F), tapered roller bearing (D), keyed washer (E) (left side only) and bearing cup (G) from bearing housing (C).
2. Remove grease fitting (B) and breather (A).
3. Clean bearings and housing with solvent.

IMPORTANT: Avoid damage! Always replace bearings and bearing cups as a set.

4. Inspect bearings and bearing cups for scoring, pitting or bluing from overheating. Replace as needed.

Assemble Bearing Housing - Vertical Cutting Unit (2500M)

NOTE: LEFT or RIGHT positions are determined by standing at the rear of the unit and looking forward.



MIF M98496

1. Install bearing cup (G) into housing (C) using a suitable driver or a press (tapered end facing the outside of the housing).

2. Pack bearing (D) with John Deere special purpose golf and turf cutting unit grease and position in the bearing cups.

3. Install keyed washer (E) (left side only).

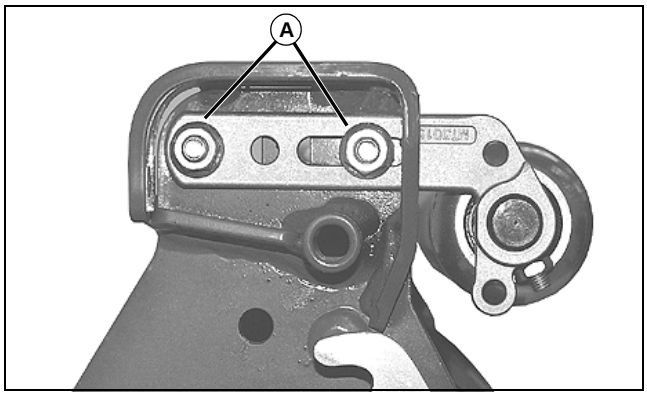
4. Install breather (A) and grease fitting (B).

5. Install seal (F) flush with the face of the housing. Apply John Deere special purpose golf and turf cutting unit grease to the seal lips.

Remove and Install Front Roller - Vertical Cutting Unit (2500M)

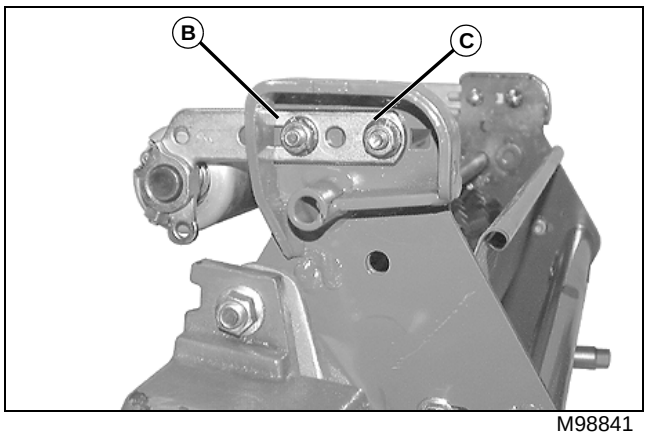
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



M84841

3. Remove two flanged nuts and carriage bolts (A).



M98841

4. Remove lower flanged nut and carriage bolt (B) from both sides.

5. Remove nut, serrated washer and carriage bolt (C) from both sides.

6. Remove roller and bracket assembly.

Installation is done in the reverse order of removal.

NOTE: DO NOT install set screws into the holes in the roller bearing shafts.

Roller brackets are offset. For standard use, the bracket should be installed on the roller with the offset to the rear of the cutting unit.

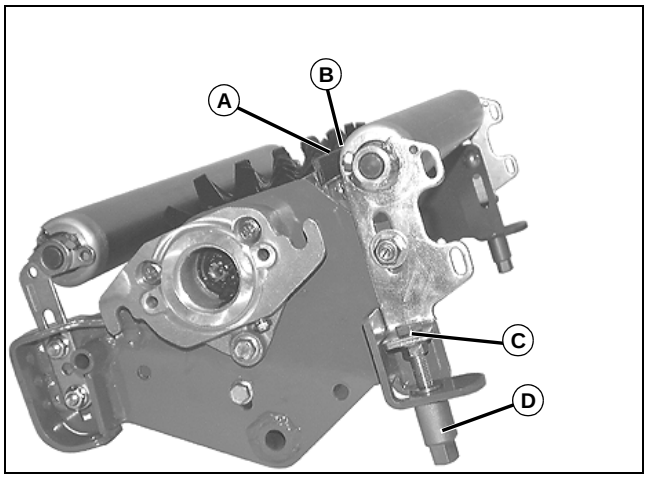
Install roller bracket with the larger holes and adjustment slot on the left side of the cutting unit, in the direction of travel.

• Adjust roller height. (See “Adjust Front Roller - 2500M” on page 432.)

Remove Rear Roller - Vertical Cutting Unit (2500M)

1. Remove cutting units from mower.

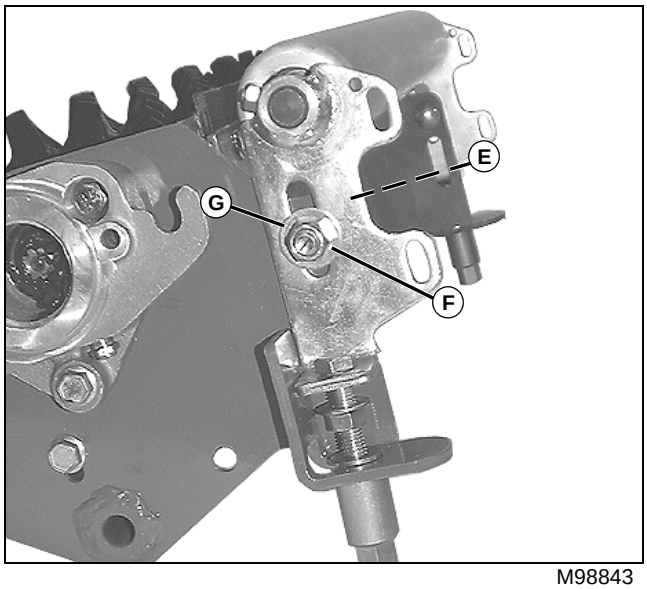
2. Place cutting unit upside-down on a stable working surface (rollers facing up).



M98842

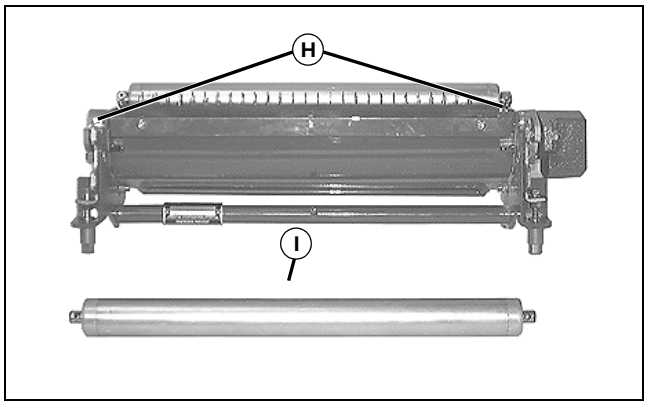
3. Loosen jam nut (B) and set screw (A) on both sides of cutting unit.

4. Loosen jam nut (C) on adjuster tower (D) on both sides of cutting unit.



M98843

5. Remove carriage bolt (E), flat washer (F) and lock nut (G) on both sides of cutting unit.

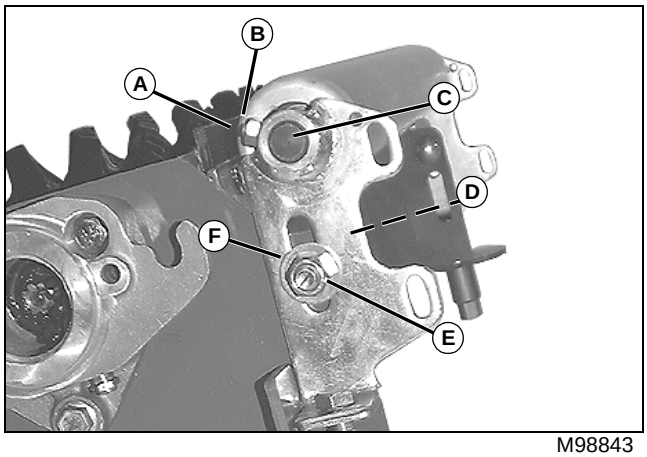


M98844

6. Move height-of-cut brackets (H) away from bearing spindle shaft ends.

7. Remove rear roller (I).

Install Rear Roller - Vertical Cutting Unit (2500M)



M98843

NOTE: DO NOT tighten roller shaft set screws and jam nuts at this time.

1. Install roller bearing spindle shaft (C) into height-of-cut brackets on both sides of machine.

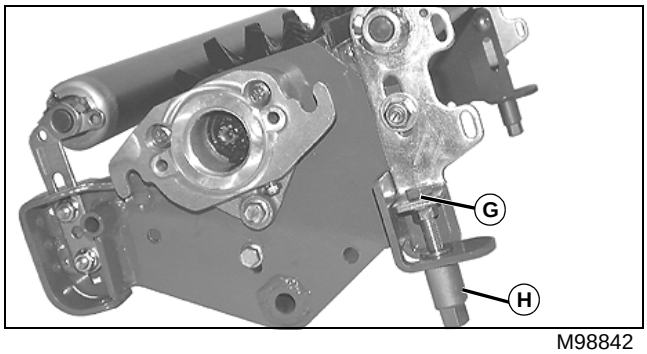
NOTE: Install carriage bolts with the flat washer and nut on the outside of the cutting unit.

2. Attach height-of-cut bracket to cutting unit frame using carriage bolt (D), flat washer (E) and lock nut (F) on both sides of cutting unit.

NOTE: DO NOT install set screws into holes in roller spindle shafts.

3. Center rear roller between height-of-cut brackets.

4. Tighten set screw (A) and jam nut (B) on both sides of cutting unit.



M98842

5. Loosen bracket lock nuts approximately 1/4 turn (both sides of cutting unit).

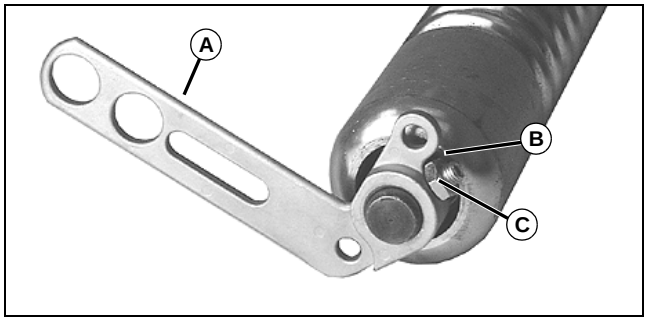
6. Tighten jam nut (G) on adjuster tower (H) on both sides of cutting unit.

7. Tighten bracket lock nuts (both sides of cutting unit).

8. Adjust cutting depth. (See “Adjust Depth-of-Cut - Vertical Cutting Units (2500M)” on page 437.)

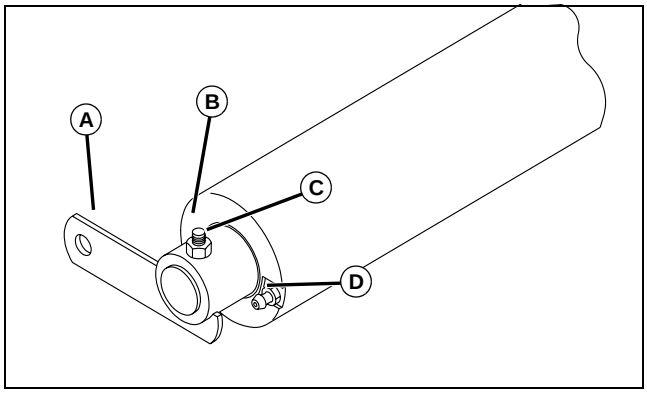
Replace Roller Bearing - Vertical Cutting Unit (2500M)

NOTE: This procedure applies to both smooth and grooved rollers.



M84840

Picture Note: Grooved Roller Shown



M83582

Picture Note: Smooth Roller Shown

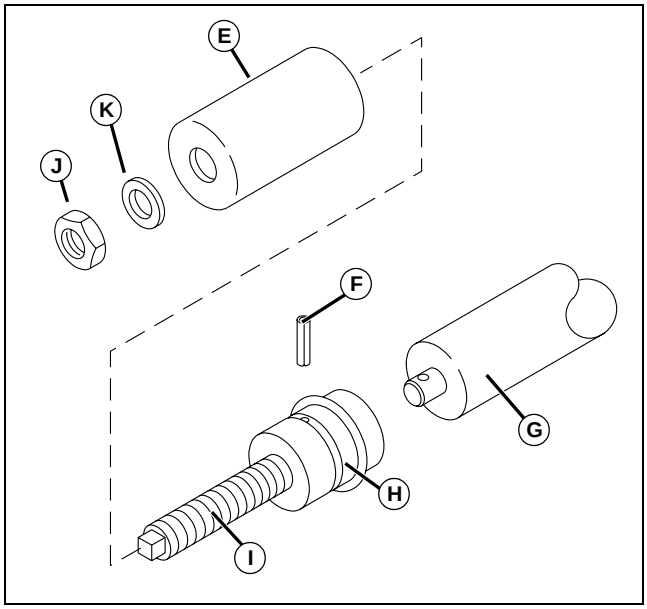
1. Loosen jam nut (C) and remove set screw (B).

NOTE: It may be necessary to press the bearing shaft from the bracket.

2. Remove bracket (A) from bearing shaft.

3. Remove grease fitting (D) (smooth rollers only).

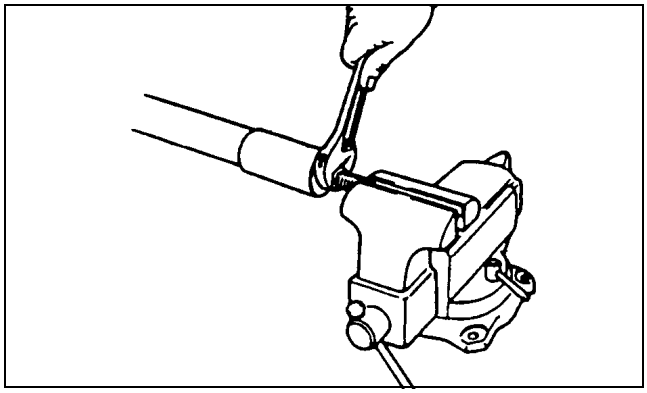
CAUTION: Avoid injury! Wear approved eye protection when using roller bearing puller.



M83583

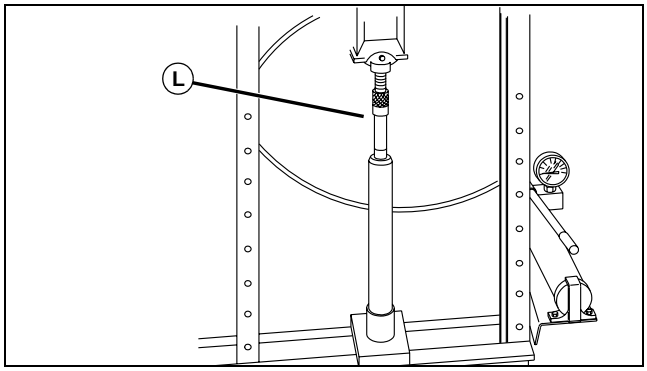
4. Attach threaded puller (I) to the bearing by inserting the pin (F) through the hole in the bearing shaft and puller. Slide the O-ring (H) over the pin to keep it in position.

5. Slide roller sleeve (E) over the threaded puller with the concave end of the roller sleeve against the end of the roller (G). Install flat washer (K) and nut (J) on threaded puller.


M83584

6. Clamp the hex end of the threaded puller in a vise or hold it with a wrench. Turn nut counterclockwise until the bearing is removed from the roller.

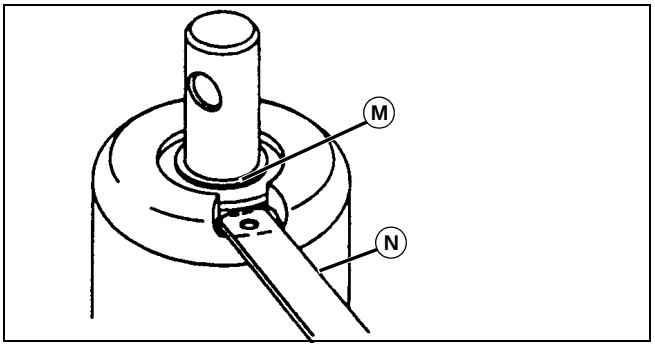
IMPORTANT: Avoid damage! DO NOT press on center shaft of bearing when installing bearing. Bearings will set and become tight. Bearings must only be installed by pressing on the outisde of bearing race.



M83586

7. Position roller in a press using the roller sleeve to hold the roller while installing the bearing in the other end.

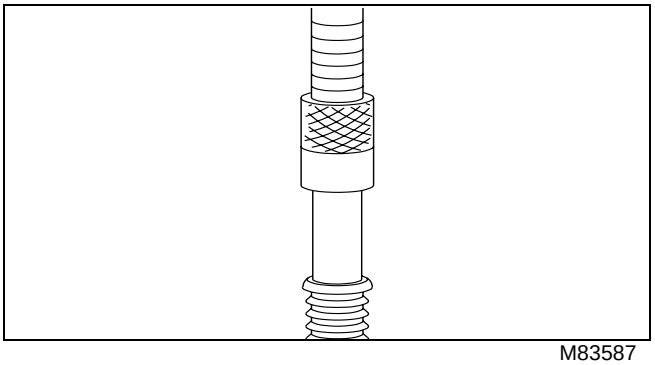
8. Position JD243 or JD506 Bearing Installer (L) over the new bearing in the top end of the roller.



M83585

9. Smooth Rollers: Place a 0.89 mm (0.035 in.) feeler gauge (N) in the slot where the grease fitting was located. Press the bearing into the roller until the top of the outside bearing race (M) is flush with the top of the feeler gauge.

10.Install the grease fitting.



M83587

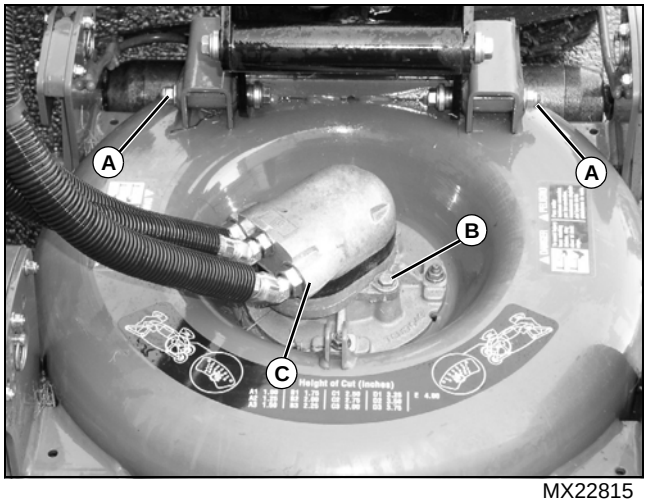
11.Grooved Rollers: Press bearing into roller until the top of the outside bearing is flush with the end of the roller.

Remove and Install Cutting Units (IRS)

Remove

1. Park machine safely. See “Parking Safely” in the SAFETY section.

2. Lower mower deck to the ground.



MX22815

3. Remove both cap screws and lock nuts (A).

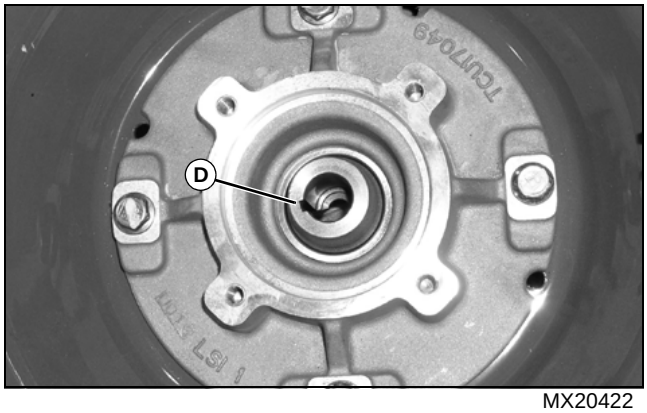
4. Remove blade.

5. Remove two cap screws (B) and remove hydraulic motor (C) from cutting unit.

6. Slide deck forward away from mower.

Install

Installation is performed in reverse order of removal.



MX20422

- Ensure key on motor is properly aligned with keyway (D) on blade adapter.
- Tighten blade cap screw to specification.

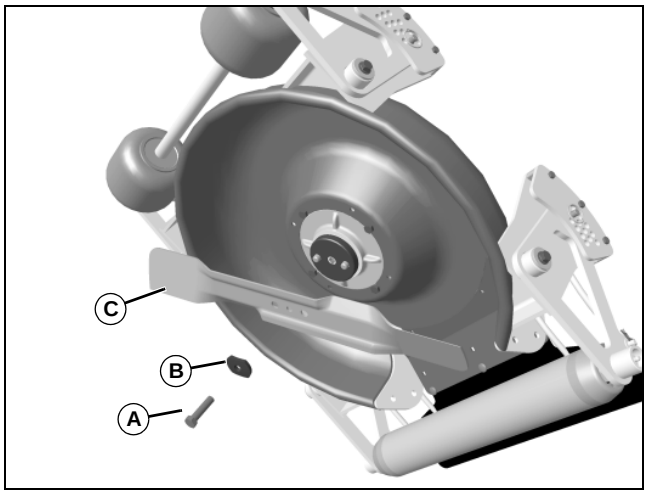
Specifications

Rotary Deck Blade Cap Screw
Torque . . . . . 47.5 N•m (35 lb-ft)

Remove and Install Blades (IRS)

Remove

1. Stop machine on a level surface.
2. Lock park brake.
3. Raise mower decks completely.
4. Stop engine and remove the key.
5. Insert a wooden block between end of blade and edge of deck to prevent blade from turning while removing attaching hardware.



MX17929

6. Remove cap screw (A), washer (B) and blade (C) by turning the cap screw counterclockwise.
7. Inspect the blades for damage. Replace all damaged blades.
8. Sharpen and balance all blades.

Install

Installation is performed in reverse order of removal.

- Tighten blade cap screw to specification.

Specifications

Rotary Deck Blade Cap Screw Torque . 47.5 N•m (35 lb-ft)

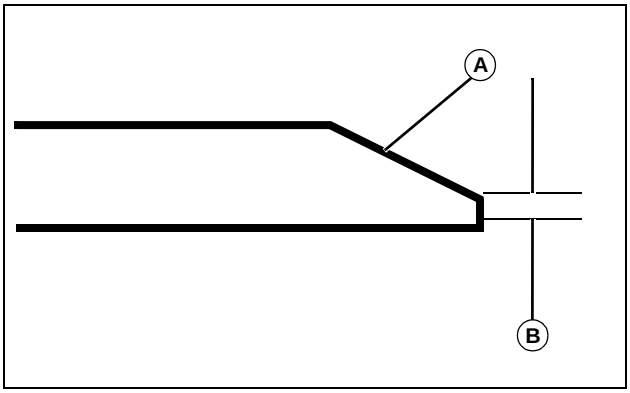
Sharpen Blades

CAUTION: Avoid injury! Mower blades are dangerous!

1. Always wear gloves while working on blades.

2. Always wear safety eye protection when grinding.

- Sharpen blades with grinder, hand file, or electric blade sharpener.



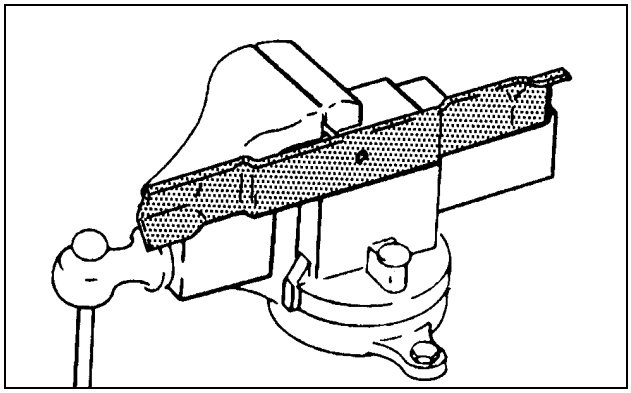
MIF

- Keep original bevel (A) when grinding.
- Blade should have 0.40 mm (1/64 in.) cutting edge (B) or less.
- Balance blades before installing.

Balance Blades

CAUTION: Avoid injury! Mower blades are sharp. Always wear gloves when handling mower blades or working near blades.

1. Clean blade.



M61524

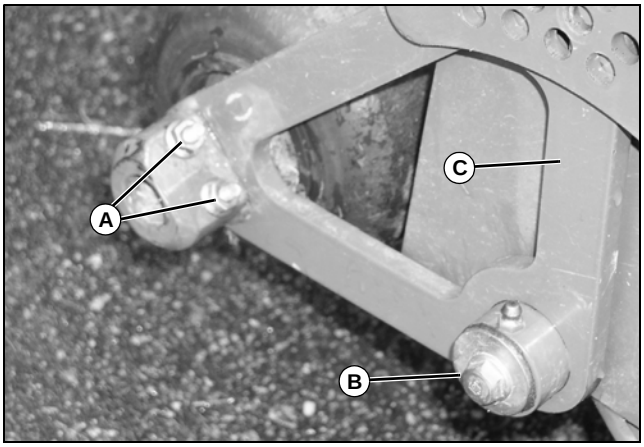
2. Put blade on nail in a vise. Turn blade to horizontal position.

3. Check balance. If blade is not balanced, heavy end of blade will drop.

4. Grind bevel of heavy end. Do not change blade bevel.

Remove and Install Front Rollers

NOTE: This prodedure can be done with mower deck installed on machine or removed.



MX22816

1. Remove height adjusting pins on both sides of mower deck and allow assembly to swing free of adjusters.

2. Remove nuts and u-bolt (A).

3. Remove cap screw and washer (B).

4. Remove bracket (C).

5. Remove shaft and roller assembly from the remaining bracket.

6. Repair as necessary.

7. Installation is done in the reverse of removal.

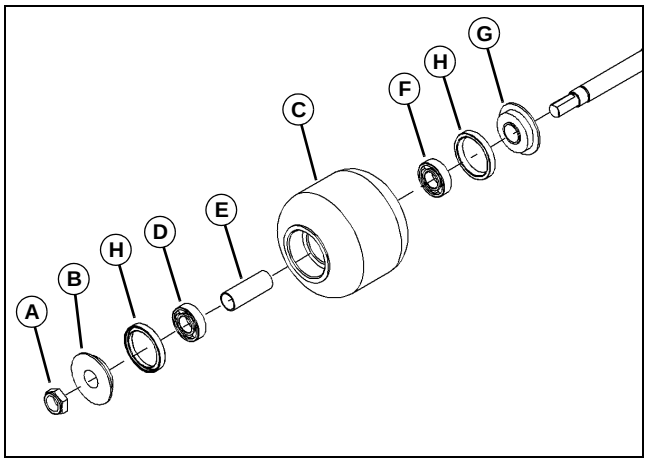
   • Center the rollers between the brackets before tightening u-bolts.

   • Lubricate pivot points.

   • Adjust roller height. (See “Adjust Rotary Cutting Units (IRS)” on page 438.)

Repair Front Roller Assembly

1. Remove front roller assembly from mower deck. (See “Remove and Install Front Rollers” on page 488.)



MX20386

2. Remove lock nut (A) from each end of shaft.

3. Remove outer plate (B), roller (C) and outer bearing (D).

4. Remove spacer (E), inner bearing (F) and inner plate (G).

5. Repeat for opposite end.

6. Remove seals (H) from both sides of roller.

7. Inspect all parts and replace as necessary.

8. Assembly is done in the reverse of disassembly.

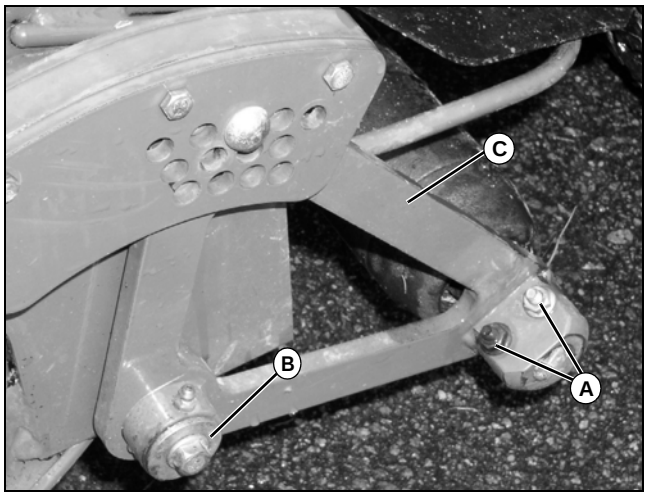
   • Install roller with the deepest recess facing the end of the shaft.

NOTE: Spacers (B and G) must remain stationary thus forcing the inner seals to rotate.

   • Tighten lock nut enough to keep the outer spacers (B and G) from spinning.

Remove and Install Rear Roller

NOTE: This prodedure can be done with mower deck installed on machine or removed.



MX20406

1. Remove height adjusting pins on both sides of mower deck and allow assembly to swing free of adjusters.
2. Remove nuts and u-bolt (A) on both ends of roller shaft.
3. Remove cap screw and washer (B) from either side of deck. Remove bracket (C).
4. Remove shaft and roller assembly from the remaining bracket.
5. Repair as necessary.
6. Installation is done in the reverse of removal.
   - Center the roller between the brackets before tightening u-bolts.
   - Lubricate pivot points.
   - Adjust roller height. (See “Adjust Rotary Cutting Units (IRS)” on page 438.)

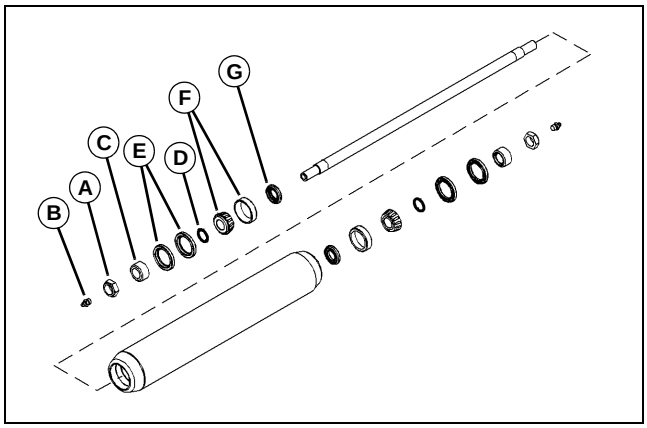
Repair Rear Roller Assembly

Other Material

Part No.	Part Name	Part Use
TY25083	John Deere Golf And Turf Cutting Unit Grease	Used to lubricate roller bearings and seals.

Disassembly

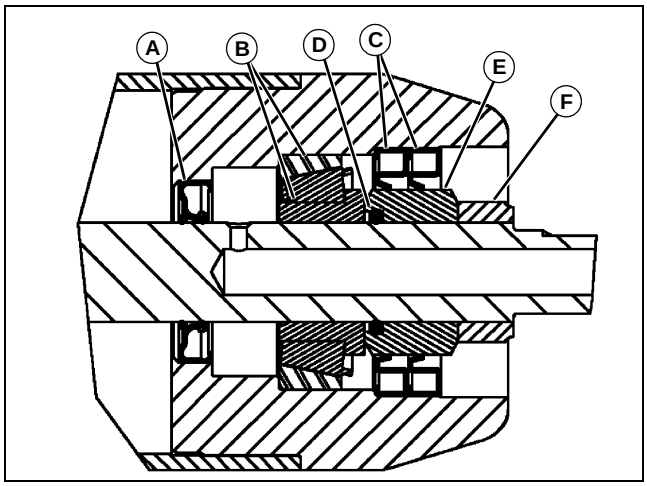
1. Remove rear roller assembly from mower deck. (See “Remove and Install Rear Roller” on page 489.)



MX20405

2. Remove lock nut (A) from both ends of shaft.
3. Remove grease fittings (B) from each end of shaft.
4. Push shaft through roller to remove.
5. If spacer (C) and O-ring (D) did 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



MX20407

1. Install inner seal (A) with lip facing out.
2. Pack bearing (B) with TY25083 Golf and Turf Cutting Unit Grease. Install bearing.

IMPORTANT: Avoid damage! Install outer seals with lips facing out.

3. Press outer seals (C) into place. Apply TY25083 Golf and Turf Cutting Unit Grease between lips of outer seals.

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 (E). Apply a light coat of grease to bore of spacer and install with O-ring next to bearing.

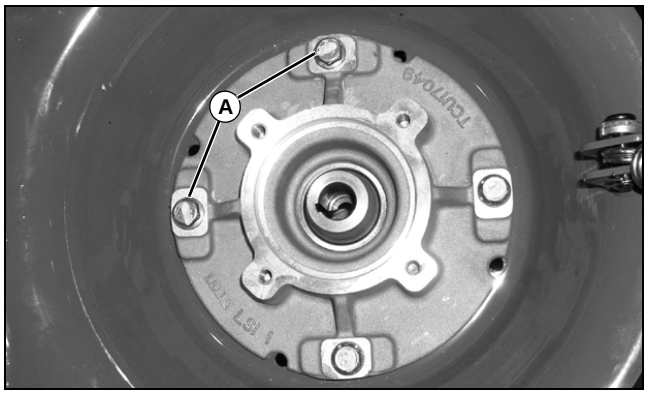
6. Repeat for opposite end of roller.

7. Install both lock nuts (F) and tighten until end play is gone, yet roller rotates freely.

8. Install roller assembly onto mower deck. (See “Remove and Install Rear Roller” on page 489.)

Remove and Install Spindle Housing

1. Remove cutting unit. (See “Remove and Install Cutting Units (IRS)” on page 486.)



MX20422

2. Remove four cap screws (A) and remove spindle housing from deck shell.

3. Installation is done in the reverse of removal.

- Tighten spindle housing cap screws to specification.

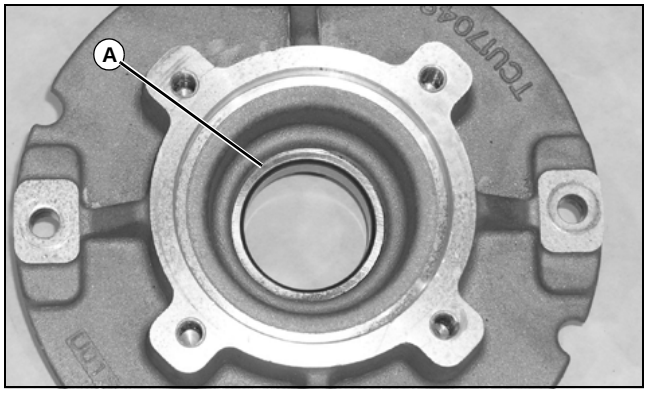
Specifictions

Spindle Housing Cap Screws . . . . . 24 N•m (18 lb-ft)

Repair Spindle

1. Remove spindle housing.(See “Remove and Install Spindle Housing” on page 490.)

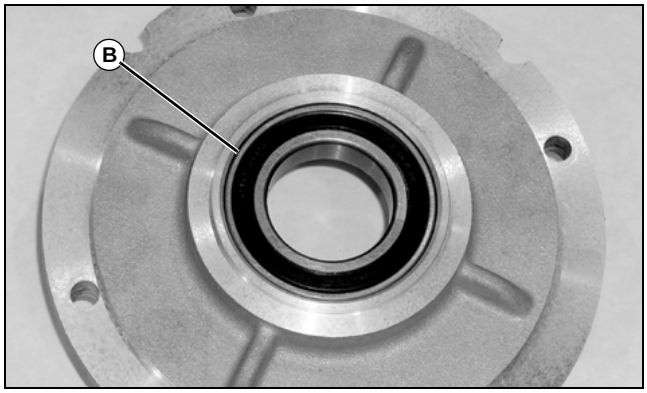
IMPORTANT: Avoid damage! You must press on inner race of bearing to remove from housing. Pressing on inner race damages bearing and it must be replaced.



MX20423

2. Support spindle housing in a press.

3. Using a bearing or bushing driver of the apropriate size, press on inner race (A) of bearing and remove bearing from housing. Dis card bearing.



MX20424

4. Using a bearing and bushing driver of the appropriate size, press bearing into housing, pressing only on the outer race (B) of bearing, until bearing bottoms out in housing.

5. Install spindle housing. (See “Remove and Install Spindle Housing” on page 490.)

INDEX

Numerics

A

B

C

INDEX

D

E

F

G

H

I

J

L

M

O

P

R

S

T

U

V

W